CARIBBEAN EXAMINATIONS COUNCIL

# CSEC®
# Physics

SYLLABUS
SPECIMEN PAPER
MARK SCHEME
SUBJECT REPORTS

Macmillan Education Ltd
4 Crinan Street, London, N1 9XW
A division of Springer Nature Limited
Companies and representatives throughout the world

www.macmillan-caribbean.com

ISBN 978-0-230-48229-6

www.cxc.org
www.cxc-store.com



First published 2014
This revised edition published 2020



Designed by Macmillan Education Limited
Cover design by Macmillan Education Limited and Red Giraffe

**CSEC® Physics Free Resources**

## LIST OF CONTENTS

**Physics Syllabus Extract**

Physics is a science that deals with matter and energy and their interactions. It is concerned with systems, laws, models, principles and theories that explain the physical behaviour of our world and the universe. Physics is regarded as a fundamental scientific discipline since all advances in technology can be traced either directly or indirectly to the physical laws and theories.

The CSEC Physics syllabus is redesigned with a greater emphasis on the application of scientific concepts and principles. Such an approach is adopted in order to develop those long-term transferrable skills of ethical conduct, team work, problem solving, critical thinking, innovation and communication. In addition, it encourages the use of various teaching and learning strategies to inculcate these skills while, at the same time catering to multiple intelligences and different learning styles and needs. The syllabus will assist students to develop positive values and attitudes towards the physical components of the environment and will also provide a sound foundation for those who wish to pursue further studies in science.

The syllabus is arranged in five sections, namely:

- Section A Mechanics
- Section B Thermal Physics and Kinetic Theory
- Section C Waves and Optics
- Section D Electricity and Magnetism
- Section E The Physics of the Atom

# CARIBBEAN EXAMINATIONS COUNCIL

**Caribbean Secondary Education Certificate®**
**CSEC®**

# PHYSICS SYLLABUS

**Effective for examinations from May–June 2015**

Published by the Caribbean Examinations Council.



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# Content

This document CXC 22/G/SYLL 13 replaces CXC 22/G/SYLL 02 issued in 2002.

Please note that the syllabus has been revised and amendments are indicated by italics.

First published 1983

Reprinted with amendments 1986, 1987
Revised 1991, 1996, 2002, 2013

Please check the website www.cxc.org for updates on CXC's syllabuses.

# Physics Syllabus

## ♦ RATIONALE

*The application of scientific principles and the conduct of relevant research are of significant importance in identifying, assessing and realising the potential of the resources of Caribbean territories. A good foundation in the sciences will enhance the ability of our citizens to respond to the challenges of a rapidly changing world using the scientific approach.*

*Physics is a science that deals with matter and energy and their interactions. It is concerned with systems, laws, models, principles and theories that explain the physical behaviour of our world and the universe. Physics is regarded as a fundamental scientific discipline since all advances in technology can be traced either directly or indirectly to the physical laws and theories.*

*The CSEC Physics Syllabus is redesigned with a greater emphasis on the application of scientific concepts and principles. Such an approach is adopted in order to develop those long-term transferrable skills of ethical conduct, team work, problem solving, critical thinking, innovation and communication. In addition, it encourages the use of various teaching and learning strategies to inculcate these skills while, at the same time catering to multiple intelligences and different learning styles and needs. The syllabus will assist students to develop positive values and attitudes towards the physical components of the environment and will also provide a sound foundation for those who wish to pursue further studies in science.*

*It contributes to the development of the Ideal Caribbean Person as articulated by the CARICOM Heads of Government in the following areas: respect for human life; and awareness of the importance of living in harmony with the environment; demonstrates multiple literacies; independent and critical thinking and the innovative application of science and technology to problem solving. Such a person should demonstrate a positive work ethic and value and display creative imagination and entrepreneurship. In keeping with the UNESCO Pillars of Learning, on completion of the study of this course, students will learn to do, learn to be and learn to transform themselves and society.*

## ♦ AIMS

This syllabus aims to:

1. *acquire technical and scientific vocabulary;*

2. *develop the ability to apply an understanding of the principles and concepts involved in Physics to situations which may or may not be familiar;*

3. *appreciate the contributions of some of the outstanding regional and international scientists to the development of Physics;*

4. *develop critical thinking and problem solving skills;*

5. *plan, design and perform experiments to test theories and hypotheses;*

6. *collect and represent data in an acceptable form;*

7. *report accurately and concisely;*

8. *develop the ability to appraise information critically, identify patterns, cause and effect, stability and change, and evaluate ideas;*

9. *develop the ability to work independently and collaboratively with others when necessary;*

10. *appreciate the significance and limitations of science in relation to social and economic development;*

11. *develop an awareness of the applications of scientific knowledge and a concern about the consequences of such applications, particularly the impact on the environment;*

12. *integrate Information and Communication Technology (ICT) tools and skills.*

## ♦ CANDIDATE POPULATION

The syllabus is designed for students intending to pursue further studies in science at the tertiary level as well as students whose formal study of the subject is unlikely to proceed further.

### CANDIDATE REQUIREMENTS

1. Candidates should have been exposed to at least three years of science at the secondary level, which should provide an introduction to basic scientific principles.

2. Candidates should be concurrently studying or have done:

    (a) CSEC Mathematics or its equivalent;

    (b) CSEC English A (English Language) or its equivalent.

### CLASS SIZE

It is recommended that practical classes accommodate approximately **twenty-*five*** candidates.

## ♦ SUGGESTED TIME-TABLE ALLOCATION

It is recommended that a minimum of five 40-minute periods per week, including one double period, be allocated to the subject over a two-year period.

## ♦ ORGANISATION OF THE SYLLABUS

The syllabus is arranged in *five* sections, namely:

| | | |
|---|---|---|
| SECTION A | - | Mechanics |
| SECTION B | - | Thermal Physics and Kinetic Theory |
| SECTION C | - | Waves and Optics |
| SECTION D | - | Electricity and Magnetism |
| SECTION E | - | The Physics of the Atom |

## ♦ SUGGESTIONS FOR TEACHING THE SYLLABUS

*It is recommended that Section A be taught first.*

*The organisation of each section in the syllabus is designed to facilitate inquiry-based learning and to ensure that connections among physical concepts are established. Teachers should ensure that their lessons stimulate the use of the senses in learning as this will help students view science as a dynamic and exciting investigative process.*

*The general and specific objectives indicate the scope of the content including practical work that should be covered. However, unfamiliar situations may be presented as stimulus material in examination questions.*

*This syllabus caters to varying teaching and learning styles, with specific attention made to ensure the interrelatedness of concepts. The fourth column entitled, "Skills and Interrelationships" states which specific objectives are best suited for Observation, Recording and Reporting (ORR), Manipulation and Measurement (MM), Analysis and Interpretation (AI), and Planning and Designing (PD) skills. Whenever possible, a practical approach should be employed, with special attention given to the identification of variables and the use of information gathering technological tools and social networking media to aid investigations and team work. The need for good observational, mathematical, data analysis and reporting skills must be emphasised.*

*Column four also highlights connections between physical concepts and the fields of Chemistry, Biology, Mathematics and other related disciplines. In order to make the course as relevant as possible, students' awareness of the effect of science and technology on society and environment and vice versa should be encouraged.*

*While classical Physics is several hundred years old, it is the fundamental discipline responsible for the modern technological era we live in and a strong appreciation of this must be inculcated by linking the work of the classical scientists to the present technological development.*

*Greater emphasis should be placed on the application of scientific concepts and principles and less on the factual materials, which encourage memorisation and short-term recall. Every opportunity should be made to relate the study of physical principles to relevant, regional and global examples. The relationship between the theory and practical is to be continually highlighted.*

*The role of the teacher is to facilitate students' learning of accurate and unbiased information that will contribute to a more scientifically literate society, capable of making educated decisions regarding the world we live in.*

## ♦ CERTIFICATION AND DEFINITION OF PROFILES

The syllabus will be examined for General Proficiency certification.

In addition to the overall grade, there will be a profile report on the candidate's performance under the following headings:

1. Knowledge and Comprehension.
2. Use of Knowledge.
3. Experimental Skills.

**Knowledge and Comprehension (KC)**

| | |
|---|---|
| | The ability to: |
| Knowledge | identify, remember and grasp the meaning of basic facts, concepts and principles; |
| Comprehension | select appropriate ideas, match, compare and cite examples of facts, concepts and principles in familiar situations. |

**Use of Knowledge (UK)**

| | |
|---|---|
| | The ability to: |
| Application | use facts, concepts, principles and procedures in unfamiliar situations; transform data accurately and appropriately; use formulae accurately for computations; |
| Analysis and Interpretation | identify and recognise the component parts of a whole and interpret the relationship between those parts; identify causal factors and show how they interact with each other; infer, predict and draw conclusions; make necessary and accurate calculations and recognise the limitations and assumptions inherent in the collection and interpretation of data; |
| Synthesis | combine component parts to form a new meaningful whole; make predictions and solve problems; |
| Evaluation | make reasoned judgments and recommendations based on the value of ideas and information and their implications. |

**Experimental Skills (XS)**

| | |
|---|---|
| | The ability to: |
| Observation/Recording/ Reporting | select observations relevant to the particular activity; record the result of a measurement accurately; select, draw and use appropriate models of presenting data, for example, tables, graphs and diagrams; organise and present a complete report in a clear and logical form; report accurately and concisely; report and recheck unexpected results; |
| Manipulation/Measurement | follow instructions; set up and use carefully and competently simple laboratory apparatus and measuring instruments; |
| Planning and Designing | develop hypotheses and devise means of carrying out investigations to test them; plan and execute experimental procedures and operations in an appropriate sequence; use controls where appropriate; modify original plan or sequence of operations as a result of difficulties encountered in carrying out experiments or obtaining unexpected results; take into account possible sources of error, precautions and limitations in the design of an experiment. |

## ♦ FORMAT OF THE EXAMINATION

| | |
|---|---|
| **Paper 01** (1 hour 15 minutes) | An objective test consisting of 60 multiple choice items. |
| **Paper 02** (2 hours *30* minutes) | One compulsory data analysis question, two structured questions and three extended response questions. |
| **Paper 03/1** School-Based Assessment (SBA) | School-Based Assessment will evaluate the achievement of the candidate in the Experimental Skills and Analysis and Interpretation involved in the laboratory and fieldwork. Candidates will be required to keep a separate practical workbook which must be made available for moderation. |
| **Paper 03/2** Assessment for Private candidates only (2 hours and 10 minutes) | Alternate to the School-Based Assessment for private candidates. This paper will examine the same skills as those tested in Paper 03/1. The focus, therefore, will be on Experimental Skills, Analysis and Interpretation and Use of Knowledge. |

**NOTES ON THE EXAMINATION**

1. The use of silent non programmable calculators will be allowed. The use of a calculator to previously store and then recall information during an examination is prohibited.

2. SI units will be used on all examination papers.

**WEIGHTING OF PAPERS AND PROFILES**

The percentage weighting of the examination components and profiles is as follows:

**Table 1 – Percentage Weighting of Papers and Profiles**

| **PROFILES** | **PAPER 1** Multiple Choice | **PAPER 2** Structured and Data Analysis | **PAPER 3** SBA | **TOTAL RAW** SBA | **TOTAL** % |
|---|---|---|---|---|---|
| Knowledge and Comprehension | *50* | *35* | - | *85* | *43* |
| Use of Knowledge | *10* | *55* | *10* | *75* | *37* |
| Experimental Skills | – | *10* | *30* | *40* | *20* |
| **TOTAL %** | ***60*** | ***100*** | ***40*** | ***200*** | ***100*** |

## ♦ REGULATIONS FOR PRIVATE CANDIDATES

Private candidates must be entered for examination through the Local Registrar in their respective territories and will be required to sit Papers 01, 02, and EITHER Paper 03/1 OR Paper 03/2.

Paper 03/2 is a practical examination designed for candidates whose work cannot be monitored by tutors in recognised educational institutions. The Paper will be of 2 hours and 10 minutes duration and will consist of three questions. Questions will test the Experimental Skills and Use of Knowledge (Analysis and Interpretation) profiles and will incorporate written exercises and practical activities.

## ♦ REGULATIONS FOR RESIT CANDIDATES

Resit candidates must complete Papers 01 and 02 and Paper 03 of the examination for the year for which they re-register. Resit candidates may elect not to repeat the School-Based Assessment component, provided they re-write the examination no later than two years following their first attempt.

*Candidates may opt to complete the* School-Based *Assessment (SBA) or may opt to re-use another SBA score which satisfies the condition below.*

*A candidate who re-writes the examination within two years may re-use the moderated SBA score earned in the previous sitting within the preceding two years. Candidates re-using SBA scores in this way must register as "Resit candidates" and provide the previous candidate number.*

All resit candidates may enter through schools, recognized educational institutions, or the Local Registrar's Office.

## ♦ *THE PRACTICAL APPROACH*

*The syllabus is designed to foster the use of inquiry-based learning through the application of the practical approach. Students will be guided to answer scientific questions by a process of making observations, asking questions, doing experiments, and analysing and interpreting data. The CXC CSEC Physics syllabus focuses on the following skills.*

1. <u>*Planning and Designing (PD)*</u>

   Student's ability to:

   *(a)* *Ask questions: how, what, which, why or where. (Students must be guided by their teachers to ask scientific questions).*

   *Example: How does the length of the simple pendulum affect its period of swing?*

   *(b)* *Construct a hypothesis: The hypothesis must be clear, concise and testable.*

   *Example: There is direct correlation between the length of the pendulum and period of the swing.*

   *(c)* *Design an experiment to test the hypothesis. Experimental report must include the following:*

   (i) *problem statement;*

   (ii) *aim;*

   (iii) *list of materials and apparatus to be used;*

   (iv) *identification of variables;*

   (v) *clear and concise step by step procedure;*

   (vi) *display of expected results;*

   (vii) *use of results;*

   (viii) *possible sources of error/precaution;*

   (ix) *possible limitations.*

2. <u>*Measurement and Manipulation (MM)*</u>

   (a) *Student's ability to handle scientific equipment competently.*

   *The list of equipment is:*

   (i) *Bunsen burner;*

   (ii) *Vernier callipers;*

   (iii) *measuring cylinder;*

(iv) *beakers;*

(v) *thermometer;*

(vi) *ruler;*

(vii) *stop watch/clock;*

(viii) *balance;*

(ix) *micrometer screw gauge;*

(x) *voltmeter;*

(xi) *multimeter;*

(xii) *ammeter.*

(b) *Student's ability to take accurate measurements.*

(c) *Student's ability to use appropriate units.*

3. *Observation, Reporting and Recording (ORR)*

(a) *Recording*

*Student's ability to record observations and to collect and organise data; observations and data may be recorded in:*

*(i)* *Prose*
*Written description of observations in the correct tense.*

*(ii)* *Table*
*Numerical: physical quantities with symbols and units stated in heading, significant figures.*

*(iii)* *Graph*
*Title axes labelled, correct scales, accurate plotting fine points, smooth curves/best fit lines.*

*(iv)* *Calculations*
*Calculations must be shown with attention paid to units.*

(b) *Reporting*

*Student's ability to prepare a comprehensive written report on their assignments using the following format.*

(i) ***Date*** *(date of experiment).*

(ii) ***Aim*** *(what is to be accomplished by doing the experiment).*

(iii) ***Apparatus and Materials*** *(all equipment and materials used in the experiment must be listed).*

(iv) ***Method/Experimental Procedure*** *(step by step procedure written in the past tense).*

(v) ***Results and Observations*** *(see (a) above: Recording).*

(vi) ***Discussion and Conclusion*** *(see 4: Analysis and Interpretation).*

4. <u>*Analysis and Interpretation*</u>

*Student's ability to:*

(a) *make accurate calculations;*

(b) *identify patterns and trends, cause and effect, and stability and change ;*

(c) *compare actual results with expected results if they are different;*

(d) *identify limitations and sources of error and error ranges if appropriate;*

(e) *suggest alternative methods or modification to existing methods;*

(f) *draw a conclusion justified by data.*

## ♦ SECTION A – MECHANICS

*Mechanics is the branch of physics which deals with the study of motion. This section introduces the scientific method, physical measurements, significant figures and units, which transcends the entire syllabus.*

**GENERAL OBJECTIVES**

On completion of this Section, students should:

1. *understand the importance of measurement and graphical representation of data;*
2. *appreciate the difference between scalar and vector quantities;*
3. *be familiar with the various effects of forces;*
4. *appreciate the universal applicability of the laws of dynamics and the conservation of momentum;*
5. *understand the significance of the concept of energy;*
6. *be aware of the application of hydrostatics in everyday life.*

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| **1. *SCIENTIFIC METHOD*** | | | |
| Students should be able to: | | | |
| ***Galileo*** | | | |
| 1.1 *discuss how the methodology employed by Galileo contributed to the development of Physics;* | *Relate the scientific method to the methodology employed by Galileo.* | | |
| ***Simple Pendulum*** | | | |
| 1.2 *investigate the factors which might affect the period of a simple pendulum;* | *Restrict factors to length of string, mass of bob, angle of displacement.* | *Take readings of the period for the variation of the different factors.* | *Skills: MM; ORR; AI; PD.* |
| 1.3 *use graphs of experimental data from simple pendulum;* | *Use ⊙ or × to denote plotted points.* | *Allow students to plot T vs L and $T^2$ vs L.* | *Mathematics- Functions, Relations and Graphs*<br>*Skill: ORR.* |

## SECTION A – MECHANICS (cont'd)

| SPECIFIC OBJECTIVES | | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|---|
| Students should be able to: | | | | |
| *1.4* | *draw a line of 'best fit' for a set of plotted values;* | *Reasons why 'best fit' line is the 'best' average of the data.* | | *Skill: AI.* |
| *1.5* | *determine the gradient of the straight line graph;* | *Use a triangle that covers at least half of the 'best fit' line.*<br><br>*Include the derivation of the unit of the gradient.* | *Use gradient to determine g.* | *Mathematics – Functions, Relations and Graphs.* |
| ***MEASUREMENT*** | | | | |
| *1.6* | *express the result of a measurement or calculation to an appropriate number of significant figures;* | *Refer to SO A 1.5.* | | *Mathematics.* |
| *1.7* | *discuss possible types and sources of error in any measurement;* | *Include those made with digital instruments, and ways of reducing such errors.* | | |
| *1.8* | *use a variety of instruments to measure different quantities;* | *Measurements should include length – rulers, vernier calipers, micrometer screw gauge; units.*<br>*Mass – balances; units.*<br>*Time – clocks, stop clocks or watches; units.*<br>*Volume – measuring cylinder; units.* | | *Skill: MM.* |
| *1.9* | *assess the suitability of instruments on the basis of sensitivity, accuracy and range;* | *Similar instruments should be compared in the discussion.* | *Comparison of readings for the same quantity.* | *Skill: MM.* |

| SPECIFIC OBJECTIVES | | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|---|
| Students should be able to: | | | | |
| *1.10* | *apply the formula for density:* $\rho = \frac{m}{V}$. | *Deduce unit.* | *Determine the density of regular and irregular solids and a liquid.* | |
| 2. | ***VECTORS*** | | | |
| 2.1 | *distinguish between scalars and vectors and give examples of each;* | *Everyday examples for each type, for example, movement of a hurricane as vector.*<br><br>*Mass of objects as scalar.* | | |
| 2.2 | *use scale diagrams to find the resultant of two vectors;* | *Oblique vectors included.* | | *Mathematics- Vectors.* |
| *2.3* | *calculate the resultant of vectors which are parallel, anti-parallel and perpendicular;* | *Limit calculations to four or less vectors.* | | *Mathematics - Trigonometry.*<br><br>*Skills: MM; AI.* |
| *2.4* | *explain that a single vector is equivalent to two other vectors at right angles.* | *Everyday examples of motion and force, for example, velocity of a ball thrown through the air.* | *Using single pulleys and masses against a grid board.* | *Mathematics - Vectors.* |
| ***3. STATICS*** | | | | |
| ***<u>Forces, F</u>*** | | | | |
| 3.1 | *explain the effects of forces;* | *A force can cause a change in the size, shape or motion of a body.* | *Use plasticene and marbles to demonstrate effect of forces.* | *Biology Movement Chemistry Bonding.*<br><br>*Skills: MM; AI.* |

## SECTION A – MECHANICS (cont'd)

| SPECIFIC OBJECTIVES | | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|---|
| Students should be able to: | | | | |
| 3.2 | *identify types of forces;* | *Situations in which electric, magnetic, nuclear or gravitational forces act.* | *Use magnets, falling objects.*<br><br>*Static electricity.* | *Chemistry – Nuclear force.*<br><br>*Skills: ORR., MM.* |
| 3.3 | *determine the weight of objects;* | *Weight = mass × gravitational field strength:* $W = mg$<br>On earth, g = 10 $Nkg^{-1}$<br>Note that:<br>$Nkg^{-1} \equiv ms^{-2}$. | *Measure mass and weight for different objects.*<br><br>*Plot a graph of weight vs mass.*<br><br>*Determine the gradient.* | *Skills: MM; ORR; AI.* |
| 3.4 | *show how derived quantities and their related units are produced;* | *Note how unit ρ may be derived by multiplying and dividing fundamental quantities and their units; From the definition of the quantity, for example:* $N \equiv kgms^{-2}$. | | *Mathematics- Algebra.* |
| *3.5* | *recall the special names given to the units for some derived quantities;* | $kgms^{-2} = N$. | | |
| 3.6 | *express derived units using the index notation;* | | *Conversion of units for given quantities into base units.* | *Biology - All measurements*<br><br>*Chemistry - All measurements Mathematics- measurement.* |
| 3.7 | *identify situations in which the application of a force will result in a turning effect;* | *Situations that are relevant to everyday life, for example, opening a door, sitting on a 'seesaw', using a spanner.* | | |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| ***Turning Forces*** | | | |
| 3.8 *define the moment of a force, T;* | *Moment units of Nm. Note that Nm is not equivalent to a Joule. Refer to SO A3.4 - 3.6.* | *Perform simple experiments to investigate the turning effects of forces on bodies in equilibrium.* | *Skills: MM; ORR; AI.* |
| 3.9 *apply the principle of moments;* | *Oblique forces are excluded. Use of measuring instruments to indicate the magnitude of the forces in equilibrium.* | *Observe situations in which forces are in equilibrium (varied to give different equilibrium situations).* | |
| 3.10 *explain the action of common tools and devices as levers;* | *Identification of load, effort and fulcrum for each device and tool in use.* | *Hammers or spanners of different lengths, bottle openers, crowbars.* | *Biology- Movement in limbs.* |
| 3.11 *determine the location of the centre of gravity of a body;* | *Centre of gravity of a variety of regular and irregular shaped solids, including lamina.* | *Find the centre of gravity for the given objects. Plumbline for lamina.* | *Skill: MM.* |
| 3.12 *relate the stability of an object to the position of its centre of gravity and its weight;* | *The orientation of an object can change the position or height of its centre of gravity and affect its stability.* | *Compare the stability of the same regular solid, for example, cylinder, metre rule, cuboid in different positions, for example, horizontal, vertical, inclined.* | *Biology-Structure of the human body.* |
| ***Deformation*** | | | |
| 3.13 *investigate the relationship between extension and force;* | *Interpretation of simple force-extension graphs. Identification of regions of proportionality for springs.* | *Perform experiments to determine the relationship between applied force and the resulting extensions, for springs and elastic bands.* | *Chemistry- Properties of materials. Mathematics Proportionality.*<br><br>*Skills: MM; ORR; AI; PD.* |

## SECTION A – MECHANICS (cont'd)

| SPECIFIC OBJECTIVES | | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|---|
| Students should be able to: | | | | |
| 3.14 | *solve problems using Hooke's law.* | *Problems involving springs and elastic bands only.* | | |
| ***4.*** | ***DYNAMICS: MOTION IN A STRAIGHT LINE*** | | | |
| 4.1 | *define the terms: distance, displacement, speed, velocity, acceleration;* | *Distance and displacement, s or x; speed and velocity, v; acceleration,* $a = \frac{v-u}{t}$. | *Trolleys on inclined plane.* | *Mathematics – Algebra/ Computation.*<br><br>*Skills: MM;AI;PD.* |
| 4.2 | *apply displacement-time and velocity-time graphs;* | *Finding the gradient for straight lines only.* | *Ticker tape timer, car racing.* | *Mathematics – Functions, Relations and Graphs.*<br><br>*Skills: ORR; AI.* |
| **<u>Aristotle</u>** | | | | |
| 4.3 | *discuss Aristotle's arguments in support of his "law of motion", that is, v* $\propto$ *F";* | *Aristotle's law was eventually discredited.* | *Push trolley on a flat surface.* | |
| ***<u>Newton's Laws</u>*** | | | | |
| *4.4* | *state Newton's three laws of motion;* | *Have students identify applicable laws after viewing examples.* | *Marbles in a groove.* | |
| *4.5.* | *use Newton's laws to explain dynamic systems;* | *Examples - rockets, garden sprinklers, trampolines.* | | *Skill: AI.* |
| *4.6* | *define linear momentum;* | *Units of kg* $ms^{-1} \equiv$ *Ns.* | | |
| *4.7* | *define linear momentum describe situations that demonstrate the law of conservation of linear momentum;* | | Collisions of Billiard balls. | |

| **SPECIFIC OBJECTIVES** | **CONTENT/ EXPLANATORY NOTES** | **SUGGESTED PRACTICAL ACTIVITIES** | ***SKILLS AND INTER-RELATIONSHIP*** |
|---|---|---|---|
| Students should be able to: | | | |
| *4.8 apply the law of conservation of linear momentum.* | *Oblique collisions are excluded.* | *Collisions between objects of different sizes or velocity.* | |
| 5. ***ENERGY*** | | | |
| **<u>Forms of Energy</u>** | | | |
| *5.1 define energy;* | *Unit: Joule.* | | |
| *5.2 identify the various forms of energy;* | *Gravitational, elastic, chemical, electrical, magnetic, electro-magnetic, thermal, nuclear, kinetic, sound.* | | |
| *5.3 describe the energy transformation(s) in a given situation;* | *Transformations should be limited to one-step or two-step only. Note that thermal energy is always a product and by-product of every transformation. Examples of the conversion of electrical energy to other forms and vice versa.* | *Observe and list the energy transformations for the particular situation, for example, radio playing music, vehicles coming to rest, cooking food in microwave oven.* | *Biology - Food web, Photosynthesis, Respiration. Chemistry-Burning of hydrocarbons.* |
| *5.4 apply the relationship: work = force x displacement;* | *Unit: Joule.* | | *Mathematics-Algebra/ computation.* |
| *5.5 discuss the use of energy from alternative sources, and its importance to the Caribbean;* | *Emphasis on examples relevant to the Caribbean, to include hydroelectricity, geothermal energy, tidal energy waves, solar energy, wind energy, nuclear energy. More efficient and economical use of energy.* | *Project on alternative energy sources.* | *Biology-Food web. Chemistry-Burning of hydrocarbons.* |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| ***Potential Energy, Ep*** | | | |
| *5.6 define potential energy;* | *Examples of this form of energy, for example, battery, stretched spring or elastic band, object on shelf.* | | *Skill: AI.* |
| 5.7 *calculate the change in gravitational potential energy using:* $\Delta E_p = mg\Delta h$; | | | *Mathematics- Algebra/ Computation* |
| **Kinetic Energy, $E_k$** | | | |
| 5.8 *define kinetic energy;* | *Definition.* *Give everyday examples.* | | *Skill: AI.* |
| *5.9 calculate kinetic energies using the expression:* $E_k = \frac{1}{2}mv^2$; | | | *Mathematics- Algebra/ Computation* |
| ***Conservation*** | | | |
| *5.10 apply the law of conservation of energy;* | *Use different energy forms in these problems. Conversion of P.E. to K.E. on a moving swing, pendulum, kicking a football.* | | *Skill: AI.* |
| **Power, P** | | | |
| 5.11 *define power and apply definition;* | *Unit: Watt* *Apply:* $P = \frac{E}{t}$. Refer to SO D3.3. | Perform activities to find the power in situations for which the energies and time intervals involved can be measured or calculated. | *Skills: MM; ORR; AI.* |

SECTION A – MECHANICS (cont'd)

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| 5.12 *explain the term efficiency;* | *The factors which affect its value.* | | *Mathematics-Computation.* |
| 5.13 *calculate efficiency in given situations.* | *Efficiency = <u>output value</u> x 100% input value.* | | *Skill: AI.* |
| 6. **HYDROSTATICS** | | | |
| *6.1 define pressure and apply definition;* | *Apply:* $P = \frac{F}{A}$. <br><br> *Refer to SO A3.5.* | Pressure extended standing on one foot. | *Mathematics-Algebra/ Computation. Skill: MM; ORR; AI.* |
| *6.2 relate the pressure at a point in a fluid to its depth and the density;* | Apply: $\Delta p = \rho g \Delta h$ *(for fluid pressure); (Pascal) Pa* $\equiv$ *Nm*$^{-2}$. *All points on the same horizontal level in a fluid at rest, have the same pressure.* | *Demonstrate using a can with holes at same and at different levels, to illustrate the principle.* | *Mathematics-Algebra/ Computation. Skill: MM.* |
| *6.3 apply Archimedes' principle to predict whether a body would float or sink in a given fluid.* | *Relevant examples include rafts, boats, balloons, and submarines.* | *Perform activities to check predictions.* | *Biology - Dispersal of seeds.* <br><br> *Skills: MM; ORR; AI; PD.* |

***<u>Suggested Teaching and Learning Activities</u>***

*To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.*

1. ***Galileo:*** *Galileo has been called the "father of modern observational Astronomy", the "father of Modern Physics", and the "father of science". Do group research projects on what his different contributions were to Science to earn him all these titles.*

## SECTION A – MECHANICS (cont'd)

2. ***Scientific method:*** *Galileo made the important discovery that sunspots were on the surface of the sun by extremely patient and detailed daily observations of the Sun. Explain why this technique is critical to scientific study, even today.*

   *"Galileo: Sunspots" by NOVA can be viewed as a class project*

   *http://www.teachersdomain.org/resource/ess05.sci.ess.eiu.galileosun/*

3. ***Effect of gravity****: Have students drop a heavy and a light book from the same height at the same time and observe if they land at the same time or not. Discussion should ensue about the leaning tower of Pisa experiment.*

4. ***Units:*** *Students should do a five-minute PowerPoint presentation on the failure of the $125 Million Mars Climate orbiter mission, which was launched in 1999 due to a mix up of metric and imperial units. The importance of units in Physics should be emphasised through this exercise.*

5. ***Centre of gravity:*** *Is it easier or harder to balance a yardstick on your finger than a pencil or ruler? Experiment and try to figure out why. Can you make a pencil easier to balance on your finger by adding weight at the top? Explain. "Centre of gravity: Pencil balance" from ZOOM should be viewed as a class activity.*

   *http://www.teachersdomain.org/resource/phy03.sci.phys.mfw.zpencilbalance/*

6. ***Hydrodynamics:*** *Write an essay on the history and design of submarines.*

   *What will it take to make a floating toy submarine sink to the bottom of a bathtub? Conduct an experiment based on your understanding of the factors that influence an object's buoyancy to the test in this interactive brainteaser from the* NOVA *website.*

   *http://www.teachersdomain.org/resource/phy03.sci.phys.matter.buoqu/*

7. ***Friction:*** *Design a mini poster on "shooting stars". Explain why the meteors burn up in the atmosphere. List the major meteor showers and see how many "shooting stars" you can observe during a meteor shower.*

8. ***Gravity:*** *Do a research project on how the construction industry evolved to build modern day sky scrapers and why they could not be built in the past. The tallest constructions of the past were pyramids. Why did they have to have bigger bases the taller they were built?*

   *http://science.howstuffworks.com/engineering/structural/skyscraper1.htm*

9. ***Laws of motion, momentum and energy:*** *Arrange a cricket match with the class divided into two teams. Subsequent to the match, discuss from principles of Physics why the winning team won and the losing team did not. Use the items listed in the paper "Physics of Cricket" to discuss your points.*

   *http://www.physics.usyd.edu.au/~cross/cricket.html*

## SECTION A – MECHANICS (cont'd)

10. ***Laws of motion, momentum and energy:*** *With the school's permission, have a water rocket display with your class. The students must write a paper explaining the Physics of the trajectories and patterns formed.*

11. ***Friction, turning forces:*** *Design a poster to explain why rally cars can drift around corners and Formula 1 cars do not.*

12. ***Pendulums:*** *Do five minute group presentations on clocks through the ages and how the pendulum is used to build the clocks.*

13. ***Vectors****: Conduct research on Caribbean icon and scientist Dr. Rudranath Capildeo.*

    *http://www.caribbean-icons.org/profiles/rudranath.capildeo.htm*

14. ***Renewable energy:*** *Divide the class into groups with each group being assigned a different form of renewable energy to research and investigate its suitability in the Caribbean. Design scaled models of their renewable energy options assigned.*

    *http://www.teachersdomain.org/resource/phy03.sci.engin.systems.lp_renew/*

    *"What is the design process?"*

    *http://www.teachersdomain.org/resource/phy03.sci.engin.design.desprocess/caribbean-icons.org/profiles/rudranath.capildeo.htm*

## ♦ SECTION *B* - THERMAL PHYSICS AND KINETIC THEORY

*Thermal physics is the study of heat, temperature and heat transfer. It can be explained in terms of kinetic theory at the microscopic level. It helps us to capture the different phases of matter.*

### GENERAL OBJECTIVES

On completion of this Section, students should:

1. *be familiar with the development of the theory of heat;*
2. *relate macroscopic phenomena to the kinetic theory of matter;*
3. *have a conceptual understanding of thermal quantities and the relationship between them;*
4. *understand the various modes of thermal energy transfer.*

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| **1. *NATURE OF HEAT*** | | | |
| 1. 1 *differentiate between the caloric and kinetic theories of heat as they existed in the eighteenth century;* | *Rumford's cannon-boring experiments as evidence against the caloric theory.* | *Discussion.* | |
| *1. 2 discuss the role of Joule's experiments in establishing the principle of conservation of energy.* | | | |
| **2. *MACROSCOPIC PROPERTIES AND PHENOMENA*** | | | |
| **<u>Temperature, T</u>** | | | |
| 2.1 *relate temperature to the direction of net thermal energy transfer;* | *Temperature T, units.* | | |
| 2.2 *identify physical properties which vary with temperature and may be used as the basis for measuring temperature;* | | *Perform activities to observe change in length of liquid column with temperature.* | *Skills: MM; ORR.* |

## SECTION *B* - THERMAL PHYSICS AND KINETIC THEORY (cont'd)

| SPECIFIC OBJECTIVES | | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|---|
| Students should be able to: | | | | |
| 2.3 | *relate the use of a thermometer to its design;* | *Highlight design features which make a thermometer suitable for its particular task. Note temperature ranges for each.* | *Draw and explain design of:*<br>*(a) laboratory; thermometer;*<br>*(b) clinical thermometer*<br>*(c) thermocouple.* | *Chemistry and Biology – Thermometer.* |
| 2.4 | *define the fixed points on the Celsius scale;* | *Lower and upper fixed points.* | | |
| 2.5 | *relate the temperature of a body to the kinetic energy of molecules;* | | | |
| **<u>Phases of Matter</u>** | | | | |
| 2.6 | *distinguish among solids, liquids and gases;* | *Note the differences with respect to inter-molecular forces, motion of molecules, shape and volume of matter.* | | *Chemistry- States of matter.* |
| 2.7 | *use the Kinetic theory to explain the different macroscopic properties of solids, liquids and gases;* | | *Perform simple experiments to illustrate the existence of inter-molecular forces, for example, compression of a syringe containing a liquid.* | *Chemistry - Diffusion, osmosis, particulate nature of matter.*<br>*Biology - Diffusion, osmosis.* |
| **<u>Expansion</u>** | | | | |
| 2.8 | *explain observations of the effects of thermal expansion;* | *Telephone lines. Application of thermal expansion, for example, opening jars, carbonated beverages, creaking roofs.* | *Demonstrations which illustrate expansion of solids, liquids, for example, ball and ring, bar breaking, bimetallic strip.* | *Chemistry - Properties of materials.*<br><br>*Skill: ORR.* |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND* INTER-RELATIONSHIP |
|---|---|---|---|
| Students should be able to: | | | |
| **<u>Gas Laws</u>** | | | |
| 2.9 *relate graphs of pressure or volume against temperature to the establishment of the Kelvin temperature scale;* | | *Experiments to investigate the relationships among pressure, volume and temperature of a gas.* | *Chemistry – Gas Laws.*<br><br>*Skills: MM; ORR; AI.* |
| 2.10 *use the relationship between Kelvin and Celsius scale.* $T/K = \theta/°C + 273$; | | | |
| 2.11 *apply the gas laws;* | (a) *Boyle's Law* – $PV =$ constant;<br>(b) *Charles' Law* – $\frac{V}{T}$= constant;<br>(c) *Pressure Law* – $\frac{P}{T}$ = constant;<br>(d) *General Gas Law* - $\frac{PV}{T}$ = *constant.* | *Virtual labs*<br>*Use of trapped gas in sealed syringe; sealed U-tube.* | *Chemistry.*<br>*Mathematics-Algebra/ Computation.*<br>*Skill: AI; ORR.* |
| 2.12 *give qualitative explanations of the gas laws in terms of the Kinetic theory.* | *Explain gas pressure in terms of molecular motion.* | | |
| **3. *THERMAL MEASUREMENTS*** | | | |
| **<u>Specific Heat Capacity, c</u>** | | | |
| 3.1 *distinguish between specific heat capacity, 'c' and heat capacity 'C';* | *Note that specific heat capacity and heat capacity are related by the formula* $C = mc$. | | *Chemistry – properties of materials.* |
| 3.2 *apply the relationship* $E_H = mc\,\Delta\Theta$, *or* $E_H = mc\,\Delta T$; | | | *Mathematics-Algebra/ Computation.*<br>*Skill: AI.* |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| 3.3 *determine the specific heat capacity of metals and liquids;* | *Use electrical method and method of mixtures.* | *Perform activities to measure specific heat capacity.* | *Skills: MM; ORR; AI; PD.* |
| **<u>Specific Latent Heat, l</u>** | | | |
| 3.4 *demonstrate that temperature remains constant during a phase change;* | | *Perform cooling curve demonstration, for example, candle wax.* | *Chemistry - Melting point of metals and non-metals, separation in mixtures, properties of materials.*<br><br>*Skill: ORR.* |
| 3.5 *apply the relationship $E_H = ml$;* | | *Perform activity to determine the specific latent heat of fusion of ice, using method of mixtures with a container of negligible heat capacity.* | *Mathematics- Algebra/ Computation Skills: MM; ORR; AI; PD.* |
| 3.6 *determine the specific latent heat of vaporization $l_v$, and fusion, $l_f$ of water;* | *Unit: $Jkg^{-1}$ Use an electrical method.* | *Perform activity to determine specific latent heat of fusion.* | *Skills: MM; ORR; AI.* |
| 3.7 *distinguish between evaporation and boiling.* | *Use the Kinetic theory to explain evaporation and boiling.*<br><br>*Give examples of application of cooling effect of evaporation - air conditioners, earthenware vessels, refrigerators, perspiration.* | | *Biology – Homeostasis.* |

## SECTION *B* - THERMAL PHYSICS AND KINETIC THEORY (cont'd)

| **SPECIFIC OBJECTIVES** | **CONTENT/ EXPLANATORY NOTES** | **SUGGESTED PRACTICAL ACTIVITIES** | ***SKILLS AND INTER-RELATIONSHIP*** |
|---|---|---|---|
| Students should be able to: | | | |
| **4.** ***TRANSFER OF THERMAL ENERGY*** | | | |
| 4.1 *explain the transfer of thermal energy by conduction;* | *Relate the fact that air is a very poor conductor to the insulation properties of certain materials, for example, expanded polystyrene, hollow blocks.*<br><br>*Refer to SO B2.6.* | *Perform activity to compare qualitatively the thermal conductivities of different solids.* | *Skills: MM; ORR.* |
| 4.2 explain the transfer of thermal energy by convection; | Relate convection to common phenomena, for example, land and sea breezes. | Perform demonstrations to show convection in fluids. | |
| 4.3 explain the transfer of thermal energy by radiation; | Recall that radiant energy is electromagnetic (infra-red). | Perform demonstration to show that radiant energy does not need a medium for transmission. | Chemistry-Use of solar energy. |
| 4.4 conduct experiments to investigate the factors on which absorption and emission of radiation depend; | Factors limited to:<br>(a) texture of surface (rough, smooth);<br>(b) nature of surface (shiny, dull);<br>(c) colour of surface (black, white);<br>(d) area of surface. | Perform experiments to investigate such factors. | *Skills: ORR; MM; AI; PD.* |
| 4.5 recall that good absorbers are good emitters; | Relate the phenomenon of radiation to common practices. | | |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| 4.6 relate the principles of thermal energy transfer to the design of devices. | Conduction, convection, radiation.<br><br>*Vacuum flask and solar water heater. Explanation of the glass house (green house) effect, including role of atmospheric $CO_2$. Global Warming.* | | |

***Suggested Teaching and Learning Activities***

*To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.*

1. ***Expansion and contraction:*** *Do a short research paper on why the Columbia space shuttle disaster occurred in 2003, killing all persons on board. Highlight the role of thermodynamics in it.*

2. ***Heat:*** *Make a list of applications of infrared imaging. Some examples can be found from the US Geological survey website at http://www.usgs.gov/science/.*

   http://coolcosmos.ipac.caltech.edu/image_galleries/ir_zoo/lessons/background.html.

3. ***Heat sensors:*** *What animals use infrared vision and how does it help them? Imagine you could see in infrared, do a sketch of what the classroom would look like through infrared goggles.*

4. ***Heat transfer:*** *In the Caribbean islands, note where air conditioning units are typically placed in rooms. In cold countries where will heaters be located in a room? Explain the choices from principles of Physics.*

5. ***Temperature:*** *Play the online educational game in identifying the range of temperatures in different scales.*

   *http://funphysics.jpl.nasa.gov/adventures/temperature-game.html.*

6. ***Temperature:*** *The temperature of zero Kelvin cannot be attained but very interesting phenomena happen as you get closer and closer to that temperature. Design a poster highlighting the phenomena and its use in modern technology.*

## SECTION *B* - THERMAL PHYSICS AND KINETIC THEORY (cont'd)

7. ***Temperature ranges:*** *Explore some of the extreme temperatures on the moon through this video clip on the moon and why that happens.*

   *http://www.teachersdomain.org/resource/ess05.sci.ess.eiu.extemp/*

8. ***Phases:*** *The water cycle is the process that moves water around Earth. In this video segment adapted from* ZOOM*, cast members use a homemade solar still to mimic this natural process, separating pure water from a saltwater mixture. The class can make this homemade solar still as a project and see the processes of condensation and evaporation and its relevance on planet earth.*

   *http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.solarstill1/*

9. ***Local scientist:*** *Create a small booklet highlighting the biography and the contribution of Professor O. Headley in applications of solar energy in the Caribbean.*

   *caribbean-icons.org/science/index.htm*

## ♦ SECTION C - *WAVES AND OPTICS*

*Wave theory represents the branch of Physics that deals with wave processes. It is significant to the understanding of sound phenomena. Light, which is electromagnetic in origin, is fundamental to the understanding of optics.*

**GENERAL OBJECTIVES**

On completion of this Section, students should:

1. appreciate that wave motion is a means of transferring energy and that there are certain features common to all waves;
2. understand the way in which sound waves are produced and propagated;
3. understand the properties of the electromagnetic spectrum;
4. be familiar with the historical development of the theory of light;
5. appreciate how a ray treatment facilitates the understanding of reflection and refraction of light waves.

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND* INTER-RELATIONSHIP |
|---|---|---|---|
| Students should be able to: | | | |
| **1. WAVE MOTION** | | | |
| **<u>Types of Waves</u>** | | | |
| 1. 1 differentiate between types of waves; | Pulses, progressive waves, transverse and longitudinal waves. | Production of waves using springs and in ripple tanks.<br><br>Draw diagrams of:<br>(a) transverse waves in ripple tank and slinky spring;<br><br>(b) longitudinal wave in a slinky spring. *Virtual simulations.* | *Skill: ORR.* |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| **Wave Parameters** | | | |
| 1. 2 *apply speed, frequency, wavelength, period and amplitude;* | *Use:* $v = f\lambda$. *Refer to SO D2.7.* | *Timing echoes.* | *Mathematics- Algebra/ Computation. Skills: PD; MM.* |
| 1. 3 represent transverse and longitudinal waves in displacement-position and displacement-time graphs. | *Note: a progressive wave varies in both time and space simultaneously. To represent it on paper, either time or position must be held constant.* *Refer to SO D2.6.* | *Extract information about wave parameters from graphs representing waves.* | *Mathematics: Trigonometric functions.* *Skills: ORR; AI.* |
| **2. SOUND** | | | |
| **Production and Propagation** | | | |
| 2.1 describe how sound is produced and propagated in a medium; | *Sound is transmitted as a longitudinal wave and is produced by vibrating systems.* | *Cup and string telephone. Different sounds produced by vibrating systems. For example, stretch rubber bands.* | *Biology – Hearing.* |
| 2.2 relate the terms 'pitch' and 'loudness' to wave parameters; | *Pitch - frequency Loudness - amplitude.* Recall the range of frequencies detectable by the normal human ear; | *Playing drums and steel pan. Tuning forks. Using bottles with water at different heights.* | |
| **Speed of Sound** | | | |
| 2.3 *apply the speed of sound to practical situations;* | *Thunder and lighting and the proximity of the strike.* | *Estimate the speed of sound in air using echoes.* | *Skills: MM; ORR; AI; PD.* |

| **SPECIFIC OBJECTIVES** | **CONTENT/ EXPLANATORY NOTES** | **SUGGESTED PRACTICAL ACTIVITIES** | ***SKILLS AND INTER-RELATIONSHIP*** |
|---|---|---|---|
| Students should be able to: | | | |
| 2.4 *cite evidence that sound waves reflect, refract, diffract and interfere;* | *Reflect – echoes*<br>*Refract – sound travelling from air to water.*<br>*Diffract – hearing sound around corners/barriers.*<br>*Interfere – sound systems.* | | |
| 2.5 *describe the use of ultrasound.* | *Definition of ultrasound; pre-natal and materials testing.* | | *Biology- Reproduction.* |
| **3. *ELECTROMAGNETIC WAVES*** | | | |
| 3.1 *state the properties of e.m. waves;* | *For example, travels same speed, are transverse and propagates in a vacuum.* | | |
| 3.2 *differentiate between types of e.m. waves in terms of their wavelengths;* | *Radio, infrared, visible, ultraviolet, x-rays, Y-rays. Discuss the spectrum.* | *Research project.* | |
| 3.3 *identify a source and use of each type of e.m. wave.* | | | *Biology – Medical applications of Y-rays and x- rays.* |
| **4. *LIGHT WAVES*** | | | |
| ***<u>Wave Particle Duality</u>*** | | | |
| 4.1 compare the rival theories of light held by scientists; | *Theories of Huygens, Newton, Young, Einstein. Recall that in the twentieth century experiments have provided evidence that light has both a particle and a wave nature. Knowledge of the photo-electric effect not required. Photo sensors, digital cameras.* | | |

**SECTION C - WAVES AND OPTICS (cont'd)**

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| 4.2 *conduct a Young's double slit experiment to show that light is a wave;* | *Diffraction and interference.* | Young's experiment looking at a straight filament lamp through a double slit. *Ripple tank.* | |
| ***Rays of Light*** | | | |
| 4.3 *explain why the diffraction of light is not normally observed;* | Wavelength comparable to the width of slit. | *Use ripple tank. Observe diffraction with gaps of different widths.* | |
| 4.4 *apply the principle that light travels in straight lines;* | *Use straight lines to represent beams. Shadows, eclipses, pin hole camera.* | *Demonstrate that light travels in straight lines. Construct a pin hole camera.* | *Skill: MM.* |
| ***Reflection*** | | | |
| 4.5 *apply the laws of reflection;* | | *Perform experiments to show the angle of incidence and the angle of reflection are equal.* | *Skills: MM; ORR.* |
| 4.6 describe the formation of images in a plane mirror; | Object and image distances are equal. The image is virtual and the object size is equal to the image size. | Locate virtual image using:<br>(a) ray plotting;<br>(b) no parallax method.<br><br>Construct diagrams to show the formation of virtual images. | *Mathematics-Transformations*<br><br>*Skills: MM; ORR; PD.* |
| **Refraction** | | | |
| 4.7 give examples of observations which indicate that light can be refracted; | Appearance of water on the road, apparent depth of swimming pool. Refraction occurs as a result of the change of speed of light. | Activities to illustrate refraction of light, for example, pencil in water. | *Skills: MM; ORR.* |

## SECTION C - WAVES AND OPTICS (cont'd)

| SPECIFIC OBJECTIVES<br><br>Students should be able to: | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| 4.8 describe the refraction of light rays; | Recall that the passage of a ray of light through a rectangular block may results in lateral displacement of that ray. | Passage of light rays through:<br>(a) rectangular blocks;<br>(b) triangular prisms.<br>Draw diagrams. | *Skill: MM.* |
| 4.9 *describe how a prism may be used to produce a spectrum;* | *Use a source of white light.*<br>*Newton's experiment with prisms.* | Demonstrate:<br>(a) dispersion using a triangular prism.<br>(b) rainbow. | *Skill: MM.* |
| 4.10 *apply Snell's Law;* | *Definition of refractive index.* | Perform an experiment to test Snell's Law. | *Mathematics-Trigonometry.*<br><br>*Skills: MM; ORR; AI.* |

**Critical Angle and Total Internal Reflection**

| | | | |
|---|---|---|---|
| 4.11 explain 'critical angle' and 'total internal reflection'; | | Measure critical angle in glass or other transparent material. Use diagrams to illustrate. | *Skills: MM; ORR.* |
| 4.12 relate critical angles to total internal reflection; | *Definition of total internal reflection.* | | *Mathematics-Trigonometry.*<br><br>*Skill: AI.* |
| 4.13 draw diagrams illustrating applications of total internal reflection. | Periscope, fibre optic cable, endoscopes. | | |

**SECTION C - WAVES AND OPTICS (cont'd)**

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND* INTER-RELATIONSHIP |
|---|---|---|---|
| Students should be able to: | | | |
| **5. LENSES** | | | |
| **<u>Action of Lenses</u>** | | | |
| 5.1 illustrate the effect of converging and diverging lenses on a beam of parallel rays; | *Use ray boxes or virtual simulation.* | Investigate the properties of converging and diverging lenses on a beam of parallel rays. | Biology – Eye.<br><br>*Skills: MM; ORR.* |
| 5.2 define *the terms*:<br>(a) principal axis;<br>(b) principal focus;<br>(c) focal length;<br>(d) focal plane;<br>(e) magnification; | | | |
| **<u>Image Formation</u>** | | | |
| 5.3 *differentiate* between real and virtual images; | | *Perform experiments to locate real and virtual images and draw diagrams.* | *Skills: MM; ORR.* |
| 5.4 *apply the equations for magnification;* | *Magnification* $= \frac{\text{image size}}{\text{object size}}$ $= \frac{\text{image distance } (v)}{\text{object distance } (u)}$. | | *Biology – Drawing.*<br><br>*Mathematics - Transformations,*<br><br>*Skill: AI.* |
| *5.5 determine the focal length of a converging lens.* | *Use lens formula and scale diagram:* $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ | *Perform experiments to measure focal length of converging lens.* | *Mathematics - Functions and Relations; Algebra/ Computation.*<br><br>*Skills: MM; ORR; AI; PD.* |

## SECTION C - WAVES AND OPTICS (cont'd)

***Suggested Teaching and Learning Activities***

*To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.*

1. ***Standing waves:*** *Conduct experiments to explore why ants survive in an operating microwave oven.*

2. ***Light, refraction:*** *Discuss how raindrops and prisms have similar effect with light in forming rainbows and spectrum respectively using diagrams. Simulation at:*

   *http://micro.magnet.fsu.edu/optics/activities/students/prisms.html*

3. ***Electromagnetic spectrum:*** *List a use of each band in the electromagnetic spectrum with examples and make a model to depict them as for a science centre display. Show time scales of the use/discovery of examples you show.*

4. ***Sound:*** *Arrange a field trip to a concert hall to look at its design and how this affects the acoustics. Students should write a report of the activity. Discuss the quality of a band concert in a hall versus being played in the open air.*

   *http://www.concerthalls.org/*

5. ***Transverse and longitudinal waves; transmission of energy****: Show how earthquakes are located. How tsunami waves are formed and why are they so much larger than normal sea waves?*

   *This video segment from Nature examines the anatomy of the tsunami and the possibility that animals sensed the coming waves of destruction.*

   *http://www.teachersdomain.org/resource/nat08.earth.geol.tec.waves/*

6. ***Sound waves:*** *Imagine you are a bat looking in the darkness of the caves for your companions who have ventured deep into the caves but instead there is a large predator lurking. Write a short story of your adventure. Make sure you include the principles of Physics used in your story.*

7. ***Wave-particle duality:*** *Identify modern technology that operates on the principle that light behaves as a particle. Observe pictures with a digital camera and a traditional film camera and compare the differences between them including how each forms the image.*

8. ***Light, reflection, transmission:*** *Discuss the holographic projectors in "Star Trek". How realistic are they in producing holograms.*

   *http://memory-alpha.org/wiki/Category:Holographic_technology.*

## ♦ SECTION *D* - ELECTRICITY AND MAGNETISM

*In this section, Electricity and Magnetism, we explore electrical, magnetic and electromagnetic principles and phenomena. The importance of electronics in modern society is also introduced.*

**GENERAL OBJECTIVES**

On completion of this Section, students should:

1. *understand electrostatic phenomena;*
2. *understand the ways in which electricity is conducted;*
3. *understand electrical quantities and the relations between them;*
4. *have a working knowledge of electrical circuits and components;*
5. *be aware of the applications of electronics in technology;*
6. *understand the simple phenomena associated with magnets;*
7. *have a working knowledge of electromagnetic phenomena.*

| SPECIFIC OBJECTIVES<br>Students should be able to: | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND* INTER-RELATIONSHIP |
|---|---|---|---|
| **1. ELECTROSTATICS** | | | |
| **<u>Electric Charge, Q</u>** | | | |
| 1. 1 *explain the charging of objects;* | *Explain in terms of properties of electrons which are relatively free to move; charging of glass, perspex or polythene by rubbing with a dry cloth and explain in terms of electron transfer by friction.* | Demonstrate 'charging by friction'. | |
| 1. 2 *describe the forces that electric charges exert on each other;* | *The forces between charges as a fundamental property of electric charges.* | *Perform simple activities to show that like charges repel and unlike charges attract.* | *Skills: MM; ORR.* |
| 1. 3 *explain charging by induction;* | *How a charged object can attract objects having zero net charge.* | *Perform simple experiment.* | |

SECTION *D* - ELECTRICITY AND MAGNETISM (cont'd)

| SPECIFIC OBJECTIVES | | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|---|
| Students should be able to: | | | | |
| **Electric Fields** | | | | |
| 1. 4 | *define an electric field;* | *Draw the electric fields around and between point charges, and between charged parallel plates; Refer to other force fields such as gravitational and magnetic. Refer to SO A3.2; D6.7.* | | |
| 1. 5 | describe one hazard and one useful application of static charge. | *Electrostatic painting; Lightning strikes, dust extraction, photocopying, static build up on vehicles. The effects of a local charged ionised atmosphere.* | | |
| **2.** | **CURRENT ELECTRICITY** | | | |
| 2.1 | distinguish between conductors and insulators; | *Definitions, properties and classification.* | Use a low voltage test circuit with lamp indicator to test different materials. | *Chemistry - Electrons; properties of metals and non-metals.*<br><br>*Skills: MM; ORR.* |
| 2.2 | *state that an electric current in a metal consists of a flow of electrons;* | *In other conducting media an electric current may consist of the movement of both negative and positive charge carriers.*<br><br>*For example, the use of silicon and germanium, in semi-conductors and electrolytes in batteries.* | | *Chemistry- Electrons; properties of metals and non-metals.* |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND* INTER-RELATIONSHIP |
|---|---|---|---|
| Students should be able to: | | | |
| 2.3 differentiate between electron flow and conventional current; | *The convention behind current flow.* | | |
| 2.4 *state the unit of electrical current;* | *Ampere, A.* | | |
| 2.5 apply the relationship Q = It; | The unit of charge, the coulomb, can be obtained from this equation. Thus, 1 coulomb = 1 amp-second. | | Chemistry-Electro-Chemistry. Mathematics-Algebra/ Computation.<br><br>*Skill: AI.* |
| **Alternating Current** | | | |
| 2.6 differentiate between direct and alternating currents; | Recognise that current reverses direction of flow in a.c. systems. | Draw current time or voltage time graphs to represent direct and alternating current *simulations.* | *Mathematics: Functions and Graphs.* |
| 2.7 analyse current-time or voltage-time graphs. | *Use f = 1/T.*<br><br>*Deduce the period and frequency of alternating currents or voltages.*<br>*Refer to SO C1.2.* | | *Mathematics-Algebra/ Computation.*<br><br>*Skill: AI.* |
| **3. ELECTRICAL QUANTITIES** | | | |
| ***Power, P and Energy, E*** | | | |
| 3.1 cite examples of the conversion of electrical energy to other forms and vice versa; | *Refer to SO A5.3.* | Demonstrate energy conversions in the laboratory. | |

**SECTION D - ELECTRICITY AND MAGNETISM (cont'd)**

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| 3.2 *apply the relationship V = E/Q;* | *Definition of terms and their units.* | | *Mathematics-Algebra/ Computation*<br><br>*Skill: AI.* |
| 3.3 *apply the relationship P =IV ;* | *Compare consistency of units for P=IV and P= E/t.*<br>*Refer to* SO A5.11. | | *Mathematics - Algebra/ Computation.* |
| 3.4 discuss the importance of conserving electrical energy and the means of doing so. | *Limited reserves of fossil fuel hence the need to conserve. Fluorescent, LED rather than incandescent lamps.*<br><br>*Solar rather than electrical or gas water heaters. High efficiency refrigeration and air condition units.* | | Chemistry - Burning of hydrocarbons. Biology-Ecology.<br><br>*Skill: AI.* |
| **4. CIRCUIT AND COMPONENTS** | | | |
| **<u>Circuit Diagrams</u>** | | | |
| 4.1 *use symbols to construct circuit diagrams;* | *Refer to list of Graphical Symbols.* | | *Skill: MM.* |
| 4.2 *differentiate between series and parallel circuits;* | *Consider series, parallel and series-parallel combinations and polarity of devices. Simple series circuits with diode, resistor and instruments* | Set up a simple circuit given a circuit diagram paying due regard to the polarity and suitability of components. | |

**SECTION D - ELECTRICITY AND MAGNETISM (cont'd)**

| SPECIFIC OBJECTIVES | | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|---|
| Students should be able to: | | | | |
| **<u>Cells</u>** | | | | |
| 4.3 | *explain the functions of the various parts of a zinc-carbon cell;* | *The parts of the cell and their functions. Mention the fact that there are other types of primary cells.* | Draw a diagram. | *Chemistry - Electro-chemistry.* |
| 4.4 | *distinguish between primary and secondary cells;* | Comparison of characteristics such as:<br>(a) terminal voltage;<br>(b) maximum current;<br>(c) internal resistance;<br>(d) portability;<br>(e) rechargeability. | | |
| 4.5 | *draw a circuit diagram to show how a secondary cell can be recharged;* | Note polarity and charging voltage. | | |
| **<u>I - V Relationships</u>** | | | | |
| 4.6 | *investigate the relationship between current and potential difference;* | *(a) Metallic conductors at constant temperature.*<br>*(b) Filament lamps.*<br>*(c) Semiconductor diodes.*<br>*(d) Solutions of copper sulphate in water using copper electrodes.*<br><br>*Refer to SO A1.4.* | Perform these experiments.<br>Draw I – V graphs from the result of such experiments and draw appropriate conclusions from the graphs obtained. | Chemistry- Properties of matter.<br>Mathematics- Functions, Relations and Graphs.<br><br>*Skills: MM; ORR; AI; PD.* |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| **Resistance, R** | | | |
| 4.7 explain the concept of resistance; | *Point out the fact that resistance varies with the current in some cases.* | | |
| 4.8 apply the relationship $R = \frac{V}{I}$; | *Ohm's Law.* *Refer to SO D4.6.* | *Determine resistance using the formula* $R = \frac{V}{I}$. | *Mathematics-Algebra/ Computation.* *Skill: AI.* |
| 4.9 explain why it is necessary for an ammeter to have a very low resistance; | | | |
| 4.10 explain why it is necessary for a voltmeter to have a very high resistance; | | | |
| 4.11 *solve problems involving series and parallel resistance;* | *Use the formulae:* $R_s = R_1 + R_2 + R_3 ....$ *for resistors in series; and* $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + .......$ *for resistors in parallel;* | | *Mathematics-Algebra/ Computation.* *Skill: AI.* |

## SECTION D - ELECTRICITY AND MAGNETISM (cont'd)

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| 4.12 *solve problems involving series, parallel and series-parallel circuits;* | Properties of current and potential difference (p.d.) in series and parallel circuits. | Set up a series circuit and measure current at various points.<br><br>*Set up a parallel circuit and measure current in the branches and on entry and exit.*<br><br>*Set up a series circuit and measure p.d. across components.*<br><br>*Set up a parallel circuit and measure p.d. across components.* | *Mathematics.*<br><br>*Skills: MM; ORR; AI; PD.* |
| **<u>Electricity in the Home</u>** | | | |
| 4.13 discuss the reasons for using parallel connections of domestic appliances; | | | |
| 4.14 explain the purpose of a fuse or circuit breaker and the earth wire; | *Highlight safety issues.* Include fuse in live wire. | | |
| 4.15 select a fuse or circuit breaker of suitable current rating for a given appliance; | | | |
| 4.16 state the adverse effects of connecting electrical appliances to incorrect or fluctuating voltage supplies. | | | |

SECTION D - ELECTRICITY AND MAGNETISM (cont'd)

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| ***5. ELECTRONICS*** | | | |
| Students should be able to: | | | |
| *5.1* describe how a semi-conductor dioxide can be used in half wave rectification*;* | | *Sketch V-t graphs to compare variation of voltage with time before or after rectification.* | *Mathematics- Functions, Relations and Graphs.* |
| *5.2 differentiate between direct current from batteries and rectified alternating current by a consideration of the V – t graphs for both cases;* | | | |
| **Logic Gates** | | | |
| 5.3 *recall the symbols for AND, OR, NOT, NAND, NOR logic gates;* | Limited to two-input logic gates. | | |
| 5.4 *state the function of each gate with the aid of truth tables;* | *Refer to SO D1.3 for similarity to electrical charges.* | | |
| 5.5 *analyze circuits involving the combinations of not more than three logic gates;* | *Example: simple alarm circuits.* | | |
| 5.6 *discuss the impact of electronic and technological advances on society.* | | | |

## SECTION D - ELECTRICITY AND MAGNETISM (cont'd)

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| **6. *MAGNETISM*** | | | |
| **Permanent Magnets** | | | |
| *6.1 differentiate between magnetic and non-magnetic materials;* | | | |
| *6.2 explain how a magnet can attract an unmagnetised object;* | *Refer to SO D1.3 for similarity to electrical charges.* | | |
| *6.3 distinguish between materials used to make "permanent" and "temporary" magnets;* | *Permanent magnets: steel and magnadur. Temporary magnets: iron and mumetal.* | | |
| *6.4 identify* the poles of a magnetic dipole; | *Alignment with the earth's magnetic field.* | Perform an activity to identify the poles of a magnetic dipole. | *Skill: MM.* |
| **Magnetic Forces** | | | |
| 6.5 investigate the forces between magnetic poles; | The effect of the polarity and separation of magnets on the magnitude of the force between them. | *Use two strong magnets to investigate forces between like and unlike poles.* | |
| *6.6* define a magnetic field; | A magnetic field line indicates the direction of the magnetic force acting on an N-pole; | | |

SECTION D - ELECTRICITY AND MAGNETISM (cont'd)

| SPECIFIC OBJECTIVES<br><br>Students should be able to: | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| *6.7* map magnetic fields. | Familiarity with iron filings and plotting compass methods:<br>*(a)* *around a single strong magnet.*<br>*(b)* *around and between two strong magnets.*<br>*Oriented* parallel and anti-parallel and pole to pole with each other. | Map the magnetic field using iron filings and plotting compass. | *Skill: MM.* |
| **7.** ***ELECTROMAGNETISM*** | | | |
| *7.1* conduct simple experiments to investigate the magnetic field pattern around current-carrying conductors; | Straight conductors, flat coils, solenoids. | Map the fields for the given conductor. Sketch the magnetic flux patterns. | *Skills: MM; ORR.* |
| *7.2* apply suitable rules which relate the direction of current flow to the direction of the magnetic field; | *Right hand grip rule, right hand screw rule.* | | |
| *7.3* describe a commercial application of an electromagnet; | Example:<br>Starter Motor.<br>Magnetic Relay. | Construct a simple electromagnet. | *Skills: MM.* |
| **<u>Electromagnetic Force</u>** | | | |
| *7.4* conduct an experiment which demonstrates the existence of a force on a current-carrying conductor placed in a magnetic field; | | Demonstrate the force on the current carrying conductor in a magnetic field. | |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| 7.5 sketch the resultant magnetic flux pattern when a current carrying wire is placed perpendicular to a uniform magnetic field; | | | Skill: ORR. |
| *7.6* apply Fleming's left-hand (motor) rule; | *Predict what will happen when current flow perpendicular to a uniform magnetic field.* *Refer to SO E3.5.* | | |
| 7.7 *identify the factors that affect the force on a current-carrying conductor in a magnetic field;* | *Strength of the field and on the magnitude of the current.* | | |
| **<u>Motors</u>** | | | |
| 7.8 explain the action of a D.C. motor; | | Draw a diagram of a simple D.C. electric motor. *Appliances such as fans, mixers.* | |
| **<u>Induced e.m.f.</u>** | | | |
| 7.9 describe simple activities which demonstrate an induced e.m.f.; | Coil and magnets; two coils. | *Perform activities demonstrating induced e.m.f.* | *Skill: MM.* |
| 7.10 *conduct simple experiments to show the magnitude of the induced e.m.f.;* | *Effect of the rate of change of magnetic flux experienced by the conductor.* | Perform experiments to investigate the factors which affect the magnitude of the induced e.m.f. | *Skills: MM; ORR; AI; PD.* |

## SECTION D - ELECTRICITY AND MAGNETISM (cont'd)

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| 7.11 *predict the direction of induced current given the direction of motion of the conductor and that of the magnetic field;* | | | |
| 7.12 *explain the action of the A.C. generator;* | | *Sketch graphs to represent the output from a simple A.C generator.* | *Mathematics – Graphs and Trigonometric functions.*<br><br>*Skill: ORR.* |
| **<u>Transformers</u>** | | | |
| 7.13 *explain the principle of operation of a transformer;* | Diagram of a simple transformer. | Construct a simple transformer. | *Skill: MM.* |
| 7.14 *state the advantages of using a.c. for transferring electrical energy;* | | | |
| 7.15 *apply the ideal transformer formula* $P_{out} = P_{in}$. | Transformer formulae to solve problems $\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$. | Perform activities to show that for an ideal transformer $\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$. | *Mathematics- Algebra/ Computation* |

## SECTION *D* - ELECTRICITY AND MAGNETISM (cont'd)

***Suggested Teaching and Learning Activities***

*To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.*

1. ***Earth's magnetic poles****: Write a science fiction on a trip to the centre of Earth and use it to explain how planet Earth gets its magnetism.*

   *http://www.physics.org/article-questions.asp?id=64*

2. ***Magnetic fields****: Prepare a five-minute presentation on how frogs, and by extension humans can be levitated.*

   *http://www.physics.org/facts/frog-really.asp*

3. ***Electromagnetic induction:*** *Design a poster to show how metal detectors work employing the principles of electromagnetic induction. Simulation at*

   *http://micro.magnet.fsu.edu/electromag/java/detector/index.html*

4. ***Electric fields:*** *Prepare a safety brochure on the dangers of lightning. Include and explain how tingling of the skin and hair raising can be indicators. During thunderstorms, time the difference between seeing the lightning and hearing the thunder to determine how far away the storm is.*

   *http://theboar.org/science/2010/nov/7/hair-raising-truth-about-lightning/*

   *Simulation - http://micro.magnet.fsu.edu/electromag/java/lightning/index.html*

5. ***Static electricity:*** *Prepare a poster showing examples of use of static electricity in life.*

   *http://hubpages.com/hub/Uses-of-Static-Electricity*

6. ***Magnetic and true north:*** *Fieldwork – determine the difference in the true north found by astronomical position of the north star and the magnetic north using a compass. Observe over a few weeks and see if there are any differences. Write a report.*

   *http://adventure.howstuffworks.com/survival/wilderness/true-north.htm*

   *Simulation: http://micro.magnet.fsu.edu/electromag/java/compass/index.html*

7. ***Electromagnetism:*** *As a class project, build an electromagnet and experiment with their operations.*

   *http://education.jlab.org/beamsactivity/6thgrade/magnetsandelectromagnets/overview.html*

8. ***Transformers:*** *make a list of the items in the home that require a transformer when plugged in. Explain why this is so.*

9. ***AC and DC:*** *Write an essay on how Direct Current (DC) and Alternating Current(AC) were discovered. Why did the AC prevail? List items in the house that use AC and those that use DC.*

   *http://www.teachersdomain.org/resource/phy03.sci.phys.mfw.acdc/*

10. ***Ohm's law****: observe the simulation at:*

    *http://micro.magnet.fsu.edu/electromag/java/ohmslaw/index.html*

## ♦ SECTION *E* - THE PHYSICS OF THE ATOM

*This is the branch of physics that studies the structure of the atom and the interaction of the sub-atomic particles of matter and electromagnetic fields. Students will appreciate how energy can be released from inside the atom and become aware of its impact on society and the environment.*

***GENERAL OBJECTIVES***

On completion of this Section, students should*:*

1. *appreciate the development of atomic theory and the concept of the nucleus;*
2. *understand how the elements differ in atomic structure;*
3. *be familiar with the phenomenon of radioactivity and the safety measures when dealing with radioactive substances;*
4. *know that a change in the nuclear mass is associated with the release of energy;*
5. *appreciate the importance of nuclear energy on society and the environment.*

| **SPECIFIC OBJECTIVES** | **CONTENT/ EXPLANATORY NOTES** | **SUGGESTED PRACTICAL ACTIVITIES** | ***SKILLS AND*** **INTER-RELATIONSHIP** |
|---|---|---|---|
| Students should be able to: | | | |
| **1. MODELS OF THE ATOM** | | | |
| 1. 1 describe the work done in establishing the modern view of the atom; | Include Thomson, Rutherford, Bohr, Chadwick. | | *Chemistry - Atoms and the Periodic table.* |
| 1. 2 *describe the Geiger-Marsden experiment.* | Establish the nuclear structure of the atom. Consider that the nucleus contains protons and neutrons of approximately equal mass. | | *Chemistry-Structure of the atom.* |
| **2. STRUCTURE OF THE ATOM** | | | |
| <u>**Particles in the Atom**</u> | | | |
| 2.1 *sketch the structure of simple atoms;* | Include the distribution of charge. | | Chemistry-Structure of the atom, metallic bonding. |

SECTION *E* - THE PHYSICS OF THE ATOM (cont'd)

| SPECIFIC OBJECTIVES | | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|---|
| Students should be able to: | | | | |
| 2.2 | compare the mass and charge of the electron with the mass and charge of the proton; | Mention could be made of the absolute values in kg and C. | | |
| 2.3 | explain why an atom is normally neutral and stable; | | | *Chemistry- Structure of the atom.* |
| 2.4 | *apply the relationship* $A = Z + N$; | Use of standard notation for representing a nuclide, ${}^{A}_{Z}X$ for example ${}^{12}_{6}C$. | | Chemistry - Atomic number and atomic mass. |
| 2.5 | explain what is meant by the term "isotope"; | | | Chemistry- Isotopes. |
| 2.6 | relate the shell model of the atom to the periodic table. | Any element in the periodic table has one more proton than an element before it. | | Chemistry- Periodic table. |

**3. RADIOACTIVITY**

**Radioactive Emissions**

| | | | | |
|---|---|---|---|---|
| 3.1 | describe Marie Curie's work in the field of radioactivity; | | *Research biography.* | *Chemistry - Marie Curie* |
| 3.2 | *state the nature of the three types of radioactive emissions;* | Relationship between radioactivity and nuclear instability. | Video simulation. | |
| 3.3 | describe experiments to compare the ranges of $\alpha$, $\beta$, and $\gamma$ emission; | | | |
| 3.4 | describe the appearance of the tracks of radioactive emissions in a cloud chamber; | The details of the operation of the cloud chamber are not required. | | |

**SECTION *E* - THE PHYSICS OF THE ATOM (cont'd)**

| SPECIFIC OBJECTIVES | | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|---|
| Students should be able to: | | | | |
| 3.5 | predict the effects of magnetic and electric fields on the motion of $\alpha$ and $\beta$ particles and $\gamma$ rays; | Refer to S.O.D7.7. | | |
| 3.6 | *interpret nuclear reactions in the standard form;* | $^{226}_{88}Ra \rightarrow ^{222}_{86}Rn + ^{4}_{2}He$ <br> $^{14}_{6}C \rightarrow ^{14}_{7}N + ^{0}_{-1}e$ | | *Chemistry-Balancing equations.* |
| 3.7 | conduct an activity to demonstrate the random nature of radioactive decay; | *Activity from which a radioactive decay curve can be obtained.* | *Perform analogue demonstrations to illustrate random processes, for example, throwing of dice, tossing of coins.* | *Skills: MM; ORR; AI.* |
| 3.8 | recall that the decay process is independent of the conditions external to the nucleus; | | | |
| **Half-life** | | | | |
| 3.9 | use graphs of random decay to show that such processes have constant half-lives; | *Definition of the term "half-life", $T_{½}$* Use more than one set of values from graph for comparison. | Plot graphs of demonstrations performed in SO 3.7. | *Mathematics-Functions, Relations and Graphs.* <br><br> *Skills: AI; ORR.* |
| 3.10 | *solve problems involving half-life;* | | | Mathematics-Algebra/ Computation. |
| **Radioisotopes** | | | | |
| 3.11 | discuss the useful applications of radio-isotopes; | Tracers. *Medical and industrial applications. Carbon dating.* | | Chemistry-Isotopes. |

| SPECIFIC OBJECTIVES | CONTENT/ EXPLANATORY NOTES | SUGGESTED PRACTICAL ACTIVITIES | *SKILLS AND INTER-RELATIONSHIP* |
|---|---|---|---|
| Students should be able to: | | | |
| ***Nuclear Energy*** | | | |
| 3.12 *relate* the release of energy in a nuclear reaction *to a* change in mass; | Application of Einstein's equation: $\Delta E = \Delta mc^2$. *Include fission and fusion.* | | Mathematics- Algebra/ Computation.<br><br>Skill: AI. |
| 3.13 cite arguments for and against the utilisation of nuclear energy. | Cost of environmental impact; disposal; safety. | | Biology-Ecology. |

***Suggested Teaching and Learning Activities***

*To facilitate students' attainment of the objectives of this Section, teachers are advised to engage students in the teaching and learning activities below. These activities are designed to promote inquiry-based learning and cater to students with various learning styles.*

1. ***Fusion and fission:*** *Write a play of the story of "Cold Fusion" and its discovery. At the end of the play, explain how energy from fusion can only occur naturally in the sun.*

   http://w3.gre.ac.uk/~bj61/talessi/tlr22.html

2. ***Nuclear Radiation:*** *Organise a class debate for and against the establishment of a nuclear reactor in the Caribbean.*

   http://news.discovery.com/tech/top-five-nuclear-disasters.html
   http://www.benefitsofnuclearpower.com/

3. ***Cosmic radiation:*** *Write a short science fiction story of an Astronomer travelling to Mars and the risks he or she is exposed to.*

   http://spaceinfo.com.au/2011/05/07/space-travel-could-kill-you/

4. ***Nuclear radiation:*** *Design a poster showing the uses of radiation in medicine.*

   http://health.howstuffworks.com/medicine/modern/nuclear-medicine.htm

5. ***Marie Curie:*** *Design a poster highlighting the accomplishments of Marie Curie particularly as a woman in a male dominated field.*

   http://nobelprize.org/nobel_prizes/physics/laureates/1903/marie-curie-bio.html

6. ***Science in research:*** *Conduct research to ascertain if there are any scientists in the region working on nuclear energy. What are the challenges and opportunities for it in the region?*

## ♦ GUIDELINES FOR THE SCHOOL-BASED ASSESSMENT

**RATIONALE**

School-Based Assessment (SBA) is an integral part of student assessment in the course covered by this syllabus. It is intended to assist students in acquiring certain knowledge, skills and attitudes that are critical to the subject. The activities for the School-Based Assessment are linked to the "Suggested Practical Activities" and should form part of the learning activities to enable the student to achieve the objectives of the syllabus.

During the course of study of the subject, students obtain marks for the competencies they develop and demonstrate in undertaking their SBA assignments. These marks contribute to the final marks and grades that are awarded to students for their performance in the examination.

The guidelines provided in this syllabus for selecting appropriate tasks are intended to assist teachers and students in selecting assignments that are valid for the purpose of the SBA. These guidelines are also intended to assist teachers in awarding marks according to the degree of achievement in the SBA component of the course. In order to ensure that the scores awarded by teachers are not out of line with the CXC standards, the Council undertakes the moderation of a sample of SBA assignments marked by each teacher.

School-Based Assessment provides an opportunity to individualise a part of the curriculum to meet the needs of students. It facilitates feedback to the students at various stages of the experience. This helps to build the self-confidence of the students as they proceed with their studies. School-Based Assessment further facilitates the development of critical skills and that allows the students to function more effectively in their chosen vocation and in everyday life. School-Based Assessment therefore, makes a significant and unique contribution to the development of relevant skills by the students. It also provides an instrument for testing them and rewarding them for their achievements.

**PROCEDURES FOR CONDUCTING SBA**

**SBA assessments should be made in the context of normal practical coursework exercises**. *It is expected that the exercises would provide authentic learning experiences.* Assessments should only be made after candidates have been taught the skills and given enough opportunity to develop them. **Sixteen** practicals over the two-year period would be considered the **minimum** number for candidates to develop their skills and on which to base realistic assessments. **These practicals MUST include all of the following:**

1. *Pendulum.*
2. *Momentum/Conservation of Energy.*
3. *Specific heat capacity/Specific Latent heat capacity.*
4. *Refraction.*
5. *Series and Parallel Circuits.*
6. *I-V Relationships.*
7. *Radioactivity Decay (Simulation).*

*Each skill must be assessed* ***at least three times*** *over the two-year period.* Candidates should be encouraged to do corrections so that misconceptions will not persist. As the assessment of certain skills, especially those requiring on-the-spot observation or involve looking at several behaviours or criteria, teachers are advised to select not more than two skills to be assessed in any activity. The practical exercises selected to be used for assessment should make adequate demands on the candidates and the skills assessed should be appropriate for the exercises done. For the assessment of written work, the practical selected should be one that can be completed in the time allotted for the class and **the notebooks should be collected at the end of the period**.

Candidates who have not been assessed over the two-year period will be deemed absent from the whole examination. Under special circumstances, candidates who have not been assessed at all points may, at the discretion of CXC, have their marks pro-rated (adjusted proportionately).

1. **In preparation for an SBA practical, the teacher should**:

   (a) select tasks which must include the **seven** (7) topics on page 53 and should be related to a given syllabus objective. These tasks may be chosen from the "Suggested Practical Activities" and should fit in with the normal work being done in that class;

   (b) list the materials including quantities and equipment that will be needed for each student;

   (c) carry out the experiment beforehand, if possible, to ascertain the suitability of materials and the kind of results (observations, readings) which will be obtained, noting especially any unusual or unexpected results;

   (d) list the steps which will be required by the candidates in performing the experiment. From this it will be clear to the teacher how the candidates should be arranged in the laboratory, whether any sharing of equipment or materials is necessary, the skills which can be assessed from the practical, and the instructions to be given;

   (e) list the skills that may be assessed (for example, observation/recording/reporting, analysis and interpretation). **No more than two practical skills should be assessed from any one activity;**

   (f) select the skills to be assessed on this occasion. Skills other than those required for that year should also be included for teaching purposes;

   (g) work out the criteria for assessing each skill. This will form the basis of a mark scheme and a checklist.

2. **The teacher should carry out the assessment and record the marks.**

   This is the most critical step in the assessment process. For a teacher to produce marks that are reliable, the marking must be consistent for all candidates and the marks should reflect the standard of performance at the level. The teacher must be able to justify the marks, and this occurs when there is a fixed set of conditions, factors or criteria for which the teacher looks. Marks should be submitted electronically to CXC on the SBA form provided. *The forms should be dispatched through the Local Registrar by the Moderator to reach CXC by 30 April of the year of the examination.*

**ASSESSMENT OF PRACTICAL SKILLS**

School-Based Assessment will assess skills under the profiles Experimental Skills and Use of Knowledge (Analysis and Interpretation only).

The assessment will be conducted during Terms 1 - 5 of the two-year period following the programme indicated in the Table below.

**SBA SKILLS TO BE ASSESSED FOR CXC MODERATION**

| **PROFILE** | **SKILLS** | **YEAR 1** | | **YEAR 2** | | ***TOTAL*** | | |
|---|---|---|---|---|---|---|---|---|
| | | **NO. OF TIMES SKILLS TO BE ASSESSED** | **MARKS** | **NO. OF TIMES SKILLS TO BE ASSESSED** | **MARKS** | **NO. OF TIMES SKILLS TO BE ASSESSED** | ***MARKS*** | |
| | Manipulation/ Measurement | 1 | *10* | *2* | *20* | ***3*** | *30* | |
| XS | Observation/ Recording/ Reporting | 1 | *10* | *2* | *20* | *3* | *30* | *90* ***(30*)*** |
| | Planning and Designing | 2 | *20* | *1* | *10* | *3* | *30* | |
| UK | Analysis and Interpretation | 2 | *20* | *1* | *20* | *3* | *40* | *40* ***(10*)*** |
| | **TOTAL** | 6 | *60* | *6* | *70* | *12* | *130* | *40** |

***Weighted mark**

*Investigative project to be done in Year 2.*

*The investigative project would be assessed for two skills, Planning and Design and Analysis and Interpretation.*

***Students who are pursuing two or more of the single science subjects (Biology, Chemistry, Physics) may opt to carry out ONE investigation* only from any of these subjects.***
***[ONLY the marks for the investigation can be transferred across subjects.]***

**ASSESSMENT OF INVESTIGATION SKILLS**

**Proposal (Planning and Design)**

| | |
|---|---|
| **The maximum marks available for the Proposal is** | ***10 marks*** |

The format for this part is shown below

| | |
|---|---|
| Observation/Problem/Research question stated | |
| Hypothesis | *2 marks* |
| Aim | *1 mark* |
| Materials and Apparatus | *1 mark* |
| Method | *2 marks* |
| *Controlled variables* | *1 mark* |
| *Expected Results* | *2 marks* |
| *Assumptions, Precautions/ Limitations* | *1 mark* |
| ***TOTAL*** | ***10 marks*** |

**Implementation (Analysis and Interpretation)**

| | |
|---|---|
| **The maximum marks available for the Implementation is** | ***20 marks*** |

The format for this part is shown below.

| | |
|---|---|
| Method | *1 mark* |
| Results | *4 marks* |
| Discussion | *5 marks* |
| Limitation | *3 marks* |
| Reflection | 5 marks |
| *Conclusion* | *2 marks* |
| ***TOTAL*** | ***20 marks*** |

## REPORTING FORMAT OF INVESTIGATION

**PART A THE PROPOSAL (Planning and Design)**

**Statement of the Problem** – Can be an observation, a problem
**Hypothesis**
**Aim** – Should be related to the hypothesis
**Materials and Apparatus**
**Method** – Should also include variables
**Assumptions/Precautions**
**Expected Results**

**PART B THE IMPLEMENTATION (Analysis and Interpretation)**

**Method** - Linked to Part A (change of tense)
**Results**
**Discussion** – Explanations/Interpretations/Trends
**Limitations**
**Reflections**
**Conclusion**

## CRITERIA FOR ASSESSING INVESTIGATIVE SKILLS

**A. PLANNING AND DESIGN**

| | | | |
|---|---|---|---|
| **HYPOTHESIS** | | **2** | |
| - *Clearly stated* | *1* | | |
| - *Testable* | *1* | | |
| **AIM** | | **1** | |
| - *Related to hypothesis* | *1* | | |
| **MATERIALS AND APPARATUS** | | **1** | |
| - *Appropriate materials and apparatus* | *1* | | |
| **METHOD** | | **2** | |
| - *Suitable* | *1* | | |
| - *At least one manipulated or responding variable* | *1* | | |
| **CONTROLLED VARIABLE** | | **1** | |
| -*Controlled variable stated* | *1* | | |
| **EXPECTED RESULTS** | | **2** | |
| - *Reasonable* | *1* | | |
| - *Link with method* | *1* | | |
| **ASSUMPTIONS/PRECAUTIONS/POSSIBLE SOURCES OF ERRORS** | | **1** | |
| - *Any one stated* | *1* | | |
| **TOTAL** | | | **(10)** |

**B. ANALYSIS AND INTERPRETATION**

| | | |
|---|---|---|
| **METHOD** | | **1** |
| Linked to Proposal, Change of tense | | |
| ***RESULTS*** | | **4** |
| - *Correct formulae and equations:* | *2* | |
| *Accurate (2)* | | |
| *Acceptable (1)* | | |
| - *Accuracy of data:* | *2* | |
| *Accurate (2)* | | |
| *Acceptable (1)* | | |
| **DISCUSSION** | | **5** |
| - *Explanation* | *2* | |
| *Development of points:* | | |
| *Thorough (2)* | | |
| *Partial (1)* | | |
| - *Interpretation* | *2* | |
| *Fully supported by data (2)* | | |
| *Partially supported by data (1)* | | |
| - *Trends:* | *1* | |
| *Stated* | | |
| **LIMITATIONS** | | **3** |
| -Sources of error identified | *1* | |
| -Precautions stated | *1* | |
| -*Limitation stated* | *1* | |
| **REFLECTIONS** | | **5** |
| - *Relevance between the experiment and real life (Self, Society or Environment)* | *1* | |
| - *Impact of knowledge gain from experiment on self* | *1* | |
| - *Justification for any adjustment made during experiment* | *1* | |
| - *Communication of information* | *2* | |
| (Use of appropriate scientific language, grammar and clarity of expression all of the time (2); some of the time (1) | | |
| **CONCLUSION** | | **2** |
| - *Stated* | *1* | |
| - *Related to the aim* | *1* | |

**TOTAL** **(20)**

**EXEMPLAR OF INVESTIGATIVE PRACTICAL**

**EXEMPLAR 1**

**PART A-THE PROPOSAL**

**Observation**

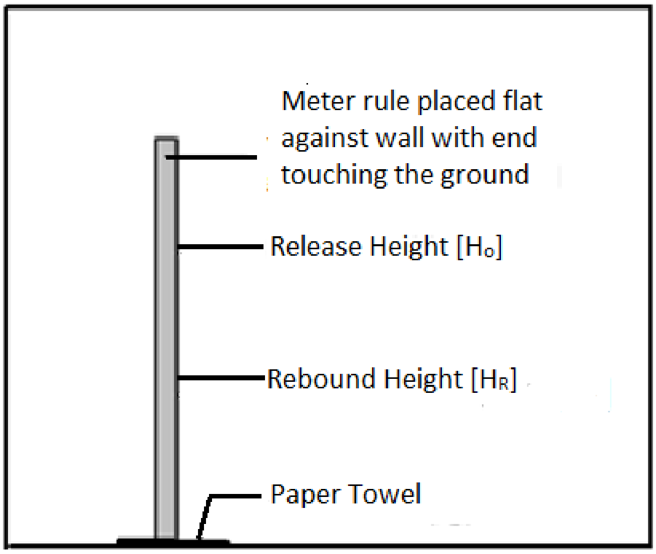
During lunch break at school Darren noticed his rubber ball did not bounce as high as it normally would when it landed on a paper towel. Darren now claims if more paper towels are added the ball's rebound height would decrease.

**Hypothesis:** The height of rebound of a rubber ball decreases with the addition of paper towels.

**Aim:** To investigate the height of rebound [$H_r$] of a rubber ball with increasing paper towels.

**Apparatus:** Meter rule; paper towels; rubber ball; pencil.

**Diagram**




**Variables**

Independent – Number of paper towels
Dependent – Height of rebound
Controlled/ Constant – Rubber Ball; Height of Release

**Method**

1. Securely place meter rule vertically against a wall.

2. Mark off a suitable release height [$\mathbf{H_O}$] , [the ball must be allowed to FALL vertically and REBOUND on nearly the same straight line].

3. With no paper towels at the base of the meter ruler, release the rubber ball from the marked height [the ball must be completely above the marked line with its bottom edge just touching the line].

4. Observe and record the rebound height of the ball [$\mathbf{H_R}$], [this should be done from in front of the ruler and eye level]. Repeat twice for this number of paper towels. Record all data.

5. Place a single paper towel at the base of the ruler and release it from marked height.

6. Observe and record the rebound height of the ball. Repeat steps 4 and 5 twice for that number of paper towels, recording all data.

7. Continue adding paper towels and repeat step 6 until there are 8 paper towels.

8. Calculate average rebound height [$H_r$] for each number of paper towels.

9. Plot a graph of Rebound Height [y axis] against Number of paper towels [x axis]

**Expected Results**

The rubber ball will reach maximum rebound height when it bounces on the ground with no paper towels present. As the paper towels are added it will rebound to a consistently lower height.

**PART B- THE IMPLEMENTATION**

**Method**

1. The meter rule was securely placed vertically against a wall with the 0 cm end touching the ground.

2. The release height, $H_o$, was set at 60 cm.

3. With no paper towels at the base of the meter ruler, the rubber ball was released from the 60 cm mark and the height of rebound was recorded. This step was repeated two more times and the data recorded.

4. A single paper towel was placed at the base of the ruler and the ball was released from the 60 cm mark. The new height of rebound was recorded. This was repeated two more times and data recorded.

5. Another paper towel was added and the rubber ball was released three times from the 60 cm mark. All rebound heights were recorded.

6. Step 5 was repeated until there were 7 paper towels at the base of the ruler.

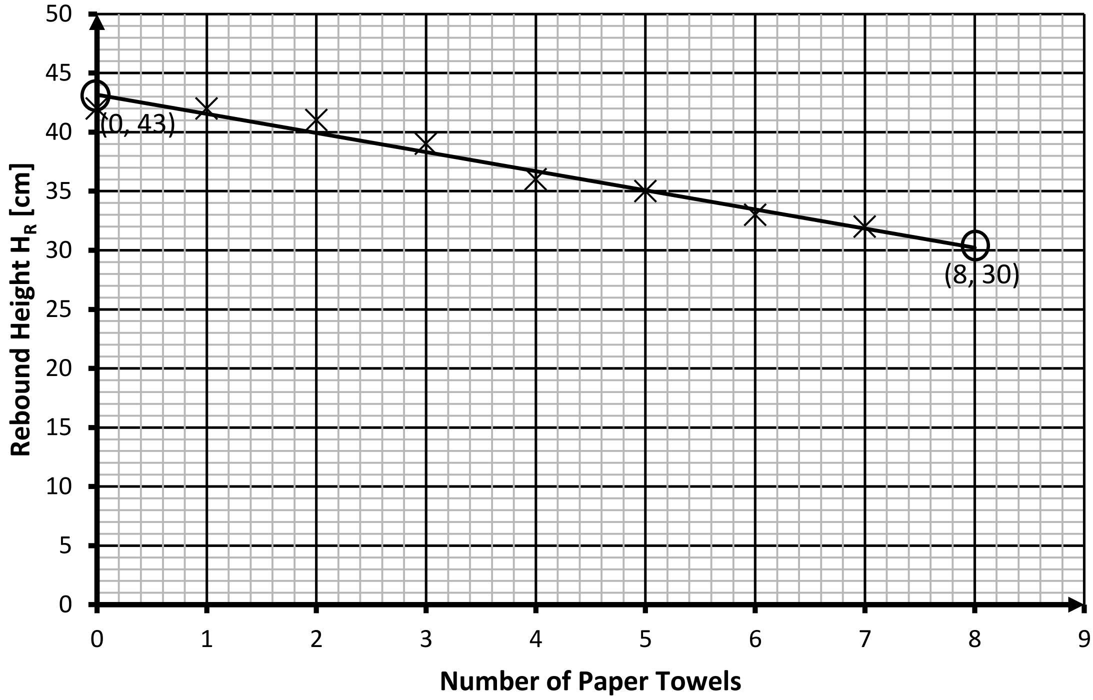
7. The average rebound height [$H_r$] was calculated for each number of paper towels.

8. A graph of Rebound Height [y axis] against Number of paper towels [x axis] was plotted.

**Results**

| # of paper towels | Rebound Height, $H_R$[cm] (Attempts) | | | Average Rebound Height, $H_R$[cm] |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| 0 | 42 | 43 | 42 | 42 |
| 1 | 42 | 42 | 42 | 42 |
| 2 | 41 | 41 | 41 | 41 |
| 3 | 39 | 40 | 39 | 39 |
| 4 | 36 | 35 | 36 | 36 |
| 5 | 34 | 35 | 35 | 35 |
| 6 | 33 | 33 | 33 | 33 |
| 7 | 32 | 32 | 32 | 32 |

## Graph of Rebound Height Against Number of Paper Towels for a Rubber Ball



**Calculations**

Using points (0, 43) and (8, 30) to calculate the slope/gradient:

$$S = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{43 - 30}{0 - 8}$$
$$= \frac{13}{-8}$$
$$= -1.6 \text{ (cm/paper towel)}$$

**Discussion**

When the results were represented on a graph, the points defined a straight line. This allows the relation between the rebound height and the paper towels to be described by a linear equation of the form:

$$y = mx + c$$

Where $y$ = Rebound height, $x$ = number of paper towels, $m$ = slope/gradient and $c$ = intercept on the $y$-axis.

From the calculations the relation between the paper towels and the rebound height of the ball is described by:

$$R_H = -1.6N + 43$$

Where $R_H$ is the rebound height and $N$ is the number of paper towels.

When $N$ = 0, the rebound height is 43 cm. As $N$ increases, $R_H$ decreases because the slope is negative. According to the relation, the rebound height will be zero when the number of paper towels is approximately 27.

**Limitations**

**Sources of Error/Limitation**

The ball achieves its rebound height for a very short time. To measure this height during this short time was difficult. At times only an approximation can be made. This introduces an error and a limitation in determining the accurate rebound height whenever a paper towel is added.

**Precautions**

Read rebound heights perpendicular to the ruler.
Repeat the experiment for each number of paper towels at least 3.

**Reflections**

The paper towels used in this experiment are much softer than the ground and the ball. This indicates that the paper towels decreases the rate of change of momentum of the ball and as a result decreases the force of impact of the ball with the ground. The reduction in the force of impact is as a result of the work done in compressing the paper towels on impact. Thus, the ball has less energy to rebound and as a result its rebound height decreases.

**Conclusion**

The rebound height decreases with increasing number of paper towels.

**Exemplar 2**

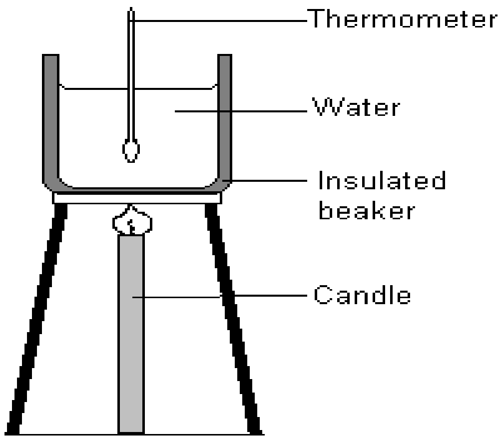
**PART A - THE PROPOSAL**

**Observation**

During a power outage one night, Devon lit a candle and without thinking, placed it near to his bedroom wall. Shortly after, the power was restored. He was surprised when he noticed the wall was warm. The following day in school he told some classmates about this and they decided to see how much energy a candle could release in a few minutes.

**Aim:** To investigate the heat energy released by a candle in 5 minutes.

**Apparatus:** Tripod stand; candle; insulated beaker; stirrer; thermometer; retort stand.




**Variables**

Independent – Time for which candle is lit
Dependent – Energy Released
Controlled – volume of water

**Method**

1. Fill the beaker up to the 300 ml mark with distilled water and place it on the tripod stand.

2. Using the retort stand, suspend the thermometer in the centre of the beaker [ensure the thermometer does not touch the bottom of the beaker]. Observe and record initial temperature of the water.

3. Place candle directly under the tripod stand and light it [ensure the flame is as close to the bottom of the beaker as possible].

4. Let the candle light for 5 minutes. Observe and record the final temperature of the water.

5. Calculate the heat supplied by the candle using the formula $E_H = mc\Delta\Theta$.

**Expected Results**

The temperature of the water will increase by as much as $5^{o}$ or more.

**PART B - THE IMPLEMENTATION**

**Method**

1. The beaker was filled up to the 300 ml mark with distilled water and placed on the tripod stand.

2. Using the retort stand, the thermometer was secured at the centre of the beaker so that it does not touch the bottom of the beaker. The initial temperature of the water was measured and recorded.

3. The candle was placed directly under the tripod stand and lit. It was ensured the flame was as close to the bottom of the beaker as possible. The stop watch was started simultaneously.

4. The candle was allowed to be lit for 5 minutes .

5. The final temperature of the water after the five minutes was measured and recorded.

6. The heat supplied by the candle was calculated using the formula $E_H = mc\Delta\Theta$.

**Results**

Initial Temperature of water [$\Theta_1$] = 28°C
Final Temperature of water [$\Theta_2$] = 34°C
Volume of water = 300 ml

**Calculations:**

Temperature change [$\Delta\Theta$] = $\Theta_2 - \Theta_1$ [note the temperature change in degrees Celsius is the same as in Kelvin] = 34 – 28 = 6 K

Mass of water = Volume of water × Density of water
= $300cm^3 \times 1g/cm^3$ = 300g = 0.3kg
$E_H$ = mass of water × temperature change × specific heat capacity of water
$E_H$ = 0.3 kg × 6 K × 4200 J/kg/K
$E_H$ = 7560 J

**Discussion**

The amount of energy released by a candle in 5 minutes was of the order of several kilojoules. If the candle was lit for a longer period of time more energy would be released. It requires 90,720 J of heat energy to bring 300 g of water to its boiling point. According to the calculations, it would take the candle approximately 12 minutes to accomplish this task.

**Limitations**

**Sources of Error/Limitation**
Not all the heat energy produced by the candle was absorbed by the water. Some heat energy was absorbed by the beaker and tripod stand. Hence, the heat energy yielded for this experiment is only a fraction of the total heat energy produced by the candle.

**Precautions**
Read temperature perpendicular to the scale and above the meniscus.
Place candle as close to the beaker as possible

**Reflections**

Candles are commonly used during power outages as a source of light. A lit candle generates both light energy and heat energy. The latter being the greater energy produced. These cheap and common light sources can be dangerous if attention is not paid to how and where they are placed.

**Conclusion**

The heat energy released by the candle in 5 minutes is 7560 J.

***Moderation of School-Based Assessment***

*The reliability (consistency) of the marks awarded by teachers on the School-Based Assessment is an important characteristic of high quality assessment. To assist in this process, the Council undertakes on-site moderation of the School-Based Assessment conducted by visiting external Moderators.*

*The Moderator will make a first visit in Term 3 of Year 1. Teachers must make available to the Moderator **ALL** Assessment Sheets (Record of Marks, Mark Schemes and the proposal for the Investigation).*

*During the Term 2 of Year 2, the Moderator will make a second visit. Teachers must make available to the Moderator **ALL** Assessment Sheets (Record of Marks, Mark Schemes and the report on the Investigation). **Teachers are NOT required to submit to CXC samples of candidates' work, unless specifically requested to do so by the Council BUT will be required to submit the candidates' marks electronically.***

*The Moderator will remark the skills, and investigation reports for a sample of five candidates, who are selected using the guidelines listed below.*

1. *Candidates' total marks on the SBA are arranged in descending order (highest to lowest).*

2. *The sample comprises the work of the candidates scoring the:*

   (a) *highest Total mark;*
   (b) *middle Total mark;*
   (c) *lowest Total mark;*
   (d) *mark midway between the highest and middle Total mark;*
   (e) *mark midway between the middle and lowest Total mark;*

3. *The candidates selected above may be required to demonstrate some practical skills.*

*Teachers' marks may be adjusted as a result of the moderation and feedback will be provided by the Moderator to the teachers.*

*The Moderator may re-mark the assignments of additional candidates. Where the total number of candidates is five or fewer, the Moderator will remark **ALL**.*

*On the first visit, the Moderator will re-mark a sample of the Year 1 candidates. A copy of this report must be retained by the teacher, and be made available to the Moderator during Term 2 of Year 2.*

*The Moderator will submit the Assessment Sheets, moderation of SBA Sample and the moderation reports to the Local Registrar by April 30 of the year of the examination. A copy of the Assessment Sheets and candidates' work must be retained by the school for three months after the examination results are published by CXC.*

*School-Based Assessment Record Sheets are available online via the CXC's website www.cxc.org.*

*All School-Based Assessment Record of marks must be submitted online using the SBA data capture module of the Online Registration System (ORS).*

**STRATEGIES FOR ASSESSING PRACTICAL OBJECTIVES**

The basic strategy for assessing practical objectives in Physics comprises the following:

**STEP I**

Selection of the task or investigation and the corresponding syllabus objectives.

**STEP II**

1. Preparing the apparatus and the teacher performing the activity.
2. Determining and selecting skills to be assessed.
3. Developing the criteria for assessing each skill.
4. Designing rating scales based on the criteria.

**STEP III**

Breakdown of work to be done by candidate.

**STEP IV**

Carrying out assessment and recording marks.

**Further explanation of Steps I-IV**
The following is a more detailed explanation of what should take place in Steps I - IV.

**Re: STEP I**

The selection of the task or investigation should be done along with the preparation of the scheme of work for the term or year for each class. The task selected should contribute to the development of skills and attitudes within the subject and match a given syllabus objective (general or specific). Both qualitative and quantitative work should be included.

**Re: STEP II**

1. After selection of the task the teacher should prepare the required apparatus and materials. The teacher should perform the activity before presentation to the candidates as this can help in determining the steps involved and the skills that can be assessed (see Step III).

2. Before selecting the skills to be assessed the teacher should list all the skills that could be assessed. This may be achieved by preparing a step by step outline of the task and noting the skills involved in each step. Teachers are advised whenever possible to select only one skill to be assessed in any one activity.

3. Developing the criteria for assessing each skill is the most critical step in the assessment process. For a teacher to produce marks that are reliable the marking must be consistent for all candidates and the marks should reflect the standard of performance at the level. The teacher must be able to justify the marks and this occurs when there is a fixed set of conditions, factors or criteria for which the teacher looks.

## CRITERIA FOR THE ASSESSMENT OF EACH SKILL

For each skill there may be a number of general criteria from which the teacher may select depending on the nature of the activity. It is especially important to make such a selection when there are numerous criteria as it is difficult to assess more than a few at a time without sacrificing accuracy. The following lists represent general criteria as may be defined under a particular skill:

### A. OBSERVATION/RECORDING/REPORTING

(i) Selects appropriate observations.
(ii) Makes accurate recordings/observations.
(iii) Uses appropriate format of presentation.
(iv) Uses acceptable language/expression.
(v) Uses appropriate tables/diagrams/graphs.

### B. MANIPULATION/MEASUREMENT

(i) Follows instructions.
(ii) Uses basic laboratory equipment correctly.
(iii) Sets up electrical circuits correctly.
(iv) Uses electrical circuits correctly.
(v) Prepares material for observation or investigation correctly.

### C. *PLANNING AND DESIGNING*

(i) Suggests appropriate hypotheses.
(ii) Suggests suitable and feasible methods for data collection.
(iii) Identifies and controls variables appropriately.
*(iv)* Takes account of possible sources *of error or danger.*

### D. ANALYSIS AND INTERPRETATION

(i) Makes accurate calculations and logical inferences from data.
(ii) Predicts from data.
(iii) Evaluates data (including sources of error).
(iv) Identifies relationships and patterns within data.

**NOTE: Plotting and drawing of graphs would be assessed in Observation/Recording/Reporting whereas inferences from graphs would be assessed under Analysis and Interpretation.**

**Using a Checklist**

Assessing candidates in some of the skills could be conveniently done by marking the candidates' laboratory notebooks. However, in the skills Manipulation/Measurement teachers will find it easier to write down marks as the activity is occurring. A convenient way of doing this is by using checklists. The column headings reflect what the teacher is looking for and a tick may be used to show that the candidate was displaying a satisfactory behaviour. More than one tick may occur in one column if the teacher checks a candidate more than once during the activity. A zero may be used to show that the candidate was displaying an unsatisfactory behaviour. The ticks and zeros should help the teacher decide on a mark for a candidate (see below).

**CHECKLIST FOR USE OF A MEASURING CYLINDER**

| NAMES | Rests on flat surface | Meniscus read to avoid parallax | Bottom of meniscus read | MARK |
|---|---|---|---|---|
| L. Allie | | | | |
| H. Cassie | | | | |
| S. Williams | | | | |
| D. Wong | | | | |

4. If the criteria are clear and adequate, a rating scale is relatively easy to define. The range required by the syllabus is an 11-point scale ranging from 0-10. If the number of criteria is small then several assessments may be necessary, perhaps of different pieces of apparatus in one activity.

   It is important that a record of the criteria and rating scale used for each activity be kept to avoid duplication and it is advisable to submit, along with the final mark sheet of candidates' scores, a copy of such record.

**Re: STEP III**

The teacher should prepare a step by step outline of the task. Such an analysis would provide a good guide as to the format of the sessions, for example, work stations, groups, individual and worksheets, experimental format and the skills and objective(s) which may be assessed.

**Re: STEP IV**

A Teacher's Mark Book (which is retained by the school) should contain all the marks from which the averages are derived. The SBA Form which is submitted to CXC shows only the candidate's average mark at each point in each skill to be assessed at the point. At the end of this appendix is an example of the SBA Form and a possible format of a Teacher's Mark Book.

**LABORATORY NOTEBOOKS**

A sample of laboratory notebooks will be required to help moderate the teacher's scores.

1. The notebook should contain all the practical work that the candidate does (not only that which is assessed).

2. It is advisable for three pages to be left blank at the front of the practical notebook for a list of contents giving the practical activity and the date on which it was performed.

3. The activities used for SBA should be indicated.

4. The marks awarded for each skill selected within an activity should be indicated.

5. The notebooks should contain a variety of practical activities that are spread over the entire syllabus. Teachers may wish to consider some of the questions set by CXC in Question 1 of the Practical examination prior to 1997 as possible examples of open-ended investigative activities.

**SELECTION OF ACTIVITIES**

Teachers must bear in mind that opportunities for the development of the skills in the SBA are needed before their assessment. Again the point is made that practicals of a more open-ended, investigatory nature should also be utilized. Teachers should refer to the "Suggested Practical Activities" for ideas for practical work in the different section of the syllabus.

## APPLYING THE ASSESSMENT STRATEGY

### EXAMPLE

The following is an example of how the strategy may be applied to a specific task:
**STEP I**

To investigate the factors which might affect the period of simple pendulum (Specific Objective Section A 1.2).

**STEPS II AND III**

**Apparatus per candidate or group**
Stand or clamp, fine thread, several small objects of various masses for use as pendulum bobs, stop watch, metre rule.

**1. Outline of task**

(a) Sets up apparatus appropriately.
(b) Controls variables (in procedure).
(c) Times several oscillations more than once.
(d) Averages sensible results.
(e) Compares results and draws appropriate conclusions.

**2. Manipulation/Measurement is the skill selected for assessment.**

**3. Manipulation/Measurement**

Criteria for assessment.

(a) Uses vertical reference lines.
(b) Measures length of pendulum to centre of bob.
(c) Checks zero error on stop clock or stop watch.
(d) Operates clock or watch correctly.
(e) Uses count down method.
(f) Reads scale to avoid parallax.

**Note:** The same experiment could have been used to assess Planning and Designing as follows:

Planning and Designing

(i) identifies appropriate variables.
(ii) maintains all but one variable constant for one series of readings.
(iii) times a reasonable number of oscillations.
(iv) repeats timing for same number of oscillations under same conditions.

4. **Teacher's rating scale**

**STEP IV**

Assessment performed and marks entered in Teacher's Mark Book.

**RECORDING FOR SBA**

**Teacher's Mark Book**

| SKILL | OBSERVATION/RECORDING/ REPORTING | | | MANIPULATION/ MEASUREMENT | | | ANALYSIS AND INTERPRETATION | | | | PLANNING AND DESIGNING | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 18/1 | Total | Out of 10 | 10/12 | Total | Out of 10 | 25/1 | 28/3 | Tot. | Out of 20 | 3/2 | 31/3 | Tot. | Out of 20 | YEAR 1 |
| Maximum Mark | 12 | 12 | | 8 | 4 | | 15 | 10 | 25 | | 8 | 9 | 17 | | 60 |
| Ammar, Annette | 12 | 5 | 9 | 7 | 4 | 9 | 10 | 8 | 18 | 14 | 6 | 5 | 11 | 12 | |
| McNab, Bryan | 10 | 4 | 6 | 6 | 3 | 7 | 12 | 10 | 22 | 18 | 3 | 2 | 5 | 6 | |
| Singh, Ricki | 4 | 2 | 3 | 4 | 3 | 7 | 1 | 5 | 6 | 4 | 2 | 7 | 9 | 10 | |
| Thompson, Neil | 9 | 5 | 8 | 8 | 3 | 8 | 8 | 4 | 12 | 10 | 4 | 9 | 13 | 16 | |
| Wong, Claudette | 7 | 4 | 6 | 3 | 2 | 5 | 14 | 9 | 23 | 18 | 3 | 4 | 7 | 8 | |

**Teacher's Mark Book**

| SKILL | OBSERVATION/RECORDING/ | | | | MANIPULATION/ MEASUREMENT | | | | ANALYSIS AND INTERPRETATION | | | PLANNING AND DESIGNING | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | | 14/3 | Tot. | Out of 20 | | 20/4 | Tot. | Out of 20 | | Tot. | Out of 10 | 3/2<br>31/3 | Tot. | Out of 20 | YEAR 1 |
| Maximum Mark | | 6 | 27 | | | 4 | 18 | | | 25 | | 8<br>9 | 17 | | 70 |
| Ammar, Annette | | 5 | 25 | | | 4 | 16 | | | 18 | | 6<br>5 | 11 | | |
| McNab, Bryan | | 4 | 16 | | | 3 | 11 | | | 22 | | 3<br>2 | 5 | | |
| Singh, Ricki | | 2 | 9 | | | 3 | 12 | | | 6 | | 2<br>7 | 9 | | |
| Thompson, Neil | | 5 | 21 | | | 3 | 14 | | | 12 | | 4<br>9 | 13 | | |
| Wong, Claudette | | 4 | 17 | | | 2 | 9 | | | 23 | | 3<br>4 | 7 | | |

**N.B.:**

1. Although more than one skill may be assessed by any one component, the marks are more objective if the teacher concentrates on assessing one skill during a particular period of time.

2. **Note that no special assessment exercises need to be planned. The teachers will, as is customary, be recording periodic "marks" for their candidates. The difference is that, since these "marks" will now contribute to an assessment external to the school, they need to be more directed. Several of the objectives can be assessed from work which would normally be collected for marking.**

# CARIBBEAN EXAMINATIONS COUNCIL

**SCHOOL-BASED ASSESSMENT IN PHYSICS7**

NAME OF SCHOOL:________________________________ SCHOOL CODE:________________ YEAR OF FINAL EXAMINATION______________________

NAME OF TEACHER:________________________________ TERRITORY:________________________

| REGISTRATION NUMBER | CANDIDATES NAME | YEAR 1 | | | | TOTAL | YEAR 2 | | | | TOTAL | TOTAL | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | XS MM | XS ORR | XS PD | UK AI | Year 1 | XS MM | XS ORR | XS PD | UK AI | Year 2 | PROFILE | | OVERALL | |
| | | P3 (10) | P3 (10) | P3 (20) | P2 (20) | 60 | P3 (20) | P3 (20) | P3 (10) | P2 (20) | 70 | P3 (90) | P2 (40) | | |
| | | | | | | | | | | | | | | | |
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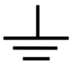
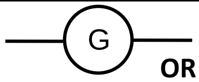
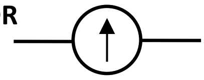
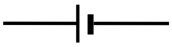
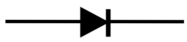
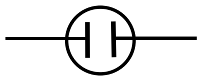
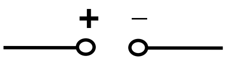
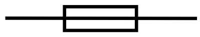
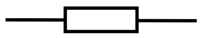
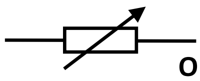
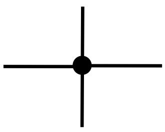
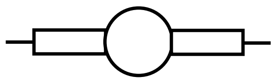
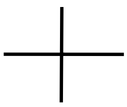
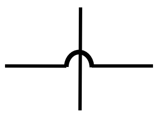
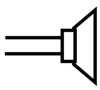
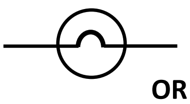
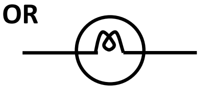
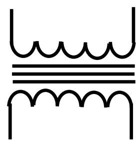
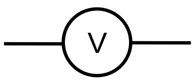
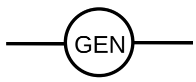
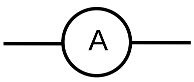
TEACHER'S SIGNATURE:______________________ PRINCIPAL'S NAME: ___________________________________

**DATE:** ___________________________________ **PRINCIPAL'S SIGNATURE:** ___________________________________

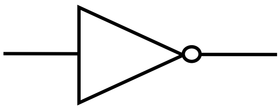
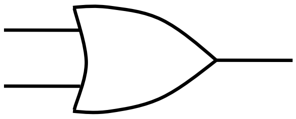
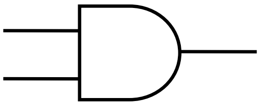
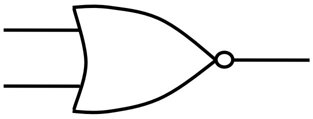
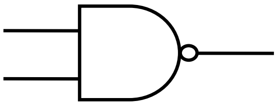
## ♦ LIST OF PHYSICAL QUANTITIES AND THEIR SYMBOLS

| NAME OF QUANTITY | SYMBOL | NAME OF QUANTITY | SYMBOL |
|---|---|---|---|
| ELECTRIC CURRENT | $I$ | SPECIFIC LATENT HEAT | |
| LENGTH | $l$ | OF FUSION | $l_f$ |
| MASS | $m$ | OF VAPORISATION | $l_v$ |
| TEMPERATURE: (KELVIN) | $T$ | WAVELENGTH | $\lambda$ |
| (CELSIUS) | $\theta$ | | |
| TIME | $t$ | PERIOD | $T$ |
| VOLUME | $V$ | AMPLITUDE | $a$ |
| AREA | $A$ | FREQUENCY | $f$ |
| ANGLE | $\theta$ | OBJECT DISTANCE | $u$ |
| DENSITY | $\rho$ | IMAGE DISTANCE | $v$ |
| RELATIVE DENSITY | $\rho_r$ | FOCAL LENGTH | $f$ |
| FORCE | $F$ | REFRACTIVE INDEX | $n$ |
| MOMENT OF FORCE OR TORQUE | $T$ | LINEAR MAGNIFICATION | $m$ |
| DISPLACEMENT, DISTANCE | $s, x$ | ELECTRIC CHARGE | $Q$ |
| SPEED, VELOCITY | $v$ | POTENTIAL AND POTENTIAL DIFFERENCE | $V$ |
| ACCELERATION | $a$ | ELECTRO-MOTIVE FORCE | $E$ |
| MOMENTUM | $p$ | RESISTANCE | $R$ |
| ENERGY | $E, W$ | WEIGHT (GRAVITATIONAL FORCE) | $W$ |
| WORK | $W$ | ACCELERATION DUE TO GRAVITY | $g$ |
| POTENTIAL ENERGY | $E_P$ | MASS OF ELECTRON | $m_e$ |
| KINETIC ENERGY | $E_K$ | CHARGE OF ELECTRON | $e$ |
| THERMAL ENERGY | $E_H$ | PROTON (ATOMIC) NUMBER | $Z$ |
| POWER | $P$ | NUCLEON (MASS) NUMBER | $A$ |
| PRESSURE | $p$ | NEUTRON NUMBER | $N$ |
| SPECIFIC HEAT CAPACITY | $c$ | HALF LIFE | $T_{½}$ |
| HEAT CAPACITY | $C$ | VELOCITY OF LIGHT IN VACUO | $c$ |

## ♦ LIST OF GRAPHICAL SYMBOLS AS USED IN CIRCUIT DIAGRAMS

| DESCRIPTION | GRAPHICAL SYMBOL(S) | DESCRIPTION | GRAPHICAL SYMBOL(S) |
|---|---|---|---|
| EARTH |  | GALVANOMETER |   OR  |
| CELL |  | SEMI-CONDUCTOR DIODE |  |
| BATTERY OF CELLS |  | ELECTROLYTIC CELL OR VOLTAMETER |  |
| D. C. SUPPLY |   | FUSE |  OR  |
| A. C. SUPPLY |  | FIXED RESISTOR |  OR  |
| SWITCH |  | VARIABLE RESISTOR |  OR  |
| JUNCTION OF CONDUCTORS |  | ELECTRIC MOTOR |  |
| ONE WIRE CROSSING ANOTHER NO ELECTRICAL CONNECTION |  OR  | LOUDSPEAKER |  |
| FILAMENT LAMP OR BULB |  OR  | TRANSFORMER |  |
| VOLTMETER |   | GENERATOR |   |
| AMMETER |   | | |

**LIST OF GRAPHICAL SYMBOLS AS USED IN CIRCUIT DIAGRAMS (cont'd)**

| DESCRIPTION | GRAPHICAL SYMBOL(S) | DESCRIPTION | GRAPHICAL SYMBOL(S) |
|---|---|---|---|
| NOT |  | OR |  |
| AND |  | NOR |  |
| NAND |  | | |

# RECOMMENDED MINIMUM EQUIPMENT LIST

(Recommended quantity per 25 candidates)

| | QUANTITY | ITEM |
|---|---|---|
| 1. | 12 | Metre rule |
| 2. | 12 | Half metre rule |
| 3. | 12 | Callipers |
| 4. | 12 | Vernier callipers |
| 5. | 12 | Micrometer screwgauge |
| 6. | 5 | Top pan balance |
| 7. | 112 | Spring balance (0 - 2.5)N |
| 8. | 1 | Spring balance (0 - 10)N |
| 9. | 12 | Stop watch (or clock) |
| 10. | 24 | Retort stand and clamp/boss head |
| 11. | 12 | Pendulum bob |
| 12. | 5 | Eureka/overflow can |
| 13. | 2 | Sets rectangular blocks of different materials having similar and different dimensions |
| 14. | 12 | Knife edge (commercial or improvised) |
| 15. | 12 | Helical spring yielding 0.5N $cm^{-1}$ |
| 16. | | Thread/String (as needed) |
| 17. | 144 | Straight (common) pin |
| 18. | 12 | Set hook (stirrup) + set of slotted masses (10 x 100g) |
| 19. | 2 | Acceleration trolley |
| 20. | 1 | Electronic timer |
| 21. | 12 | Single pulley |
| 22. | 12 | Double pulley |
| 23. | 1 | Manometer |
| 24. | 1 | 12m length of transparent PVC tubing diameter = 3cm |
| 25. | 8 | Sets brass masses (1 x 10g; 2x20g; 1x50g; 1x100g) |
| 26 | 12 | Thermometer: –10°C to 110°C |
| 27. | 5 | Clinical thermometer |
| 28. | 1 | Thermocouple |
| 29. | 1 | Ball and ring demonstration apparatus |
| 30. | 1 | Bimetallic strip |
| 31. | 20 | Bunsen burner |
| 32. | 12 | Tripod stand and wire gauze |
| 33. | 12 | Beaker (100ml) |
| 34. | 12 | Beaker (250ml) |
| 35. | 12 | Beaker (400ml) |
| 36. | 12 | 100 ml graduated measuring cylinder. |
| 37. | 6 | 1 metre length of glass tubing (each 4mm internal diameter). |
| 38. | 2 | Glass funnel |
| 39. | 2 | Sets rods of identical dimensions and different metals. |
| 40. | 1 | Ripple tank and accessories |
| 41. | 1 | Slinky spring |
| 42. | 1 | Bell jar, electric bell and vacuum pump apparatus. |
| 43. | 12 | Pinboard (of softwood or cardboard or polystyrene). |

| | QUANTITY | ITEM | | QUANTITY | ITEM |
|---|---|---|---|---|---|
| 44. | 1 | Ray optics kit | 61. | 1 | Small d.c. motor (as from toy). |
| 45. | 100 | Optical pins | 62. | 12 | Variable resistors, commercial or improvised. |
| 46. | 12 | Rectangular glass block | 63. | 2 | Reel-resistance wire (bare) constantan (SWG 26) |
| 47. | 12 | Right-angled triangular glass prism. | 64. | 2 | Reel-resistance wire (bare) constantan (SWG 28). |
| | 12 | Equilateral triangular glass prism. | | | |
| 48. | 1 | Light pipe | 65. | 2 | Sets assorted standard resistors. |
| 49. | 12 | Converging lens-focal length 10 cm | 66. | 12 | Circuit key or switch. |
| 50. | 12 | Converging lens-focal length 15 cm | 67. | 12 | Diodes |
| 51. | 5 | Diverging lens- any focal length. | 68. | 0.5kg | Copper sulphate ($CuSO_4$ $5H_20$) |
| 52. | 12 | Thin plane mirror (each 5cm x 8cm) | 69. | 1 | Pair-copper electrodes (thick bare copper wire suitable) |
| 53. | 12 | Power pack OR accumulator OR dry cells in holder or with soldered leads | 70. | 1 | Card-fuse wire. |
| 54. | 5 | Reel-varnished or insulated copper wire SWG 24. | 71. | 1 | 110 V plug |
| 55. | 12 | Ammeter (0 - 1)A | 72. | 1 | 220 V plug. |
| | 12 | Voltmeter (0-5)V | 73. | 1 | G.M. tube + electric accessories. |
| | 12 | Analog Multimeter | 74. | 1 | $\alpha$ radioactive source. |
| 56. | 30 | Doz. Crocodile clips | 75. | 1 | $\beta$ radioactive source. |
| 57. | 5 | Small screwdrivers | 76. | 1 | $\gamma$ radioactive source. |
| 58. | 1 | Pair of pliers or wire cutter | 77. | 1 | Set of aluminium and lead plates. |
| | | | 78. | 1 | Diffusion cloud chamber. |
| 59. | 24 | 2.5V (MES) torchlight electric lamp | 79. | 2 | 1 Set-identical dice. |
| 60. | 24 | MES lamp holder | 80. | 2 | Reel-PVC insulated connecting wire. |

## ♦ RESOURCES


| | |
|---|---|
| Avison, J., Henry, D. and Neeranjan, | *Physics for CSEC,* United Kingdom: Nelson Thornes Limited, 2007. |
| Farley, A. and Trotz, C. | *CXC Physics*, Oxford: Macmillan Education, 2007. |
| Jackson, B. and Whiteley, P. | *Physics for CSEC*, Jamaica: Carlong Publishers (Caribbean) Limited, 2007. |

## ♦ GLOSSARY

| WORD/TERM | DEFINITION/MEANINGS | NOTES |
|---|---|---|
| annotate | add a brief note to a label | {simple phrase of a few words only; KC} |
| apply | use knowledge and principles to solve proble | {make inferences and conclusions; UK} |
| assess | present reasons for the importance of particular structures, relationships or processes | {compare the advantages and disadvantages or the merits and demerits of a particular structure, relationship or process; UK} |
| calculate | arrive at the solution to numerical problem | {steps should be shown; units must be included; UK} |
| cite | quote or refer to | {KC} |
| classify | divide into groups according to observable characteristics | {UK} |
| comment | state opinion or view with supporting reasons | {UK} |
| compare | state similarities and differences | {an explanation of the significance of each similarity and difference stated may be required for comparisons which are other than structural; UK} |
| construct | use a specific format to make or draw a graph, histogram, pie chart or other representation using data or material provided or drawn from practical investigations, build (for example, a model) draw scale diagram | {such representation should normally bear a title, appropriate headings and legend; UK} |
| deduce | make a logical connection between two or more pieces of information; use data to arrive at a conclusion | {UK} |
| define | state concisely the meaning of a word or term | {this should include the defining equation or formula where relevant; KC} |

| WORD/TERM | DEFINITION/MEANINGS | NOTES |
|---|---|---|
| demonstrate | show, direct attention to... | {KC} |
| derive | to deduce, determine or extract from data by a set of logical steps some relationship, formula or result | {this relationship etc. may be general or specific; KC} |
| describe | provide detailed factual information on the appearance or arrangement of a specific structure or the sequence of a specific process | {descriptions may be in words, drawings or diagrams or any appropriate combination. Drawings or diagrams should be annotated to show appropriate detail where necessary; KC} |
| determine | find the value of a physical quality | {UK} |
| design | plan and present, with appropriate practical detail | {where hypotheses are stated or when tests are to be conducted, possible outcomes should be clearly stated the way in which data will be analyzed and presented; XS} |
| develop | expand or elaborate on an idea or argument with supporting reasons | {KC/UK} |
| differentiate or distinguish (between or among) | state or explain briefly those differences between or among items which can be used to define the items or place them into separate categories | {KC} |
| discuss | present reasoned argument; consider points both for an against; explain the relative merits of a case | {UK} |
| draw | make a line representation of apparatus which shows accurate relationship between the parts | {A diagram is a simplified representation showing the relationship between components; KC/UK} |
| estimate | make an approximate quantitative judgement | {UK} |
| evaluate | weigh evidence and make judgements based on given criteria | {the use of logical supporting reasons for a particular point of view is more important than the view held; usually both sides of an argument should be considered; UK} |

| WORD/TERM | DEFINITION/MEANINGS | NOTES |
|---|---|---|
| explain | give reasons, based on recall, to account for | {KC} |
| find | locate a feature or obtain as from a graph | {UK} |
| formulate | devise a hypothesis | {UK} |
| identify | name or point out specific components or features | {KC} |
| illustrate | show clearly by using appropriate examples or diagrams, sketches | {KC/UK} |
| investigate | use simple systematic procedures to observe, record data and draw logical conclusions | {XS} |
| label | add names to identify structures or parts indicated by pointers | {KC} |
| list | itemise without detail | {KC} |
| measure | take accurate quantitative readings using appropriate instruments | {XS} |
| name | give only the name of | {no additional information is required; KC} |
| note | write down observations | {XS} |
| observe | pay attention to details which characterise reaction or change taking place; to examine and note scientifically | {observations may involve all the senses or extensions of them but would normally exclude the sense of taste; XS} |
| plan | prepare to conduct an exercise | {XS} |
| predict | use information provided to arrive at a likely conclusion or suggestion possible outcome | {UK} |
| record | write an accurate description of the full range of observations made during a given procedure | {this includes the values for any variable being investigated; where appropriate, recorded data may be depicted in graphs, histograms or tables; XS} |

| WORD/TERM | DEFINITION/MEANINGS | NOTES |
|---|---|---|
| relate | show connections between; explain how one set of facts or data depend on others or are determined by them | {UK} |
| sketch | Make a simple freehand diagram showing relevant proportions and any important details | {KC} |
| state | provide factual information in concise terms omitting explanations | {KC} |
| suggest | Offer an explanation deduced from information provided or previous knowledge. (... an hypothesis; provide a generalisation which offers a likely explanation for a set of data or observations.) | {no correct or incorrect solution is presumed but suggestions must be acceptable within the limits of scientific knowledge; UK} |
| test | to find out following set procedures | {XS} |

**KEY TO ABBREVIATIONS**

KC - Knowledge and Comprehension
UK - Use of Knowledge
XS - Experimental Skills

***Western Zone Office***
***12 June 2013***

# CARIBBEAN EXAMINATIONS COUNCIL®

## Caribbean Secondary Education Certificate (CSEC)®

# PHYSICS

## Specimen Papers and Mark Schemes/Keys

| | |
|---|---|
| Specimen Papers: | Paper 01<br>Paper 02<br>Paper 03/2 |
| Mark Schemes/Keys: | Paper 02<br>Paper 03/2 |

**FORM 01238010/SPEC**

**C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L**

**CARIBBEAN SECONDARY EDUCATION CERTIFICATE®**
**EXAMINATION**

**PHYSICS**

**SPECIMEN PAPER**

**Paper 01 – General Proficiency**

***75 minutes***

**READ THE FOLLOWING INSTRUCTIONS CAREFULLY**

**1.** This paper consists of 60 items. You will have 75 minutes to answer them.

**2.** In addition to this test booklet, you should have an answer sheet.

**3.** Each item in this test has four suggested answers, lettered (A), (B), (C) and (D). Read each item you are about to answer and decide which choice is best.

**4.** On your answer sheet, find the number which corresponds to your item and shade the space having the same letter as the answer you have chosen. Look at the sample item below.

Sample Item

The SI unit of length is the

(A) metre
(B) newton
(C) second
(D) kilogram

Sample Answer

● Ⓑ Ⓒ Ⓓ

The best answer to this item is “metre”, so answer space (A) has been shaded.

**5.** If you want to change your answer, erase it completely and fill in your new choice.

**6.** When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, omit it and go on to the one. You can return later to the item omitted. You score will be the number of correct answers produced.

**7.** You may do any rough work in the booklet.

**8.** Figures are not necessarily drawn to scale.

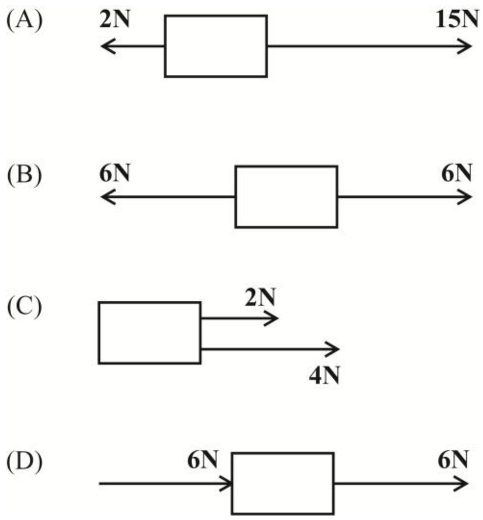
**9.** The use of silent electronic calculators is allowed.

**DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO**

1. Which of the following is a vector quantity?

   (A) Mass
   (B) Density
   (C) Moment
   (D) Momentum

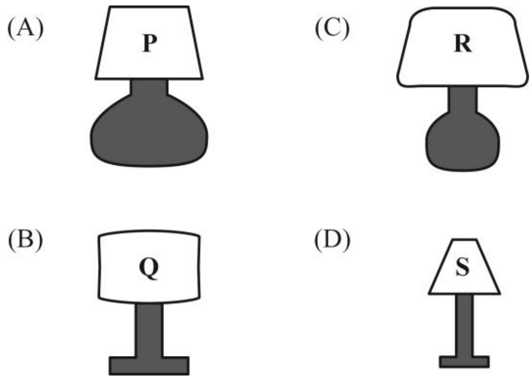
2. Which arrangement gives the greatest resultant force acting on the block?




3. Which of the following is a non-renewable energy source?

   (A) Biomass
   (B) Wind
   (C) Natural Gas
   (D) Sun

4. Item 4 refers to the lamps below.




   The most stable lamp is

   (A) P
   (B) Q
   (C) R
   (D) S

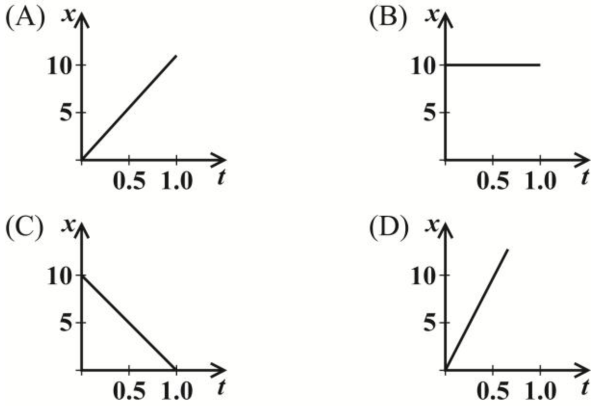
5. Which of the following is MOST suitable for measuring the diameter of a wire?

   (A) Metric rule
   (B) Tape measure
   (C) Vernier calipers
   (D) Micrometer screw gauge

6. Which of the following is the correct SI unit for pressure?

   (A) Joule (J)
   (B) Pascal (Pa)
   (C) Newton-metre (Nm)
   (D) Newton per metre ($Nm^{-1}$)

7. A vehicle with a uniform velocity of $10ms^{-1}$ is represented by which of the following graphs?




8. Which of the following is NOT a vector quantity?

(A) Mass
(B) Force
(C) Velocity
(D) Acceleration

9. Force is directly proportional to

(A) velocity
(B) acceleration
(C) displacement
(D) momentum

10. A cyclist riding down a hill applies his brakes and eventually comes to rest at the bottom of the hill. Which of the following energy changes takes place?

(A) Potential → kinetic
(B) Potential → kinetic → heat
(C) Kinetic→ potential → heat
(D) Potential → kinetic → chemical

11. Acceleration can be defined as the rate of change of

(A) velocity
(B) energy
(C) momentum
(D) displacement

12. Which of the following does the pressure of a fluid depend?

I. The depth of the fluid
II. The density of the fluid
III. The acceleration due to gravity

(A) I only
(B) II only
(C) I and II only
(D) I, II and III

13. The period of a simple pendulum depends on

(A) The length of the string
(B) The mass of the bob
(C) The initial displacement
(D) The stop watch used

14. An aeroplane is travelling at a constant speed at an altitude of 1000 m above sea level. Which of the following is TRUE?

(A) Its kinetic energy is increasing
(B) It has kinetic energy only
(C) It has potential energy only
(D) It has both potential and kinetic energy

15. Which of the following is TRUE of a body in equilibrium.

I. The sum of the forces in one direction is equal to the sum of the forces in the opposite direction
II. The sum of the clockwise forces is equal to the sum of the anticlockwise forces
III. The sum of the clockwise moments is equal to the sum of the anticlockwise moments

(A) I only
(B) II only
(C) I and III only
(D) I, II and III

16. 400 kg of methylated spirit occupies a volume of 0.50 $m^3$. What is its density?

(A) $8 \times 10^2$ kg $m^{-3}$
(B) $8 \times 10^{-2}$ kg $m^{-3}$
(C) $2 \times 10^2$ kg $m^{-3}$
(D) $1.25 \times 10^{-3}$ kg $m^{-3}$

17. What is the gain in gravitational potential energy of a body of weight 2000 N as it rises from a height of 20 m to a height of 25 m above the earth's surface?

(A) 400 J
(B) 1 000 J
(C) 10 000 J
(D) 20 000 J

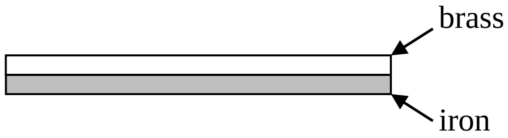
18. When liquid in a puddle evaporates its temperature changes. How does the temperature of the liquid change and why?

| | Temperature | Reason |
|---|---|---|
| (A) | decreases | less energetic molecules leave the liquid |
| (B) | decreases | more energetic molecules leave the liquid |
| (C) | increases | less energetic molecules leave the liquid |
| (D) | increases | more energetic molecules leave the liquid |

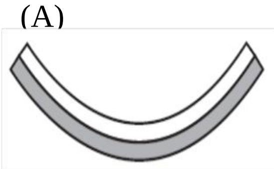
19. Which scientist successfully showed the relationship between heat and mechanical work?

(A) Joule
(B) Einstein
(C) Rumford
(D) Watts

20. A thermostat used in a domestic iron is made from a bimetallic strip comprising of a strip of iron and a strip of brass as shown below.

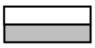



The strip is heated and the brass expands more than the iron.
The shape the strip becomes:

(A)


(B)


(C)


(D)


21. The name given to the amount of energy needed to raise the temperature of 1kg of iron by 1 K is

(A) latent heat
(B) heat capacity
(C) specific latent heat
(D) specific heat capacity

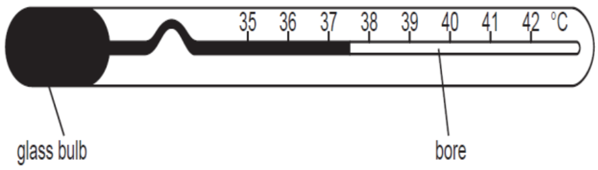
22. Sharon painted half the roof of her dog house white and the other half black. She noticed that the half painted black dried quicker than the half painted white.
The property that BEST explains why the half painted black dried quicker is that dark bodies are better

(A) insulators.
(B) heat absorbers
(C) reflectors of heat
(D) conductors of heat

23. Bubbles of gas rising from a scuba diver below the surface of the sea increase in size as they rise to the surface. Their size increase is because

(A) Water pressure on the bubbles decreases
(B) Water pressure on the bubbles increases
(C) Atmospheric pressure on the bubble decreases
(D) Atmospheric pressure on the bubbles increases

24. The clinical thermometer is designed so that it is very sensitive to small changes in temperature.




Which of the following features should it have?:

(A) A thick-walled bulb and a wide bore
(B) A thin walled bulb and a wide bore
(C) A thin-walled bulb and a narrow bore
(D) A thick-walled bulb and a narrow bore

25. In a YouTube video, Mr. Lee and his students heat a metal drum which is then capped and dumped into a tub of cold water. The video shows that the drum is crushed.

The gas law that BEST explains this observation is due to

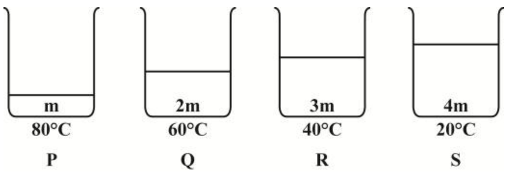
(A) Boyle's
(B) Charles'
(C) Pressure
(D) Combined Gas

26. An electronic air conditioner maintains the temperature of the inside of an office building at 24$^o$C. Which of the following measures could noticeably reduce the electricity bill?

I. Reducing the temperature to 21$^o$C
II. Hanging curtains at the window
III. Painting the roof of the building with aluminum paint

(A) I only
(B) I and II only
(C) II and III only
(D) I, II and III

27. Item 27 refers to the diagram below.




In the diagram above, P, Q, R and S are identical containers containing water of masses m, 2m, 3m and 4m respectively at the temperatures indicated. Which of the following must lose the most energy to cool down to 10 $^o$ C?

(A) P
(B) Q
(C) R
(D) S

28. Item 28 refers to the following table.

| Pressure/kPa | Volume/cm$^3$ |
|---|---|
| 1.0 | 40 |
| 1.3 | 30 |

The table shows two pairs of readings taken from an experiment to investigate Boyle's law. Which of the values below is MOST likely to be the measured pressure if the volume is reduced to 20 cm$^3$?

(A) 0.5 kPa
(B) 1.6 kPa
(C) 1.9 kPa
(D) 2.3 kPa

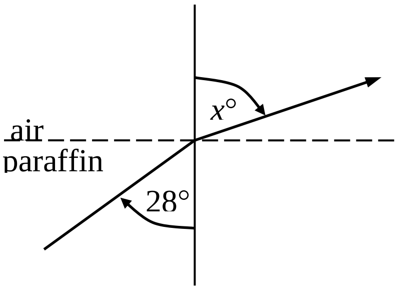
29. Lightning is seen several seconds before thunder is heard because

(A) thunder is produced after the lightning
(B) light can pass through a vacuum but sound cannot
(C) the speed of light is much faster than the speed of sound
(D) sound is reflected by the clouds several times before it reaches the ear.

30. The list of electromagnetic waves in order of DECREASING wave length is

(A) Xrays, ultraviolet, infrared, microwaves
(B) Xrays, infrared, ultraviolet, microwaves
(C) Microwaves, ultraviolet, infrared, x rays
(D) Microwaves, infrared, ultraviolet, x-rays.

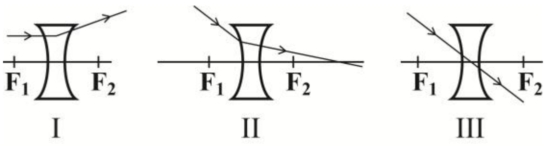
<u>Item 31</u> refers to the following diagram




31. A ray of light passes from paraffin into air at an angle of incidence of $28^0$. If the refractive index of paraffin is 1.44, the value of sin $x^0$ is

(A) $\frac{1.44}{\sin 28°}$
(B) $1.44 \times \sin 28^0$
(C) $\frac{\text{Sin } 28°}{1.44}$
(D) $\frac{1.44}{\sin 62°}$

<u>Item 32</u> refers to the following diagram




32. Which shows a ray of light passing through a diverging lens?

(A) II only
(B) I and II only
(C) I and III only
(D) I, II and III

33. The refractive index for light traveling from air to glass is

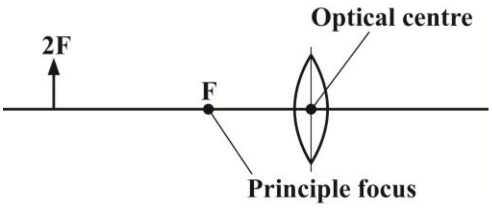
I. $\frac{\text{speed of light in glass}}{\text{speed of light in air}}$

II. $\frac{\text{wave length of light in air}}{\text{wave length of light in glass}}$

III. $\frac{\text{frequency of light in air}}{\text{frequency of light in glass}}$

(A) II only
(B) I and II only
(C) II and III only
(D) I, II and III

<u>Item 34</u> refers to the following diagram




34. From the diagram above, a real image is produced with a converging lens when the object is located

(A) At F only
(B) At 2F only
(C) Between F and infinity
(D) Between the optical centre and

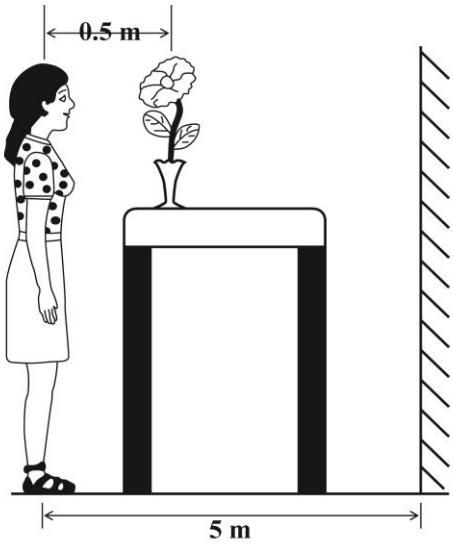
35. When Young's Double Slit experiment is conducted, it is expected to show

(A) That light can bend
(B) A series of dots on a screen
(C) That light travels in a straight line
(D) Interference patterns on a screen

36. "Pitch" and "loudness" refer <u>respectively</u> to

(A) Amplitude and frequency
(B) Frequency and amplitude
(C) Wavelength and speed
(D) Speed and wavelength

Item 37 refers to the following diagram.



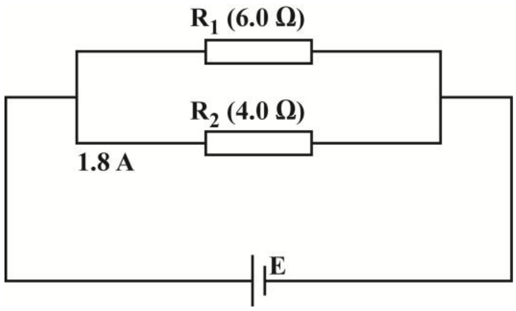

37. A lady faces a plane mirror which is 5.0 m away from her. She views the image of a vase, which is 0.5 m in front of her. How far from her is the image of the vase?

(A) 4.5 m
(B) 5.5 m
(C) 9.0 m
(D) 9.5 m

38. A transmitter emits radio waves of frequency 750 kHz. If the velocity of electromagnetic waves is 3 x $10^8$ m $s^{-1}$, what is the wavelength of the transmission?

(A) 200 m
(B) 250 m
(C) 400 m
(D) 800 m

Item 39 refers to the following diagram, which shows two resistors, $R_1$= 6.0 Ω and $R_2$ = 4.0Ω, in parallel.




39. What is the current in $R_1$ if the current in $R_2$ is 1.8A?

(A) 1.2 A
(B) 1.8 A
(C) 2.7 A
(D) 3.0 A

40. A transformer was connected to a 100 V supply and the output measured and found to be 10 V, 0.5 A. The primary current was

(A) 0.005 A
(B) 0.05 A
(C) 0.5 A
(D) 5.0 A

Item 41 refers to the truth table below

| A | B | C |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

41. The logic gate that gives the above output is

(A) OR
(B) AND
(C) NOR
(D) NAND

42. If in a transformer, $N_S$ is greater than $N_P$, then the transformer is a

(A) Smoothing transformer
(B) Step – up transformer
(C) Alternating transformer
(D) Step-down transformer

43. Which of the following quantities is constant in a parallel circuit?

(A) Current
(B) Voltage
(C) Resistance
(D) Power

44. A magnetic field can be used to deflect the path of

(A) β-rays
(B) γ- rays
(C) X-rays
(D) Light rays

45. Which of the following scientists discovered the relationship $E = mc^2$?

(A) Marie Curie
(B) Isaac Newton
(C) Albert Einstein
(D) Ernest Rutherford

46. For any TWO consecutive elements in the periodic table the first element has one less

(A) proton
(B) electron
(C) neutron
(D) neutrino

47. For a radioactive substance with a particular half-life, as time increases, the radioactive substance

(A) vanishes
(B) increases
(C) decreases
(D) remains constant

48. What did the Geiger-Marsden experiment establish as being present in the atom?

(A) Electrons
(B) Nucleus
(C) Neutrons
(D) Electrical forces

49. The atomic number and the mass number of an atom are 50 and 120 respectively. This means that in the atom there are

(A) 120 protons
(B) 120 neutrons
(C) 70 protons and 50 neutrons
(D) 50 protons and 70 neutrons

50. On Sunday, the corrected count rate of a radioactive source was 240 counts per second. Exactly two days later, the count rate had fallen to 120 counts per second. After exactly four more days (on Saturday), the count rate in counts per second was

(A) zero
(B) 24
(C) 30
(D) 60

51. When a polythene rod is rubbed with a cloth, it becomes

(A) Positively charged by losing electrons
(B) Positively charged by gaining protons
(C) Negatively charged by losing electrons
(D) Negatively charged by gaining electrons

52. The role of a transformer in an electrical circuit is to

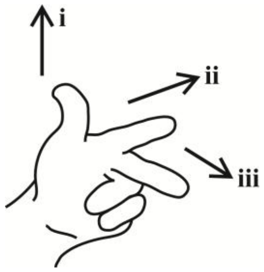
(A) alter the voltage
(B) alter the frequency
(C) convert alternating current to direct current
(D) convert direct current to alternating current

53. Which of the following materials are conductors?

I. Wood
II. Gold
III. Graphite

(A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III

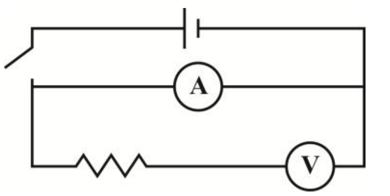
54. Fleming's left hand rule associates a quantity with each finger shown in the diagram below. The correct **ORDER** of the quantities labelled **i**, **ii** and **iii** is



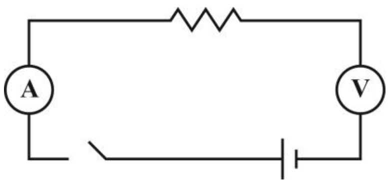

(A) Current, Force, Field
(B) Field, Current, Force
(C) Field, Force, Current
(D) Force, Field, Current

55. A student requires a circuit to measure the resistance of a resistor. Which of the circuits below is correctly connected?

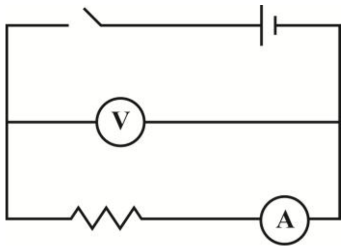
(A)



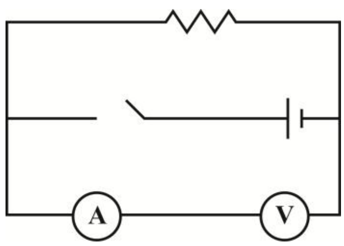

**(B)**



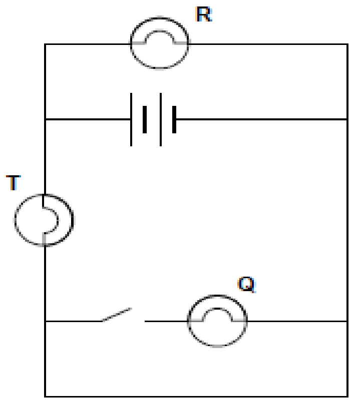

(C)




(D)



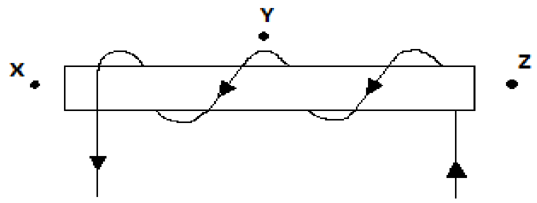

Item 56 refers to the following circuit.




56. In the circuit shown above, which lamps will be lit when the switch is closed?

(A) R only
(B) T, Q and R
(C) T and Q only
(D) T and R only

Item **57** refers to the following diagram which shows a coil carrying a current and wrapped around wooden cylinder.




57. Which row of the table below shows the magnetic field directions at x, y and z?

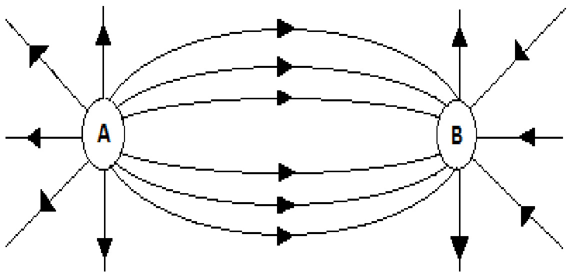
| | x | y | z |
|---|---|---|---|
| (A) | ← | → | ← |
| (B) | → | ← | → |
| (C) | → | ← | ← |
| (D) | → | → | → |

58. Which of the following is **NOT TRUE** when a magnet is moved relative to a coil?

I. The greater the number of turns in the coil, the smaller the induced e.m.f.
II. The faster the magnet moves relative to the coil, the greater the induced e.m.f.
III. The stronger the magnetic field, the greater the induced e.m.f.

(A) I only
(B) II only
(C) III only
(D) II and III only

Item 59 refers to the diagram below.




59. In the electric field diagram above the charges labelled A and B are

(A) Positive and positive
(B) Negative and positive
(C) Negative and negative
(D) Positive and negative

60. The radioactive decay of an isotope of Radon is represented by the equation

$$^{220}_{86}Rn \rightarrow {}^{a}_{b}Po + {}^{4}_{2}He$$

The values of *a* and *b* are respectively

| | a | b |
|---|---|---|
| (A) | 216 | 88 |
| (B) | 216 | 84 |
| (C) | 220 | 84 |
| (D) | 220 | 83 |

# CARIBBEAN EXAMINATION COUNCIL
# SECONDARY EDUCATION CERTIFICATE
# PHYSICS SPECIMEN PAPER 2012

| Item | Specific Objective | Key | Item | Specific Objective | Key |
|---|---|---|---|---|---|
| 1 | A2.1 | D | 31 | C4.10 | B |
| 2 | A.2.3 | A | 32 | C5.1 | C |
| 3 | A5.5 | C | 33 | C4.10 | A |
| 4 | A3.12 | A | 34 | C5.3 | C |
| 5 | A1.9 | D | 35 | C4.2 | D |
| 6 | A6.1 | B | 36 | C2.2 | B |
| 7 | A4.2 | A | 37 | C4.5 | D |
| 8 | A2.1 | A | 38 | C1.2 | C |
| 9 | A4.4 | B | 39 | D4.11 | A |
| 10 | A5.10 | B | 40 | D7.16 | B |
| 11 | A4.1 | A | 41 | D5.4 | D |
| 12 | A6.1 | C | 42 | D7.14 | B |
| 13 | A1.2 | A | 43 | D4.11 | B |
| 14 | A5.6 | D | 44 | E3.5 | A |
| 15 | A3.9 | C | 45 | E3.12 | C |
| 16 | A 1.10 | A | 46 | E2.6 | A |
| 17 | A5.7 | C | 47 | E3.10 | C |
| 18 | B3.7 | B | 48 | E1.2 | B |
| 19 | B1.2 | A | 49 | E2.4 | D |
| 20 | B2.8 | B | 50 | E3.10 | C |
| 21 | B3.1 | D | 51 | E1.1 | D |
| 22 | B4.5 | B | 52 | D7.14 | A |
| 23 | B2.11 | A | 53 | D2.1 | C |
| 24 | B2.3 | C | 54 | D7.6 | D |
| 25 | B2.11 | B | 55 | D4.1 | C |
| 26 | B4.6 | C | 56 | D4.2 | D |
| 27 | B3.2 | B | 57 | D7.2 | B |
| 28 | B2.11 | C | 58 | D7.11 | A |
| 29 | C2.3 | C | 59 | D1.4 | D |
| 30 | C3.2 | D | 60 | E3.6 | B |

**FORM 01238020/SPEC**

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

**CARIBBEAN SECONDARY EDUCATION CERTIFICATE®**
**EXAMINATION**

# PHYSICS

## SPECIMEN PAPER

**Paper 02 – General Proficiency**

***2 hours and 30 minutes***

**READ THE FOLLOWING INSTRUCTIONS CAREFULLY.**

**1.** This paper consists of **SIX** questions in two sections. Answer ALL questions.

**2.** For Section A, write your answers in the spaces provided in this booklet.

**3.** For Section B, write your answers in the spaces provided at the end of each question, in this booklet.

**4.** All working **MUST** be **CLEARLY** shown.

**5.** The use of non-programmable calculators is permitted, but candidates should note that the use of an inappropriate number of figures in answers will be penalized.

**6.** Mathematical tables are provided.



GO ON TO THE NEXT PAGE

**SECTION A**
**Attempt ALL questions**
**You MUST write your answers in this answer booklet.**

1. Rihanna, a student, carried out an experiment to investigate the properties of a spring. The results of the variation of the length of the spring with load, is shown in Table 1.

**TABLE 1**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Load (N)** | **4.0** | **8.0** | **12.0** | **16.0** | **20.0** | **24.0** |
| **Length (mm)** | **18.4** | **20.5** | **22.4** | **24.3** | **26.4** | **28.5** |

(a) On the grid provided on page 3, plot the graph of Length (mm) against Load (N).

**(7 marks)**

(b) Calculate the slope, P, of the graph.

______________________________

______________________________

______________________________

**(4 marks)**

(c) Given that the spring constant equal $\frac{1}{P}$, calculate the spring constant stating its units.

______________________________

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______________________________

**(2 marks)**

(d) Use your graph to determine the spring's length when the load is 0N.

______________________________

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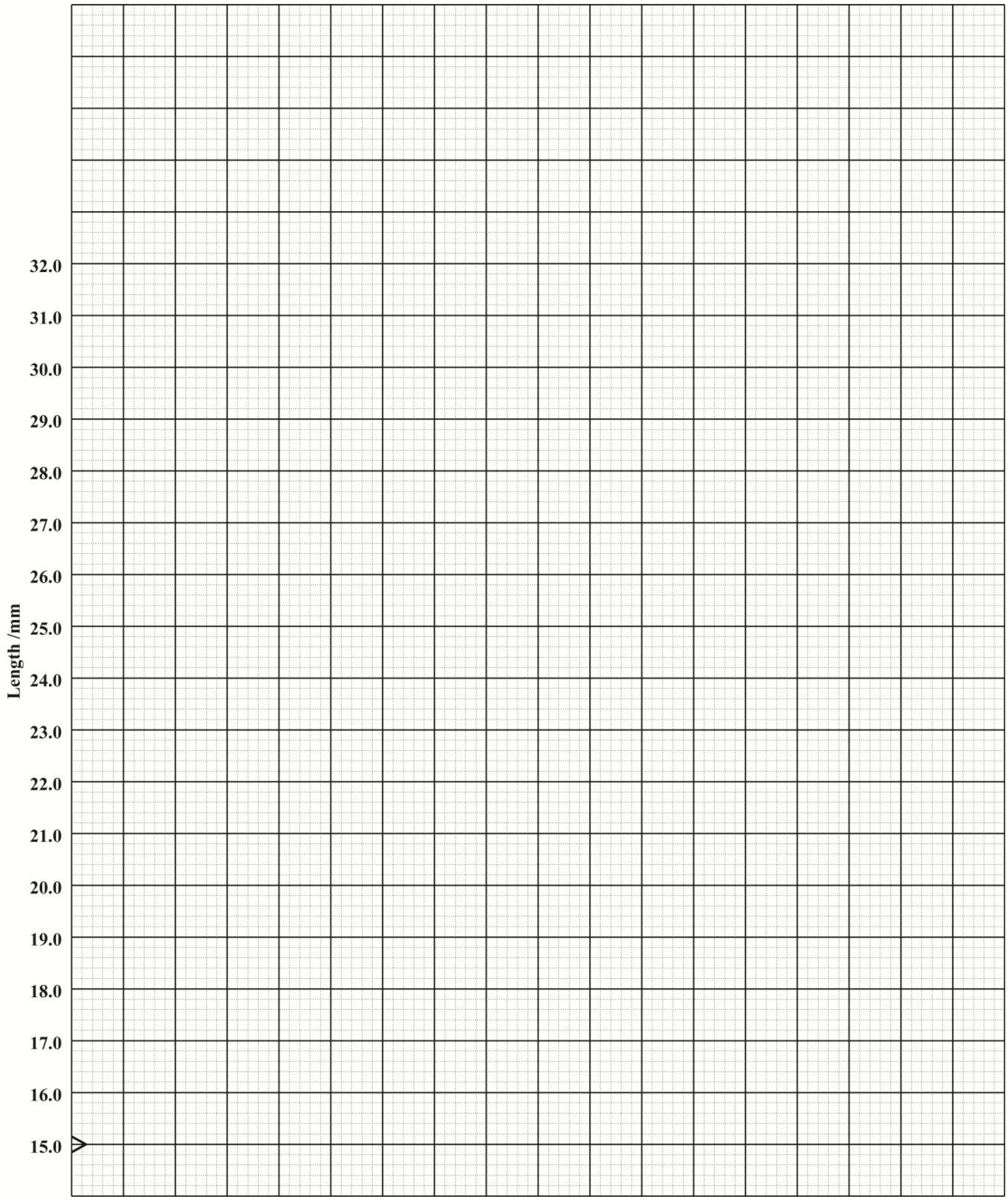
______________________________.

**(1 mark)**


Length /mm
32.0
31.0
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
17.0
16.0
15.0

(e) What mass must be placed on the spring to produce an extension of 9mm?

**(7 marks)**

(f) State THREE precautions Rihanna would have taken to ensure the accuracy of the readings and to prevent damage to the spring.

**(3 marks)**

**Total 25 marks**

2. (a) Draw a circuit with three resistors in parallel across a two-cell battery. Include an ammeter in the circuit so that its reading is the total current in the circuit.

**(3 marks)**

(b)(i) Give the equation relating resistance, voltage and current. State the unit for resistance.

**(2 marks)**

GO ON TO THE NEXT PAGE

(ii) Explain whether or not an ammeter should have a high resistance?

**(2 marks)**

(c)(i) If the three resistors in 2(a) are each 2Ω, what is the total effective resistance in the circuit?

**(2 marks)**

(ii) The voltage supplied by the two-cell battery is 3V. What is the reading on the ammeter?

**(3 marks)**

(iii) If the ammeter is replaced by one which has a resistance of 3 Ω, calculate the new reading.

**(3 marks)**

**Total 15 marks**

GO ON TO THE NEXT PAGE

3. (a) Distinguish between the mode of propagation of transverse waves and longitudinal waves.

________________________________________

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________________________________________

**(2 marks)**

(b) Give ONE example of EACH of the following waves:

Longitudinal: ________________________________

Transverse: ________________________________

**(2 marks)**

(c) Define the following terms:

(i) wavelength

________________________________________

________________________________________

(ii) frequency

________________________________________

________________________________________

(iii) amplitude

________________________________________

________________________________________

**(3 marks)**

(d) (i) Draw a wave of wavelength 6 cm using the axes provided in Figure 1.

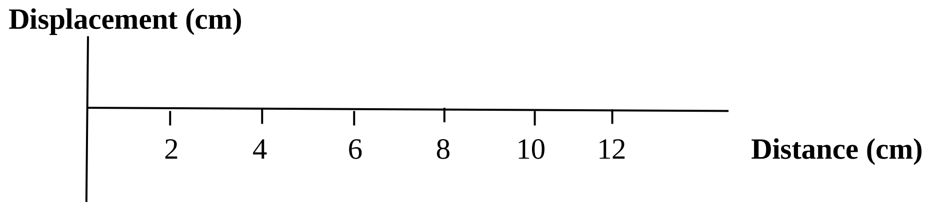


**Figure 1**

**(2 marks)**

Figure 2 shows a displacement-time graph of a small Styrofoam cup floating, in the path of water wave in a pond.

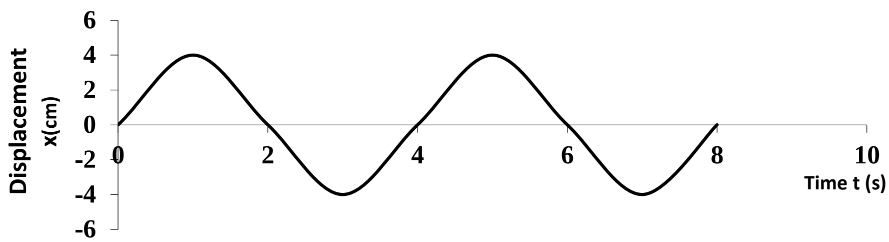


**Figure 2**

(ii) Use the graph in Figure 2 to determine the frequency of the wave.

**(3 marks)**

(iii) Use the graph to determine the amplitude of the wave.

**(1 mark)**

(e) Give ONE example of the use of waves in each of the following:

Medical testing ________________________________________________________

Industry _____________________________________________________________

**(2 marks)**

**Total 15 marks**

**SECTION B**
**Attempt ALL questions**
**You MUST write your answers in the space provided after each question.**

4. (a) A typical lap top computer operates on 18 V d.c. As a result, to safely power a lap top from 120V a.c. domestic mains, a specialized power cable must be used.

(i) State the TWO essential components that must be included in this specialized cable.

**(2 marks)**

(ii) Sketch TWO separate graphs to show the variation of voltage vs. time of a 120 V a.c. domestic mains and the output of the specialized power cable. Assume that the power cable is only able to accomplish $\frac{1}{2}$ wave rectification.

**(4 marks)**

(b) An electric kettle is connected to an alarm that sounds whenever the kettle is switched on and the lid is left open or the water level is below the heating element. Figure 3 shows the circuit that controls the electric kettle's alarm.

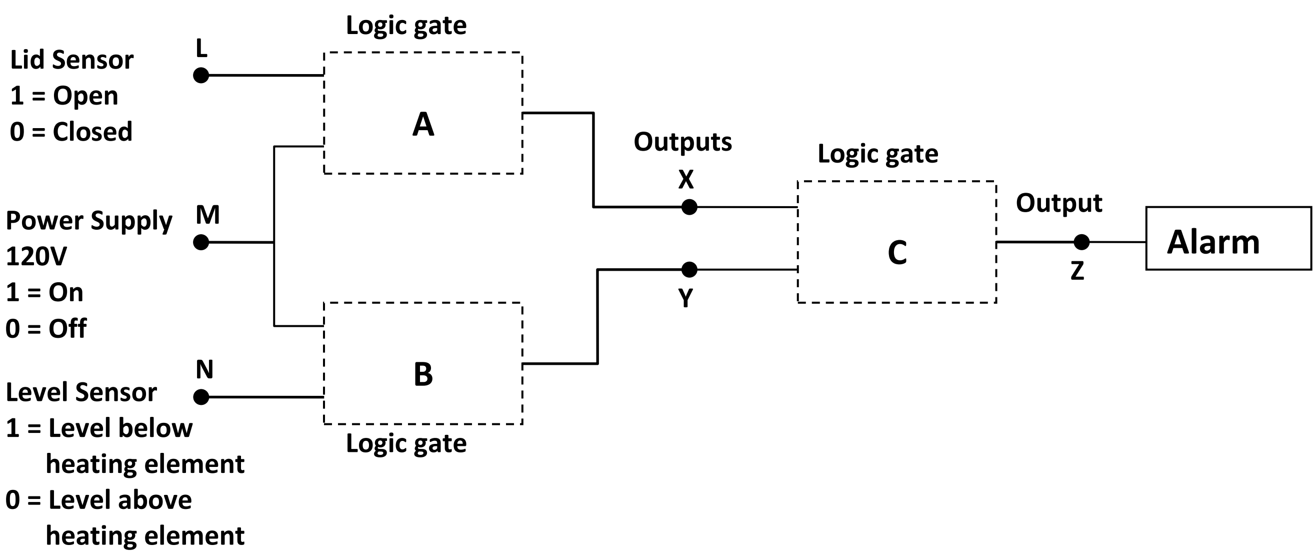


**Figure 3**

(i) What are points **L**, **M** and **N** collectively called?

**(1 mark)**

(ii) What logic gate(s) should be placed at **A**, **B** and **C**?

**(3 marks)**

(iii) The table below shows the inputs for a truth table. In the space provided for your answers, complete the truth table to show outputs at **X**, **Y** and **Z** that satisfies the condition that will make the alarm sound.

| **Input** | | |
|---|---|---|
| **L** | **M** | **N** |
| 0 | 0 | 0 |
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |
| 1 | 1 | 1 |

**(3 marks)**

(c) Discuss ONE way in which lap top computers have evolved into a versatile tool of communication.

**(2 marks)**

**Total 15 marks**

**Write the answer to Question 4 here.**

_______________________________________________

_______________________________________________

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(b) (iii)

| Input | | | Output | | |
|---|---|---|---|---|---|
| **L** | **M** | **N** | **X** | **Y** | **Z** |
| 0 | 0 | 0 | | | |
| 0 | 0 | 1 | | | |
| 0 | 1 | 0 | | | |
| 0 | 1 | 1 | | | |
| 1 | 0 | 0 | | | |
| 1 | 0 | 1 | | | |
| 1 | 1 | 0 | | | |
| 1 | 1 | 1 | | | |

5 (a) (i) Describe an experiment to compare the ranges of α, β and γ emissions.

**(5 marks)**

(ii) Which of these emissions would not be deflected by strong electric or magnetic fields?

**(1 mark)**

(b) (i) $^{24}_{11}$Na is a beta emitter. It decays to Mg with a half-life of 15 hours. Write a nuclear equation for the decay of $^{24}_{11}$Na.

(3 **mark)**

(ii) A sample contains 24g of $^{24}_{11}$Na. How long would it take for 21g to decay?

**(4 mark)**

(iii) Discuss ONE safety measure necessary when handling a sample of $^{24}_{11}$Na.

**(2 marks)**

**Total 15 marks**

**Write the answer to Question 5 here.**

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GO ON TO THE NEXT PAGE

6 (a) (i) Define the term specific latent heat of vaporisation.

**(2 marks)**

(ii) Identify THREE processes that require specific latent heat.

**(3 marks)**

(b) An electric kettle is rated at 1500W. It takes 98s to bring water originally at 30°C to 100°C.

(i) Describe the energy change that takes place in the kettle.

**(1 mark)**

(ii) How much energy is supplied by the kettle in the given time?

**(3 marks)**

(iii) Calculate the specific heat capacity of the water.

**(3 marks)**

(iv) 0.1 Kg of water is converted to steam when the kettle is left on for an additional 150s. Calculate a value for the specific latent heat of vaporisation of steam.

**(3 marks)**

**Total 15 marks**

**Write the answer to Question 6 here.**

**END OF TEST**

**C A R I B B E A N E X A M I N A T I O N S C O U N C I L**

**CARIBBEAN SECONDARY EDUCATION CERTIFICATE®**
**EXAMINATION**

# PHYSICS

**SPECIMEN PAPER**

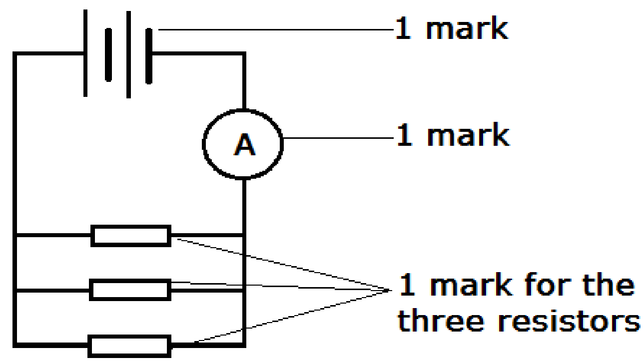
**PAPER 02 – GENERAL PROFICIENCY**

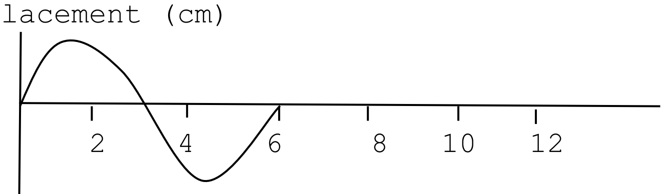
**MARK SCHEME**

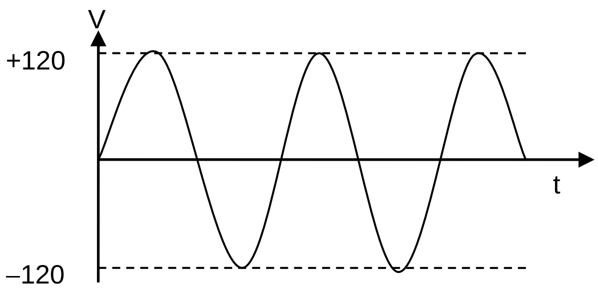
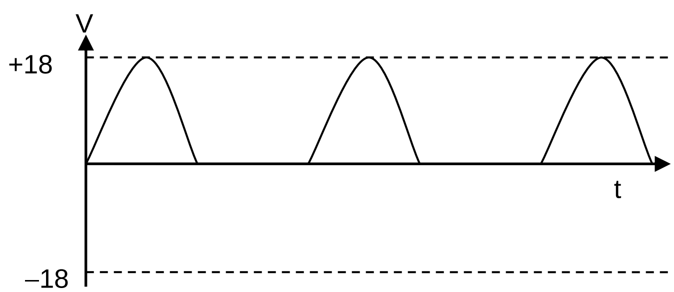
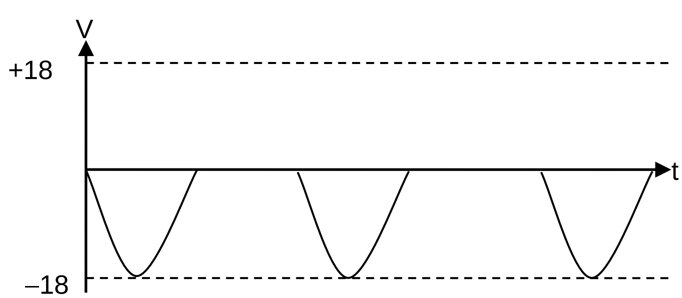
**2012**

| Question 1 P2 | MARK SCHEME | KC | UK | XS |
|---|---|---|---|---|
| 1 (a) | L-Label axes (1)<br>A-correct Axes Length on y-axis and load on x-axis (1)<br>S-scales (1)<br>P-Plots<br>6-5 correct -3<br>4-3 correct -2<br>2-1 correct -1<br>Best fit line (1) | | | 7 |
| (b) | Large Δ (1)<br>Correct read offs = $\frac{28.60-17}{25-1.4}=\frac{11.60}{22.6}$ (1)<br>gradient formula = $\frac{AB}{BC}$ (1)<br>(1)<br>Answer = 0.55 ± 0.05 $mmN^{-1}$ (1) | | 3 | 2 |
| (c) | Spring's constant = $\frac{1}{P}=\frac{1}{0.55}$ (1)<br>= 1.81 $Nmm^{-1}$ (1) | | 2 | |
| (d) | Spring's length = <u>16.3</u> mm (1) | | | 1 |
| (e) | Original length = 16.3 mm<br>New Length of spring = Original length + Extension (1)<br>= 16.3 mm + 9 mm (1)<br>= 25.3 mm (1) | | | |
| SP. OBJ | | | | |

| Question 1 Cont'd | MARK SCHEME | KC | UK | XS |
|---|---|---|---|---|
| (e) c'td | Corresponding Load = 17.5 N (1)<br>Load = mg (1)<br>17.5 = m.10 (1)<br>$m = \frac{17.5}{10}$<br>m = 1.75 Kg (1) | | 7 | |
| (f) | (i) Avoid the error of parallax by reading the scale accurately. (1)<br>(ii) Do not overload the spring to prevent permanent damage. (1)<br>(iii) Add loads when the system comes to rest. (1)<br>(iv) Take measurements when the system comes to rest. (1)<br><br>Any 3: 1 mark each. | 3 | | |
| SP. OBJ | A 1.4, 1.5, 3.13 Total | **3** | **12** | **10** |

| Question 2 | MARK SCHEME | | KC | UK | XS |
|---|---|---|---|---|---|
| 2a. |  | | 3 | | |
| b (i) | Resistance = V/I.<br>The unit of resistance is the Ohm[Ω]. | (1)<br>(1) | 2 | | |
| (ii) | It must offer no resistance to current flow - the circuit must function as if the ammeter is not in the circuit. | (1)<br>(1) | 2 | | |
| (c) (i) | $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$<br>$1/R_T = ½ + ½ + ½$<br>$1/R_T = 3/2$<br>$R_T = 2/3\Omega$ or $0.67\ \Omega$ | (1)<br>(1) | | 2 | |
| (ii) | V = IR<br>$I = V/R = \frac{3V}{\frac{2}{3}}$<br>$= 4.5A$ | (1)<br>(1)<br>(1) | | 3 | |
| (iii) | $R_T = 3\Omega + 0.67\Omega = 3.67\Omega$<br>$I = 3V/3.67\Omega$<br>$= 0.82A$ | (1)<br>(1)<br>(1) | | 3 | |
| SP. OBJ | D 4.7, 4.9 | Total | **7** | **8** | |

| Question 3 | MARK SCHEME | KC | UK | XS |
|---|---|---|---|---|
| (a) | For propagation of <u>transverse</u> waves, the displacement of the medium is <u>perpendicular</u> to the direction of motion while for propagation of <u>longitudinal</u> waves, the displacement of the medium is <u>parallel</u> to the propagation of the wave. | | 1<br>1 | |
| (b) | Examples: transverse wave - electromagnetic / water waves | 1 | | |
| | Longitudinal wave - sound waves | 1 | | |
| (c) (i) | Wavelength: The distance between successive crests or troughs of a wave | 1 | | |
| (ii) | Frequency: Number of waves per unit time | 1 | | |
| (iii) | Amplitude: This is the maximum displacement of the wave | 1 | | |
| (d) (i) | displacement (cm)<br><br>distance(cm)<br>1 mark for general sinusoidal shape<br>1 mark for crossing at 3 cm and ending on 6 cm | | 2 | |
| (ii) | Frequency = Number of waves / time = 1 / 4<br>f = 0.25 /seconds<br>(1) (1) (1)<br>marks for equation, substitution, correct answer | | 3 | |
| (iii) | Amplitude of the wave = 4 cm (1) | | 1 | |
| (e) | Example in medical testing: ultrasound in prenatal care (1)<br>Example in industry: testing of materials for defects (1) | 2 | | |
| SP. OBJ | C 1.1,1.2,2.5 Total | **7** | **8** | |

| Question 4 | MARK SCHEME | KC | UK | XS |
|---|---|---|---|---|
| (a) (i) | 1 mark for stating: Transformer | 1 | | |
| | 1 mark for stating:<br>Semiconductor rectifiers,<br>or<br>diodes | 1 | | |
| (ii) | 1 mark for sketching a sinusoidal waveform<br>1 mark for indicating peak values at ±120V<br><br> | | 2 | |
| | 1 mark for sketching a $\frac{1}{2}$-waveform<br>1 mark for indicating peak values at +18V or −18V<br>e.g.<br><br><br>or<br><br> | | 2 | |

| Question 4 Cont'd | MARCH SCHEME | KC | UK | XS |
|---|---|---|---|---|
| (b) (i) | 1 mark for stating: L, M and N are inputs | 1 | | |
| (ii) | 1 mark for stating: A is an AND gate<br><br>1 mark for stating: B is an AND gate<br><br>1 mark for stating: A is an OR gate | 3 | | |
| (iii) | 1 mark for correctly completing the outputs of X using gates the student suggested in (b) (ii)<br><br>1 mark for correctly completing the outputs of Y using gates the student suggested in (b) (ii)<br><br>1 mark for correctly completing the outputs of Z using gates the student suggested in (b) (ii)<br><br>*THE TRUTH TABLE FOR THE COMBINATION OF THE LOGIC GATES IN b(ii) IS SHOWN BELOW.* | | 3 | |
| (c) | 2 marks for stating two or more points from the list below:<br>1 mark for stating one point from the list below:<br><br>• Lap tops have become lighter.<br>• Lap tops have become faster.<br>• Built-in video camera and microphones are standard in lap tops. | | | |

| Input | | | Output | | |
|---|---|---|---|---|---|
| L | M | N | X | Y | Z |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 |

| Question 4 Cont'd | MARKSCHEME | KC | UK | XS |
|---|---|---|---|---|
| | • They can connect to the internet from locations where internet is available wirelessly.<br>• Laptops are more efficient<br>• Online communication/games/facebook/social<br>Or any other acceptable response | | 2 | |
| SP. OBJ | D 5.1, 5.2, 5.4, 5.5, 5.6 Total | **6** | **9** | |

| Question 5 | | | KC | UK | XS |
|---|---|---|---|---|---|
| (a)(i) | States/list equipment used:<br>• $\alpha$, $\beta$, and $\gamma$ source;<br>• Detector: GM tube or Cloud Chamber<br>• Metre rule;<br><br>States all three (2)<br>States any 2 (1)<br>States none (0) | <br><br><br><br><br>(2)<br>(1)<br>(0) | 2 | | |
| | Procedure of experiment<br>• Places GM tube in front of source, or: Places source inside cloud chamber;<br>• Moves GM tube away from source until no radiation is detected, or: Observes/identifies tracks formed inside chamber<br>• Measures distance between GM tube and source, or: Measures length of tracks | <br>(1)<br><br>(1)<br><br>(1) | 3 | | |
| (ii) | Identifies $\gamma$ radiation is undeflected | (1) | 1 | | |
| (b)(i) | Beta-decay equation: ${}^{24}_{11}\text{Na} \rightarrow {}^{0}_{-1}e + {}^{24}_{12}\text{Mg}$<br>${}^{0}_{-1}e$ (1) ; ${}^{24}_{12}\text{Mg}$ (2) [1 for Mg and 1 for atomic number and atomic mass] | | | 3 | |
| (ii) | Length of time:<br>• Identifies/calculates that $\frac{7}{8}$ of the sample remains: $\frac{21 \text{ grams}}{24 \text{ grams}} = \frac{7}{8}$<br>• Identifies/calculates that $\frac{1}{8}$ of sample remains: $1 - \frac{7}{8} = \frac{1}{8}$<br>• Identifies/calculate that 3 half lives have elapsed: $\left(\frac{1}{2}\right)^n = \frac{1}{8} \Rightarrow n = 3$<br>• Calculates length of time: $n \times ½ = 3 \times 15 \text{ hrs} = 45 \text{ hours}$ | (1)<br><br>(1)<br><br>(1)<br><br>(1) | | 4 | |
| (iii) | Discussion of safety measure<br>• States 1 appropriate safety Measure<br>• Presents reasoned argument why safety measure must be observed argument reasoning | (1)<br><br>(1)<br>(1) | | 2 | |
| Sp. Obj | E, 3.3; 3.4; 3.5; 3.6; 3.10 | | **6** | **9** | |

| Question 6 | | KC | UK | XS |
|---|---|---|---|---|
| (a) (i) | Heat required to change the unit mass of a liquid to a gas (1) without a temperature change (1). | 2 | | |
| (ii) | melting, boiling, evaporation | 3 | | |
| (b) (i) | electrical $\Rightarrow$ heat | 1 | | |
| (ii) | Energy supplied = Pt (1)<br>= 1500 x 98 (1)<br>= 147 000 J (1) | | 3 | |
| (iii) | Heat energy = $mc\Delta\theta$ (1)<br>147 000 = 0.5 x $c$ x 70 (1)<br>Specific heat capacity, $c$ = 4200J Kg°C (1) | | 3 | |
| (iv) | Pt = $ml$ (1)<br>1500 x 150 = 0.1 x $l$ (1)<br>S.l.h.of vaporisation, $l$ = 2 250 000 $JKg^{-1}$ (1) | | 3 | |
| SP.OBJ | A 5.10, 5.11; B3.1 - 3.3; B3.5 - 3.7 Total | 6 | 9 | |

# FORM 01238032/SPEC

**C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L**

**CARIBBEAN SECONDARY EDUCATION CERTIFICATE®**
**EXAMINATION**

**PHYSICS**

**SPECIMEN PAPER 2012**

**Paper 032 – General Proficiency**

***2 hours 10 minutes***

**READ THE FOLLOWING DIRECTIONS CAREFULLY**

1. You MUST use this answer booklet when responding to the questions. For each question, write your answer in the space provided and return the answer booklet at the end of the examination.

2. ALL WORKING MUST BE SHOWN in this booklet, since marks will be awarded for correct steps in calculations.

3. Attempt ALL questions.

4. The use of non-programmable calculators is allowed.

5. Mathematical tables are provided.

**DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO**

1. In this experiment you are required to investigate the period of a pendulum made from paperclips.

The paperclips provided are to be linked together, in a chain, and swung as a single pendulum, as shown below in Figure 1**.**The period of the pendulum, $\boldsymbol{T}$, depends on the number of paperclips, $\boldsymbol{n}$, linked together.

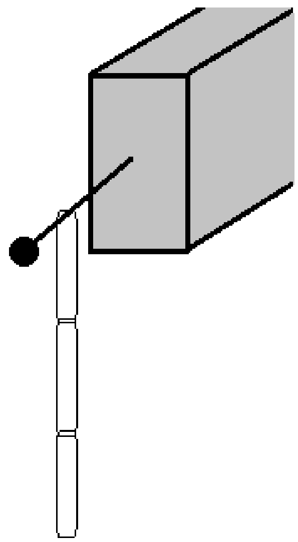


Figure 1

It is suggested that the relationship between $\boldsymbol{T}$ and $\boldsymbol{n}$ is $\boldsymbol{T = kn}$ where k is a constant.

Describe how you would use the paperclips provided to test this theory for n = 3, 6 and 9.

Include in your answer:

(a) The steps taken in obtaining your results

______________________________________________________________________

______________________________________________________________________

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**(6 marks)**

(b) A record of the measurements

**(5 marks)**

(c) Calculations

**(7 marks)**

(d) Two possible sources of error and the precautions taken

**(2 marks)**

(e) Conclusion

______________________________________________________________________

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**(4 marks)**

**Total 24 marks**

2. Table 1 shows the relationship between the temperature, *T*, of the measuring junction of a thermocouple and the thermocouple emf, *E*, that is measured by a millivoltmeter.

**Table 1**

| | | | | | | |
|---|---|---|---|---|---|---|
| Thermocouple emf *E* (mV) | 0.1 | 0.4 | 0.7 | 1.0 | 1.4 | 1.8 |
| Temperature *T* (°C) | 44 | 118 | 163 | 202 | 247 | 293 |

(a) (i) Plot on page 5, a graph of the thermocouple emf, *E*, against Temperature, *T*. Draw your BEST straight line. **(7 marks)**

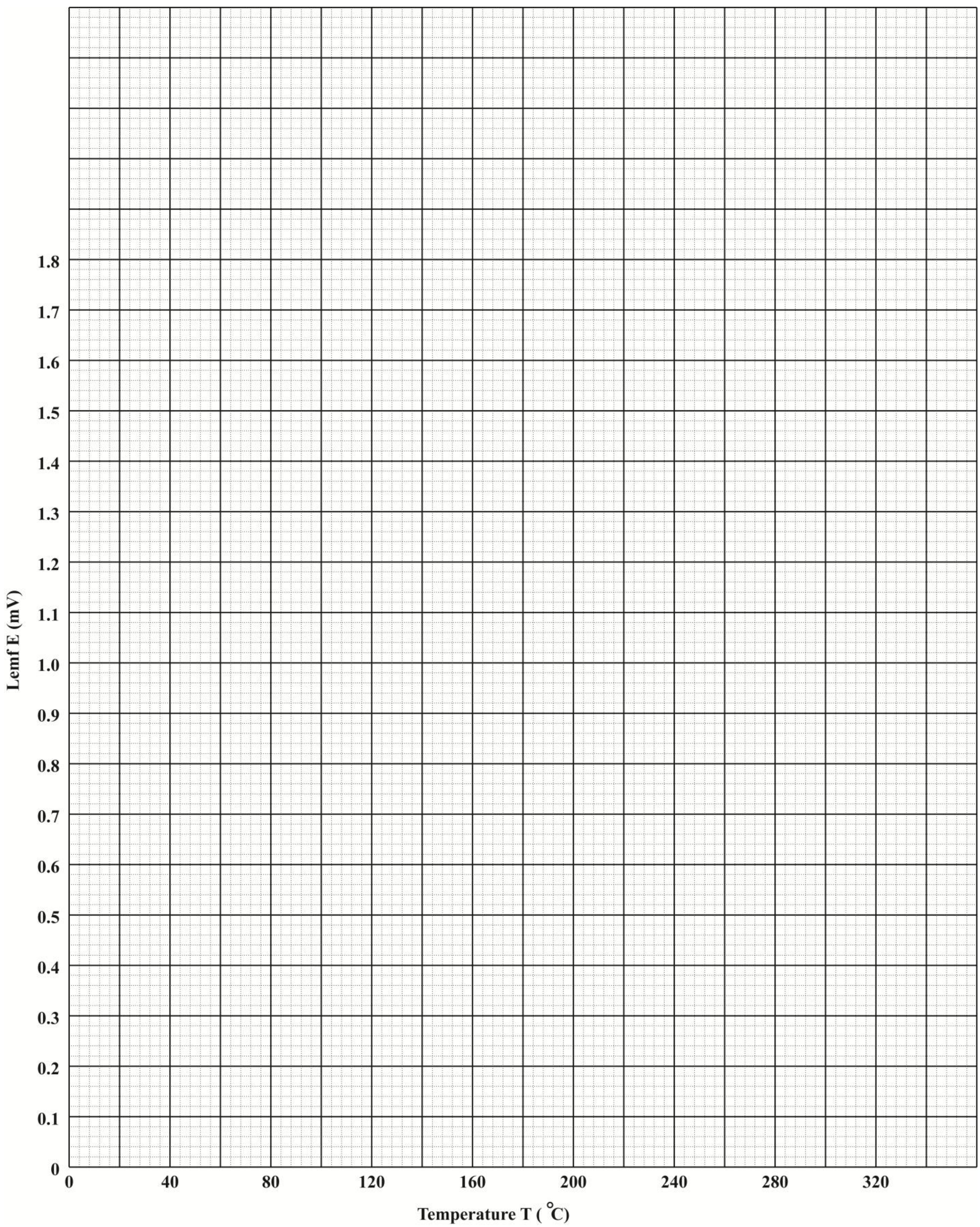
(ii) Find the slope *S* of the graph.

**(6 marks)**

(b) (i) Using the graph determine $T_0$, the temperature at which the thermocouple emf $E = 0$ mV

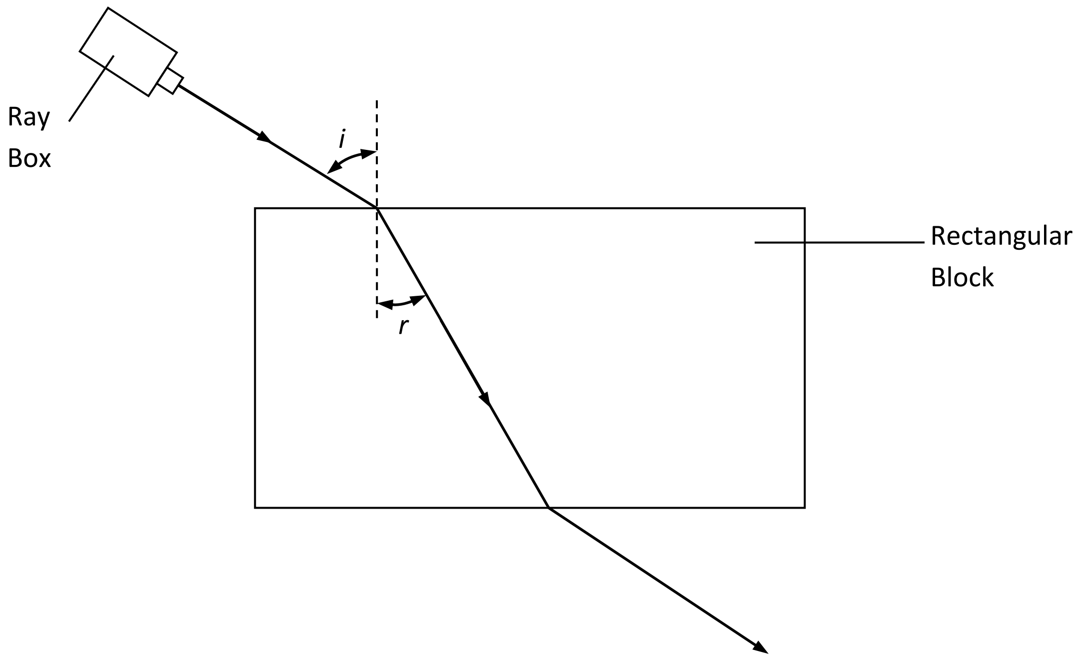
**(1 mark)**

**Total 14 marks**


1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Lemf E (mV)
0
40
80
120
160
200
240
280
320
Temperature T (°C)

3. In an examination question about refraction, a student draws the diagram below and writes:

"*If angle i is doubled, angle r will also be doubled*"




Plan and design an experiment to investigate the student's statement.
Your design must include:

(a) A clear objective/aim

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

**(1 mark)**

(b) A list of equipment used

(2 marks)

(c) Clear procedures in an appropriate sequence

(4 marks)

(d) A statement/explanation of the manipulation of the data collected;

(1 mark)

(e) A precaution taken during investigation;

(1 mark)

(f) One possible limitation of your design.

**(1 marks)**

**Total 10 marks**

**C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L**

**CARIBBEAN SECONDARY EDUCATION CERTIFICATE®**
**EXAMINATION**

# PHYSICS

**SPECIMEN PAPER**

**PAPER 032 – GENERAL PROFICIENCY**

**MARK SCHEME**

**2012**

PHYSICS
PAPER 032 - GENERAL PROFICIENCY
MARK SCHEME

| Question No. 1 | Mark Scheme | KC | UK | XS |
|---|---|---|---|---|
| (a) | Method:<br>• Pendulum set in motion with small angle of swing (1)<br>• Started count simultaneously with stopwatch (1)<br>• Measured time for X swings (1)<br>• Repetition (1)<br>• Repeat with 6 and 9 paperclips (1)<br>• Use of English - tense (1) | | | 6 |
| (b) | Table:<br>• Neat table (1)<br>• Headings with units for each column (2)<br>• Consistent sig. fig. time column (1)<br>• period column (1) | | | 5 |
| (c) | Calculations<br>• Average time for each length (1)<br>• Period (3 x 1)<br>• k for each set (3 x 1 ) | | 7 | |
| (d) | Possible Sources of error<br>• Timing (1)<br>• Angle of release (1) | | | 2 |
| (e) | Precautions<br>• Repetition (1)<br>• Small displacement (1) | | | 2 |
| | Conclusion<br>• Relates to aim (1)<br>• Valid (1) | | 1 | 1 |
| Sp. Obj | A 1.2, 1.7, 1.8, 1.9 Total | | 8 | 16 |

PHYSICS
PAPER 032 - GENERAL PROFICIENCY
MARK SCHEME

| Question No. 2 | MARK SCHEME | | KC | UK | XS |
|---|---|---|---|---|---|
| (a) (i) | L-Label axes | (1) | | | |
| | A-Correct orientation of axes | (1) | | | |
| | S-Scales | (1) | | | |
| | P-Plots: | (3) | | | |
| | 6 – 5 correct – 3<br>4 – 3 correct – 2<br>2 – 1 correct – 1 | | | | 7 |
| | Best line | (1) | | | |
| (a) (ii) | Large Δ | (1) | | | |
| | Correct read offs | (1) | | | 2 |
| | Gradient formula = $\frac{\Delta E}{\Delta T} = \frac{1.86-0}{300-80} = \frac{1.86}{220} = 0.0085$ mV°C$^{-1}$ (2 s.f.) | (3) | | | |
| | Answer = _____±0.001 | (1) | | 4 | |
| (b) | Read off correct value of *T* | (1) | | | 1 |
| Sp. Obj | A 1.4, 1.5; B 2.3 | Total | | **4** | **10** |

PHYSICS
PAPER 032 - GENERAL PROFICIENCY
MARK SCHEME

| Question 3 | MARK SCHEME | KC | UK | XS |
|---|---|---|---|---|
| (a) | Clear objective/aim:<br>To investigate the relationship between *i* and *r*.<br>or (1)<br>To measure *r* for various *i* | | | 1 |
| (b) | List of equipment<br>• Glass block;<br>• Ray box/plotting pins;<br>• Protractor; 4-3 items (2)<br>• Ruler 2-1 items (1) | | | 2 |
| (c) | Procedure:<br>• Draws outline of block or reference lines and normal;<br>• Shines ray of light for various angles *i*;<br>• Marks path of light;<br>• Measures angles *r*.<br>4 steps (3)<br>3 step (2)<br>2-1 step (1)<br>App. Seq. (1) | | | 4 |
| (d) | Manipulation of data<br>• States that *i* and *r* are compared; or (1)<br>• States that a graph of *r* vs. *i* is plotted and explains the use of the graph in the analysis of *i* and *r*; or<br>• Any other reasonable analysis of data | | | 1 |
| (e) | Precaution (1)<br>States one reasonable precaution | | | 1 |
| (f) | Limitation<br>States one reasonable limitation of method (1) | | | 1 |
| Sp. Obj | C 4.4, 4.8 Total | | | 10 |

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

**REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATIONS JUNE 2005**

# PHYSICS

# PHYSICS

## GENERAL PROFICIENCY EXAMINATION
## JUNE 2005

## SCHOOL'S REPORT

### General Comments

In June 2004 the total number of candidates sitting this year's CSEC Physics exam was 9209 compared with 8042, an increase of 15%. At the same time there has been an across the board increase of approximately 15% in total CSEC registrations this year. The examiners find it most pleasing that Physics, considered by many students to be one of the more difficult subjects, is outpacing the average growth rate across all subjects.

Although we would not wish to claim sole credit for this welcome and pleasing trend, we wish to record the fact that over the years this committee has expended considerable effort in trying to construct examination questions which are grounded in the real-life experiences of students and would therefore make Physics a more appealing subject to a wider range of candidates.

Overall performance in the 2005 Physics CSEC Examination was, in the opinion of the Examiners, quite satisfactory with 61 per cent of candidates achieving between Grades I and III. One commendable feature of this performance was the fact that the performances in both Use of Knowledge sections and the Knowledge and Comprehension sections were similar.

Many of the areas of weakness observed in this year's examinations are the same ones which occur year after year. The examiners wish to make a special plea to principals and heads of science departments to pay special attention to interventions which can correct these weaknesses. Very often the intervention needed requires no additional resources apart from a certain diligence in carrying them out and can yield significant improvement in performance

### Paper 01 – Multiple Choice

The performance in this year's multiple choice paper is similar to that of recent years. The average on this paper has remained fairly stable between 33 and 35 (out of a possible 60) over the last 5 years, and this year's average score was of 34 (out of a possible 57) with a standard deviation of 10.2 is very much of the same order.

***Editorial note.***

In the remainder of this report, the exam questions are broken down to show their correspondence to the Specific Objectives of the Physics syllabus. The Specific Objectives are italicized while the corresponding question sections are shown immediately below in normal type. The performance of candidates on each of these questions in turn is then discussed.

**Paper 02 – Structured Questions**

**Question 1 Data Analysis, Section D – Light and Waves**

Candidates were given the tabulated results of an experiment to find the index of refraction of a glass block and were given the following tasks:

(a) Complete a table of values using calculators to obtain the sines of six angles of incidence "i" and the corresponding six angles of refraction "r" .

(b) Use the values obtained to plot a graph of sin *i* against sin *r* on the graph paper provided.

*A2.3 express the result of a measurement or calculation to an appropriate number of significant figures or decimal places;*

*A3.1 plot, interpret and use graphs of experimental data;*

*A3.2 draw a line of 'best fit' for a set of plotted values;*

Candidates were given the following tasks:

(c) Find the slope n of the line drawn in part (b).

(d) State what the slope of the graph represents.

*A3.3 determine the gradient and intercept of a straight line graph.*

Candidates were given the following tasks:

(e) Draw a labeled diagram identifying the apparatus used and angles measured by the student to obtain the results.

(f) In the experiment on which this question is based, candidates are asked to consider A ray of light incident at an angle of 35 and with the aid of dotted lines on the graph to determine the angle of refraction produced.

D*6.4 describe the refraction of light rays;*

*Recall that the passage of a ray of light through a parallel - sided transparent medium may result in lateral displacement of that ray. Draw diagrams.*

*D6.5 state the laws of refraction and use Snell's Law to solve numerical problems;*

*Perform an experiment to test Snell's Law.*

**Performance Overall:** The average mark for this question was 16.72 out of a possible 30 and the standard deviation was 7.52. Approximately 6 candidates scored full marks.

**Areas of good performance** Most students were able to complete the table correctly.

**Areas of weak performance** Many candidates did not realize that their calculator was in the radian mode rather than the degree mode.

Many candidates appeared to be unfamiliar with the sine function.

Many candidates were not aware that their calculated results should have been given to 3 significant figures.

Some candidates were not able to round off decimals.

Some candidates were unaware that the sine of an angle has no units.

Many candidates had difficulty in choosing a suitable scale and in selecting the correct orientation of the axes.

Many candidates used data from the table to determine the slope of their graph and some of those who used points from the line did not use a large enough triangle.

Part (e) of this question was very poorly done by the majority of candidates.

**General comments and recommendations** It is surprising that a large number of candidates have not mastered the basic skills tested by the data analysis question despite the fact that these skills are examined year after year.

Teachers need to bring to the attention of their candidates the fact that writing an examination is an exercise in communication and they need to show all the required working in order to obtain maximum marks.

**Question 2 Section B - Mechanics**

(a) (i) State the principle of conservation of energy

*B5.4 state the law of conservation of energy and apply to problems;*

(ii) Define the term 'potential energy'

(iii) Give one example of a body possessing potential energy.

*B5.6 define potential energy as the energy stored by an object by virtue of its position or state;*

(iv) Define the term 'kinetic energy'

(v) Give one example of a body possessing kinetic energy.

*B5.7 define kinetic energy as the energy possessed by a body by virtue of its motion;*

(b) At a football match between two college teams, the referee ordered a free kick. The ball of mass 1.5 kg was placed at rest. The kick was about to be taken by an eager footballer.
What was the potential energy of the ball just before the kick was taken?

(c) The footballer kicked the ball and it was caught by the opposing goalkeeper, 4 metres above the ground. The ball was travelling at 10 $ms^{-1}$

(i) Calculate the potential energy of the ball just before it was caught

*B5.9 calculate the change in gravitational potential energy using* $\Delta E_p = mg\Delta h$;

(ii) Calculate the kinetic energy of the ball just before it was caught.

*B5.10 calculate kinetic energies using the expression:* $E_K = \frac{1}{2} mv^2$;

(iii) After the ball was caught, what was the kinetic energy converted into?

*B5.4 describe the energy transformation(s) in a given situation;*

**<u>Performance Overall:</u>** The average mark for this question was 9.25 out of a possible 15 and the standard deviation was 4.26. Approximately 411 candidates scored full marks.

**<u>Areas of good performance:</u>**

(a) (iv) and (v) Definition and examples of kinetic energy

(c) (i) and (ii) formulae for calculating kinetic and potential energy.

**<u>Areas of weak performance:</u>**

(c) (iii) Energy conversions

(a) (ii) Potential energy definition

**<u>General comments and recommendations</u>**

The vast majority of candidates believed that a body had to be at rest in order to have potential energy. Teachers should try to use imaginative examples to dispel this common misconception.

Many candidates could not state the entire "Principle of Energy Conservation". Most recognized that energy could not be destroyed but for some strange reason they believed that energy could be created.

Many candidates did not know that any number multiplied by zero equals zero.

**<u>Question 3. Section C – Thermal Physics</u>**

(a) Define the "heat capacity of a substance" and state its SI unit.

*C3.1 define heat capacity, 'C';*

(b) Name THREE modes of heat transfer

*C4.1 explain the transfer of thermal energy by conduction.*

*C4.2 explain the transfer of thermal energy by convection;*

*C4.3 explain the transfer of thermal energy by radiation;*

(c) A well-insulated hot water tank is used to supply hot water to a residential dwelling house. The immersion heating element inside the tank has a power rating of 2200 W and the tank contains 125 kg water at 28·C. Calculate

(i) the energy supplied by the heating element in 2 hours

*B5.11 recall power as energy converted per unit time and use this relationship to solve problems;*

$$P = \frac{E}{t}$$

(ii) the heat energy supplied to the water, given that its temperature increases to 58·C

(iii) the heat capacity of the tank, assuming that the tank and the water reach the same final temperature of 58·C.

*C3.1 define specific heat capacity, 'c';*

*C3.2 recall* $E_H = mcÐ\theta$ *and use it to solve problems on specific heat capacity and heat capacity;*

*C3.1 define heat capacity, 'C';*

**Performance Overall:** The average mark for this question was 7.19 out of a possible 15 and the standard deviation was 4.52 . Approximately 160 candidates scored full marks.

**Areas of good performance**

The modes of heat transfer.
All the relevant formulae required in this problem.

**Areas of weak performance**

A large number of candidates were unsure of the distinction between "heat capacity" and "specific heat capacity".
(c) (iii) calculation of heat capacity.

**General comments and recommendations**

The examiners recommend that teachers spend some time driving home and distinguishing between the TWO concepts: Specific Heat Capacity and Heat Capacity. It may be useful to recognize that specific heat capacity is a property of a SUBSTANCE (usually homogenous), such as water, copper, rice, aluminium, nitrogen, glass, tin, gold etc. while heat capacity is a property of DISCRETE OBJECTS such as a cup, a concrete block, a given glass vessel, a thermometer, a piece of wire and so on.

Some candidates did not seem to appreciate the difference between a "temperature" and a "temperature difference". Teachers should make every effort to eliminate these conceptual weaknesses.

**Question 4. Section E – Electricity and Magnetism**

(a) Explain what is meant by the term 'magnetic field'.

*E6.7 define a magnetic field as the region in which a magnetic force may be exerted;*

(b) TWO bar magnets are close to each other so that their magnetic fields interact. Sketch the field pattern for the TWO arrangements shown

(i) Two bar magnets aligned along a straight line so that their N poles are closest to each other.

(ii) Two bar magnets aligned along a straight line so that the N of one is closest to the S pole of the other.

E6.8 *map the magnetic fields;*

*(a) around a single strong magnet;*
*(b) around and between two strong magnets;*

(c) Candidates were given a figure showing a transformer in which the primary is connected to a dc battery and a switch while the secondary is connected to a center-zero galvanometer. The following questions were asked:

(i) (ii) Describe and explain what would be observed on the galvanometer when the switch is closed.

(iii) Describe what would be observed on the galvanometer if the switch is subsequently opened.

(iv) Deduce what would be observed on the galvanometer if the battery were replaced by a low frequency a.c. supply.

(v) How would these observations be affected if the number of turns on the transformer were significantly increased?

*E7.11. describe simple activities which demonstrate an induced e.m.f. caused by changing magnetic flux;*

*E7.18. recall that for an ideal transformer,* $P_{out} = P_{in}$ .

*Transformer formulae to solve numerical problems* $\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$

**Performance Overall:** Performance on this question was the worst in paper 2 and was very much out of keeping with performance on the other questions on this paper. The average mark for this question was 4.62 out of a possible 15 and the standard deviation was 2.65. Approximately 18 candidates scored full marks.

**Areas of good performance :**

(b) (i) and (b) (ii)

**Areas of weak performance**

(a) (i) definition of a magnetic field.

(c) (ii) electromagnetic induction and transformer operation

**General comments and recommendations**

Teachers are encouraged to make every effort to ensure that their candidates know ALL definitions required by the syllabus.

Concerning the weak performance on part (c) (ii): candidates who found this section difficult did not recognize or were not taught that an e.m.f. is induced in a wire **ONLY while it is cutting lines of flux**. The wire will cut lines of flux when there is relative motion between it and a B-field, or when the B-field is changing. The implication of this is that a d-c source of e.m.f. in the primary of a transformer will only produce current in the secondary immediately after it is switched ON or immediately after it is switched OFF.

**<u>Question 5. Section E – Electricity and Magnetism</u>**

(a) Candidates were given a verbal description of three logic gates and asked to identify each gate and draw its logic symbol.

*E5.4 recall the symbols for AND, OR, NOT, NAND, NOR logic gates;*

*E5.5 state the function of each gate with the aid of truth tables;*

(b) Given a simple alarm circuit with three gates, two inputs and two outputs, candidates were required to determine the truth table for one intermediate signal and the two outputs.

Each output was connected to an alarm.

Candidates were also asked to find the state of the outputs given that the logical conditions of the input switches S1 and S2 were associated with certain physical conditions in a motor car as shown in the table below

| | **ENGINE ON** | **ENGINE OFF** | **DOOR OPEN** | **DOOR CLOSED** |
|---|---|---|---|---|
| **SWITCH S1** | ON | OFF | ANY STATE | ANY STATE |
| **SWITCH S2** | ANY STATE | ANY STATE | ON | OFF |

*E5.6 analyze circuits involving the combinations of not more than three logic gates. Example, simple alarm circuits.*

**<u>Performance Overall:</u>** Although the overall performance on this question was satisfactory rather than outstanding, yet the performance was remarkable for the large number of candidates who scored full marks. In fact the modal score for this question was 15 marks, the maximum possible. The average mark for this question was 7.66 out of a possible 15 and the standard deviation was 4.58 . Approximately 995 candidates scored full marks.

**<u>Areas of good performance:</u>**

The majority of candidates knew how to interpret a TRUTH TABLE.

**<u>Areas of weak performance</u>**

Far too many candidates did not realize that ALL LOGIC GATES (EXCEPT THE NOT GATE) HAVE MORE THAN ONE INPUT.

**<u>General comments and recommendations:</u>**

Teachers need to identify the difficulties of candidates who are weak in this area and make every effort to help them overcome their difficulties.

**Paper 03 – Essay Questions**

**Question 1. Section E – Electricity and Magnetism**

(a) An acetate rod may be charged positively by rubbing it with a dry cloth, whereas a polyethylene rod will be negatively charged if similarly rubbed. Explain why this occurs.

*E1.1 explain the charging of objects in terms of properties of negatively charged electrons which are relatively free to move;*

Explain with the aid of diagrams if necessary, why it is possible to pick up small bits of paper with either of these charged rods.

*E1.3 explain how a charged object can attract objects having zero net charge;*

(b) The positively charged acetate rod and the negatively charged polyethylene rod are made to touch each other, causing 3 μA of current to flow from one rod to the other for a period of 4 ms.

Calculate

(i) the amount of charge which flows through the rod
(ii) the number of electrons involved in the current flow.

*E2.4 recall the relationship $Q = It$, and apply it to solve simple problems;*

(c) (i) A cloud has the charge distribution shown in a given Figure 1,
In your answer booklet sketch the electric field pattern inside the cloud, treating the charge distribution as that for TWO parallel plates.

*E1.4 define an electric field as a region in which an electric charge experiences a force of electrical origin and draw the electric fields around point charges and between charged parallel plates;*

(ii) If this cloud is directly over a tall building, explain how the distribution of charges in the building's structure will be affected

*E1.1 explain the charging of objects in terms of properties of negatively charged electrons which are relatively free to move;*

(iii) The air between the cloud and the building breaks down and there is a flash of lightning. Deduce the direction in which the electrons will flow in this lightning bolt.

*E2.3 differentiate between electron flow and conventional current;*

**Popularity:** This question was attempted by approximately 53% of the candidates

**Performance Overall:** The average mark for this question was 8.09 out of a possible 20 and the standard deviation was 5.65. Approximately 23% of the candidates scored full marks.

**Areas of good performance:**

(a) (ii) Charging by induction.
(b) (ii) Q = It and Q = ne
(c) (i) Electric field pattern between parallel plates.

**Areas of weak performance:**

(a) (i) Charging by friction
(b) (i) The vast majority of candidates (approx. 90%) lost marks by not converting ms to s and μA to A. Some candidates thought that ms meant minutes.
A significant number of candidates appeared to be unfamiliar with index notation such as $1.6x10^{-19}$.

**General comments and recommendations**

Teachers are encouraged to take note of the areas of weakness and to instruct their candidates in how to avoid these difficulties.

**Question 2. Section F – Physics of the Atom**

(a) Candidates were given TWO nuclear reactions along with the data for the relevant nuclides:

$$^{212}_{83}Bi \varnothing \ ^{208}_{81}Tl + \ ^{4}_{2}He + Energy$$

$$^{1}_{0}n + \ ^{235}_{92}U \varnothing \ ^{A}_{54}Xe + \ ^{90}_{38}Sr + 3(^{1}_{0}n) + Energy$$

and were asked to:

(i) Calculate the number of neutrons in Bismuth (Bi)
(ii) Determine the atomic mass or nucleon number of Xe

*F3.2 represent and interpret nuclear reactions in the standard form;*

*F2.4 recall and use the relationship*

*A = Z + N;*
*A - nucleon (mass) number*
*Z - proton (atomic) number,*
N - Neutron number

*Use of standard notation for representing a nuclide,*

$$^{A}_{Z}X \text{ for example, } ^{12}_{6}C$$

(iii) Calculate the energy released in EACH nuclear reaction and the ratio of the larger to the smaller. Deduce the recommendation that the engineer will give to the investor.

*F4.1* *relate the release of energy in a nuclear reaction to a change in mass; Solution of problems using*

*Einstein's equation* $ĐE = Đmc^2$.

*Include fission (with radioactivity) and fusion.*

(b) Candidates were asked to characterize $\alpha$, $\beta$ and $\gamma$ rays in terms of their

Range in air
Behaviour in an electric field
Types of track in a cloud chamber.

*F3.1* *recall the nature of the three types of emissions from radioactive substances;*
*F3.2* *describe the appearance of the tracks of radioactive emissions in a cloud chamber;*
*F3.3* *predict the effects of magnetic and electric fields on the motion of* $\alpha$ *and* $\beta$ *particles and* $\gamma$ *rays;*

**Popularity:** This question was attempted by approximately 33% of the candidates

**Performance Overall:** The average mark for this question was 7.91 out of a possible 20 and the standard deviation was 4.27. Approximately 6% of the candidates scored full marks.

**Areas of good performance:**

(a) (i) A = N + Z

**Areas of weak performance:**

(a) (iii) Conversion of Đm from mass units to kg.

(b) Range, in air, of the different types of radiation

**General comments and recommendations:**

Teachers are encouraged to:

(i) Emphasize the difference between "atomic mass number" and "atomic mass".

(ii) Explain conversion using $u = 1.66 \times 10^{-27}$.

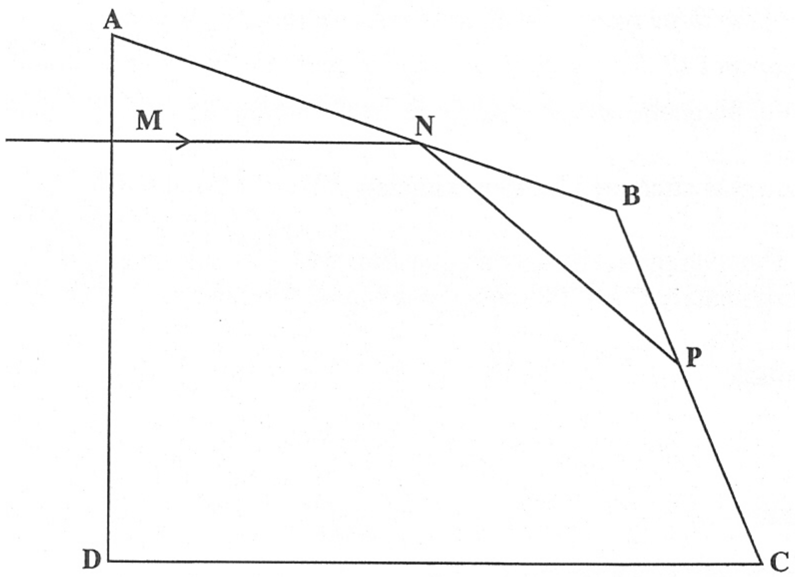
(iii) Distinguish clearly between the types of tracks produced in a cloud chamber by $\alpha$, $\beta$, and $\gamma$ radiation.

**Question 3. Section D – Waves and Light**

(a) With the aid of a neat, clearly labelled diagram, describe an experiment to prove the relationship between the angle of incidence, i, and the angle of reflection, r, for a ray of light incident on a plane mirror

*D6.1* *state and apply the laws of reflection;*
*Use laws to solve problems.*
*Perform experiments to show the angle of incidence and the angle of reflection are equal.*

*D5.4* *recall that light travels in straight lines and give examples.*




(b) Candidates were referred to the diagram of an irregular prism as shown above with ray MN incident on the face AD as shown and were asked to:

(i) Show that MN will be totally internally reflected from the face AB.

(ii) Determine the angle $\theta_m$ , the angle which the reflected ray makes with the face BC at point P.

(iii) Candidates were asked to redraw the diagram in their answer books and to sketch on their diagrams the ray from point P, showing clearly the path from P through to its emergence from the prism.

Indicate any refraction.

*D6.6* *explain with the aid of diagrams what is meant by 'critical angle' and 'total internal reflection';*

*D6.7* *calculate critical angles and relate to total internal reflection;*

**Popularity:** This question was attempted by approximately 54% of the candidates.

**Performance Overall:** The average mark for this question was 5.57 out of a possible 20 and the standard deviation was 4.91. Approximately 0.5% of the candidates scored full marks.

**Areas of good performance**

Most candidates were familiar with the experiment but a significant proportion neglected to list the apparatus used.

**Areas of weak performance**

Some candidates were confused about the difference between reflection and refraction.
Many candidates did not realize that the problem required some elementary geometry for its solution.

**General comments and recommendations**

Teachers should get their candidates to practice writing out experiments in a structured step-by-step fashion. The examiners were of the opinion that the confusion between reflection and refraction arose largely because of the homophonic relationship between the two words. Teachers are encouraged to note the likely occurrence of this problem and to take steps to avoid it when teaching this topic.

More emphasis should be placed on the teaching of mathematical methods in Physics.

**Question 4. Section B – Mechanics**

(a) With the aid of a labelled diagram describe an experiment to determine the centre of gravity of an irregularly shaped sheet of cardboard.

*B1.8 determine the location of the centre of gravity of a body;*
*B1.9 Centre of gravity of a variety of regular and irregular shaped solids, including lamina.*

(b) Given a labelled diagram of a bicycle on level ground, candidates were required to write the two equations which satisfy the conditions of equilibrium.

(c) Kenny and Candy decided to sit on a see-saw while visiting a local play park. Candy of mass 50 kg, sat 250 cm from the pivot of the seesaw.

(i) Where should Kenny of 60 Kg mass sit so that a state of stable equilibrium exists?
(ii) What should Kenny do if he wanted to elevate Candy.

*B1.4 identify situations in which a turning effect on a body will result from the application of a force; Situations that are relevant to everyday life for example, opening a door, a 'seesaw', a spanner.*

*B1.5 state the principle of moments and use it to solve problems on equilibrium.*

*Observe situations in which forces are varied to give different equilibrium situations.*

**Popularity:** This was the most popular question on the paper and was attempted by approximately 85% of the candidates

**Performance Overall:** The average mark for this question was 10.64 out of a possible 20 and the standard deviation was 5.5. Approximately 0.92% of the candidates scored full marks

**Areas of good performance:**

(a) The standard experiment was known by most candidates.
(c) (i) Was very well done

**Areas of weak performance**

Very few candidates were able to formulate the equations correctly.

**General comments and recommendations**

Teachers should get their candidates to practice writing out experiments in a structured step-by-step fashion. The conditions for equilibrium should be expressed in words as well as in algebraic equations.
Teachers should help their candidates appreciate the fact that the Principle of Moments is stated with respect to FORCES and not MASSES.

**Question 5. Section C – Thermal Physics**

(a) (i) Distinguish between EACH of the following pairs of terms:

(a) Solidification and fusion

(b) Condensation and vaporization

(ii) Describe FULLY the process of sublimation.

*C3.5 distinguish amongst solids, liquids and gases;*

*C3.10 distinguish between evaporation and boiling.*

(b) For the changes of state mentioned in (a) and (b) above to take place, energy must be added to or removed from a substance. Give the general name for this type of energy and state what happens to the temperature during these processes.

*C3.7 describe a demonstration that shows that temperature remains constant during a phase change;*

(c) A student placed 700 g. of water at 28°C in a freezer. After 6 minutes and 15 seconds the water was transformed to ice.

Calculate

(i) the heat energy transferred from the water during the temperature change

*C3.3 recall $E_H = mc\mathrm{Đ}\theta$ and use it to solve problems on specific heat capacity and heat capacity;*

(iii) the latent heat of solidification, given that 235200 J of heat energy was transferred during the change of state

*C3.8 define the specific latent heat and use the relationship $E_H = ml$ to solve problems on specific latent heat;*

(iv) the rate of heat energy transfer for the entire process.

*B5.11 recall power as energy converted per unit time and use this relationship to solve problems;*

$$P = \frac{E}{t}$$

**Popularity:** This was the second most popular question on the paper and was attempted by approximately 76% of the candidates

**Performance Overall:** The average mark for this question was 9.34 out of a possible 20 and the standard deviation was 5.64. Approximately 1.99% of the candidates scored full marks

**Areas of good performance:**

(a) (ii) Sublimation

**Areas of weak performance:**

(b) Identifying the general name for the energy involved in phase changes.

**General comments and recommendations:**

Heat and temperature should be clearly distinguished.
T and t cannot both be used to represent time.
Teachers need to make a clear distinction between thermal fusion and nuclear fusion.

**Paper 04 – School Based Assessment (SBA)**

Performance by centres in the School Based Assessment was again quite good as a large majority of marks submitted were accepted.

There were still a few areas that teachers have to pay special attention to.

(1) Planning and Design activities should NOT be traditional laboratory activities but should present candidates with a hypothesis that requires investigation. Special attention should be paid in the design of the relevant mark scheme.

(2) Mis-matching of criteria. Teachers should be clear about the criteria for each specific skill being tested.

(3) Breakdown to one (1) of all marks allocated. An example is

| | | |
|---|---|---|
| in Plotting of points : | 6 plotted accurately | - 4 marks |
| | 5 plotted accurately | - 3 marks |
| | 4 plotted accurately | - 2 marks |
| | 3 points or less | - 1 mark |

(4) All assessments for SBA should have a clear breakdown of marks according to the scheme by skill and criteria. It is tedious to moderate if only a total mark is given per skill.

(5) No mark schemes submitted. Teachers should plan their activities and schemes together. The most accurate moderation takes place if teachers provide an acceptable mark scheme with detailed marking in the laboratory books.

Assistance in the preparation for School Based Assessment in Physics is provided in:

(1) CXC Physics Module #1 - School Based Assessment in Physics.

(2) CXC Physics Syllabus (2002) - pp 62 - 69.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

**REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION JUNE 2006**

**PHYSICS**

# PHYSICS

## GENERAL PROFICIENCY EXAMINATION

## JUNE 2006

**General Comments**

Ten thousand three hundred and thirty candidates registered for the examination this year compared with 9,965 in June 2005. This represents a marginal increase of 3% when compared with June 2005.

An area of weakness which occurs year after year and was also evident in this year's responses is the inability of many candidates to transpose simple formulae. We encourage teachers to make a special attempt to deal with this particular weakness. It should be possible to correct this by simple repetitive drills.

The examiners also wish to highlight the fact that a major proportion of candidates were unable to carry out basic unit conversions such as $cm^3$ to $m^3$ or km to m. Again these weaknesses may be corrected by practice drills.

Many candidates appeared to be quite unfamiliar with the use of standard form and were unable to enter numbers in standard form into their calculators. Teachers should make every effort to make sure that every student who sits the CSEC Physics exam is able to work problems with numbers expressed in standard form.

### Paper 01 – Multiple Choice

The performance in this year's multiple choice paper is the worst in recent years. Whereas the average on this paper has remained fairly stable between 33 and 35 (out of a possible 60) over the last 5 years, this year's average score was 30 (out of a possible 58) with a standard deviation of 9.3.

### Paper 02 – Structured Questions

**Question 1**

**Data Analysis, Section A – Physical Measurements and Units, Section C – Thermal Physics**

**Performance Overall:** The average mark for this question was 12.3 out of a possible 30 and the standard deviation was 8.18. Approximately 30 candidates scored full marks

**Areas of good performance:**

Part (f). Most candidates were able to obtain maximum marks for this part of the question. This was a calculation of the quantity of heat energy supplied to convert 2 kg of water at 100°C to steam. The formula Q = mL had to be used.

**Areas of weak performance:**

Part (e). A large number of candidates failed to realize that their answer to part (d) was required for the solution of this part of the question. For part (d) the gradient represented the heat capacity of 2 kg of water.

For part (e) the gradient or heat capacity of 2 kg of water must be divided by 2 to give the heat capacity of 1 kg of water or the specific heat capacity of water.

**General comments and recommendations:**

(a) Teachers are encouraged to stress the importance of significant figures and units when stating the results of physical measurements and calculations. This lesson is best driven home by repetition. The teacher should at all times try to ensure that he/she uses the appropriate number of significant figures and the correct units.

(b) Students should be helped to realize that a convenient choice of scale and proper orientation of the axes are necessary to obtain full marks on the data analysis question.

A plot of P vs (or against) T means that P is plotted on the vertical axis and T on the horizontal axis.

(c) Many candidates answered this "distinguish between" question as if it had asked for definitions. Physics teachers should try to ensure that their students are familiar with the meanings of all the key words of interrogation such as: calculate, estimate, deduce, determine, distinguish between, compare, explain etc.

**Question 2**

**Section E – Electricity and Magnetism**

**Performance Overall:** The average mark for this question was 7.3 out of a possible 15 and the standard deviation was 4.50. Approximately 171 candidates scored full marks.

**Areas of good performance:**

(b) (ii) The symbol for the bulb was well known.

(c) (ii) The Ohm's Law equation V = IR was well known.

**Areas of weak performance:**

(a) Many candidates seemed to be unaware of a difference between the definition of and an explanation of electrical resistence.

(b) (ii) Many candidates could not identify the symbol for an electric motor. Many candidates could not identify a parallel circuit. Many candidates failed to recognize the "tilde ~ " symbol as an indication of alternating current/voltage.

(c) (i) Many candidates confused W, the symbol for the Watt, with V, the symbol for volts. Many candidates did not appear to be familiar with the equation P = VI.

(c) (iii) Many candidates although defining efficiency correctly, in terms of useful power output over input power, did not seem to realize that they had to subtract losses from input power to obtain useful power. Many candidates confused ENERGY and POWER.

**General comments and recommendations**

(a) Many candidates seemed to be unaware of a difference between a definition and an explanation. The meanings of these words of interrogation are explained with great clarity in the syllabus. (See comment (iii) on paper 2 Question 1)

(b) Many students could not identify a parallel circuit. The configurations themselves are so easily distinguishable that the problem must reside in confusion of the meaning of the two words.

Teachers can get around this problem by using the terms in both physics and non physics contexts. Appropriate examples are left to the imagination of the teacher.

It is clear from the plethora of weaknesses enumerated above, that a fairly large number of teachers are falling short in the preparation of their candidates for this section of the syllabus. It is also obvious that many candidates come to this topic with a flawed set of preconceived notions based on erroneous everyday use of words such as power and energy. It does not appear that these mistaken ideas are corrected by their study of CXC Physics.

Teachers should realize that these false notions represent a glorious teaching opportunity. By starting with the every day concept and gradually moving the correct ideas, and highlighting the differences, it should be possible to drive home the desired idea.

**Question 3**

**Section D – Wares and Light**

**Performance Overall:** The average mark for this question was 8.16 out of a possible 15 and the standard deviation was 3.65 . Approximately 260 candidates scored full marks.

**Areas of good performance**

Sections (b) and (d) involving UK marks were very well done. For part (a) most candidates knew the formula $c = f\lambda$ and were able to complete the calculation. Similarly most candidates were able to apply the formula speed = $\frac{\text{distance moved by the waves}}{\text{time}}$
to calculate the distance moved by the wave then divided by 2 to find the depth of the water.

**Areas of weak performance**

Section (c) (ii). Many candidates attempted to describe transverse and longitudinal waves without reference to motion of the particles as was required in part (c) (ii).

**General comments and recommendation**

Slinky springs are fairly cheap and easily obtainable. We believe that the teaching of this subject would be considerably enhanced if teachers were able to carry out practical demonstrations, using slinky springs, while discussing the characteristics of waves.

**Question 4**

**Section B – Mechanics**

**Performance Overall:** The average mark for this question was 3.9 out of a possible 15 and the standard deviation was 3.12 . Approximately 11 candidates scored full marks.

**Areas of good performance**

Part (a) + (b). Most candidates knew how to define the moment of a force and state the principle of moments.

(c) (iii) The conversion of mass to weight was well-known.

**Areas of weak performance**

(a) Many candidates did not know or did not think it important to note that in the Principle of Moments it is the ***perpendicular distance from the pivot*** that must be multiplied by the force.

(b) Many candidates did not realize that the Principle of Moments was a statement of an equilibrium condition.

(c) Indicating the forces on the bicycle.

(d) Many candidates had difficulty writing the two equations for the equilibrium of the bicycle.

**General comments and recommendations:**

A ***description of the effect*** of the moment of a force is not the same as a ***definition*** of the "moment of a force". Teachers should distinguish, clearly, between a description and a definition and make scrupulous efforts to prevent confusion of the two in the minds of their students.

Teachers should help their students realize that FORCES have both "a line of action" and a "point of application" and both must be taken into account when drawing forces on any diagram.

Algebra is a very important part of the language of science. Many scientific principles are expressed as algebraic equations. It is, therefore, very desirable that Physics students have a sound grasp of the meaning of algebraic equations and be able to express physical relationships in algebraic format. The suggested pedagogical approach is exhaustive repetition.

**Question 5**

**Section E – Electricity and Magnetism**

**Performance Overall:** The average mark for this question was 6.5 out of a possible 15 and the standard deviation was 4.3 . Approximately 320 candidates scored full marks.

**Areas of good performance:**

Part (b) of this question was widely known. The formula required for Part (c) (iv) was known but the value substituted for V was very often wrong.

**Areas of weak performance:**

Part (a) of this question presented difficulty. Candidates seemed to answer according to their own practical experience. Calculation kWh in (c) (ii) also gave difficulty. In calculating the bill in (c) (iii), students failed to recognize that answers in millions of dollars would be ridiculous for a household bill.

**General comments and recommendations**

Many students offered a regional/national insulation colour code for the International Insulation Colour Code. Although there may be regional and national variations in practice, it is important that international standards be known. The syllabus is clear and unequivocal on this. Teachers should take advantage of what is familiar to teach what is unfamiliar. Teachers can help their students to become familiar with the international code by comparing it with what is familiar to their students and stressing the differences.

An appreciation of how to manipulate units would greatly assist students in answering questions appropriately.

**Paper 03 – Essay Questions**

**Question 1**

**Section B – Mechanics**

**Popularity:** This was a popular question on the paper and was attempted by approximately 87% of the candidates.

**Performance Overall:** The average mark for this question was 10.5 out of a possible 20 and the standard deviation was 4.95 . Approximately 43 candidates scored full marks.

**Areas of good performance**

The distribution of marks obtained for this question indicated that performance was fairly evenly distributed over most sections of the question.

**Areas of weak performance**

The distribution of marks obtained for this question indicated that performance was fairly evenly distributed over most sections of the question.

**General comments and recommendations**

Teachers should stress and explain the necessity and importance of using the word "resultant" or "unbalanced" or "net" as a for force in Newton's First Law.

**Question 2**

**Section C – Thermal Physics and Kinetic Theory**

**Popularity:** This was another popular question on the paper and was attempted by approximately 83% of the candidates.

**Performance Overall:** The average mark for this question was 6.9 out of a possible 20 and the standard deviation was 4.72 . When 87% of the scripts had been examined it was found that 2 candidates had scored full marks.

**Areas of good performance**

(c) (i) Generally well done except in cases where candidates did not realize that the measured pressure should be added to atmospheric pressure to obtain the total pressure.

**Areas of weak performance**

Parts (a) + (b). For Part (a) many candidates were unable to present a well labelled diagram and explain the procedure for observing Brownian motion either by the smoke cell or the pollen grain experiments. For part (b) candidates in using the kinetic theory needed to express that for a gas or liquid the assumption is that particles can move randomly and are free to move throughout a container. For the pressure law candidates were required to express the following:

- Pressure is directly proportional to absolute temperature while volume is constant.
- An increase in temperature gives rise to an increase in kenitic energy of the particles.
- Increase kinetic energy of the particles give rise to more frequent and harder collisions of particles thus giving rise to greater pressure.

In explaining how a drop of blue ink placed in a container of pure water eventually spreads out to occupy the entire volume candidates must explain diffusion. This is when water particles collide with the ink particles and the ink particles eventually through collisions with the water particles are dispersed to all parts of the container.

**General comments and recommendations**

The areas of weak performance are traditional weak areas. Teachers should give their students practice in answering questions which require discourse, explanation or exposition. The primary problem seems to be organization of ideas. This is a teachable skill. It is also a necessary skill not only in scientific areas but in many areas of everyday life. It overlaps with the ORR of SBA in terms of the reporting aspect. Physics teachers are encouraged to help their students to master this very important life skill.

**Question 3**

**Section D – Waves and Light**

**Popularity:** This was not a particularly popular question and was attempted by only 48% of the candidates.

**Performance Overall:** The average mark for this question was 5.5 out of a possible 20 and the standard deviation was 4.24 When 87% of the scripts had been examined it was found that only 1 candidate had scored full marks.

**Areas of good performance**

(a) Part (b) (ii) Most candidates were able to recognize the relation

$$\text{Speed of the laser light} = \frac{\text{2 x distance travelled by the light}}{\text{Time}}$$

and were able to complete the calculation.

(b) Part (b) (iv). Most candidates were able to express the condition for total internal reflection: angle of incidence > critical angle.

**Areas of weak performance**

(a) (i) In describing the properties of e.m. waves, many candidates gave general wave properties such as reflection, refraction, interference etc. rather than the specific properties of e.m. radiation.

(b) (ii) Many candidates had difficulty rearranging the formula $v = f\lambda$. Many candidates were unable to solve equations in which one of the quantities is expressed in scientific notation.

(b) (iii) The simple geometry required to solve this section proved to be beyond the abilities of most candidates.

**General comments and recommendations**

Physics teachers need to make sure that their students get a lot of practice in rearranging simple formulae. Teachers should also ensure that their students know how to work with quantities expressed in scientific notation.

Geometry is an essential part of geometrical optics. Physics teachers should ensure that their students get adequate practice in the solution of problems involving geometry.

**Question 4**

**Section E – Electricity and Magnetism**

**Popularity:** This was the least popular question on the paper and was attempted by approximately 25% of the candidates.

**Performance Overall:** The average mark for this question was 8.08 out of a possible 20 and the standard deviation was 4.25. Approximately 0.04% of candidates scored full marks.

**Areas of good performance**

Part (a) + (b) (i). Most candidates were able to compare the lead-acid battery with the zinc-carbon battery in terms of the terminal voltage, maximum current, internal resistance and rechargeability. Most candidates were able to recall and apply the formula P = IV.

**Areas of weak performance**

Parts (c) (i) + (c) (ii). For part (c) (i), candidates were required to divide the total power required by the power for one battery to find the number of batteries required for full power. For part (c) (ii), candidates were required to realize that if the motor requires 120 V and this must be supplied by 10 twelve-volt batteries in series, the total number of batteries must be a multiple of 10. The result in (c) (i) is 31.3 or 32 batteries thus one can infer 40 batteries.

**General comments and recommendations**

The use of multiplier prefixes such as mega-, kilo-, micro-, milli-, is basic to physics. All students of physics should be familiar with their meaning and use and should be able to convert from the unitary quantity to the multiplied quantity and vice versa with great facility. Teachers should ensure that their students have adequate practice in making these conversions.

**Question 5**

**Section F – The Physics of the Atom**

**Popularity:** This was a fairly popular question and was attempted by approximately 57% of the candidates.

**Performance Overall:** The average mark for this question was 8.7 out of a possible 20 and the standard deviation was 5.13 . When 87% of the scripts had been examined it was found that 47 candidates had scored full marks.

**Areas of good performance**

Part (a). Many candidates were able to answer this part of the question.

| Field | Application | Isotope | Radiation |
|---|---|---|---|
| Medicine | Monitor salt absorption | Sodium<br>Strontium<br>Iodine | |
| | Organ disorders | Iodine<br>Technetium | |
| | Kill cancer cells | Cobalt | $\gamma$ - radiation |
| | Kill germs/ bacteria | | $\gamma$ - radiation |
| Agriculture | Detect leaks | Sodium | $\beta$ - radiation |
| | Monitor food uptake in plants | Phosphorous | $\gamma$ - radiation |
| | Test welds | cobalt | $\alpha$, $\beta$ - thin sheets |
| | Measure sheet thickness | | $\gamma$ - thick sheets |

**Areas of weak performance**

(b) (iii) Many candidates did not realize that the mass defect is so small compared to the atomic mass that they need to carry all quantities to 6 or the given number of decimal places. A considerable number of candidates rounded off the atomic masses and so were not able to obtain an accurate value for the mass defect.

**General comments and recommendations:**

Teachers should give their students an adequate amount of practice in the solution of this type of problem.

## Paper 04 – School-Based Assessment (SBA)

Performances by centres have improved again this year as over 82% of the samples moderated showed that teacher's marking reflected the standard expected. However, a small percentage of teachers are still using traditional laboratory experiments to test Planning and Design skills.

Teachers are reminded that all assessments are to be marked in detail and not given an overall mark alone. The quality of the mark schemes are improving as many teachers breakdown all marks per criterion to one.

Teachers are encouraged to consult the following information sources to assist them in designing their SBA programme.

1. CXC Physics Module -1 School Based Assessment in Physics.
2. CXC Physics Syllabus - pp 62-71.
3. CXC website - Schools Reports. www.cxc.org.

C A R I B B E A N    E X A M I N A T I O N S    C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION MAY/JUNE 2007

## PHYSICS

# PHYSICS
# GENERAL PROFICIENCY EXAMINATION
# MAY/JUNE 2007

## GENERAL COMMENTS

Ten thousand eight hundred and forty-seven candidates registered for the examination this year compared with 10,330 in June 2006. This represents an increase of 5% when compared with June 2006.

Candidates showed weaknesses in performing mathematical calculations and in understanding some concepts which are sometimes overlooked by teachers. The calculations involving the scientific notation are still presenting some candidates difficulty. Teachers are encouraged to have students competent in the use of the scientific notation.

Teachers are encouraged to deliver the syllabus in a complete manner rather than choosing a core of objectives. This examination is a critical building block for further study at the Caribbean Advanced Proficiency Examination (CAPE) and for university level courses.

## Paper 01 – Multiple Choice

The performance in this year's multiple choice paper has improved over that of June 2006. This year, the average score was 38.72 out of a possible 60, with a standard deviation of 11.49.

## Paper 02 – Structured Questions

**Question 1**

**Data Analysis, Section A – Physical Measurements and Units, Section C – Thermal Physics**

**Performance Overall**

The average mark for this question was 14.49 out of a possible 30 and the standard deviation was 7.43. Approximately 30 candidates scored full marks.

**Areas of good performance**

Part (b), plotting of the graph. Most candidates demonstrated a good display of plotting skills. Skills tested were labelling, using appropriate scales, plotting, drawing the best line, fine line and extrapolation.

**Areas of weak performance**

Part (f). A large number of candidates failed to realize that if the pressure is doubled, the volume is halved. Features of Line 2 were (i) x-intercept is the same as Line 1 and (ii) y-intercept is $\frac{1}{2}$ that of Line 1.

**General comments and recommendations:**

(a) It is expected that when asked to draw a diagram, it is also labelled.

(b) The key criteria in determining the slope of a graph are

(i) a large triangle

(ii) correct read offs

(iii) calculation with units.

(c) Candidates should be given adequate practice in graph skills before marking for School Based Assessments.

(d) Syllabus objectives assessed: C 1.9 (b), A 3.1, A 3.2, A 3.3.

**Question 2**

**Section B – Mechanics**

**Performance Overall**

The average mark was 6.53 out of 16. The standard deviation was 4.51. Approximately 280 candidates scored full marks.

**Areas of good performance**

Part (b) (iii), the calculation of the average speed of the car.

Part (b) (iv), using the formula F = ma.

**Areas of weak performance**

The linking of b (i) to b (ii). This involved a drawing of how velocity changes with time but includes the identification of reaction time on the graph.

Acceleration was taken by some candidates as average speed divided by time instead of change of velocity divided by time. There was also a misconception of velocity as being speed.

**General comments and recommendations**

(a) Teachers should ensure that candidates have a good understanding of the concepts of average speed, velocity change, and per unit time.

(b) There is a need to perform activities involving reaction time and plot associated graphs.

(c) Syllabus objectives assessed: B 3.2, B 3.3, B 4.3.

**Question 3**

**Section B – Mechanics and C – Thermal Physics and Kinetic Theory**

**Performance Overall**

The average mark for this question was 7.11 out of a possible 14. The standard deviation was 3.40 and approximately 100 candidates scored full marks.

**Areas of good performance**

Part (b) concerning energy conversion and loss, and part (c) the calculation of energy using $E = MC\Delta\theta$.

**Areas of weak performance**

Part a (ii) – Many candidates did not recognise that emission of radiation was the issue in this section.

Part d – Many candidates wrote the wrong equation. Here $E = ml_V$ was the needed equation. In part (c) and (d) candidates are still being confused with scientific notation.

**General comments and recommendation**

Teachers should ensure that candidates, in their study of thermal physics, know that

(i) shiny surfaces are poor emitters of radiation,

(ii) a change of temperature in ˚C and K carries the same value and

(iii) candidates should pay attention to vocabulary, grammar and appropriate use of Physics terms and symbols.

Syllabus objectives assessed: B 5.4, B 5.18, C 4.1, C 4.2, C 4.3, C 4.4, C 3.3, C 3.8.

**Question 4**

**Section D – Waves and Light**

**Performance Overall:**

The average mark for this question was 7.11 out of a possible 16 and the standard deviation was 3.40 . Approximately 10 candidates scored full marks.

**Areas of good performance**

Section (c) (iv) and (v) of the question were generally widely known. Candidates appear to be familiar with $n = \frac{\text{Sin } \hat{i}}{\text{Sin } \hat{r}}$ and $n = \frac{c}{v}$ .

**Areas of weak performance**

Section (a) and (b) presented difficulties for candidates. Teachers are encouraged to look at the history of physics and relevant theories concerning the wave-particle duality. Some candidates gave the properties of light instead of the two theories.

In Section (c) part (i); although simply asked to say that all light was reflected at C, they were explaining how and why total internal reflection occurs.

**General comments and recommendations:**

(a) The following content should be well internalised by candidates

$$\frac{\text{Sin } \theta_1}{\text{Sin } \theta_2} = {}_1n_2 = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

and total internal reflection via the use of a light-pipe.

A hands-on approach to this topic is highly recommended.

(b) Syllabus objectives assessed: D 2.2, D 2.4, D 2.5, D 5.1, D 5.4, D 6.5, D 6.6.

**Question 5**

**Section E – Electricity and Magnetism**

**Performance Overall**

The average mark for this question was 4.7 out of a possible 14 and the standard deviation was 2.59. Approximately 4 candidates scored full marks.

**Area of good performance**

Section (c) of this question was widely known. Most candidates knew the formula Q = it and the unit of charge – the coulomb.

**Areas of weak performance**

Section (a) part (ii). This involved explaining why there is a net force of attraction. The response expected includes two statements: (i) negative attracts positive and attraction greater than negative – negative repulsion. Part (iii) charging by contact was a difficult concept for some. Section (c) – conversion of millisecond to second.

**General comments and recommendations**

(a) There is a need for more hands-on experiences in this area – use of electroscopes. The need to discuss practical applications of lightning rods emphasizing the conducting path.

(b) Syllabus objectives assessed: E 1.1, E 1.2, E 1.3, E 1.4, E 1.5.

**Paper 03 – Essay Questions**

**Question 1**

**Section B – Mechanics**

**Popularity**

This was a popular question on the paper and was attempted by approximately 83% of the candidates.

**Performance Overall**

The average mark for this question was 5.63 out of a possible 20 and the standard deviation was 3.93. Fewer than 10 candidates scored full marks.

**Area of good performance**

Section (b) which involved the application of the formulae kinetic energy = $\frac{1}{2}mv^2$ and potential energy = mgh, was the section showing a good performance.

**Areas of weak performance**

Sections (a) and (c) presented difficulty to students. The statement of Newton’s first and second laws of motion is precise and does not require any explanation. The second law can be expressed in terms of acceleration or the rate of change of momentum of a body.

The explanation of how a satellite remains in orbit around the earth involves the following four points:

(i) A satellite needs centripetal force to maintain an orbit.

(ii) Gravitational attraction.

(iii) Causes an acceleration towards the centre.

(iv) This prevents the satellite from going off in a straight line.

The solution to section (c) parts (i) and (ii) involve the application of the formulae a = F/m and $a = \frac{\text{change in velocity}}{\text{time}}$ respectively.

**General comments and recommendations**

(a) There is a need for teachers to ensure that candidates can use the following terms in context and have a clear understanding of the concepts: “speed”, “velocity”, “moment”, “momentum” “net force”, “unbalanced force” and “resultant”. Candidates can be engaged in little oral and written activities using these terms appropriately.

(b) Syllabus objectives assessed: B 3.1, B 4.2, B 4.3, B 5.1, B 5.8, B 5.10.

**Question 2**

**Section D – Waves and Light**

**Popularity**

This was another popular questions on the paper and was attempted by approximately 56% of the candidates.

**Performance Overall**

The average mark for this question was 6.04 out of a possible 20 and the standard deviation was 4.18 .

**Areas of good performance**

Section (c) part (i) using $\lambda = \frac{v}{f}$ . A large marjority of candidates got this part correct.

**Areas of weak performance**

Section (a) Definition of vibrating in phase. Candidates were expected to respond with – Particles always at same position (1) and moving in the same direction (1) or crest and crest/trough and trough (1) moving in step with one another/in the same direction (1).

Section (c) part (iv). The expression "effect on the observations" did cause some confusion in some minds and did not lead to distances – the distance between A and B is less (1). Section (c) part (ii) the sketching of the graph of displacement vs position posed a challenge.

**General comments and recommendations**

(a) Candidates need to gain greater experience in this area. This can be attained through practical demonstrations using the slinky, ripple tank and rope. Another effective method of learning about this area is through simple visual aids or low cost/free computer-based resources. The internet is a rich source of free resources.

(b) Syllabus objectives assessed: D 1.1, D 1.2, D 1.3, D 2.6, D 3.2

**Question 3**

**Section C – Thermal Physics and Kinetic Theory**

**Popularity**

This was the second most popular question and was attempted by 72.3% of the candidates.

**Performance Overall**

The average mark for this question was 5.90 out of a possible 20 and the standard deviation was 4.69. At least 12 candidates scored full marks.

**Areas of good performance**

Most of the candidates knew

(i) that particles bombard each other

(ii) the gas law and density formulas

(iii) about the relative spacing of particles in liquids and gases.

Candidates were also familiar with the pressure law formula as needed for Section (b) part (ii) of the question.

**Areas of weak performance**

(i) The concept of what occurs during phase change and bombardment being a force on an area, i.e. pressure.

(ii) Interpretation of numbers/data in section (b) and the conversion from Degrees Celcius to Kelvin.

(iii) The fact that energy change must state from which form of energy to which other form of energy.

**General comments and recommendations**

(a) There should be a greater emphasis on

(i) what happens to molecules during phase changes

(ii) conversion of temperature between scales and

(iii) more practice in questions involving numbers.

(b) Syllabus objectives assessed: C 1.9, C 1.10, C 3.7.

**Question 4**

**Section F – The Physics of the Atom**

**Popularity**

This question was attempted by approximately 38% of the candidates.

**Performance Overall**

The average mark for this question was 7.51 out of a possible 20 and standard deviation 5.34. Approximately 20 candidates scored full marks.

**Areas of good performance**

Most candidates knew the equations and how to determine protons, neutrons and electrons.

**Areas of weak performance**

Section (c) parts (i) and (ii). Even though some candidates mentioned that decay was unaffected by temperature they also thought that "very high temperature" might make a difference.

**General comments and recommendations**

(a) This section of the course is relatively simple but many teachers rush this area at the end of the syllabus. If time is taken, students would enjoy and perform better on this section.

(b) Computer software can be used to facilitate learning.

(c) Syllabus objectives assessed: F 1.2, F 2.4, F 2.5, F 3.6, F 3.12

**Question 5**

**Section E – Electricity and Magnetism**

**Popularity**

This question was attempted by approximately 38% of the candidates.

**Performance Overall**

The average mark for this question was 5.85 out of a possible 20 and the standard deviation was 4.83 .

**Areas of good performance**

Section (b) parts (i) and (ii), using the formulas V = IR and P = IV respectively.

**Areas of weak performance**

(i) The labelled diagam and explaining the operation of the loudspeaker.

(ii) Section (c) part (i) writing $R_{TOT} = \frac{1}{R_1} + \frac{1}{R_2}$ instead of $\frac{1}{R_{TOT}} = \frac{1}{R_1} + \frac{1}{R_2}$.

(iii) Section (b) part (iii). Candidates did not realise that it was 15% of the energy needed.

**General comments and recommendations**

(a) Just over one-third of the population chose this question. Teachers have to spend more time on electromagnetism on the whole. It is a tough sub-section with instruments as the d.c. motor, magnetic relay, loud speaker, ac generator and the transformer. Teachers should allocate a significant time-frame to cover this section especially.

(b) Syllabus objectives assessed: E 7.10, E 3.3, E 4.7, E 4.15.

**Paper 04 – School-Based Assessment (SBA)**

This year random sampling was applied and centres provided five books instead of each teacher providing five books. Schools are reminded to plan for common SBA assessments from early in the school year. Teachers can engage students in other practical activities but not for SBA marks. Adequate exposure to the four skills is important before students are marked. Most centres had an acceptable performance in SBA.

Note the following:

1. Ten or more topics should be covered over the two years.

2. Each skill is to be tested at least 4 times (16 labs minimum).

3. More than 5 laboratory activities with graphs should be completed.

4. All criteria should be to a 1 mark breakdown.

5. Clear instructions and mark scheme are required for each SBA marked activity.

6. References: CXC Physics Module -1 School Based Assessment in Physics; CXC Physics Syllabus - pp 62-71.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

**REPORT ON CANDIDATES' WORK IN THE**
**CARIBBEAN SECONDARY EDUCATION CERTIFICATE EXAMINATION**
**JANUARY 2008**

# PHYSICS

# PHYSICS

## GENERAL PROFICIENCY EXAMINATION

## JANUARY 2008

## GENERAL COMMENTS

Overall performance in the 2008 Physics CSEC Examination was, in the opinion of the Examiners, quite satisfactory with nearly 60 per cent (59.8 per cent) of candidates achieving between Grades I and III. One commendable feature of this performance was the fact that the performances in both Use of Knowledge (Profile 1) and the Knowledge and Comprehension (Profi similar.

An area of weakness which occurs year after year and was also evident in this y s responses is the inability of many candidates to transpose simple formulae. We encourage teachers to make a special attempt to deal with this particular weakness. It should be p sible to correct this by simple repetitive drills.

The examiners also wish to highlight the fact that a major proportion of candidates were unable to carry out basic unit conversions such as mass in grams to weight in newtons. Again these weaknesses may be corrected by practice drills.

Many candidates appeared to experience considerable difficulty when asked to apply familiar concepts to unfamiliar situations. Physics teachers are encouraged to expose their students to a wide a variety of everyday situations in which physics is applicable thereby developing in them the ability to identify the physical principles at work in these situations.

## PAPER 01

## MULTIPLE CHOICE

## DETAILED COMMENTS

The performance in this year's multiple choice paper i similar to that of recent January sittings. The average on this paper has remained between 33 and 35 ( t of a possible 60) over the last few January sittings, and this year was no exception with average score was 38 (out of a possible 59) with a standard deviation of 10.2. Approximately 10 candidates scored full marks.

## PAPER 02

## STRUCTURED QUESTIONS

## SECTION B

## DATA ANALYSIS, MECHANICS

Question 1

Overall Performance

The average mark for this question was 17.7 out of a p sible 30 and the standard deviation was 6.91. One candidate scored full marks.

Areas of Good Performance

Standards for the plotting of graphs
Apparatus required for an investigation

Areas of Weak Performance

Units of gradient hence the unit of spring constant
Extrapolation of graphs
Conversion of mass in grams to force in Newtons
Knowledge of an elastic limit

General Comments and Recommendations

Teachers are encouraged to use sample graphs to illustrate to candidates that graphs have units and to do exercises in class

**THERMAL PHYSICS**

Question 2

Performance Overall

The average mark for this question was 5.96 (or 39.7 per cent) out of a possible 15. The standard deviation was 3.99. Nine candidates scored full marks. Sixty-seven candidates scored zero.

Areas of Good Performance

Statement of Boyle's Law

Areas of Weak Performance

Kinetic theory and its applications. Most candidates appear to be unfamiliar with the relationship between temperature and the kinetic energy of particles.

General Comments and Recommendations

None.

**SECTION D**

**LIGHT AND WAVES**

Question 3

Performance Overall

The average mark for this question was 6.39 (or 36.3 per cent) out of a possible 15 marks. The standard deviation was 4.27. Approximately 31 candidates scored full marks.

Areas of Good Performance

None in particular

Areas of Weak Performance

Very few candidates attempted to label the "lateral displacement" of a ray of light passing through a glass block.

General Comments and Recommendations

None.

**SECTION**

**ELECTRICITY AND MAGNETISM**

Question 4

Performance Overall

The average mark for this question was 4.80 (or 32 per cent) of a possible total of 15 marks. The standard deviation was 3.39. Approximately 6 candidates scored ull marks.

Areas of Good Performance

Part (a) (i); Part (b) (i)

Areas of Weak Performance

Part (a) (ii); Part (b) (ii) and (b) (iii)

General Comments and Recommendations

When teaching the a.c generator, teachers should emphasize the shape of the graph of output current vs time.

Many candidates did not grasp the concept of an induced e.m.f. In many cases where candidates found difficulty in grasping the concept, it can often be brought home by appealing to a more familiar analogous situation. For example, the motion induced in a compass needle by a changing magnetic field is visible and readily accepted. This can be used as a basic point to develop and solidify the concept of electromagnetic induction.

Many candidates appear not to have mastered the relationship between the period and the frequency. This can easily be corrected by exposure and drill.

**SECTION E**

**ELECTRICITY AND MAGNETISM**

Question 5

Performance Overall

The average mark for this question was 6.56 (or 43.7 per cent) out of a possible score of 15 marks. The standard deviation was 3.47. No candidate scored full marks.

Areas of Good Performance

Series and parallel circuits
Symbols for electrical components

Areas of Poor Performance

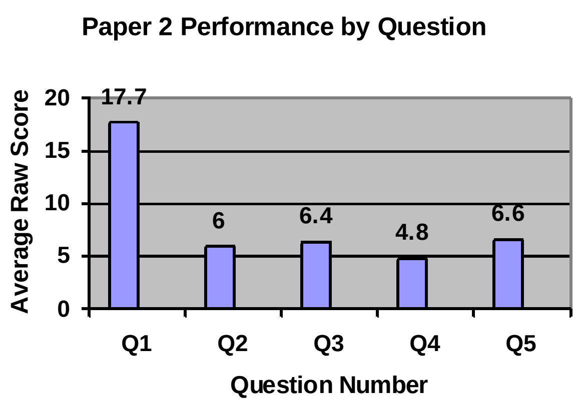
Resistance value of an open circuit
Calculation of potential difference.

General Comments and Recommendations

Teachers should show candidates the effect of larger and smaller resistances on bright ss of a lamp in a simple series circuit. Candidates should be encouraged to note that as resistance gets r the lamp gets dimmer indicating a smaller current and ultimately as the resistance becomes infinite (an open circuit) there is no current at all. Conversely the lamp gets brighte when the series resistance is decreased indicating that the current has increased.

Candidates should also be encouraged to make the association between an open circuit and infi ite resistance and a short circuit and zero resistance.

**CHART I**




**PAPER 03**

**FREE RESPONSE (ESSAY TYPE) QUESTIONS**

**MECHANICS AND THERMAL PHYSICS**

Question 1

Popularity

This was the least popular question on the paper and was attempted by approximately 42 per cent of the candidates.

Performance Overall

The mean score for this question was was 3.2 (15.5 per cent) with a standard deviation of 2.36. No candidate scored full marks.

Areas of Good Performance

(a), b (ii)

Areas of Weak Performance

b (i)

General Comments and Recommendations

Candidates need to see the manometer in operation in order to fully understand it. It is a very easy device to construct and even the most cash strapped schools should be able to afford two lengths of glass tubing and a length of plastic or rubber tubing.

## THERMAL PHYSICS

Question 2

Popularity

This was the second most popular question on the paper and was attempted by about 65.6 per cent of the candidates.

Performance Overall

The mean score for this question was was 7.1 (35.7 per cent) with a standard deviation of 4.57. No candidate scored full marks.

Areas of Good Performance

There was wide distribution of good performances across the entire question. Some candidates knew some parts well while others knew other parts.

Areas of Poor Performance

Many candidates seemed to unaware the distinction between natural convection and forced convection.

General Comments and Recommendations

It is recommended that teachers provide their candidates with greater exposure to descriptive type practice questions. This would assist candidates in the organization of their own ideas an absolute necessity for the answering of free response type questions.

## LIGHT AND WAVES

Question 3

Popularity

This was the third most popular question on the paper and was attempted by approximately 52.3 per cent of the candidates.

Performance Overall

The mean score for this question was was 5.1 (25.4 per cent) with a standard deviation of .43. No candidate scored full marks.

Areas of Good Performance

a (i), Most candidates knew the magnification formula.

Areas of Weak Performance

c (i) and c (iv)

General Comments and Recommendations

Application of lenses in forming real and virtual images needs to be emphasized as well as the differentiation between real and virtual images.

**SECTION E**

**ELECTRICITY AND MAGNETISM**

Question 4

Popularity

This was the most popular question on the paper and was attempted by approximately 85.6 per cent of the candidates.

Performance Overall

The mean score for this question was was 8.9 (44.8 per cent) with a standard deviation of 4.72. Four candidates scored full marks.

Areas of Good Performance

The types of energy in a (i).

Areas of Weak Performance

b (i).

General Comments and Recommendations

No specific recommendations

**NUCLEAR PHYSICS**

Question 5

Popularity

This was the second most unpopular questions on the paper and was only attempted by approximately 49.6 per cent of the candidates.

Performance Overall

The mean score for this question was was 7.0 (35 per cent) with a standard deviation of 3.95. No candidate scored full marks.

Areas of Good Performance

The 3 types of e/m radiation

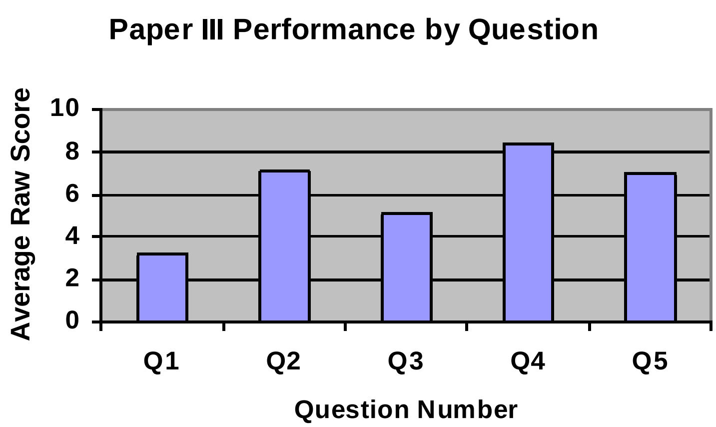
Areas of Weak Performance

Many candidates had problems expressing powers of 10.

General Comments and Recommendations

Teachers should teach this topic earlier and do more e  ercises to improve their candidates' familiarity with the material.

**CHART II**




**PAPER 04**

**ALTERNATIVE TO SCHOOL BASED ASSESSMENT**

**SECTION A**

**MEASUREMENT**

Question 1

Popularity

All candidates attempted the questions.

Performance Overall

The mean score for this question was 8.5 (52.9 per cent) with a standard deviation of 3.6.  No candidate scored full marks.

Areas of Good Performance

None.

Areas of Weak Performance

None.

General Comments and Recommendations

None

Question 2

Popularity

The question was attempted by all candidates.

Performance Overall

The mean score for this question was 11.5 (57.5 per cent) with a standard deviation of 2.2. Two candidates scored full marks.

Areas of Good Performance

Graph plotting.

Areas of Weak Performance

Intercept calculation.

General Comments and Recommendations

None

Question 3

Popularity

This question was attempted by all candidates.

Performance Overall

The mean score for this question was 9.2 (76.5 per cent) with a standard deviation of 2.2. Forty-four candidates scored full marks.

Areas of Good Performance

Almost all sections were fairly well done.

Areas of Weak Performance

A significant number of candidates could not distingui h clearly between observation and conclusion.

General Comments and Recommendations

None.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION MAY/JUNE 2008

## PHYSICS

# PHYSICS

## GENERAL PROFICIENCY EXAMINATION

## MAY/JUNE 2008

## GENERAL COMMENTS

This year eleven thousand and fifty three candidates registered for the examination. This is an increase of 1.94 % of the May/June 2007 population. This year also confirms an increasing trend in candidates for Physics. This can be seen in the Table 1 below.

**Table 1: Candidates registered by year**

| Year | Number of Candidates |
|---|---|
| 2008 | 11,053 |
| 2007 | 10,843 |
| 2006 | 10,330 |
| 2005 | 9,965 |

This trend is encouraging, as it is important for the region to have qualified Physics graduates to cater for the increasing thrust in Science and Technology which is the foundation of development in the Caribbean.

With respect to candidates' performance, Table 2 shows the percentage of candidates gaining Grade I-VI this year..

**Table 2: Overall Performance in May/June 2008 Examination**

| **Grade** | I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|
| **Percentage** | 19.58 | 28.36 | 30.27 | 16.62 | 5.02 | 0.14 |

Once again candidates needed to show better mathematical skills in areas as scientific notation, solving equations and simple geometry. More emphasis must be placed on using mathematical skills in studying physics.

Although School-Based Activity moderation showed mostly acceptable performances, experiments not assessed via the School Based Assessments have given candidates problems in writing up. Teachers are encouraged to make the Physics course as practical as possible while satisfying the minimum requirements of the School- Based Assessment. The more direct experience candidates gain will result in better understanding and retention.

### Paper 01 – Multiple Choice

The performance in this year's multiple choice paper has improved over that of June 2007. This year, the average was 30.76 out of 60, with a standard deviation of 9.59.

**Paper 02 - Structured Questions/ Essay Type**

This year was the first time that the restructured Paper 02 was tested in the May/June exams. Candidates coped well with this format, although some educators voiced the need to have choice in the paper. This paper consisted of one Data Analysis, two other structured questions and three essay type questions.

**Question 1**

**Data Analysis, Section A - Physical Measurements and Units, Section E- Electricity and Magnetism.**

**Performance Overall**

The average (mean) mark for this question was 11.95 out of a possible 25. The standard deviation was 5.53. Twenty candidates scored full marks.

**Areas of good performance**

This question tested graphical, mathematical and power losses in Transformers.

Two main areas of good performance were in (a) plotting the graph and (b) determining the slope of the graph. These skills were also tested in the School- Based Activity where at least five graphs are required. In marking a graph, core requirements include labels with units, correct axes orientation, regular scales, plotting and best straight line or curve.

In determining the slope, a large triangle is needed, correct read offs, calculation and two significant figures are also required.

**Area of work performance**

Part (h) was the section where many candidates did not respond as expected. Obviously some candidates might have not been exposed to this area of transformers. Teachers are expected to practice with students, how to get information from a graph and to use related formulae.

**General comments and recommendations**

(a) Candidates should use the graph page to its maximum.

(b) Use a or x when plotting points.

(c) Candidates should be given adequate practice in drawing graphs and analysis of the graph before marking for School-Based Assessments.

(d) Syllabus objectives assessed: A3.1,3.2,3.3, E 4.7,7.16,7.18

**Question 2**

**Section A - Physical Measurements and Units**

**Performance Overall**

The mean mark was 9.46 out of 15. The standard deviation was 3.46. Three hundred and thirty-four candidates scored full marks.

**Areas of good performance**

The whole question was generally widely known and responded to. The table in section (a) provided an easy format to elicit responses.

The mathematical levels of the question were suited to most candidates.

**Areas of weak performance**

The unit of temperature, the Kelvin, was not identified by some candidates.

Also in part (a), the instrument to measure force- the Force meter, Spring Balance or Bathroom Scale was difficult for some candidates to identify.

**General comments and recommendations**

(a) Teachers should reinforce the fact that the clinical thermometer measures body temperature not just temperature.

(b) The mark scheme catered for a variety of instruments to measure volume.

(c) Syllabus objectives assessed: A- 1.1,1.2,1.3,1.7 ,2.6,2.9,2.10,2.11

**Question 3**

**Section F - The Physics of the Atom**

**Performance Overall**

The mean mark was 7.52 out of a possible 15. The standard deviation was 3.32 and eighty-three candidates scored full marks.

**Areas of good performance**

Parts (a) particles of an atom, (b) location of these particles and (c) the particle with no charge were the clear areas of good performance.

**Areas of weak performance**

Part (f) provided a challenge as candidates had to think about applying the half-life to getting the age of objects. Some candidates responded perfectly while many were able to get a partial mark. Essentially it involved finding the number of half-lives the object experienced and multiplying this by the half-life of Carbon-14 which was given in Part(e).

**General comments and recommendations**

(a) Teachers are expected to cover the entire syllabus and practice of problems must be given.

(b) Candidates should be encouraged to explored applications arising out of basic concepts.

(c) Half-life is a key concept in radioactivity.

(d) Syllabus objectives assessed: F 1.2,2.1,2.2,2.4,3.10,3.12,3.13

**Question 4**

**Section B - Mechanics**

**Performance Overall**

The mean mark for this question was 4.93 out of a possible 15. The standard deviation was 3.55 and twenty-six candidates scored full marks.

**Areas of good performance**

Section (b) Part (ii) (a) using the formula W=mg was clearly the part showing good performance.

**Areas of weak performance**

Section (b) Part (i) to identify the nature of the force and the point of action of the force. The word "nature" could have given candidates some problem in interpreting.

Section (b) Part (iii), some candidates had difficulty in doing the problem with the principle of moments.

**General comments and recommendations**

(a) In defining the "moment"- candidates should note that the perpendicular distance is from the pivot.

Candidates could be marked as follows.

| | |
|---|---|
| Product of force | (1)-KC |
| and perpendicular distance from the pivot | (1)-KC |
| OR reference to "turning effect" | (1)-KC |

(b) For (a) (ii) the force multiplier, teachers should require candidates to show - the relative position of the effort, the fulcrum and the load. (1)-KC
and also – Direction of the two forces (1)-KC

(c) Syllabus objectives assessed: B 1.3,1.5,1.6,1.7,4.4,5.15

**Question 5**

**Section D - Waves and Light**

**Performance Overall**

The mean mark for this question was 4.44 out of a possible 15. The standard deviation was 3.86. Seventy-nine candidates scored the maximum mark.

**Areas of good performance**

Section (b), Part (i) the equation of Snell's Law was widely known.

**Areas of weak performance**

Part (a) the write up of the experiment was difficult to mark as candidates responded in a manner that was not always coherent. A guide to the response expected would include:

- Apparatus
- Placement of block, draw boundary, normal and incident rays
- Shine light, or place pins along incident/emergent rays
- Removal of block and joining rays
- Record of incident and refracted rays
- Conclusion based on constant ratios of $\frac{\sin \hat{i}}{\sin r}$

Part (b) More practice on geometrical problems needed. General- Students should not confuse a compass with a protractor.

**General comments and recommendations**

(a) Candidates should not confuse reflection with refraction. These are two completely different concepts.

(b) More practice in mathematical-based problems should be given via a problem sheet with candidates performing and presenting responses to the class.

(c) Syllabus objectives assessed: D 6.4,6.5,6.7

**Question 6**

**Sections A - Physical Measurements and Units and C-Thermal Physics and Kinetic Theory.**

**Performance Overall**

The mean mark for this question was 6.51 out of a possible 15. The standard deviation was 4.53. Four hundred and fifty-one candidates scored the maximum mark.

**Areas of good performance**

Part (b) to determine the amount of heat removed each day by the quantity of urine. Part (c) to determine the mass of perspiration.

**Areas of weak performance**

Part (a), some candidates again showed how challenging it was to describe an experiment. Some candidates could not differentiate between the method of mixtures and the electrical method. It was obvious that a large number of candidates did not do this experiment. Some candidates even described cooling curves experiments as their response.

**General comments and recommendations**

(a) Candidates needed to have the experience of performing the experiment and writing in an acceptable manner.

(b) Teachers must clarify in students' minds, the difference between the method of mixtures and the electrical method.

(c) Candidates needed more practice in the use of the index notation and in transposing to find subject of the formula.

(d) Appropriate units are to be used at all times.

(e) Syllabus objectives assessed: A2.1 ,C 3.3,3.4

**Paper 03 - School-Based Assessment (SBA)**

School-Based Assessment is an integral part of the students' preparation for the final examinations. It also contributes 20% of the final marks. Teachers are expected to work together at each centre to have a common core of 16 activities. Other **minimum** requirements are:

(a) Syllabus coverage- 10 topics

(b) Marking of each skill- 4 times

(c) Graphs -5 times

(d) Detailed mark scheme breaking down each of the criteria to 1 mark.

(e) Marks and remarks in all books.

(f) Books per centre to submit- 5.

Recommendations

(a) The use of standard (traditional) laboratory exercises for the Planning/Design skill is not acceptable.

(b) Table of contents should clearly identify the 16 assessments by skill.

(c) Be prepared to submit for each assessment- clear instructions and a detailed mark scheme.

**Reference materials**

CXC Physics Module No 1- School Based Assessment in Physics

CXC - CSEC Physics Syllabus- CXC 22/G/SYLL02. pp 62-71.

CARIBBEAN EXAMINATIONS COUNCIL

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE JANUARY 2009

## PHYSICS

# PHYSICS

## GENERAL PROFICIENCY EXAMINATION

## JANUARY 2009

The candidate population for the January sitting continues to grow. In January 2009, 734 candidates wrote the examination compared with 647 in January 2008, an increase of 13.4 per cent.

Candidates' performance declined in 2009 with 56 per cent of the candidates achieving Grades I to III, compared with 63 per cent in 2008. However, this year the number of candidates who achieved Grades I and II increased to 25 per cent from 14 per cent in 2008.

The format of the examination changed from that of January 2008. In January 2008 Paper 02 (Structured) and Paper 03 (Essay Type) were written separately. This January there was a single paper comprising two sections where Section A was structured and Section B was of the essay type.

## Paper 01 – Multiple-Choice

## DETAILED COMMENTS

The performance in this year's multiple choice paper was similar to that of recent January sittings. The average score on this paper was 31 (51.7 per cent) out of a possible 60 with a standard deviation of 8.39.

## Paper 02 - Structured and Essay Questions

### Section A

<u>Question 1</u>

This question tested candidates' ability to investigate how the pressure in a liquid varies with depth and measures the pressure of the gas in a container. The overall performance revealed that forty-seven per cent of the candidates obtained a score of 13 (52 per cent) or more out of a possible 25 marks.

Areas of weakness identified were:

- Poor selection of a suitable scale to facilitate the plotting of coordinates process and ensuring that most of the graph sheet is used

- Failure to use (.) or x to indicate plotted points

- Omitting the correct labeling of axis

- Non-indication of a large triangle on the graph to determine the slope or gradient of the line of best fit

- Unable to deduce that if a graph of the relation $\Delta P = \rho g \, \Delta h$ is plotted with $\Delta h$ on the x-axis and $\Delta P$ on the y-axis, then the gradient of this graph is equal to $\rho g$ (i.e. Gradient, $S = \rho g$).

Question 2

This question tested candidates' ability to calculate wave length of microwaves. Performance on this question was satisfactory where fifty per cent of the candidates scored more than 7 marks out of a total of 15 marks.

A basic formula transposition (changing the subject of the formula) provided a challenge. Candidates should have correctly transformed $v = f\lambda$ as $\lambda = v/f$.

Question 3

This question tested candidates' ability to calculate specific heat capacity.
A few candidates scored the full 15 marks but the vast majority scored less than a quarter of the full marks.

Areas of weakness identified were:

- Failure to define the lower fixed point on the Celsius as the temperature of pure melting ice at standard atmospheric pressure

- Inability to identify the physical property that varies in a particular type of thermometer; For example, the electromotive force for a thermocouple thermometer;

- Not relating the energy conversion from gravitational potential energy to heat energy resulting in $mgh = mc\ \Delta\theta$.

**Section B**

Question 4

This question tested candidates' ability of the fundamental principles of light, in particular angle of refraction, angle of reflection and angle of incidence. Forty per cent of the candidates scored more than 7 (46.7 per cent) marks out of a total of 15 marks.

Candidates were uncertain as to the difference between reflection and refraction. It is recommended that teachers provide students with the opportunity to practice more experiments to show them that the angle of reflection is equal to the angle of refraction.

Question 5

This question tested candidates' knowledge of nuclear physics.

This question was poorly done. Seventeen per cent of the candidates scored more than 7 marks (46.7 per cent) out of a possible 15 marks. Candidates must be advised to be more precise in their construction of nuclear equations. It is imperative to use correct symbols while placing mass, atomic and neutron numbers in their correct positions.

Question 6

The question tested candidates' knowledge of Electricity and Magnetism. This question was poorly done with 80 per cent of the candidates receiving a score of less than 3 (20 per cent) out of 15. Candidates did not grasp the concept of the operation of the transformer.

## Paper 03 - Alternative to SBA

Question 1

The overall performance on this question was impressive. Ninety-two per cent of candidates obtained a score of 12 (52.2 per cent) or more out of a possible 23 marks. Candidates appeared to have a good grasp of the concept of Boyle's law.

Question 2

Candidates read analog meters very well. Eighty seven per cent of the candidates obtained a score of 7 (53.8 per cent) or more out of a possible 13 marks. However, they faced difficulty in choosing a suitable scale for the graph plotting segment. Candidates must be reminded that for a filament lamp the current through it is not directly proportional to the potential difference across it.

Question 3

This question was done well by the majority of students. Sixty-seven per cent of the candidates scored 7 (58.3 per cent) or more of a possible 12 marks. A clear statement of recorded results and what led to their conclusion on the obedience of the rubber band to Hooke's law was lacking in some instances.

**Recommendations**

Teachers are advised to make mock examinations a substantial part of the examination preparations. This would certainly sensitize candidates to their specific shortcomings, for example, time management, curve sketching skills and stating definitions precisely.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE EXAMINATION MAY/JUNE 2009

## PHYSICS

# PHYSICS

## GENERAL PROFICIENCY EXAMINATION

## MAY/JUNE 2009

## GENERAL COMMENTS

This year 11,645 candidates wrote the examination compared with 10,165 in 2008. This represents an increase of 14.6 per cent in candidature.

Approximately 77 per cent of the candidates obtained acceptable grades, Grades I – III. The standard of work seen from most of the candidates in this examination was generally good.

Candidates, however, needed to show better mathematical skills in areas such as scientific notation, solving equations and simple geometry. More emphasis must be placed on using mathematical skills in studying Physics.

Although School-Based Assessment moderation showed acceptable performances, candidates experienced difficulty in writing up experiments not accessed via the School Based Assessment. Teachers are encouraged to make the Physics course as practical as possible while satisfying the requirements of the School-Based Assessment. The more direct experience candidates gain will result in better understanding and retention.

## Paper 01 – Multiple Choice

The performance in this year's multiple choice paper improved over that of June 2008. This year, the average mark was 33.71 (56.18 per cent) out of 60, with a standard deviation of 10.12.

## Paper 02 – Structured Questions/Essay Type

Question 1

This question tested candidates' knowledge of radioactivity.

The overall performance revealed that 14 per cent of candidates obtained a score of 13 or more out of a possible 25 marks. The majority of the candidates were in the lower quartile of the distribution of marks.

Candidates were able to correctly plot the graph and explain the term 'half-life'. However, the following weaknesses were identified.

- Inability to determine the half- life of a radioactive sample from a graph of count rate versus time
- Failure to calculate the number of half-lives that can be obtained at 425 seconds interval
- Omitting to estimate the count rate after a certain number of half-lives elapsed
- Non-recognition of activity versus time graph being curved as opposed to linear

Question 2

This question tested candidates' ability to differentiate between scalar and vector physical quantities. The question further tested their ability to draw velocity – time graphs and calculate distance travelled.

The question was well answered. However, candidates are reminded of the fact that the area under a velocity – time graph gives the distance travelled. In addition, it was of concern to note that a few candidates wrote:

Distance travelled = velocity x time

$= 30 \times 5$

$= 150$ m

whereas the correct response should have been

Distance travelled = average velocity x time

$= [(30 + 0)/2] \times 5$

$= 75$ m.

Question 3

(1) This question tested candidates' knowledge of the fundamental principles of light. Many candidates avoided the question or gave inadequate responses.

(2) The point *x* on the diagram was not adequately labelled. Candidates were not penalized for this oversight on the question paper.

(3) Candidates must be reminded that as light travels from hotter (less dense) air to cooler (more dense) air it bends towards the normal. In this situation the air between the surface and the observer gradually gets more dense, therefore the light ray going from the surface to the observer would be gradually bending.

Question 4

This question tested candidates' ability to calculate work done and energy. Candidates found this question challenging.

The work done against gravity = force x distance. Most candidates applied this formula but could not identify force with weight (mass times acceleration due to gravity).

To calculate the increased speed, candidates needed to calculate the potential energy change at the end of the descent. Following that, they needed to obtain 90 per cent of that potential energy change to obtain the work done against friction. The remaining energy or the 10 per cent would now be the kinetic energy that the rider and cycle must have. Equating this to $\frac{mv^2}{2}$ would enable the speed calculation to be made. Candidates ought to have recognized that the average rate of energy conversion in Part (b) (iii) was simply a power calculation (power = energy/time).

Question 5

Candidates found this question challenging.

This question tested the candidates' knowledge of electricity and magnetism.

The stimulus material for this question appeared to initiate and direct candidates to give the desired responses. Over 50 per cent of the candidates earned more than half of the total possible marks.

Most candidates were able to sketch the magnetic field and calculate the current and the number of turns.

However, candidates failed to recognize that the answer required was the diode or a rectifier. Candidates must be reminded that efficiency is based on power or work or energy ratios and not on voltage ratio alone or current ratio alone.

Question 6

The question tested the candidates' knowledge of Thermal Physics.

This question was not well answered as candidates were unfamiliar with the method of mixtures for finding the specific latent heat of fusion of ice. One popular erroneous statement was "heat energy lost by ice is gained by water".

Candidates generally knew the formulae such as $E = mc\theta$ and $E = ml$ but had difficulty in applying them in the appropriate respective stages in Part (b). Candidates are urged to practise responding to these types of questions to gain a greater understanding of the processes involved.

**General comments and recommendations**

(a) Candidates needed to have the experience of performing the experiment and writing in an acceptable manner.

(b) Appropriate units are to be used at all times.

**Paper 03- School-Based Assessment (SBA)**

School-Based Assessment is an integral part of the students' preparation for the final examinations. It also contributes 20 per cent of the final marks. Teachers are expected to work together at each centre to have a common core of 16 activities. Other **minimum** requirements are:

(a) Syllabus coverage – 10 topics

(b) Marking of each skill – 4 times

(c) Graphs – 5 times

(d) Detailed mark scheme breaking down each of the criteria to 1 mark.

(e) Marks and remarks in all books.

(f) Books per centre to submit – 5

The quality of teachers' marking was generally good.

Teachers' marking was consistent and reflected the standard expected.

For many centres the standard of the SBA has improved. This was evidenced by the high percentage of centres with

- adequate syllabus coverage and the total number of activities
- assessment of each skill at least four times
- good graph work
- good standard of practical exercises
- good ORR
- good A/I results.

Recommendations

(a) The use of standard (traditional) laboratory exercises is inappropriate for assessing the Planning/Design skills.

(b) Table of contents should clearly identify the 16 assessments by skill.

(c) Clear instructions and a detailed mark scheme must be submitted for each assessment.

CARIBBEAN EXAMINATIONS COUNCIL

# REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION

## JANUARY 2010

## PHYSICS
## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 1667 candidates registered for the examination. This represented a 94 per cent increase in the number of registered candidates compared with 860 in January 2008.

This trend is encouraging as it is important for the region to have a sufficient number of qualified Physics graduates to cater for the increasing thrust in Science and Technology which is the driver of present and future development of the Caribbean.

Once again, candidates showed deficiency in the use of mathematical skills in the areas of scientific notation, the solving of equations and simple geometry. More emphasis must be placed on using mathematical skills in studying physics. Approximately 38.7 per cent of the candidates obtained acceptable grades — Grades I–III. There was a notable decline in the performance of candidates in Profile 3, Experimental Skills.

### Paper 01 – Multiple Choice

The performance in this year's multiple choice paper was below that of January 2009. This year, the mean score was 28.35 out of 60 with a standard deviation of 10.63.

### Paper 02 – Structured/Essay Type Questions

This paper consisted of one data analysis, two structured questions and three essay type questions.

**Section A**

Question 1

This question tested candidates' ability to investigate Charles' Law. It also involved completing a table by transforming T/˚C to T/K, drawing and interpreting a graph and solving a problem based on Charles' law.

The overall performance revealed that 40 per cent of the candidates received a score of 13 (52 per cent) or more out of a possible 25 marks.

**Areas of Good Performance**

Two main areas of good performance were in (a) plotting the graph and (b) determining the slope of the graph.

In plotting the graph, core requirements included labels with units, correct axes orientation, correct scales, and best straight line or curve.

In determining the slope, a large triangle was needed, correct read offs and calculations to significant figures were also required. Most candidates were able to convert to the Kelvin scale.

**Area of Weak Performance**

In Part (g), the problem involved converting temperature. Many candidates failed to convert correctly. Writing correct units was another weak area.

**General Comments and Recommendations**

(a) Candidates should use the graph page to its maximum.

(b) Candidates should use (.) or x when plotting points.

(c) Candidates should be given adequate practice in drawing and analysing graphs.

Question 2

This question tested candidates' knowledge of some basic concepts, quantities, their formulae and units. One of the quantities was momentum which was further explored via the law of conservation of linear momentum and two practical applications. One situation involved a societal concern related to road accidents.

Performance on this question was not good. Only 20 per cent of the candidates scored more than 7 marks out of a total of 15 marks.

**Areas of Good Performance**

Part (a) of the question was well done. This section required candidates to identify a quantity, formula or unit when given only one of either and to state the law of conversation of linear momentum.

**Areas of Weak Performances**

Parts (b) and (c) posed difficulties for candidates. Many of them used energy transfer and momentum to explain the question on the 'big crash on the highway'. Instead, change of momentum should be the focus.

**General Comments and Recommendations**

(a) Teachers should pay attention to clarifying the differences between moments and momentum.

(b) Attention should be placed on fundamental quantities and units.

Question 3

This question tested candidates' knowledge of sound waves and light. It explored waves, in particular, the definition and identification of wave parameters. The problem posed was based on the popular steelpan. A few candidates scored the full 15 marks but the vast majority scored less than a quarter of the full marks.

**Areas of Good Performance**

In Part (b) (i), the identification of a wavelength was a clear area of good performance.

**Areas of Weak Performance**

(a) Identification of amplitude.
(b) Drawing of wave trains.
(c) Converting SI units and working with formulas relating to waves.
(d) Calculating the refractive index.

**General Comments and Recommendations**

Candidates must be exposed to basic wave definitions and the drawing of waves.

**Section B**

<u>Question 4</u>

This question in part totalled candidates' knowledge of Thermal Physics which related to real life situations in a school setting. It related to a vacuum flask. The second part concerned the solar water system, very relevant in this emerging age of 'green technology'.

This question was poorly done with only 10 per cent of the candidates scoring more than 7 of the 15 available marks.

**Areas of Good Performance**

Part (b) (ii) which required the calculation of energy per day, given the percentage of heat energy emitted by a solar collector.

Part (b) (iv) which required the calculation of the mass of water that can be heated from 25˚C to 55˚ C during the day.

**Areas of Weak Performance**

Part (b) (i), the energy collected by the absorber per day.

Part (b) (iii), calculation of the quantity of energy per day to heat the water was challenging to many candidates.

**General Comments and Recommendations**

(a) There is a greater need to cover the topic of heat transfer with relevant examples.

(b) The idea of using appropriate units is again a topic of weakness.

(c) A simple mathematical skill like changing the subject of the formula needs to be developed.

<u>Question 5</u>

The question tested candidates' knowledge of Current-Voltage characteristics of an unknown electrical component. Candidates were asked to solve a problem dealing with the electrical circuit in a room. This was followed by another problem relating to the fuse. A few candidates scored the full 15 marks but the vast majority 69 per cent scored less than half of the full marks.

**Areas of Good Performance**

Candidates were quite competent at dealing with Ohm's Law and electrical power in Parts (b) (ii) and (c).

**Areas of Weak Performance**

Candidates showed some confusion in the use of the rheostat and voltmeter placement in Parts (a) and (b) (i).

Calculations involving series and parallel combinations of resistors also proved challenging.

**General Comments and Recommendations**

(a) There is clearly the need for more practical work on I-V characteristics and series, and parallel circuits.

(b) Techniques in how to answer exam questions should be part of a candidate's preparation.

<u>Question 6</u>

This question tested candidates' knowledge of the physics of the atom. This question was poorly done with very few candidates scoring full marks.

**Areas of Good Performance**

Part (c) which required candidates to calculate the energy released in a solar fusion proved to be the area widely known by candidates.

**Areas of Weak Performance**

Part (a) which required a detailed description of types of radiation was not done well by the majority of candidates.

**General Comments and Recommendations**

Candidates need to be equipped with experience in writing up experiments.

**Paper 03/2 – Alternative to SBA**

<u>Question 1</u>

This question was concerned with the melting point of naphthalene. It involved getting data from a graph, interpreting the graph and writing up a description of the relevant experiment.

It was fairly well done by the majority of candidates with 70 per cent scoring more than 8 of the 17 available marks.

**Areas of Good Performance**

The candidates were able to read off the temperature values associated with time on the cooling curve. They were also familiar with the conversion from degrees Celcius to the Kelvin scale.

**Area of Weak Performance**

Part (d) was difficult for most candidates as they were weak in the description of a cooling curve for naphthalene.

**General Comments and Recommendations**

(a) This experiment is a core experiment for preparation for the CSEC exams. It was clear that candidates lacked the experience.

(b) Teachers should identify core activities, expose their students to them and build on these experiences if time permits.

Question 2

This question involved taking measurements involved in the Hookes' Law experiment. It also included using the data to enter in a table, drawing a graph, conducting calculations based on the graph and identifying a source of error and precaution.

It was done well by the majority of candidates with 62 per cent achieving over 11 marks out of a possible 21 marks.

**Areas of Good Performance**

Parts 2 (a) and 2 (b) were clearly the sections in which candidates performed well. These involved completing a table and drawing a graph.

**Area of Weak Performance**

Part 2 (e) which involved using the graph to determine the mass required to produce a given extension proved a challenge to most candidates.

**General Comments and Recommendations**

Candidates must be given adequate opportunities in developing graph-based skills.

Question 3

This question investigated the concept of resistance and required candidates to confirm or reject the assertion — the thicker a wire is, the greater will be its resistance to current. This question was not done well by the majority of candidates. Only 31 per cent of the candidates achieved 5 or more marks out of a possible score of 10.

**Area of Good Performance**

In Part (a), candidates generally knew the needed apparatus. Some left out the connecting wire.

**Area of Weak Performance**

In Part (b) placement of the voltmeter and Nichrome wire posed a problem for some candidates.

**General Comments and Recommendations**

This question showed the need for more exposure to electrical circuits in a practical setting.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION

**MAY/JUNE 2010**

**PHYSICS**
**GENERAL PROFICIENCY**

## GENERAL COMMENTS

This year 12, 417 candidates registered for the examination. This represented a 93 per cent increase in candidates registered compared with 11, 616 in June 2009.

This trend is encouraging as it is important for the region to have sufficient numbers of qualified Physics graduates to cater to the increasing thrust in Science and Technology which is the driver of present and future development in the Caribbean.

Once again, candidates needed to show better mathematical skills in areas such as scientific notation and solving equations. More emphasis must be placed on using mathematical skills in studying Physics. Also, candidates should not be losing marks on simple recall items.

## Paper 01 – Multiple Choice

Performance on this year's Multiple Choice Paper was below that of June 2009. This year, the mean score was 31.56 with a standard deviation of 10.60 compared with a mean score of 33.71 and a standard deviation of 10.12 in 2009.

## Paper 02 – Structured Essay Questions

This paper consisted of one data analysis, two structured and three essay-type questions.

### Section A

Question 1

This question was based on the refraction of light. Candidates were required to use data given to draw a graph, determine its gradient and use this value to determine the refractive index of a lens. The question also called for the recall of the two laws of refraction.

An analysis of overall performance revealed that 60 per cent of the candidates received a score of 13 (52 per cent) out of a possible 25 marks.

**Areas of Good Performance**

Part (a) which required candidates to complete a table, Part (b) which asked that they plot a graph and Part (c) which required them to determine the slope of the graph were clearly areas in which candidates performed well.

In determining the slope the following were required:

(i) a large triangle

(ii) correct read offs

(iii) calculation to two significant figures

**Areas of Weak Performance**

In Parts (c) and (e), candidates showed some confusion in relating the refractive index to the gradient of the graph and in determining the angle of refraction when I = 90°.

**General Comments and Recommendations**

Students should

(a) use the graph page to its maximum.

(b) use a Θ or x when plotting points.

(c) be given adequate practice in drawing and analysing graphs.

Question 2

**Section B – Mechanics**.

This question was based on the concepts of velocity, acceleration, momentum and kinetic energy. It was also based on the Jamaican/World athletic icon Usain Bolt and his historic record in the 100 metres race. Performance on this question was not good. Only 36 per cent of the candidates scored more than 7 marks out of a total of 15 marks.

**Area of Good Performance**

The main area of good performance was in Part (b) (i) which required candidates to calculate the average speed.

**Area of Weak Performance**

Part (b) (iii) which required candidates to calculate the acceleration was poorly done.

**General Comments and Recommendations**

(a) Teachers should use culturally relevant examples in the teaching of Physics.

(b) More practice in mathematical problems can help candidates in clarifying concepts.

Question 3

**Section E – Electricity and Magnetism**

This question was based on a fundamental device in electronics — the diode. It involved the concept of rectification and the determination of a defective diode. The question also explored truth tables for logic gates. Performance on this question was satisfactory with 50 per cent of the candidates scoring more than 7 out of a total of 15 marks.

**Areas of Good Performance**

Part (a) (i), which required candidates to sketch the voltage-time graph when a switch is open and Part (b) which dealt with a logic gate were well done.

**Areas of Weak Performance**

Parts (a) (iii), (iv) and (v) posed difficulties for candidates. Candidates should have know that both graphs for parts (a) (iii) and (iv), were based on direct current in the circuit and that to determine if a diode was defective a check for rectification needed to be done. If there was no rectification the diode was defective.

**General Comments and Recommendations**

(a) There is clearly a need for candidates to do more electronics in their preparation. These are basic concepts and will act as a foundation for the CAPE Electronics module and electronics-based careers.

(b) Candidates should get adequate practical experience in preparation for the examination.

<u>Question 4</u>

**Sections B – Mechanics, E-Electricity and Magnetism**

This question was based on the popular DC motor. It involved how the motor worked and also the use of the commutator. The motor was used in a problem of lifting an appliance in a multi-story car park – a real-life application. A few candidates scored the full 15 marks but the vast majority, 64 per cent, scored less than half of the full marks.

**Area of Good Performance**

Candidates were able to recall the formulas relating to power.

**Areas of Weak Performance**

Candidates performed poorly on Part (a) which required them to explain the operation of the d.c. motor and the purpose of the commutator.

Critical points candidates were required to state were:

(i) When the switch is closed, current flows into the coil via carbon brushes.

(ii) The downward force on AB and upward force on CD is due to the magnetic fields produced by the magnet and the coil

(iii) The coil rotates and reaches the vertical position and continues rotating due to the commutator.

The purpose of the commutator is to

- reverse the direction of the current in the loop when it changes contact from one brush to the other or
- ensure the loop always turns in one direction.

**General Comments and Recommendations**

It is beneficial to cover the topic of the d.c. motor in a more practical way with candidates who should be allowed to actually build one and discuss how it operates. They can also make simple applications for their motor. These motors can be displayed in science fairs.

<u>Question 5</u>

**Section C – Thermal Physics and Kinetic Theory**

This question explored the idea of Specific Heat Capacity for a solid and a liquid. A diagram of a set up of the apparatus used was given as stimulus. Candidates were required to describe the method used. With the liquid, the specific heat capacity had to be determined and a related question given. This question was poorly done with very few candidates gaining full marks.

**Area of Good Performance**

Candidates understood the concept of Specific Heat Capacity and its relationship to mass, energy and temperature change.

**Area of Weak Performance**

Candidates were not too familiar with the experiment. Some candidates thought the heater was inserted in water even though the diagram clearly labelled the block. They also confused the electrical method with the method of mixtures. Many candidates did not realize that it was not necessary to convert to Kelvin in order to get a temperature difference.

**General Comments and Recommendations**

There is need for more practice in describing 'methods' in experiments. In responding to questions candidates should:

(i) State that the apparatus was set up as shown in the diagram.

(ii) Explain how each variable was measured and then state how the variables were used to calculate the quantity sought. For example: $E = Pt$, $E = mc\Delta\theta$, $c = Pt/m\Delta\theta$

Question 6

**Section F – The Physics of the Atom**

This question involved a comparison of two types of radioactive radiation. Candidates also had to calculate the amount of energy produced in a nuclear reaction and then make a judgement regarding a preferred method of energy production. Only two per cent of the candidates scored full marks on this question while 27 per cent earned more than half of the full marks.

**Area of Good Performance**

Part (a) was done relatively well by most candidates.

**Areas of Weak Performance**

Candidates were again unfamiliar with the topic of core to radioactivity. Candidates showed unfamiliarity with Part (b) which was based on an artificial radioactive decay process to produce energy.

**General Comments and Recommendations**

(a) Greater practice is needed. Teachers can use worksheets and research-based methods.

(b) Einstein's mass-energy equation should be known by all candidates. Working with the formula is essential.

**Paper 03/ 2 – Alternative to School-Based Assessment (SBA)**

Question 1

**Section A – Physical Measurements and Units, Section E – Electricity and Magnetism**

This question concerned the calculation of resistance. It measured Use of Knowledge (6 marks) and Experimental Skills (14 marks). It involved reading an ammeter, drawing and using a graph to calculate resistance. Candidates also had to identify precautions for the experiment based on Ohm's law.
Performance on this question was satisfactory with 47 per cent of candidates earning more than half the total marks.

**Areas of Good Performance**

Candidates were able to read the ammeter and plot the graph accurately.

**Area of Weak Performance**

Part (a), the determination of the gradient of the graph, proved a challenge to most candidates.

**General Comments and Recommendations**

This experiment was a core experiment for preparation for the CSEC exams in current electricity. It was clear that some candidates lacked the experience. Teachers should identify core activities, expose candidates to them and build on these experiences.

<u>Question 2</u>

**Section A – Physical Measurements and Units, Section C – Thermal Physics and Kinetic Theory.**

This question involved the use of PV/T as a constant. Candidates had to draw a graph from which they were to extract information. They also had to label parts of the apparatus. Investigating the relationship between volume and length proved challenging for many candidates. The question was poorly done with 15 per cent of candidates earning 10 or more marks out of a possible 19 marks.

**Areas of Good Performance**

Parts (a) and (c) which involved the plotting of the graph and the labelling of apparatus were well done.

**Area of Weak Performance**

Part (d) was difficult for most candidates as they were weaker in their explanation in relating volume to height. Candidates could have written:

$V = Ah$

$\therefore V \alpha h$ so that the length of the air column can be used to represent the volume.

**General Comments and Recommendations**

Candidates must be given adequate opportunities in actually performing experiments, drawing and interpreting graphs.

<u>Question 3</u>

**Section A – Physical Measurements and Units**

This question required candidates to describe an experiment to investigate the effect of the mass of the bob on the period of the pendulum. It was well done by the majority of candidates, with 36 per cent achieving over four marks out of a possible nine marks.

**Area of Good Performance**

In Part (a), candidates generally knew the apparatus that was required.

**Areas of Weak Performance**

Parts (b) and (c) were difficult for most candidates as they were weak in describing the procedure and how to use the results to come to a conclusion.

**General Comments and Recommendations**

This question showed the need for more exposure to these types of experiments in a practical setting.

## Paper 03/1 – School-Based Assessment

The overall standard of the SBA improved in June 2010 compared with June 2009. Teachers' marking was very consistent and reflected the standard expected. Random sampling was used in the moderation of the SBA as in 2009. Of the 167 centres involved, 154 submitted mark schemes.

## RECOMMENDATIONS

Teachers should pay more attention to

- graphs, diagrams, tables, equations, interpretations from observations, choice of appropriate Planning and Design activities
- the dating of all exercises
- having an index in all laboratory books
- marking and writing comments to assist students and ensuring that students do individual work.

CARIBBEAN EXAMINATIONS COUNCIL

# REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION

## JANUARY 2011

## PHYSICS
## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 1497 candidates registered for the examination. This represents a 10 per cent decrease in candidates registered compared with 1664 in January 2010.

Once again candidates needed to show better mathematical skills in carrying out basic tasks such as scientific notation, solving equations, indices and simple geometry. More emphasis must be placed on demonstrated competence in mathematical skills in studying physics.

## DETAILED COMMENTS

### Paper 01 – Multiple Choice

The performance in this year's multiple choice paper improved over that of January 2010. The mean was 33.04 with a standard deviation of 9.69 compared with a mean score of 28.35 and standard deviation of 10.63 in 2010.

### Paper 02 – Structured/Essay Type Questions

This paper consisted of one data analysis, two structured, and three essay-type questions.

Question 1

**Section A**
This question was based on the concepts surrounding motion in a straight line. Candidates were required to draw a graph consisting of two segments, calculate the slope and determine, using the slope, how far the sprinter would be from the finish line after 10s.

**Areas of Good Performance**

This was a good question in that it tested graphical and mathematical skills. It also required definitions of two basic concepts involved in the question — velocity and acceleration. The question was also relevant to candidates' experiences as sprinting is a common sporting experience in school life. The Caribbean is also noted for world-class sprinters.

Two main areas of good performance were in (a) plotting the graph and (b) determining the slope of the graph. Most of the graphs were well done.

Core criteria in marking a graph include labels with units, correct axes orientation, regular scales, plotting and best straight line or curve.

In determining the slope, a large triangle is needed, correct read offs, calculation and two significant figures are also required.

**Areas of Weak Performance**

For Part (a) some candidates incorrectly defined velocity as rate of change of distance. The correct definition of velocity is the rate of change of displacement.

In Part (f) candidates found difficulty with the calculation of how far from the finish line the sprinter would be. Distance travelled is the area of the trapezium or the area of a triangle and a rectangle. Candidates had to subtract this distance from 100m to determine how far it was from the end.

**General Comments and Recommendations**

(a) Candidates should use the graph page to its maximum.

(b) Candidates should use Ö or x when plotting points.

(c) Candidates should be given adequate practice in drawing and analysing graphs, straight lines and curves.

Question 2

**Section D – Waves and Light**

This question was based on the electromagnetic spectrum and refraction. The first part of the question asked for the recall of radiations and the sources and uses of some waves were required.

The second part of the question involved calculations with the velocity of waves formula $V = f\lambda$ and the refractive index formula.

**Areas of Good Performance**

Part (b) (i) of the question was well done. This section required candidates to calculate the frequency of gamma rays. Part (b) (ii), the refractive index formula, was also well known.

**Areas of Weak Performance**

Part (b) (ii), ray going from glass to air instead of air to glass, resulted in candidates writing n = (Sine of smaller angle/Sine of larger angle). Many candidates did not even realize that the angle to be found must be greater than $35^{o}$.

**General Comments and Recommendations**

(a) Teachers should have students use refractive index formula with $n\text{Sin}\theta$.

(b) Attention should be placed on rays entering as well as leaving another medium. Calculations should involve the reversibility of light.

Question 3

**Section E – Electricity and Magnetism**

Electrical symbols and Ohm's Law were the main topics explored in this question. These are necessary in assisting students solve problems in electricity. A Symbol/Name table was created to help students respond in a user-friendly manner. Components used were the cell, rheostat, bulb, alternating current supply, diode and the fuse. Part (b) was based on the popular V=IR formula.

Candidates responded mostly in a satisfactory manner.

**Areas of Good Performance**

Part (a) which required candidates to use the circuit symbols and Ohm's Law formula, was well done.

**Areas of Weak Performance**

Part (b) (iv) where a series and parallel combination was presented to get the equivalent resistance was poorly done. Candidates need more practice with the parallel arrangement of resistors and the use of the reciprocal formula.

**General Comments and Recommendations**

Teachers are expected to have students fully explore circuit configurations from a single component in a circuit to combinations of series and parallel.

<u>Question 4</u>

**Section C – Thermal Physics and Kinetic Theory**

The first part of this question required candidates to write an activity to show how temperature varies as a substance cools. Napthalene was suggested as a substance. The second part concerned calculations with respect to specific latent heat. This question proved challenging to candidates especially the calculation parts.

Candidates must be well prepared for the exam and specific latent heat is a more involved concept where a change of state occurs. A simple formula is applied $E= mL$. The L value depends on the specific phase change. Also $E = mc\Delta\theta$ is used as heat is absorbed or liberated during a temperature change.

The formula required to use in Parts (b) (iii) and (b) (iv) involve the combination of the two formulas above.

**Areas of Good Performance**

Candidates performed well on Part b (i) which dealt with the determination of the mass of melted ice.

**Areas of Weak Performance**

In Parts (iii) and (iv), candidates had problems getting the equation for these parts correct. It shows a weakness in the understanding of the concept of "specific latent heat".

The responses which were expected for Parts (iii) and (iv) are as follows:

(iii) Energy = heat gained by ice to melt + heat gained by melted ice

or $Q = m_i l_f + mc_w\Delta\theta$

or $= 10\ l_f + 10(4.2)(20)$

or $= 10\ l_f + 8405$

(iv) $4200 = 10\ l_f + 840$

**General Comments and Recommendations**

(a) There is a greater need to cover the topic of Specific Latent Heat with relevant examples.

(b) The experience of cooling an object and drawing cooling curves must be explored by candidates.

Question 5

**Section E – Electricity and Magnetism**

This question is rooted in Topic 7 of Section E of the Syllabus. It is not a difficult topic to understand but the question was not generally well done.

**Areas of Good Performance**

Candidates were able to recall the formula for efficiency and its calculation.

**Areas of Weak Performance**

In Part (a), candidates had difficulty in drawing an appropriate diagram to describe how the magnitude of the e.f.m. induced in a conductor depends on the rate of change of magnetic flux.

In Part (b), candidates did not understand the concept of electromagnetic induction and its application in making electric cars more efficient.

**General Comments and Recommendations**

(a) Candidates can learn about this topic via a ‘hands on’ approach.

(b) Another approach is the viewing of videos. The popular YouTube website has over 4 000 videos on this topic. This will certainly help candidates.

Question 6

**Section F – The Physics of the Atom**

This question tested ideas related to the idea of a model of the atom. The Thompson and Rutherford models were required. The other topics explored were Atomic structure and Radioactivity-Half Life.

**Areas of Good Performance**

Parts (b) (i), (ii), and (iii), all relating to atomic structure, were well done by the majority of candidates.

**Areas of Weak Performance**

Part (a), which required a description of two great scientists as it relates to the nature of the atom, posed difficulties for candidates. Expected responses are outlined below.

(a) J. J. Thompson

IDEAS (1) Perhaps atoms were like solid balls of positive charged matter with electrons dotted about like currants in a pudding

(2) There needed to be enough negative electrons to make the whole pudding electrically neutral.

NAME OF MODEL – The "plum pudding" model

Ernest Rutherford

IDEAS (1) Atoms might have a very small central core or nucleus with a strong electric charge which would deflect $\propto$ - particles.

(2) This nucleus would be surrounded by electrons of the opposite charge which filled up the rest of the atom.

**General Comments and Recommendations**

(a) Although it may seem like history, candidates must have a clear understanding of the evolution of scientific thought and must realize that in science ideas can change.

(b) Teachers can use a craft/technology education approach in this topic as models of the atom can be made and used in a display/presentation.

(c) Once more there are many web-based resources that teachers can use — shockwave applications, animations, virtual labs.

## Paper 03/2 – Alternative to School-Based Assessment (SBA)

Question 1

**Section C – Thermal Physics and Kinetic Theory**

This question concerned the verification of Snell's Law. It tested Use of Knowledge (6 marks) and Experimental Skills (14 marks). It involved measuring an angle from a protractor, determining the sine of angles, drawing a graph and using the graph to support or refute Snell's Law.

**Areas of Good Performance**

The question was generally well done. Candidates were generally able to read off the angle, complete the table and draw the graph.

**Area of Weak Performance**

Candidates lacked the understanding that this graph passes through the origin. If candidates had remembered that Sine $0^{o} = 0$, they would have had the correct orientation of the graph.

**General Comment**

This experiment is a core experiment for preparation for the CSEC exams. It was clear that candidates were able to display the required skills tested.

Question 2

**Section C – Thermal Physics and Kinetic Theory**

This question involved the concepts of specific heat capacity and specific latent heat of fusion. Provided with a graph, candidates were required to determine five points from the graph. They were also required to calculate the slope of the graph from its value, and by checking with a table, determine the specific heat capacity of a given sample.

**Areas of Good Performance**

Parts (a) and (b) (ii), the identification of point on the graph and determination of the slope, were well done.

**Area of Weak Performance**

The application of $10^3$ proved difficult for some candidates.

**General Comments and Recommendations**

(a) Students learn through experience and teachers should ensure their students get the widest hands-on experience as possible.

(b) Some students need more graph skills developed. Again, teachers should give adequate practice in this area.

<u>Question 3</u>

**Section B – Mechanics**

This question investigated the concept of centre of gravity and required candidates to confirm or reject the assertion “The centre of gravity of all uniform and regular shapes is at the centre of the shapes”.

**Areas of Good Performance**

In Part (a), candidates generally knew the apparatus that was required. Some left out the fact that at least three different shapes should be used. The triangle is a very important shape as it makes the assertion false.

**Area of Weak Performance**

Part (d), comparing the centre of each shape with the point where lines cross on suspension of the shape, was poorly done.

**General Comments and Recommendations**

(a) This was a question based on a standard experiment but with a little twist with a triangle. A number of candidates did not recognize this.

(b) More practice is needed in the writing up of experiments.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

# REPORT OF CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION

## MAY /JUNE 2011

## PYHSICS
## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 13,003 candidates registered for the examination. This represented a 5.53 per cent increase in candidates registered compared with 12,321 in June 2010. The percentage of candidates achieving Grades I–III was 74 per cent compared with 75 per cent in 2010. Candidate's performance therefore remains steady. This trend is encouraging as it is important for the region to have sufficient numbers of qualified Physics graduates to cater to the increasing thrust in science and technology which is the driver of present and future development in the Caribbean.

Once again, candidates needed to show better mathematical skills in areas such as scientific notation and solving equations. More emphasis must be placed on using mathematical skills in studying Physics. Also, candidates should not be losing marks on simple recall items.

Performance the multiple choice paper was better than that of June 2010. This year, the mean score was 33.97 with a standard deviation of 10.95 compared with a mean score of 31.56 and a standard deviation of 10.60 in June 2010.

## Paper 02 – Structured Essay Questions

This paper consisted of one data analysis, two structured and three essay-type questions.

### Section A

Question 1

This question was based on the concepts of velocity, acceleration, distance and displacement. Candidates were required to use data given to draw a graph, determine gradient and complete a velocity–time graph.

An analysis of overall performance revealed that more than 60 per cent of the candidates received a score of 13 (52 per cent) out of a possible 25 marks.

**Areas of Good Performance**

Candidates performed will on Part (a) which required them to plot a graph, Part (b) which required them to determine the slope of the graph and Part (c) which required that they find the distance using the graph.

In determining the slop, the following were required: (1) a large triangle, (ii) correct read offs, (iii) the value of the slope and (iv) unit.

A**reas of Weak Performance**

In Part (d) (ii), too many candidates attempted to find average using the formula (u+v)/2. The formula for average velocity is total Distance/Total time.

In Part (e) many candidates chose either displacement or acceleration as a vector instead of both.

**Recommendations**

Candidates should

- use the graph page to its maximum.
- use a ⊙ or x when plotting points.
- be encouraged to always include unit of gradient where necessary.
- be trained to understand the meaning of the gradient.
- use formulae in the right context.

Question 2

This question was based on specific heat capacity and specific latent heat. It tested candidates' ability to remember basic concepts and solve problems on specific heat capacity and latent heat.

**Areas of Good Performance**

The main areas of good performance were in Parts (a) (i) and (ii) which required candidates to recall symbols and definitions.

**Area of Weak Performance**

Part (a) (iii) which required candidates to remember the relationship (c = mc) between specific heat capacity and heat capacity was poorly done.

**General Comments and Recommendations**

- Teachers should place greater emphasis on SI units.
- The relationship between the concepts *specific heat capacity* and *Heat capacity* should be clearly emphasized.

Question 3

This question was based on the flow of charges in different media and the ability to differentiate between direct and alternating current.

Performance on this question was satisfactory with 50 per cent of the candidates scoring more than 7 out of a total of 15 marks.

**Areas of Good Performance**

Parts (a) (iv), which required candidates to calculate charge, and Parts 3 (b) (i) and (ii) were generally well done.

**Areas of Weak Performance**

Parts (a) (i)–(iii) presented difficulties for candidates. Candidates knew that the flow of current in the copper wire was due to electrons but did not know that the flow of current within the simple cell was due to both positive and negative ions. Some candidates mixed up the responses for Parts (a) (ii) and Parts (a) (iii) which were *carbon, rod* and *zinc*, respectively.

**Recommendation**

There is a need for candidates to do much more electronics in their preparations.

**Section B**

Question 4

This question was based on the refraction and diffraction of light waves.A few candidates scored the full 15 marks but the vast majority, 64 per cent, scored less than half of the full marks.

**Area of Good Performance**

Candidates were able to recall and use a formula to find refractive index correctly.

**Areas of Weak Performance**

Candidates performed poorly on Part (a) which required them to explain the occurrence of light and dark bands on the screen. The required responses were as follows:

S – Waves spread out from each slit and overlap
I – Interference to give bright and dark bands
B – Bright bands result from Constructive Interference
D – Dark bands result from Destructive Interference.

Many candidates also had difficulty in Part (b) (iii) in dealing with a calculation involving the unit, nanometer. (1 nanometer = $10^9$).

**Recommendation**

- Teachers should engage students in a more hands-on manner with this topic. This experience could have helped many candidates to respond in a more acceptable manner.

Question 5

This question was based on transformers and proved challenging to candidates. A few candidates scored the full 15 marks, but the vast majority scored less than half of the full marks.

**Area of Good Performance**

Part (a) (ii) was reasonably well known as most candidates had a general idea about the basic structure of a transformer, though much neater diagrams were expected.

**Area of Weak Performance**

Candidates, in Part (a) (i), had great difficulty in finding more than one advantage in using a.c, to transmit electrical power. The required responses were as follows:

AC allows voltage step up/down with current step down/up
Transmission at lower current gives lower power losses
AC allows instruments that depend on frequency

Part (b) presented problems with transposing the formulas, which were generally well known.

**Recommendation**

There is need for more practice in manipulating formulas (cross multiplication) to solve problems based on the requirements of the question.

<u>Question 6</u>

This question involved radioisotopes and nuclear energy. Candidates had to recall how radioisotopes are used in medicine, outline safety precautions when using the same, make use of information on half-life to predict the probable age of a plant and finally use Einstein's mass–energy equation to solve a problem. In this question, 25 per cent of candidates earned more than half of the full marks.

**Area of Good Performance**

Part (a) was done relatively well by most candidates.

**Areas of Weak Performance**

Although Part (a) (i) was reasonably well done, too many candidates gave general uses rather than the uses in *medicine* which the question required.

Calculating half-life in Part (b) (i) and the power output in Part (b) (ii) proved challenging for the vast majority of candidates.

**Recommendation**

More practice in solving half-life problems should be given to candidates.

## Paper 03/2 – Alternative to School Based Assessment (SBA)

<u>Question 1</u>

This question required candidates to find out how the image distance and object distance were related for a converse lens.

**Area of Good Performance**

Candidates were able to plot the graph accurately.

**Areas of Weak Performance**

In Part (a), many candidates did not read the values correctly and were unable to state the precaution. The calculation of $u$ and $v$ presented a challenge.

In Part (b), candidates need more practice in drawing, this may have affected the *best fit line*. Very few candidates drew the line passing through the origin.

It must be noted that in theory a graph of $v$ *vs* $u$ for a convex lens will *not* give a straight line through the origin. However, while this may be true in theory, candidates were given readings designed to give a straight line through the origin.

In Part (c), not many candidates were able to deduce the relationship from their graphs. For Part (d), calculation of magnification was not well done.

**Recommendation**

Candidates require practice in questions of this nature.

Question 2

This question was poorly done. In Part (a), the majority of candidates did not give a complete description of the experiment. In Part (b), many candidates were unable to read correctly from the given graph. For Parts (c) and (d), the calculations were not well done by many candidates.

Question 3

This question required candidates to describe an experiment to investigate the best conductor of electricity from six identical solids of different materials

**Area of Good Performance**

In Part (c), candidates generally knew the circuit diagram.

**Areas of Weak Performance**

Part (b), the description of the experiment, proved challenging for many students.

In Parts (c) and (d), the observation and conclusion were satisfactorily produced by some candidates only.

**Recommendation**

These types of questions continue to show the need for more exposure to these kinds of experiments in a practical setting.

**Paper 031 – School Based Assessment**

For many centres, the standard of the SBA in 2011 showed improvement. This was evidenced by the high percentage of centres with

- adequate syllabus coverage (10 topics or more and the total number of activities). (Each skill being assessed two times per school year)
- good graph work (>5 graphs over two years is very good)
- good standard of practical exercise with all headings and adequate responses
- good ORR — Observation, Recording, Reporting Skills
- good A/I — Analysis and Interpretation results

Overall, some centres have produced good work. However, P/D, Planning and Design, remains the biggest problem for many centres, although there is some improvement. In most cases, this was due to poor choice of exercises for assessing the skill rather than the actual assessments. Centres should be reminded that standard textbook exercises (Traditional Laboratory Exercises) are inappropriate for assessing P/D.

CARIBBEAN EXAMINATIONS COUNCIL

# REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION

JANUARY 2012

## PHYSICS
## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 1,225 candidates wrote the examination. This represents a 13.2 per cent increase in candidates compared with 1,063 in January 2011.

Once again, candidates needed to show better mathematical skills in areas such as scientific notation and solving equations. More emphasis must be placed on using mathematical skills in studying Physics. Teachers should also ensure that students can write coherent multi-step essay–type responses. One example where candidates had difficulty writing concerned the Direct Current (DC) motor and how it works.

## DETAILED COMMENTS

### Paper 01 – Multiple Choice

Performance on the multiple-choice paper was comparable to that of January 2011. This year, the mean score was 31.74 with a standard deviation of 9.83, compared with a mean score of 33.04 and a standard deviation of 9.69 in January 2011.

### Paper 02 – Structured/Essay-Type Questions

This paper consisted of one data analysis, two structured and three essay-type questions. All questions were compulsory. Performance on Paper 02 showed improvement compared with January 2011. This year, the mean score was 38.95 with a standard deviation of 21.38, compared with a mean score of 34.24 and a standard deviation of 18.65.

**Section A**

Question 1

This question was based on the concepts surrounding using the Principle of Moments to find the mass of and weight of an object given the gravitational field strength. Candidates were required to use data given to draw a graph, determine the gradient and use the gradient to find the mass.

**Areas of Good Performance**

This question tested graphical, mathematical and analytical skills. It required a definition of a basic concept — moments.

Candidates performed well on Part (a) which required them to complete a table using information shown in a diagram. Part (b) which required them to plot a graph, Part (c) which required them to determine the slope of the graph and Part (d) where they were required to read off from the graph, were areas of good performance.

Core criteria in marking a graph include labels with units, correct axes orientation, regular scales, accurate plotting of points and best straight line or curve.

In determining the gradient the following were required:

- A large triangle
- Correct read offs
- Calculation of an appropriate number of significant figures
- The unit where applicable.

**Areas of Weak Performance**

In Part (e), too many candidates defined the principle of moments very loosely as "anticlockwise moments equal clockwise moments".

The comprehensive definition is *For a system in equilibrium, the sum of the clockwise moments about a point is equal to the sum of the anticlockwise moments about the same point*.

In Part (e), candidates for the most part, did not realize that to find the weight in newtons, the mass had to be in kilograms. A few candidates are still having problems converting grams to kilograms.

Candidates should

- use the graph page to its maximum
- use a ⊙ or x when plotting points
- be given adequate practice in drawing and analyzing graphs- straight lines and curves.

Question 2

This question was based on fundamental quantities and their SI units and measurement. The first part of the question tested candidates' ability to recall basic facts concerning fundamental quantities and linear scales.

The second part of the question involved calculations on density and pressure.

**Area of Good Performance**

The main area of good performance was in Part (a) (i) which required candidates to recall symbols and units and Part (b) (i) where they were asked to find the density of a cement sample.

**Area of Weak Performance**

Part (a) (ii) which required candidates to state the difference between a linear and a non-linear scale was poorly done. Teachers should spend some more time with students on this area when studying scales on instruments.

**Recommendation**

Teachers should consider a more practical approach to scales with as many examples as possible.

Question 3

This question was based on Einstein's mass-energy equation, the pros and cons of utilizing nuclear energy, the structure of the atom and radioactive emissions.

Performance on this question was, for the most part, not good.

**Areas of Good Performance**

Parts (a) (i) where candidates were required to recall Einstein's mass-energy equation, Part (a) (ii), which required candidates to state arguments for and against the utilization of nuclear energy and Part (b) (i) where they were required to balance the equation to find atomic and mass number, were generally well done.

**Areas of Weak Performance**

Part (b) (ii) and Part (c) presented difficulties for candidates. Candidates had problems applying the formula $E = mc^2$ and identifying the Helium nucleus (He).

**Recommendation**

Teachers should make sure that there is a more complete coverage of syllabus objectives. It appeared that many candidates had not yet covered the topics.

**Section B**

Question 4

The first part of this question was based on an understanding of the operation of a Direct Current (DC) motor. The second part involved calculations of frequency and period of an alternating current, the voltage across and the power dissipated in a resistor. The vast majority of candidates performed well below expectation on this question.

**Area of Good Performance**

Candidates were able to use the formula $V = IR$ in Part (b) (ii) to find the voltage correctly. However many did not understand clearly what "peak to peak" meant. "Peak to peak' measures the span of the voltage from maximum to minimum.

**Areas of Weak Performance**

Candidates performed particularly poorly on Part (a) which required them to explain how the coil of the D.C. motor is able to rotate continuously. Part (b) (i), which dealt with the period of the alternating supply, also proved to be quite a challenge.

The response expected by the examining committee for Part (a) is as follows:

C — Current flows through the coil
M — As a magnetic field is present
F — Coil experiences upward and downward force respectively
R — Rotation of coil results

S — Split ring reverses the current in arms
R — Continuous rotation realized

Teachers should engage students in a more hands-on manner when the topic of electricity and magnetism is being taught. Students should then be taught to express these experiences clearly and teachers may even use a multiple intelligence approach to teach the topic — drawing posters, making up calypso and reggae songs and so on. This topic is an integral one in any electricity course.

More attention needs to be paid to the fundamental concepts of unit conversion.

Question 5

This question was framed around the solar water heating system. Alternative energy is getting very popular across the Caribbean and globally and candidates must be sensitized about the impact of this technology in the Caribbean which experiences no shortage of solar energy.

This question involving temperature, specific heat capacity and the transfer of thermal energy was generally well done.

**Areas of Good Performance**

Parts (a) (i) and (ii) were well known as most candidates were able to score full marks.

**Area of Weak Performance**

In Part (b) (ii) candidates were not able to correctly identify that the system in the solar water heating system which demonstrates heat transfer by convection is the collector.

The expected responses for the various parts of this question include:

- (a) Good absorption — a black surface
- (b) Convection — the collector
- (c) The greenhouse effect — glass cover
- (d) Conduction — copper tubing
- (e) Reduction of heat transfer by conduction — insulation.

**Recommendation**

The fact that a change in the Kelvin temperature is the same as a change in Celsius should be emphasized.

Question 6

This question required candidates to (i) differentiate between transverse and longitudinal waves (ii) to recall and use the wave equation $v = f\lambda$ and (iii) solve problems on the propagation and reflection of sound waves.

**Area of Good Performance**

Part (b) (i) was well done.

**Areas of Weak Performance**

Although Part (b) (i) was reasonably well done, a number of candidates failed to follow up in Part (b) (ii) by finding the depth correctly. Most candidates found the distance travelled by the sound which was twice the depth.

A good solution would have been:

Total Distance = 2 x depth

| | | |
|---|---|---|
| 2d = vt | | s = vt |
| d = vt/2 | OR | s = 1450 x0.3 |
| = 1450x0.3/2 | | s = 435 |
| = 217.5 m | | d = s/2 |
| | | = 437/2 =217.5 m |

Candidates also had difficulty with calculating the frequency correctly in Part (a) (ii). Based on Velocity = frequency × lambda.

**Recommendation**

More work needs to be done with applying the units associated with the various quantities.

**Paper 032 – Alternative to School-Based Assessment (SBA)**

The mean for this paper was comparable to that of 2011. In 2012, the mean was 21.88 compared with the mean of 22.94 in 2011. The maximum available mark was 40. The standard deviation for 2012 was 8.02 compared with 7.89 in 2011.

Question 1

This question required candidates to determine the refractive index of a glass block using Snell's Law. It involved measuring an angle from a protractor, drawing a graph and using the graph to find the refractive index of the glass.

**Areas of Good Performance**

The question was generally well done. Candidates were able to plot points correctly and calculate the gradient. Many of the candidates realized that the refractive index is *sin i/sin r* but were not able to use the gradient to obtain it.

**Areas of Weak Performance**

Many candidates did not read the value correctly and were unable to state appropriate precautions. A large number of candidates did not begin the scales on the axes at 0.100.

**Recommendation**

Candidates should be instructed not to 'break' scales, especially when told where to begin.

Question 2

This question involved the drawing of circuit diagrams, calculating resistance and identifying an electrical component based on its I–V characteristics.

**Area of Good Performance**

This question was generally well done. Part (c) where candidates were required to plot a graph was satisfactorily done except for the drawing of a smooth curve.

**Areas of Weak Performance**

In Part (a) for the most part voltmeters were not appropriately connected and in Part (b) calculations of resistance were not recorded to an appropriate number of significant figures.

**Recommendations**

Students should be given more exposure to electrical circuits in a practical setting and more emphasis should be placed on graphical work involving best fit curve.

Question 3

This question tested candidates' ability to (i) read off values from a given graph and (ii) determine what graph to plot from a given equation in order to obtain a straight line graph.

**Area of Good Performance**

Part (a) which required candidates to read off coordinates from the graph was particularly well done.

**Area of Weak Performance**

Very few candidates were able to answer Part (b) satisfactorily.

**General Comments and Recommendations**

Students need more practice with extracting '$y = mx + c$' from a given equation. The mathematical skill of "changing the subject of the formula" needs to be developed among candidates.

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

MAY/JUNE 2012

## PHYSICS
## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 13,860 candidates registered for the examination. This represented a 6.94 per cent increase in candidates registered compared with 12,961 in June 2011. The percentage of candidates achieving Grades I – III was 76 per cent compared with 74 per cent in 2011. This increase is encouraging as it is important for the region to have sufficient numbers of qualified Physics graduates to cater to the increasing thrust in science and technology which is the driver of present and future development in the Caribbean.

Once again, candidates needed to show better mathematical skills in areas such as scientific notation and solving equations. More emphasis must be placed on using mathematical skills in studying Physics. Also, candidates should not be losing marks on simple recall items.

Performance on the multiple-choice paper was similar to that of June 2011. This year, the mean score was 33 with a standard deviation of 10.48 compared with a mean score of 34 and a standard deviation of 10.84 in June 2011.

## Paper 02 – Structured Essay Questions

This paper consisted of one data analysis, two structured and three essay-type questions.

### Section A

Question 1

This question was based on the concepts of electrical potential difference across a device, current and the resistance which required the plotting of a PD/V vs I/A graph .

**Areas of Good Performance**

For Part (a), the graphs were well plotted with correct orientation, scales well chosen, axes labelled with quantity and unit, fine and best fit line.

The response for Part (d) was good. A significant number of candidates responded correctly by stating that as V increased, I increased and some gave the equation V = IR.

**Areas of Weak Performance**

In Part (b), many candidates did not use a large triangle to calculate the gradient. Most of the given points fell on the best straight line so it was easy to read off. Most candidates knew the formula and were able to substitute and calculate the answer but failed to give the unit.

For Part (c), most candidates knew that the gradient was associated with resistance but quite a few stated the device ‘resistor’ as the unit. Some also gave the ohm symbol.

In Part (e), candidates should have used accurate symbols; many did not include the variable resistor but used the variable power supply instead which was acceptable.

In Part (f), most candidates lost a mark for not varying the resistance.

Some candidates used the equation $R_T = 1/R_1 + 1/R_2 + 1/R_3$ or tried to use the formula for two resistors in parallel for three resistors in parallel. The correct formula use is most important.

**Recommendations**

Candidates should

- use the graph page to its maximum,
- use a Θ or x when plotting points
- be encouraged to always include unit of gradient where necessary
- be trained to understand the meaning of the gradient
- use formulae in the right context.

Question 2

This question tested SI units and density. Part (a) (i) and (ii) tested candidates' ability to recall SI units, both base units and derived units. There was some level of open/free response for the candidates as they chose their own fundamental quantities and matching SI units.

In Part (b) (i), candidates were expected to recall the formula for density and its application in a simple case. For Part (b) (iii), candidates learnt that relative density dealt with the density of the substance divided by the density of *water*. This part of the question required candidates to compare the density of gasoline with the density of *mercury*.

**Areas of Good Performance**

Part (a) (i) and Part (b) (ii) were well done.

**Areas of Weak Performance**

In Part (b) (i), candidates had difficulty in trying to change the units to SI base units; the question simply required candidates to work in the units given and give the answer in grams per $cm^3$. Correct conversion to SI units with the answer in kg per $m^3$ was accepted. Candidates also had difficulty converting $cm^3$ to $m^3$.

Part (b) (ii) required the use of the following formula:

Density = mass/volume to find volume, and there was no need to change to SI units. The answer given in $cm^3$ was accepted. Conversion to SI units was again a problem.

For Part (b) (iii), candidates were expected to know that relative density is a pale comparison of two densities and so will have no units.

**Recommendation:**

Candidates should get more exposure to problems based on the formulas.

Question 3

This question tested candidates' ability to (i) determine the weight of a body, given its mass (ii) recall the conditions necessary for a body to be in equilibrium and (iii) recall Archimedes' principle and apply it to the law of flotation. Performance on this question was satisfactory with 50 per cent of the candidates scoring more than 7 out of a total of 15 marks.

**Areas of Good Performance**

Parts (a) and (b) were particularly well done as most candidates knew and could use the formula W = mg.

**Areas of Weak Performance**

Parts (d) (ii)–(iii) presented difficulties for candidates. They could not conceptualize that the yatch is less dense than sea water as it is made up of materials other than steel and also that air is an integral part of the system.

**Recommendations**

Once again candidates need to develop their problem solving skills. Teacher can allow students to have a ‘boat’ race with boats made of many materials, for example, paper, card board, plasticine, styrotex. A trip in a ‘water taxi’, boat or cruise liner would surely give students a memorable experience for this topic.

**Section B**

Question 4

This question was based on the Geiger and Marsden experiment with the gold foil. Candidates were required to know the apparatus used and have knowledge of the results and its interpretation. Few candidates appeared to be familiar with the experiment and the content of the topic. A large number of candidates were able to calculate the energy released in the second section.

**Area of Good Performance**

The performance of candidates in the calculation of the energy released was good. However, the common errors which occurred were not squaring the *c* in the equation $E= mc^2$ and improper use of standard form.

**Areas of Weak Performance**

For candidates familiar with the experiment, the fluorescent screen/detector was the most frequent omission. Many candidates were able to calculate the atomic number for Barium (Ba) while the mass number for Kripton (Kr) proved more challenging as many of them did not include the mass of the neutron.

**Recommendations**

Candidates need to be more competent with the use of the standard form and significant figures.

Question 5

This question was based on the general gas equation, kinetic theory, specific and latent heat and power. Part (a) (i) was reasonably well done, as most candidates had a general idea about the equation, though quite a few simply stated pV/T.

**Area of Weak Performance**

Candidates, in Part (a) (ii), had great difficulty in explaining the pressure in terms of the kinetic theory.

Question 6

Part (a) (i) required candidates, to recall three differences between light waves and sound waves. There are many differences, but the common ones at least are expected: *light is transverse and sound is longitudinal, light can travel through a vacuum while sound cannot, light travels much faster than sound, light is electromagnetically produced while sound is mechanically produced, light slows down when going through a medium while sound speeds up when going through a medium.* Some candidates also included that *light can be polarized whilst sound cannot be polarized.*

Part (a) (ii) asked for three properties of electromagnetic radiation not mentioned in Part a(i). The following answers were expected

- Can be reflected, refracted, diffracted
- Travels at a speed of $3.0 \times 10^8$ m/s in a vacuum
- Takes energy from one point to another

In Part (b), candidates were expected to use the skill from their practical pendulum experiments to work out what one echo would take if 50 echoes took 30.3 seconds. It also required candidates to recognize that the echo had to travel 2 x 100m in order to be picked up. The formula speed = distance/time was then required.

The recall of the wave formula $v = f\lambda$ was required in Part (c) and the subsequent answer would be in metres. One mark was given to convert metres to centimetres.

**Paper 032 Alternative to School-Based Assessment (SBA)**

Question 1

This question explored the candidates' use of the pressure law. Experimental skills tested were:

(a) Reading off coordinates from a graph of pressure vs temperature.

(b) Gradient determination — large triangle and correct read offs

(c) Correct read off of temperature from the graph.

(d) Extrapolation of a graph — using dotted lines [4]

The use of knowledge skills tested were:

(a) Calculation of gradient using gradient change in y/ change in x with correct unit

(b) The conversion of Degrees Celsius to Kelvin. Use of $T/^{o}C = T/K - 273$

**Areas of Good Performance**

- Most candidates were able to fill the table correctly.
- The extrapolation of the graph at both ends and the reading off.

**Areas of Weak Performance**

- Most candidates did not state the formula of gradient = change in y/change in x, but used it correctly in calculating the gradient.
- The use of large triangles was another area of weakness. Instead small triangles or no triangles were used.
- Some candidates used the table to take their readings for the gradient. This should not be so.

**Recommendation**

Teachers should be clear about the requirements in data analysis questions and ensure that students get adequate practice using the skills. Parts of the scheme are included above.

Question 2

This question was well done by the majority of candidates. It explored a popular SBA topic, Ohm's Law in Current Electricity. In this question, candidates were given the circuit diagram and asked to identify the components in a table. They also had to plot a V vs I graph and hence find the resistance in the circuit. Another resistor was provided for calculation of new resistance.

The experimental skills tested were:

(a) Identification of circuit components

(b) Using values from a table to plot a graph

(c) Determining gradient

The use of knowledge skills tested included calculating gradient and resistance

**Areas of Good Performance**

- Identification of the circuit components
- Plotting the points from the table and drawing the graph.

**Areas of Weak Performance**

- In Part (b), inappropriate scales for the axes. Non-linear scales are not valid. Incorrect orientation of the axes was also evident in some scripts.
- In drawing the best straight line, candidates joined their points one after the other.
- Although candidates were not marked for spelling, few candidates spelt *ammeter* as 'ammameter' or 'ampemeter' and *voltmeter* as 'voltammeter'. Physics teachers should encourage the correct spelling of physics terms.

**Recommendations**

Teachers should build a 'Wall of Physics' in the classroom and include the terms as fast as they are encountered. Weak spellers should write the terms on the wall or maybe on a free internet site, Edmodo.com, for example.

Another application can be a free collaborative wiki at wikispaces.com. All students and teachers can contribute to it.

Question 3

In this question, candidates had to use planning and design skills to identify radioactive sources. The apparatus to use, the procedure, safety measures and conclusion were expected. Generally, candidates did not perform as expected. For those who had some idea, it was not sufficient and they had problems expressing themselves logically.

**Recommendations**

- Teachers should spend more time doing planning and design type activities with students.
- More complete coverage of the topic is needed.

**Paper 031 - School Based Assessment (SBA)**

This year also showed improvements in the quality of SBA samples. Some centres continue to have challenges in their presentation of students' work.

If a centre has five or more students, then five books are to be submitted. If there are fewer than five students, all books are to be submitted. Some teachers confused the criteria; reference to CXC's SBA module and subject reports would help.

While the Organization, Recording and Reporting skills were generally well displayed, the Planning and Design, and the Analysis and Interpretation skills can be improved.
Teachers are thanked for their continued cooperation with the Council in the presentation of the SBA samples and they are advised to communicate via email cxcezo@cxc.org or via the website www.cxc.org for Physics documents or any answers they may specifically need.  Another relevant site for CSEC Physics information is notesmaster.com.

CARIBBEAN EXAMINATIONS COUNCIL

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

JANUARY 2013

## PHYSICS
## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 1730 candidates registered for the examination. This represented a one per cent decrease in candidates registered compared with 1770 in January 2012. The percentage of candidates achieving Grades I–III was 57 per cent compared with 53 per cent in 2012. This trend is encouraging as it is important for the region to have sufficient numbers of qualified Physics graduates to cater to the increasing thrust in science and technology which is the driver of present and future development in the Caribbean.

Once again, candidates needed to show better mathematical skills in areas such as solving equations and finding angles using trigonometric functions. More emphasis must be placed on the development of basic mathematical skills in studying Physics.

## DETAILED COMMENTS

### Paper 01 – Multiple Choice

Performance on the multiple-choice paper was comparable with that of January 2012. This year, the mean score was 32.81 with a standard deviation of 9.68 compared with a mean score of 31.74 and a standard deviation of 9.83 in 2012.

### Paper 02 – Structured Essay Questions

This paper consisted of one data analysis, two structured and three essay-type questions. All questions were compulsory. Performance on Paper 02 showed improvement compared with January 2012. This year, the mean score was 40.92 with a standard deviation of 18.23 compared with a mean score of 38.95 and a standard deviation of 21.38 in January 2012.

Question 1

This question tested graphical and analytical skills. Candidates were required to use data given to draw a graph, use the gradient to determine the number of turns in the primary, $N_{p,}$ the current in the secondary, $N_s$, and the efficiency of a transformer.

**Areas of Good Performance**

For Part (a), the graphs were well plotted with correct orientation, axes labelled with quantity and unit, well-chosen regular scales and the best fit line.

In Part (b), many candidates used a large triangle to calculate the gradient. Many knew the formula and were able to substitute and calculate the answer but candidates were penalized if they used points from the table provided. This does not show the skills of reading off points from the graph.

The response to Part (d) was good. Many candidates responded by determining correctly the number of primary turns and the secondary current.

**Areas of Weak Performance**

In Part (c), the calculation of the efficiency of the transformer was challenging for most candidates. The efficiency is the ratio of the secondary power to the primary power represented as a percentage:

Efficiency = IsVs / IpVp x 100 but candidates should use the slope of the graph for Vs/Vp.

In Part (e), some of the features of the transformer that enables it to operate efficiently are:

- Low resistance wires/thick copper wire
- Lamination of the core
- Core design/closed loop
- Material (with small hysterisis loss).

**Recommendation**

Candidates should get more practice in the drawing of graphs and using the graph to calculate physical quantities.

Candidates should

- use the graph page to its maximum
- use a Θ or x when plotting points
- be encouraged to always include the unit of gradient where necessary
- be trained to understand the meaning of the gradient
- use formulae in the right context

Question 2

This question tested physical quantities and their associated instruments of measurement. It also tested the concept of the force of gravity and vectors. Performance on this question was satisfactory with more than 50 per cent of the candidates scoring 7 or more out of a total of 15 marks.

**Areas of Good Performance**

Parts (a) and (b) were particularly well done as most candidates were able to identify the physical quantities and their instruments and correctly apply the concept of the force of gravity.

**Area of Weak Performance**

In Part (c), candidates had difficulty using scale diagrams to determine a resultant vector and in the conversion of the length of the vector to its actual value.

**Recommendation**

Candidates should get more exposure to problems based on graphical representation of vectors at an angle. The parallelogram of forces is a useful representation of doing a problem involving vectors.

Question 3

This question was based on the thermal Physics and kinetic theory section of the syllabus. It specifically explored thermometers, the pressure law and the gas equation.

**Areas of Good Performance**

The performance of candidates on Parts (a) (i) and (ii) relating to thermometers and their operating temperatures was good.

**Areas of Weak Performance**

In Part (a) (i), the actual labelling of the fixed points gave some candidates difficulty. For Part (b), many candidates ignored the fact that atmospheric pressure was also acting and therefore used the basic formula, $P = \rho gh$. The formula should be $P = P_{atm} + \rho gh$.

Question 4

This question was based on an understanding of reflection and refraction.

**Areas of Good Performance**

The description of terms associated with reflection such as *normal*, *angle of incidence*, *reflection* and features of the image formed in a plane mirror were well done.

**Area of Weak Performance**

The calculations in Part (d) proved difficult for candidates. The important formula here was
$n = \text{Sin } i / \text{Sin } r$

**Recommendation**

More emphasis should be placed on problem solving using the appropriate formulas and concepts.

Question 5

This question was based on electricity concepts. The diode, truth table, resistors in series and parallel, and an application to Christmas tree lights was given. This question was satisfactorily done.

**Areas of Good Performance**

Parts (a) (iii), (b) (i) and (c) were all well known as most candidates were able to secure full marks.

**Areas of Weak Performance**

In Part (a) (i), candidates had difficulty in describing a test for a defective semi-conductor. A possible solution is that *it conducts in neither direction when a forward and reverse voltage/potential difference is applied in the current*.

Part (a) (ii) which involved sketching the graph of a functioning diode presented difficulties for candidates.

**Recommendations**

Students should be given adequate practical experiences to facilitate learning. The *defective diode* is one such opportunity for hands-on learning. Learning should also be facilitated by visual representations. Some students are visual learners, therefore teachers are encouraged to incorporate more visuals/graphs in their teaching.

## Question 6

This question explored alternative energy sources and their uses. It also covered mechanical energy in the forms of kinetic and potential.

**Areas of Good Performance**

Part (a) on alternative energy was well done. The importance of alternative energy to the Caribbean includes *pollution reduction*; *less reliance on foreign importation of energy*; *less cost in the long term* and *energy conservation*. Some sources of energy expected were *solar*, *hydro-electric*, *geothermal* and *wind*.

**Areas of Weak Performance**

In Part (b) (i), some candidates confused the energy changes. A model response is:

*Ball rises losing KE and gaining PE until a maximum height reached where KE is minimum and PE maximum*

*Ball loses PE and gains KE until ball drops behind the goalkeeper, PE=0 and KE is maximum*

For Part (b) (ii), many candidates forgot the negative sign which should be interpreted as *difference*.

**Recommendations**

Teachers can explore the topic of alternative energy via a project and presentations or a poster competition. The use of the World Wide Web for information on alternative energy is also a good option.

Students can be taken on the actual football field to demonstrate and experience the football problem.

**Paper 032 – Alternative to School Based Assessment (SBA)**

Question 1

This question was well done by the majority of candidates. It explored candidates' use of motion. The experimental and use of knowledge skills tested were:

- Plotting of a graph of velocity versus time.
- Identification of an incorrectly recorded reading
- Calculation of the gradient of the graph.
- The interpretation of the graph to interpret the gradient

**Areas of Good Performance**

Most candidates were able to plot the graph correctly. Identification of the incorrect reading and calculation of the gradient were well done.

**Areas of Weak Performance**

Most candidates did not state that the formula of gradient = (change in y)/(change in x) , but used it correctly in calculating the gradient.

Some candidates did not know that the gradient of a velocity versus time graph is acceleration.

**Recommendation**

Teachers should be clear about the requirements in data analysis questions and ensure that students get adequate practice in acquiring the skills.

Question 2

This question was based on Boyle's Law and candidates performed satisfactorily. This question engaged candidates in labelling apparatus, writing a procedure, interpreting a graph and sketching a graph.

The experimental skills tested were:

- Correct labelling of the apparatus — Dry air, glass tube, bourdon pressure gauge and oil reservoir

- Describing the procedure of the investigation — The pressure of the air in the space above the reservoir is altered by the foot pump and measured on the pressure gauge. The pressure is transmitted through the oil to the air in a glass tube whose volume is measured by the measuring cylinder

- Including one precaution

The Use of Knowledge skills tested included confirmation that a particular graph represents Boyle's Law and sketching a graph of V against P.

**Area of Good Performance**

Candidates were able to identify the apparatus via labelling.

**Area of Weak Performance**

Candidates could not adequately describe the experiment.

**Recommendation**

Candidates should familiarize themselves with the meaning of the terms *inversely proportional* and *directly proportional*.

Question 3

In this question, candidates had to use Planning and Design skills to distinguish between the north pole and the south pole of a magnet. The diagram for the set-up of the activity accounted for experimental skills. The use of knowledge skills were tested by a situation in which candidates had to identify which of two steel bars was a magnet.

**Area of Good Performance**

Candidates identified which steel bar was the magnet.

**Area of Weak Performance**

The explanation of how the choice of magnet was decided upon was poor. It was expected that candidates would have stated that repulsion is the test for a magnet.

**Recommendation**

Teachers should spend more time doing Planning and Design type activities with students.

CARIBBEAN EXAMINATIONS COUNCIL

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

JANUARY 2014

## PHYSICS
## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 1074 candidates sat the examination. This represented a 0.40 % decrease in candidates compared with 1800 in January 2013. The examination consisted of a Multiple Choice Paper 01, a structured Paper 02 and the Alternative-to-Practical Paper 032 the third being not mandatory for all. Candidates with acceptable School Based Assessment scores are exempted.

Candidates' performance declined in 2014 with 49.06 per cent of the candidates achieving Grades I to III, compared with 56.84 per cent in 2013.

Once again, candidates needed to show better mathematical skills in areas such as solving equations; .and finding angles using trigonometric functions. More emphasis must be placed on the development of basic mathematical skills in studying Physics. Candidates should not be losing marks on simple recall items.

Teachers are expected to use a practical approach to the teaching of Physics. Engage students in the enquiry-based approach and integrate ICTs in the implementation of the syllabus.

## DETAILED COMMENTS

### Paper 01-Multiple Choice

Performance in the multiple choice paper was comparable with that of January 2013. This year, the mean score was 32.15 with a standard deviation of 9.91 compared with a mean score of 32.81 and a standard deviation of 9.68 in January 2013.

### Paper 02 – Structured Essay Questions

This paper consisted of one data analysis, two structured and three essay-type questions. All questions were compulsory. With respect to performance, on Paper 02, there was a decline in mean from January 2013 by 4.44.This year, the mean score was 36.53 with a standard deviation of 19.38 compared with a mean score of 40.97 and a standard deviation of 18.23 in January 2013.

### SECTION A

Question 1

This data analysis question required candidates to:

(a) plot a graph of Image Size verses Object size and determine the graph's gradient .
(b) relate the gradient to the physical quantity-magnification, thus relating the numbers to a concept.

This question was fairly well done. The mean for this question was 13.97 and the standard deviation was 5.58.

**Areas of Good Performance**

Part (a) was well done by the majority of the candidates. The graphs were well plotted which included correct orientation of axes, axes labelled with quantity and unit, well chosen-regular scales and the best fit line.

For Part (b), the determination of the gradient was also well done.

**Areas of Weak Performance**

In Part (f) some candidates confused lenses with mirrors. They did not apply the magnification formula correctly
Formulas expected to be used were:

$$\frac{\text{Image size}}{\text{Object size}} = \frac{\text{Image Distance}}{\text{Object Distance}} \quad \text{and} \quad \text{Magnification} = \frac{\text{Image Height}}{\text{Object Height}}$$

Some candidates are still placing a unit for magnification which is incorrect as it is a ratio.

**Recommendations:**

Students should get more practice in using graphs to calculate physical quantities. Some School-Based Assessments lend themselves naturally to a graphical treatment.

Students should

- use the graph page to its maximum.
- use a ʘ or x when plotting points.
- be encouraged to always include unit of gradient where necessary.
- be trained to understand the meaning of the gradient.
- use formulae in the right context.

Teachers should share with candidates what is expected of this type of question before the assessment takes place and encourage students to reflect on and share their own responses.

<u>Question 2</u>

This question was based on the Statics part of the Mechanics Section of the syllabus. It tested the concepts of Force, Moment and the Principle of Moments, Displacement, and their units. It also tested examples of situations where different forces act.

Performance on this question was satisfactory with more than 50 per cent of the candidates scoring 7 or more out of a total of 15 marks.

**Areas of Good Performance:**

Part (a) (i) where candidates were required to match various quantities to their units and Part (a)(ii), giving a suitable force name and a situation where it occurs were all well done

**Area of Weak Performance**:

For Part (b), most candidates had difficulty in correctly applying the Principle of Moments formula.

**Recommendation:**

Students should get more exposure to problems based on the Principle of Moments. Teachers should begin with the actual hands-on practical approach and relate to real life experiences.

Teachers should also ensure that all candidates have the mathematical skills involved such as multiplication, conversion of units, knowing what “clockwise” and “anticlockwise” means and solving equations.

Question 3

This question was based on the Thermal Physics and Kinetic Theory Section of the syllabus. It specifically explored Thermometers and their design features, Charles’ Law and its application to a problem.

**Areas of Good Performance**

Part (a) was well done. Part (c) (i) where candidates were required to recall Charles’ Law was also well done.

**Areas of Weak Performance**

For Part (b), the use of a thermometer and its design feature posed some difficulty for candidates.

In Part (c) (ii), the conversion from the Centigrade Scale to the Kelvin Scale also posed problems for some candidates. The question itself seemed a very straight forward one yet candidates could not perform the mathematical skills required.

**Recommendations**

Once again students need problem solving skills development. Use of Videos in relating to the gas laws will assist students.

Teachers can create their own visual presentations and post on You Tube.

## SECTION B

Question 4

This question explored the Electromagnetic Spectrum and was taken from Section D-Waves and Light in the syllabus.

**Area of Good Performance**:

Parts (a) (i) and (ii) on the nature of electromagnetic waves and their position in the electromagnetic spectrum were well done by candidates.

**Areas of Weak Performance**

For Part (b), candidates had difficulties in doing the calculations and subtracting numbers of different powers. This is clearly a mathematical weakness that has to be addressed.

Also challenging was the determination of the fraction of the original energy which was transferred to the solar panel. The formula required was wavelength= speed of light /frequency.

**Recommendations:**

Ensure the mathematical background of the students is well developed.

Question 5

This question was based on Electricity concepts. It explored the relationship between Current and Potential Difference for a filament bulb. It also tested candidates' knowledge in calculating the potential difference and current in resistors, using an electric circuit problem.

**Areas of Good Performance**

The drawing of the circuit diagram to get the Current vs Potential Difference relationship was well done by most candidates. The components used were power supply, filament lamp, variable resistor, ammeter, and voltmeter.

The majority of the candidates knew the required formula V = IR.

**Areas of Weak Performance**

Part (b) the manipulation of the formula V=IR to determine current and potential difference was poorly done. Some candidates did not recall the fact that the resistance of 2 resistors in parallel is given as

$$\frac{R1\ R2.}{R1 + R2}$$

Once again candidates had to deal with Powers which proved a challenge.

**Recommendations**

Teachers should ensure that students get adequate practice in actually constructing circuits and then doing calculations based on different configurations. Students can also be exposed to internet-based resources as simulations.

## Question 6

This question tested candidates' knowledge of the Physics of the Atom, in particular, it explored radioactive decay, stability of an atom and isotopes.

**Areas of Good Performance:**

Part (a) dealing with alpha decay and Part (d) on the atomic structure were both well done.

**Areas of Weak Performance**

For Part (b), candidates were required to explain why an atom is normally neutral and stable. Many candidates did not give an appropriate response. The expected response was:
'Neutral because it has the same number of equal and oppositely charged particles. Stable because of the proton to neutron ratio-similar masses'.

**Recommendations**

Since this section was the final one in the syllabus, candidates may not always reach this section. Teachers should ensure a wide coverage of the syllabus as questions are posed from any section of the syllabus.

## Paper 032 Alternative to School Based Assessment (SBA)

Question 1

This question tested candidates' ability of measurements. It was fairly well done as the majority of the candidates received from 10 to 20 marks out of a maximum of 20 marks. The mean for this question was 10.96 and the Standard Deviation 4.91

The Experimental and Use of Knowledge skills were tested as follows:

(a)Reading a micrometer screw gauge, a vernier caliper and a digital watch.

(b) How to determine density from the readings taken.

**Areas of Good Performance**

Reading of the instruments.

**Areas of Weak Performance**

Description of the density calculation.

**Recommendation**

Teachers should be clear what are the requirements in data analysis questions and ensure that students get adequate practice of the skills.

Question 2

This question was based on Thermal Physics and the Kinetic Theory and more specifically change of phase. The mean for the question was 9.14 and standard deviation 3.97

This question engaged candidates in recalling precautions in conducting the cooling of liquid Napthalene. They had to draw the cooling curve and measure the melting point of the Napthalene.

The Use of Knowledge skill was tested when candidates had to calculate the quantity of heat lost during phase change for a 5 minute period.

**Area of Good Performance**

- Drawing of the graph
- Identifying precautions which included, stir, read at eye level and using the water bath.

**Area of Weak Performance**

Parts (d) (i) and (ii) which involved calculating heat lost was poorly done by candidates

**Recommendations**

More emphasis should be placed on calculations.

Question 3

In this question, candidates had to use Planning and Design skills to determine which sealed matchbox contained a magnet. This question was well done. The mean for this question was 7.31marks and the standard deviation 2.14.

**Area of Good Performance**

The question was generally well done- the identification of the list of apparatus, procedure and the conclusion based on the observations. Candidates had a choice of methods which involved a compass or a magnet or where iron filings are used.

**Area of Weak Performance**

Some candidates did not state that repulsion is the test for a magnet.

**Recommendation**

Obviously candidates were familiar with this activity and this showed in the quality of their responses. Teachers are encouraged to keep the practical, hands-on approach as the first method in teaching physics. Other methods can include use of visual stimuli as You Tube videos, online simulations/CDs, and actual site visits to experience Physics in the real world.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

**MAY/JUNE 2014**

## PHYSICS

## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 13,788 candidates registered for the examination. This represented a 5.9 per cent increase in candidates registered compared with 13,024 in June 2013. The percentage of candidates achieving Grades I–III was 77 per cent compared with 67 per cent in 2013.

Once again, candidates needed to show better mathematical skills in areas such as scientific notation and solving equations. More emphasis must be placed on using mathematical skills in studying Physics. Also, candidates should not be losing marks on simple recall items.

## DETAILED COMMENTS

### Paper 01 — Multiple-Choice

Performance in the multiple-choice paper was better than that of June 2013. This year, the mean score was 34.47 with a standard deviation of 10.09, compared with a mean score of 33.14 and a standard deviation of 10.66 in June 2013.

### Paper 02 — Structured Essay Questions

This paper consisted of one data analysis question, two structured and three essay-type questions. All questions were compulsory. Performance on Paper 02 showed improvement compared with performance in June 2013. This year, the mean score was 41.13 with a standard deviation of 20.17, compared with a mean score of 33.82 and a standard deviation of 20.68 in June 2013.

**Section A**

Question 1

**Data analysis**

This question was based on the change of phase of a substance while cooling, and an understanding of the concepts of heat capacity and specific heat capacity.

**Areas of good performance**

The subparts of the question that candidates handled best were Parts (a) plotting the graph of cooling curve data, Part (b) identifying the melting point from the graph and Part (f) identifying correct symbols and units for heat capacity and specific lalent heat of vapouisation.

The graphs were well plotted. However, some candidates did not draw a proper cooling curve.

**Areas of weakness**

Parts (c) (i), (d) which tested candidates ability to analyse and interpret data and Part (e) calculating heat lost in cooling were the most difficult. For Part (c) the substance was actually in two states.

Many candidates were probably unaware that the phase in Part (d) was just another term for state and therefore their answers included terms such as ‘cooling’ and ‘condensation’ rather than ‘solid’.

In Part (e) many candidates were able to recognize and calculate correctly the heat needed to change the state of the substance but were not able to separate the other two stages of cooling.

**Recommendations**

Students should get more practice in the drawing of graphs. In particular, more emphasis should be placed on graphical plotting skills. These skills include the following:

- Labelling of the axes with name and units, for example, t/mins
- Axes correctly oriented
- Plots done, as a recommended practice, using small 'x's. A dot alone (a blob) is not acceptable.
- Best fit: If the graph is a straight line then a ruler must be used and a line drawn through as many points as possible or drawn so that the balance of space is even on both sides of the line. If the graph is not a straight line then free hand can be used to draw a smooth curve.

Question 2

**Mechanics**

This question was based on an understanding of energy and its units. It also tested candidates' ability to calculate velocity and momentum, given relevant information. This question was satisfactorily done.

**Areas of good performance**

Parts (a) (ii) and (iii), (b) (i) and (iii) were for the most part done fairly well as most candidates were able to secure full marks by correctly naming applications and advantages of solar energy as well as correctly applying formulae for gravitational potential energy and momentum.

**Areas of weak performance**

Parts (a) (i) and (a) (iv) were poorly handled with many candidates failing to come up with equivalent units to the Joule or naming appropriate alternative energies. In Part (b) (ii), quite a large number of candidates calculated average velocity as the final velocity.

**Recommendations**

Teachers should spend more time on teaching qualitative concepts such as alternative and renewable sources of energy. They should also encourage students to use formulas based on the context of the question.

Question 3

**Thermal Physics and Kinetic Theory**

This question tested candidates' ability to recall the gas laws, apply them to the solution of problems as well as give qualitative explanations in terms of the kinetic theory.

**Areas of good performance**

Part (a) on recalling the general gas law was done fairly well; however, too many candidates did not make it clear that the temperature had to be the absolute or Kelvin temperature.

**Areas of weak performance**

Part (b) (iii) asked for a ratio of volumes, given a missing temperature at fixed pressure. This was definitely the most challenging part of the question. The majority of candidates did not convert from degrees Celsius to Kelvin, transpose correctly or write the ratio correctly.

**Recommendations**

More practice needs to be provided on problems involving temperature and the gas laws. Kinetic theory ideas may need to be reinforced with virtual practical activities.

**Section B**

Question 4

**Light**

This question was based on the laws of refraction, refractive index and total internal reflection.

**Areas of good performance**

In Part (a) most candidates knew the laws but did not state that there must be a change of medium.

**Areas of weak performance**

For Part (b) (iii) many candidates were able to write 10 m, but could not link this with the two points required, that is, critical angle exceeded and so total internal reflection took place.

**Recommendation**

It is clear that more time needs to be spent on tasks and activities that involve applying basic facts and concepts to solve problems.

Question 5

**Electricity**

This question was based on the conserving and costing of electrical energy.

**Areas of good performance**

Parts (b) (i) and (ii) were done well by most candidates. They knew the formulas to use to calculate the time in hours, energy and to convert to kWh. However, few candidates took the shorter route by using seconds in their calculation, while others arrived at the correct answers using much longer methods.

**Area of weak performance**

Part (b) (iii) finding the efficiency of the bulb was the more challenging of the question sub-parts. Many candidates failed to recognize that to obtain the useful energy, the energy loss had to be subtracted from input energy.

**Recommendation**

Students should be encouraged to work with comprehensive definitions rather than loose ideas, for example,

$$\text{Efficiency} = \frac{Output\ Energy}{Input\ Energy} = \frac{Useful\ Energy}{Total\ Energy}$$

Question 6

**The Physics of the Atom**

This question required the candidates to recall the definition of the term ‘half-life’ and apply it to solve a problem. Candidates were also required to recall precautions taken when using radioisotopes as well as some useful applications of radioactive isotopes. The question also included a problem dealing with nuclear energy.

**Areas of good performance**

Parts (a) and (b) which tested ‘half-life’ concept and useful applications of radioisotopes were done fairly well by many candidates.

**Areas of weak performance**

Candidates failed to identify the energy as $6.7 \times 10^{10}$. Many candidates used $2356.7 \times 10^{10}$ and some of them calculated the change in mass rather than the new mass.

**Recommendation**

Teachers should give students more practice in solving half-life problems, and encourage them to carefully read and answer questions more comprehensively.

## Paper 031 — School-Based Assessment

This year candidates in the majority of the centres performed up to an acceptable standard. However, there is still room for improvement by candidates in some centres. Candidates in several centres showed weakness in both the Analysis and Interpretation (A/I) and Planning and Design (P/D) skills being assessed.

Some other observations noted by the marking team were:

(1) A table of contents with the dates and skills was missing from several samples.
(2) Inappropriate activities and criteria were sometimes selected for or used in assessing.
(3) Long essay format was used in the write up of the discussion. This format is not required.
(4) Four A/I and four P/D labs were expected to be assessed. In many cases this was done. Marks cannot be awarded for missing assessments. Teachers are advised to assess two of each skill per year as a minimum. Using traditional laboratory exercises for the Planning and Design is not desirable.
(5) The skill of drawing of graphs, in some cases, needed more assessment. Students should draw more than five graphs in total.

Recommendations for improved performance are:

(1) The provision of a manual SBA activities and rubrics to teachers. CXC can facilitate a workshop to produce such a manual.
(2) Greater professional development at site-based and district levels.
(3) Development of teacher networks to facilitate continuous communication and collaboration. The Internet, including websites such as http://caribbean.notesmaster.com/#1 and the http://www.cxc.org/. can be utilized.

**From March 2015, SBA Moderators will be visiting centres to moderate the assessment in CSEC Physics. Teachers are encouraged to plan work for the academic year early in the school year. Activities aligned with the syllabus implementation and clear rubrics for each activity should be available at moderation. All books are expected to be marked in detail with reference to the rubrics.**

## Paper 032 — Alternative to School-Based Assessment (SBA)

Question 1

This question explored the candidates' understanding of the cooling curve demonstration.
Experimental Skills tested were:

(a) Reading scales
(b) Graph skills of S-Scales, L-Labels, A-Axes, P-Plot.

**Areas of good performance**

Most candidates were able to read the scales correctly.

**Area of weak performance**

Both the graph and the calculation of latent heat showed lack of knowledge on the part of many of the candidates. The reading off of the graph did not pose a major problem to candidates but they experienced difficulty with latent heat calculation.

**Recommendation**

More practice is needed to achieve the mastery of all graphical skills.

Question 2

This question tested candidates' familiarity with experiments to investigate the passage of light through a rectangular glass block.

The Experimental skills tested were:

(a) The reading off of points on a graph to complete a table
(b) The drawing of a large triangle to determine the gradient.

The Use of Knowledge skills tested involved the calculation of the gradient and relating it to refractive index.

**Area of good performance**

Candidates were able to complete the table from the graph correctly.

**Area of weak performance**

The calculation of $c_2$ in Part (c) was not well done by the majority of the candidates as most did not make $c$, the subject of the formula, $n = c_1/c_2$, correctly.

**Recommendation**

Students need to be provided with more opportunities to practise graphical skills and related analysis and calculations.

Question 3

In this question candidates had to plan and design an experiment to determine how the resistance of a metallic conductor varies with the potential difference across it.

**Area of good performance**

For Part (a) most candidates knew the components of the circuit though many of them had difficulty connecting the circuit.

**Area of weak performance**

The required procedure in Part (b) presented greatest difficulty for most candidates. Many of them misinterpreted the question and monitored resistance and temperature changes. They did not know the readings to be taken.

**Recommendation**

Students need to perform the experiment rather than try to remember such activities. The hands-on experience would be more lasting and would facilitate a better understanding of what is happening in each step of the experiment.

CARIBBEAN EXAMINATIONS COUNCIL

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

## JANUARY 2015

## PHYSICS
## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 1479 candidates registered for the examination. This represented a 2.1 per cent decrease in candidates registered compared with 1510 in January 2014. There were 1315 candidates who registered for Paper 032 compared with 1321 in January 2014. Paper 032 is not compulsory for all candidates. Those with acceptable School Based Assessment scores are exempted.

The percentage of candidates achieving Grades I–III was 57 per cent compared with 49 per cent in January 2014. This represents a return to the level of performance attained in 2013.

It is important for Physics students to have a good feel for the practical nature of the subject. Even private candidates need some exposure to hands-on practicals to improve their experimental skills. Some of these activities should include plotting graphs and using them in the analysis and interpretation of data.

Performance on Paper 01 was comparable with that of January 2014. This year, the mean score was 33.57 with a standard deviation of 9.87 compared with a mean score of 32.15 and a standard deviation of 9.91 in January 2014.

Paper 02 consisted of one data analysis, two structured and three essay-type questions. All questions were compulsory. There was an improvement in performance compared with January 2014. This year, the mean score was 40.58 with a standard deviation of 20.89 compared with a mean score of 36.53 and a standard deviation of 19.38 in January 2014.

Paper 032 largely tests candidates' experimental skills as well as their use of knowledge. There were three compulsory questions. Candidates did not perform very well this year. The mean score was 20.82 with a standard deviation of 7.16 compared with a mean score of 22.10 and a standard deviation of 7.51 in January 2014.

## DETAILED COMMENTS

### Paper 02 – Structured Essay Questions

**Section A**

Question 1

This question tested graphical and analytical skills. Candidates were given pendulum lengths and the corresponding times for 20 oscillations for a simple pendulum. They were guided through manipulation of the results in order to determine the acceleration due to gravity, g.

**Areas of Good Performance**

For Part (a), the table was completed correctly by most candidates.

For Part (b), the graphs were well plotted with correct orientation of axes and the axes labelled with quantity and unit.

In Part (c), some candidates used a large triangle to calculate the gradient and those who knew the formula were able to substitute and calculate the answer but forgot to state the units.

**Areas of Weak Performance**

In Part (e), some candidates incorrectly labelled the parts of a simple pendulum.

**Recommendations**

Ample practice with graphs is needed to ensure candidates can choose appropriate scales. There were too many inaccurate scales.

The importance of stating the units in the calculated answer must be stressed. Many candidates forgot the units in the gradient and acceleration due to gravity.

Teachers should share with students what is expected of this type of question before the assessment takes place.

Question 2

This question was based on an understanding of energy. Candidates were required to recall different forms of energy, give appropriate examples then make a calculation of work and power required for a specific task.

Performance on this question was satisfactory with more than 50 per cent of candidates scoring 7 or more out of a total of 15 marks.

**Areas of Good Performance**

For Part (a) (ii), the unit of energy was generally well known by the majority of candidates.

In Part (b) (i), most candidates were successful in calculating the energy needed as the required potential energy.

The response to Part (b) (iii) was good. Many candidates understood that the presence of friction would increase the energy requirements.

**Areas of Weak Performance**

For Part (a) (i), some candidates did not recognize that the example given was that of kinetic energy and hence duplicated for the other missing parts.

In Part (a) (ii), defining the unit of energy posed a challenge for some candidates as they attempted to rely on using a formula. A possible solution is: *the Joule is the work done when a force of 1N moves its point of application 1m.*

For Part (b) (ii), the conversion to kilowatts was often omitted.

**Recommendation**

Exposure to the definitions of units may assist candidates in the successful application of concepts to problem solution.

Question 3

This question tested candidates' knowledge of thermometers and the associated physical properties; the recall of definitions of various *fixed points* and the application of the pressure law to a problem.

**Areas of Good Performance**

In Part (a) (i), the upper and lower fixed points were chosen correctly by the majority of candidates.

For Part (b), candidates who knew the law applied it correctly. However, some of them did not convert the temperature to Kelvin.

**Area of Weak Performance**

For Part (a) (ii), most candidates had no idea what the definition of the lower fixed point was. *The lower fixed point can be given as the temperature of pure melting ice.*

**Recommendations**

Teachers need to remind students that in the general gas law, pressures and volumes as well as temperatures are absolute as opposed to $\Delta P$, $\Delta V$ or $\Delta T$. Teachers should ensure that they complete syllabus objectives and give students plenty of practice in solving problems where there is a tendency to be careless.

**Section B**

Question 4

This question was based on an understanding of reflection and refraction. The mean for this question was 6.53 while the standard deviation was 4.39.

**Area of Good Performance**

For Part (a) (ii), the majority of candidates recognized the reflective nature of a wet road surface on a rainy night and correctly identified other reasons that may affect drivers as a result of the increase in light.

**Areas of Weak Performance**

In Part (a) (i), candidates often confused the laws of reflection with those of refraction.

Part (b) was not well done as most candidates did not realize that the refractive index works out to be a ratio greater than 1, that is,

$n = \sin(b) / \sin(\hat{a})$
$n = \sin 45° / \sin 32°$
$n = 1.334.$

**Recommendations**

Students should be taught that the refractive index of a medium is defined from vacuum (air) to the medium regardless of the direction of the light rays under consideration.

Question 5

This question was based on an understanding of electricity and magnetism concepts.

The question dealt with resistance and the relationship between current and potential difference for a filament bulb.

**Areas of Good Performance**

Parts (a) (i) and (b) (i) were particularly well done as most candidates were able to recall the formula V = IR and also calculate the resistance of the bulb, 10.0 ohms. However, for Part (b) (ii), the calculation of the current posed some difficulty.

**Areas of Weak Performance**

For Part (b) (iii), candidates failed to realize the danger to the ammeter, that is, that the parallel resistance would decrease, resulting in more current through the bulb and the subsequent blowing of the blub.

In Part (b) (iv), the majority of candidates did not include in their response the variation of the bulb's resistance with temperature.

**Recommendations**

Teachers should ensure that students get adequate practice examining the I─V characteristics of different materials such as an ohmic conductor, a filament lamp and a diode.

Calculation of the resistance of resistors in parallel need to be reinforced. The formula is **not** $R_T = 1/R_1 + 1/R_2$ but rather $1/ R_T = 1/R_1 + 1/R_2$ .

Question 6

This question explored predicting the effects of magnetic and electric fields on alpha and beta particles, representing and interpreting nuclear reactions, and relating the release of energy in a nuclear reaction to a change in mass.

Performance on this question was particularly poor. The mean score was 3.19 while the standard deviation was 3.73.

**Areas of Good Performance**

Part (c) which required a calculation of the energy given off in a nuclear reaction utilizing the formula $E = \Delta mc^2$ was correctly answered by many candidates.

**Areas of Weak Performance**

For Part (a), some candidates seemed to have totally misinterpreted what was required. Candidates generally thought that the field lines given in the diagram represented the direction of flow of the alpha, beta and gamma rays.

In Part (b), it was clear that many candidates had no knowledge of the objective tested, that is. to represent alpha and beta decay in the standard form: ${}^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$

**Recommendations**

Since this section was the final one in the syllabus, candidates may not always complete it in their preparation. Teachers should ensure a wide coverage of the syllabus as questions are posed across the syllabus.

## Paper 032 – Alternative to School Based Assessment (SBA)

<u>Question 1</u>

This question explored candidates' Experimental Skills (XS) and ability to describe and properly write up an experiment, and their Use of Knowledge Skills (UK) in applying a given formula to calculate an unknown quantity.

**Area of Good Performance**

Most candidates were able to record observations appropriately although many lost the mark for not giving the correct number of significant figures.

**Areas of Weak Performance**

Many candidates had difficulty with basic addition of fractions.

The description of the method to find a rough value for the focal length was poorly handled by most candidates. Many candidates in describing the method of finding the focal length simply changed distances without mentioning focusing an image on the screen.

**Recommendation**

Teachers should ensure that students get adequate practice in the skills required, and that they know the criteria on which they will be assessed on.

<u>Question 2</u>

This was a simple density experiment. Candidates were required to read and record values depicted on a measuring cylinder and a triple beam balance in order to calculate the density of an object. In a related activity, candidates were given several mass and volume readings and required to plot a graph and use the slope to determine the density of plasticine.

**Area of Good Performance**

The reading of the measuring cylinder and triple beam balance was done well by the majority of candidates. Plotting of the graph was another task that was well done.

**Area of Weak Performance**

Candidates had difficulty recognizing the density as the reciprocal of the slope.

**Recommendation**

Teachers can give students additional activities that involve plotting data points and using the resulting best straight line to calculate the slope and other related properties.

<u>Question 3</u>

In this question, candidates had to use Planning and Design (P&D) skills to determine a workable method for testing materials for suitability of use as a fuse.

**Area of Good Performance**

Most candidates were able to identify the appropriate apparatus.

**Area of Weak Performance**

Interpreting the expected results to achieve the desired aim was most difficult for candidates.

**Recommendation**

Describing the procedure and how to use data to achieve the aim must be an integral part of P&D lab preparation.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

**MAY/JUNE 2015**

**PHYSICS**

**GENERAL PROFICIENCY EXAMINATION**

## GENERAL COMMENTS

This year 13 448 candidates sat the examination compared with 13 563 in June 2014. Sixty-one per cent of the candidates earned Grades I to III, compared with 77 per cent in 2014 and 67 per cent in 2013.

Once again, candidates needed to show better mathematical skills in areas such as solving equations and the drawing of graphs. Candidates lost marks on simple recall items which should not be the case. Teachers are expected to use a practical approach to the teaching of Physics. For example, they should engage students in an enquiry-based approach to the subject and integrate ICTs in the implementation of the syllabus.

## DETAILED COMMENTS

### Paper 01 — Multiple Choice

Performance on the multiple-choice paper was comparable with that of June 2014. This year, the mean score was 34.24 with a standard deviation of 10.78, compared with a mean score of 34.47 and a standard deviation of 10.09 in June 2014.

### Paper 02 — Structured Essay Questions

This paper consisted of one data analysis, two structured and three essay-type questions. All questions were compulsory. Performance on Paper 02 declined when compared with 2014. This year, the mean score was 38.02 with a standard deviation of 21.28, compared with a mean score of 41.13 and a standard deviation of 20.17 in June 2014.

**Section A**

Question 1

This question tested graphical and analytical skills. It dealt with plotting of the half-life curve for a radioactive substance, extrapolating data from the graph and calculating the half-life of a substance from the graph.

**Areas of Good Performance**

The subparts that candidates handled best were Part (a) plotting the graph of activity versus time, Part (b) calculating the average half-life, and Part (d) naming of the types of radioactive decay: alpha particles, beta particles and gamma rays. A few candidates had problems deciding on the trend of the graph and also in extrapolating it − straight lines segments were drawn instead of curves.

**Areas of Weak Performance**

In Part (c), some candidates did not recognize that the unit for activity is *disintegrations per second*− Candidates left out disintegrations per second or just stated seconds for the unit for Activity.

**Recommendations**

Candidates should get more practice in the drawing of graphs. In particular, more emphasis should be placed on graphical plotting skills. These skills include the following:

- Labelling axes – using names and units, for example, t/mins
- Ensuring that orientation of axes is correct

- Practising the plotting of graphs, especially graphs with points that have decimal points and/or trends that are curves

Question 2

This question was based on an understanding of thermal energy. It also tested candidates' ability to differentiate between heat capacity and specific heat capacity and to calculate specific heat capacity and specific latent heat. This question was satisfactorily done.

**Areas of Good Performance**

In Part (a), many candidates were able to state the equations $E = mc\Delta\theta$ and $E = ml$. In Part (b), many candidates recognized that the cooling curve should have a horizontal section.

**Areas of Weak Performance**

In Part (c), the calculation of the change in temperature was a problem for some candidates as they sought to convert to K.

**Recommendations**

It is clear that more time needs to be spent on tasks and activities that involve applying basic facts and concepts to solve problems.

Question 3

This question was based on Ohm's law and electrical circuits, finding total resistance in series and parallel and properties of ammeters and voltmeters.

**Areas of Good Performance**

For Part (a) (ii), most candidates were able to recall that an ammeter is connected in series and has low resistance, while a voltmeter is connected in parallel and has high resistance. Most candidates could recall $V = IR$. However, they did not know the reasons why this is so.

**Areas of Weak Performance**

The proper definition of resistance was rare in Part (a) (i). Candidates had a vague understanding of the concept of resistance.

Most candidates (those who used the methods below) had difficulty calculating the total resistance in Part (b) (i).

Examples: Total $R = 2 + 4 + 2 = 8\ \Omega$
$1/RT = ½ + ¼ + ½$ which gave $RT = 4/5\ \Omega$

Or ( Most popular) $RT = 2 + 1/(1/2 + ¼)$.Which gave $3.3\Omega$ and $IT = 3.6$ A

**Recommendations**

Students need to be given more practice in calculating total resistance in series and parallel and combinations of these types. Practical activities would reinforce learning. Students should also be given activities with all resistors in the circuit and note the total current. They should then use one equivalent Resistance and observe the total current. The formulas should then be introduced.

**Section B**

Question 4

This question was based on Newton's three laws of motion, applying Newton's second law, using calculations of the momentum of a car, the decelerating force on a carduring a collision and the time of a collision.

**Areas of Good Performance**

Calculations of the magnitude of momentum and force in Parts b (i) and b (ii) were done correctly.

**Areas of Weak Performance**

In Part (a), many candidates were often unable to recall complete statements of Newton's three laws of motion − a core topic in Mechanics. Some candidates confused the labelling of the laws. Manipulating the formula F= m Δv/t proved a challenge. Basic mathematics seemed to be a major factor in candidates losing marks. The required laws were:

**First law**: An object will remain in a state of rest or uniform motion in a straight line unless acted on by an external/unbalanced/net/resultant force.

**Second law**: The unbalanced force on a body is equal to its rate of change of momentum.
**OR**
The rate of change of momentum is directly proportional to the applied/net force and acts in the direction of force.

**Third law**: If body A exerts a force, F, on body B then body B exerts an equal and opposite force on body A.

**Recommendations**

'Force is proportional to mass or acceleration' should not be encouraged as a statement of Newton's second Law. It is important to mention external and unbalanced force as well as uniform motion in Newton's first Law. Hence, teachers should ensure that students get a clear understanding of Newton's Laws and their applications. The use of School-Based Assessments can also help here.

Question 5

This question was based on the gas laws: its use to establish the Kelvin temperature scale and its application in solving problems.

**Areas of Good Performance**

Part (a) (ii) was generally well known; however, many candidates carelessly wrote that 1 Celsius = 273 K or simply 'add 273' when asked for the mathematical relationship between Celsius and Kelvin.

Part (b) which involved using the gas law was done fairly well; however, too many candidates did not convert the Celsius temperature to Kelvin in Part (b) (ii).

**Areas of Weak Performance**

Part (a) (i) was definitely the most challenging part of the question. It asked candidates to describe how the graph of volume versus temperature (in Celsius) of a gas can be used to derive the Kelvin scale. A possible answer would have involved showing that the graph yields a straight line, not through the origin and if the graph is extrapolated to the temperature−axis then that value represents the zero of the Kelvin scale.

**Recommendations**

It is clear that more time needs to be spent on tasks and activities that involve applying basic facts and concepts to solve problems in thermal physics.

Students must be taught to give clear concise answers rather than loosely connected ideas.

Question 6

This question dealt with the functioning of concave and convex lenses, the application of the magnification of a lens, the lens formula and identifying real and virtual images.

**Areas of Good Performance**

The subparts of the question that candidates handled the best were Parts a (ii) and b (ii). Candidates were able to recall the magnification formula: image height/object height or image distance/object distance. Many candidates were able to recall the lens formula to solve Part b (i), 1/f= 1/u + 1/v and were also able to imply the argument that since u=2f (f=10cm) then u=v. This illustrates a sound understanding of the convex lens theory.

**Areas of Weak Performance**

Candidates gave illustrations which were a poor representation of rays refracted from a concave lens, in Part (a) (i). They failed to redraw the diagram correctly, placing the incident ray given in the wrong position. They also did not seem to know the path of the diverging ray (outwards) as many drew it either passing straight through or being convergent and did not identify the principal axis or focal lengths correctly. They showed the principal axis as being perpendicular to the lens and being represented with an arrow. The focal length was only identified by a minority of candidates as the distance between the principal focus and the centre of the lens. In addition, a limited number of candidates actually retracted the divergent ray onto the principal axis.

In Part (b) (iii), candidates failed to recognize that the image was real instead of virtual. They confused the nature of the images from Parts (a) (i) and (b) (i).

**Recommendations**

Students should get more practice in the completion of ray diagrams as it relates to the concave lens.

**Paper 032 — Alternative to School-Based Assessment (SBA)**

Question 1

The question required candidates to

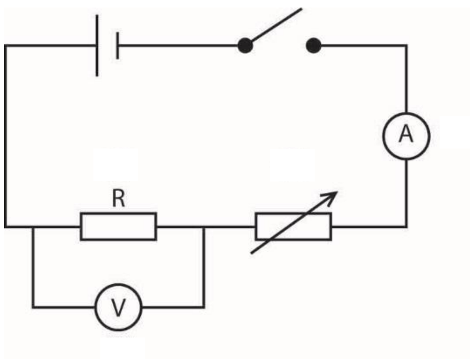
- apply knowledge of circuit symbols and the standard representation of circuits
- demonstrate experimental skills to investigate the I−V relationship for a circuit
- apply knowledge to determine the 1/R from a graph
- extrapolate information a graph and
- show that the 1/gradient of the graph= R, Resistance.

**Areas of Good Performance**

The representation of electrical components with circuit symbols in a circuit diagram was done well by most candidates. In the drawing of the graph candidates showed a proportional I−V relationship. Many candidates stated the formula correctly ($y_2$-$y_1$/$x_2$-$x_1$) and were able to correctly read off the relevant coordinates and the 0.45A corresponding voltage.

**Areas of Weak Performance**

Some candidates demonstrated lack of knowledge for about appropriate circuit symbols. A typical example is:




Some candidates were unable to draw a best fit line corresponding to the best fit of the points to provide a proportional relationship between I and V.

**Recommendations**

Teachers need to reemphasize criteria for a complete graph of data represented (inclusive of axes labels: quantities and units). Students need more practice in plotting graphs especially graphs with points that have decimal points and should engage in developing the skill of extrapolation of information from graphs and the analysis of graphs.

Question 2

For this question candidates were required to

- determine the mass of a coin by using a balance to determine the mass of 8 similar coins
- construct a table of results from a given graph
- determine the gradient of a line.

**Areas of Good Performance**

Candidates were able to use appropriate points from the graph to obtain a relatively large triangle and relate why the graph showed a zero error for the balance. The calculation of the gradient from the graph was also done well.

**Areas of Weak Performance**

Most candidates failed to obtain the majority of marks in finding two errors and a suitable precaution. For the most part, candidates related errors to the instrument or human error in using the balance. The failure to recognize the smallest subdivision on the graph, on the vertical axis, as 0.4 g was also another area of weakness.

**Recommendations**

Teachers can demonstrate how units from gradients can be used to evaluate information, for example, y-axis = mass (g) while x-axis = # coins. Therefore, the unit is g/coin which indicates the average mass per coin.

<u>Question 3</u>

In this question, candidates had to use Planning and Design (P&D) skills to determine the factors that can affect the strength of an electromagnet.

**Area of Good Performance**

For Part (a), a few candidates knew the components for the construction of a simple electromagnet.

**Area of Weak Performance**

The required manipulation in Part (c) presented the greatest difficulty for most candidates.

A typical response would include the following:

Manipulation of data − compare current reading with number of clips, compare number of turns with number of clips and use results to give a conclusion.

**Recommendations**

Teachers are reminded to use a mix of approaches in preparation for this paper. Some of the approaches expected in addition to actual hands-on activities, the use of ICT applications such as YouTube videos and also simulations.

# CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE**
**CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION**

**JANUARY 2016**

**PHYSICS**
**GENERAL PROFICIENCY EXAMINATION**

## GENERAL COMMENTS

This year 331 candidates wrote the examination. This represented a 67 per cent decline in candidate population compared with 1 041 in January 2015. The percentage of candidates earning Grades I–III was 57 per cent compared with 55 per cent in 2015.

## DETAILED COMMENTS

### Paper 01 — Multiple-Choice

Performance in the multiple-choice paper declined when compared with January 2015. This year, the mean score was 28.72 with a standard deviation of 7.00, compared with a mean score of 33.57 and a standard deviation of 9.87 in January 2015.

### Paper 02 — Structured and Extended Response Questions

This paper consisted of one data analysis question, two structured and three extended response questions. All questions were compulsory. Performance on Paper 02 declined compared with performance in January 2015. This year the mean score was 36.36 with a standard deviation of 15.33, compared with a mean score of 40.58 and a standard deviation of 20.89 in January 2015.

**Section A**

Question 1

In this question candidates were given velocity and time data at several points for a travelling car. Candidates were required to plot a graph and use it to make comments about the journey and to calculate the distance travelled.

**Areas of Good Performance**

In Part (a), candidates for the most part were able to plot the graph and draw the best fit trapezium. Also, in Part (c), most candidates were able to state correctly that the velocity for BC was constant or 30 m/s.

**Areas of Weak Performance**

In Part (b) (i), candidates were for the most part unable to find the acceleration during the interval AB. For Part (b) (ii), the velocity should have been calculated as 14.5 m $s^{-1}$ (15.0 $\pm$ 0.5 $ms^{-1}$). In Part (b) (iii), finding the total distance travelled also proved to be a problem. Candidates could have found the area under the velocity time graph as the area of a trapezium. It was surprising that in Part (d) many candidates were not able to define the term *velocity* as *the change in distance moved with time in a particular direction or the rate of change of displacement*.

**Recommendations**

Students should be reminded to always use a suitable scale when drawing graphs. They should be given more practice in reading off values from various graphs based on the scale selected. They should also be reminded to use dotted or broken lines to indicate where the value to be read off is located on the graph. Finally, unless a curve is expected, candidates should use a ruler to draw the straight line segments and not attempt to draw freehand graphs.

Question 2

This question tested candidates' ability to recall energy types, particularly potential energy and kinetic energy and then identify the energy changes taking place in specific situations.

**Areas of Good Performance**

Part (a) and (d) were done well by most candidates. In Part (c), the majority of candidates was able to state that the energy changed from kinetic to potential and back.

**Areas of Weak Performance**

Unfortunately, in Parts (b) (i) to (iii) candidates made errors in expressing the concepts of potential and kinetic energy. For example, in expressing the formula for the change in potential energy, $\Delta E_P = mg\ \Delta h$, many candidates failed to quote the change in height.

**Recommendations**

Discussing and analysing examples of systems where there is an interchange of potential and kinetic energy could go a long way in assisting students to better understand these concepts.

Question 3

This question required candidates to be familiar with physical properties which vary with temperature and to relate these to different thermometers. They also needed to be familiar with the pressure law.

**Areas of Good Performance**

In Part (b), stating the Celsius temperatures at the upper and lower fixed points was handled well. Also, in Part (c) (i), the conversion from K to °C was generally well known.

**Areas of Weak Performance**

In Part (a), the major challenge was identifying the fact that a thermocouple can respond to rapidly changing temperatures as a result of the low thermal capacity of its junctions. In Part (b), candidates had difficulty defining the upper and lower fixed points on the Celsius temperature scale, apart from stating the values. In Part (c), proper expression of the pressure law was largely absent.

**Recommendations**

Performing experiments to investigate the gas laws should help to give students a better appreciation for how they can be applied.

**Section B**

Question 4

This question was based on principles of reflection and refraction of light.

**Areas of Good Performance**

Parts (a) and (b) (i), which tested reflection, were done fairly well by many candidates.

**Areas of Weak Performance**

In Part (b) (ii), the explanation of why the sign was placed behind the truck posed problems for most candidates. A suggested explanation could have been that light travels in straight lines and that a long or wide truck blocks the line of sight to the mirror.

**Recommendations**

Teachers are advised to train students to properly go about an explanation − based on Physics concepts, laws, principles etc.

Question 5

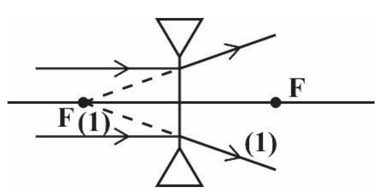
This question required candidates to be familiar with image formation using concave and convex lenses,and to use formulas to calculate magnification and focal length.

**Areas of Good Performance**

Parts (b) (i) and (ii) were the parts best handled. The required solutions were 1.5 and 30 cm.

**Areas of Weak Performance**

All of Part (a) was badly done especially Part (a) (iii) where candidates were to draw how rays parallel to the principal axis pass through a concave (diverging) lens. A possible solution for Part (a) (iii) is



**Recommendations**

Teachers are advised to spend more time training students to more fully understand concepts as it relates to waves and optics more fully.

Question 6

The question required candidates to describe a given circuit and perform various calculations based on their understanding of simple series and series-parallel circuits.

**Areas of Good Performance**

Parts (b) (i) and (ii) and to a lesser extent Part (a) were the parts better handled by candidates.

**Areas of Weak Performance**

In Part (a), many candidates did not clearly indicate that the 3V battery is connected in *series* with a *switch*, a *rheostat*, an *ammeter* and a *resistor.* The *voltmeter is placed in parallel* with the resistor.

Many candidates were not able to find the power in Part (b) (iii). A possible solution is

$$P = I^2 R$$

$$= 3\frac{3}{11} \times 3\frac{3}{11} \times 3$$

$$= \frac{36}{11} \times \frac{36}{11} \times 3$$

$$= 32.1 \text{ W}$$

**Recommendations**

Teachers are advised to help students recognize the detail expected and to write clear and comprehensive statements. More practical work and practice with problem solving especially in series-parallel circuits is advised.

**Paper 032 – Alternative to School-Based Assessment (SBA)**

Question 1

This question required candidates to set up an electric circuit and obtain data to classify different materials as either conductors or insulators. Candidates also needed to demonstrate knowledge of a standard experiment for determining the resistance of a resistor.

**Areas of Good Performance**

In Part (a) (iii), most candidates were able to classify the materials as conductors and insulators. In Part (c) (ii), most candidates recalled that R = V/I.

**Areas of Weak Performance**

Many candidates confused conclusions with results in Part (a) (iii). In Part (b), most candidates did not include polarity in the circuit diagram.

**Recommendations**

Students need further guidance in expressing how to plan and design an experiment, noting what the relevant observations are (including what precautions should be taken and what unavoidable sources of error should be noted) and how these observations may be used to make reasonable conclusions.

Question 2

Candidates were given data of corresponding lengths and periods for a simple pendulum. They were required to draw a graph and use it to comment on the effect that length has on the period.

**Areas of Good Performance**

The drawing of the graph in Part (a) was generally well done.

**Areas of Weak Performance**

Parts (b) (i) and (ii) were not well done as candidates were expected to state for Part (b) (i), *as length increases, period increases* or *length affects period*.

For Part (b) (ii), it was expected that candidates would state that the period is NOT directly proportional to the length (L) and the graph is NOT a straight line through origin

**Recommendations**

Students should be guided in understanding the mathematical meaning of *a is proportional to b*.

<u>Question 3</u>

Candidates were required to plan and design an experiment to demonstrate that heat flows at different rates through different metals.

**Areas of Good Performance**

Candidates performed best on Part (d)

**Areas of Weak Performance**

Candidates generally exhibited poor skills regarding the use of the scientific method and many misunderstood rate of heat flow confusing it with rate of expansion. To compare rates of heat flow, times had to be measured and compared. Specific mention must be made of the controls in the experiment such as identical dimensions of the different metals.

**Recommendations**

More basic practical work is recommended.

C A R I B B E A N    E X A M I N A T I O N S    C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

**MAY/JUNE 2016**

# PHYSICS
# GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

This year 14 019 candidates sat the examination. This represented a 10.2 per cent increase in the number of candidates compared with 12 721 in June 2015. The examination consisted of a multiple choice Paper 01, a structured Paper 02, the school-based assessment Paper 031 and Paper 032, the alternative to the practical for private candidates only. This year 67 students wrote Paper 032.

Candidates' performance overall improved this year over the June 2015 performance. Sixty-four per cent were awarded Grades I to III this year compared with 61 per cent in June 2015.

## DETAILED COMMENTS

### Paper 01 – Multiple Choice

Performance in the multiple-choice paper was comparable with that of June 2015. This year, the mean score was 34.35 with a standard deviation of 10.01 compared with a mean score of 34.24 and a standard deviation of 10.78 in June 2015.

### Paper 02 – Structured Essay Questions

This paper consisted of one data analysis, two structured and three essay-type questions. All questions were compulsory. With respect to performance, on Paper 02, the mean score was 39.08 with a standard deviation of 20.56 compared with a mean score of 38.02 and a standard deviation of 21.28 in June 2015.

**SECTION A**

<u>Question 1</u>

The question tested:

- The application of experimental skills via plotting of the half-life curve for a radioactive substance
- Application and analysis by calculating the half-life of a substance from the graph
- Experimental skills by extrapolation of information from the graph
- Recalling that radioactive decay has a random nature
- Knowledge of standard notation for representing nuclides generally and specifically

**Areas of Good Performance**

The subparts of the question that candidates handled best were Part (a) where, for the most part, they plotted the points correctly and represented the general trend of radioactive decay. Some candidates converted the time to seconds. This was not requested but was not penalized. Part (e), which called for defining atomic number and mass number, was also done well.

**Areas of Weak Performance**

In Part (a), some candidates were unfamiliar with the general recommendations on plotting a graph, such as inclusion of title, labelled axes (with correct units), correct orientation, appropriate scale, representation of points as small x's or circle with dot. Many candidates did not use a sharp pencil to draw the curve. Often missed were the recording and recognition that the unit for activity is 'disintegrations per second'. Some candidates left out disintegrations per second or just stated seconds for the unit for activity.

In Part (b), in the calculation of half-life some candidates

- did not use corresponding time and activity values for the coordinates selected
- used values from the table instead of the graph
- recalled the general principle of half-life but were unable to apply it
- in some cases, drew straight line segments instead of a curve.

For Part (d), some candidates referred to the intervals on the axes rather than the decay process

**Recommendations**

Candidates should be provided with more practice in the drawing of graphs. In particular, more emphasis should be placed on graphical plotting skills. These skills include the following:

- Labelling axes – using names and units, for example, t/mins
- Ensuring that orientation of axes is correct
- Practising the plotting of graphs, especially graphs with points that have decimal points and trends that are curves
- Practising extrapolation of information from graphs and analysis of graphs (especially to determine half-life of a sample by extrapolation and averages)

<u>Question 2</u>

The question dealt with:

- Identifying the SI units of linear momentum and force
- Defining linear momentum
- Recalling Newton's $3^{rd}$ law of motion
- Applying Newton's $3^{rd}$ law in the horizontal motion of an aircraft
- Applying the law of conservation of momentum in a collision

**Areas of Good Performance**

For Part (a), candidates were generally able to clearly identify the units of force as the Newton (N) and linear momentum as $kgms^{-1}$.

In Part (c) (i), candidates linked the definition of momentum with mass and velocity. Candidates were also able to provide a formula to a written definition (p= m x v). They were able to gain at least one of the two marks for this part.

In Part (b), most candidates were able to recall Newton's 3rd law. The 'action-reaction' version of the law was the more popularly stated response as opposed to the 'body A - body B' version.

In Part (c) (i), candidates recalled the law of conservation of momentum. They were able to state the law of conservation using a correct formula. While most candidates calculated correctly the answer of 7 $ms^{-1}$ for the velocity, in Part (c) (ii) some forgot to state or indicate the direction, thus obtaining three marks of the four available marks.

**Areas of Weak Performance**

Part b (ii) was not well answered. Candidates failed to identify that the motion of the aircraft was horizontal as opposed to vertical. Many candidates identified the force of gravity, an irrelevant force to the horizontal motion. They also failed to demonstrate clear understanding of the application of Newton's 3rd law. Candidates failed to link the motion of the engine on the air and the resulting opposing force of the air on the plane as maintaining the forward horizontal motion of the aircraft. Weaker responses scored zero or one mark for the diagram. Candidates also failed to mention that the plane moved in a forward direction. There were also a few candidates who confused the direction of the engine and the air, resulting in the plane moving backward.

For Part (c) (ii), while candidates correctly stated the law of conservation of momentum, there was a widespread failure to apply this law. They did not identify that the two objects were moving opposite to each other and thus the total momentum before a collision was a subtraction between the two masses. They also failed to identify correctly the final momentum after the collision. Very few candidates stated clearly the direction of the body. A popular response was 9 $ms^{-1}$ as candidates added the total momentums before the collision.

**Recommendations**

It is clear that more focus is needed on the applications of Newton's 3rd law and other laws of motion, which are the core to understanding Physics. Candidates showed a weak understanding of this area. Teachers should highlight velocity as a vector quantity in the application of the law of conservation of momentum.

<u>Question 3</u>

The question dealt with:

- Quantities and their units involved in Thermal Measurements
- Defining specific latent heat
- Calculating specific latent heat of fusion of ice

**Areas of Good Performance**

In Part (c) (i) many candidates were able to correctly state the equation associated with the calculation of the heat energy lost by the water.

**Areas of Weak Performance**

In Part (a), too many candidates wrote simply "energy" for $E_H$ without saying it is "heat" energy. This was the case also with "c". The response "heat capacity" was quite common. Also, $\Delta\theta$ was given as "temperature" rather than as "**change** in temperature."

In Part (b) many candidates omitted "specific" in "specific latent heat."

In Part (c), the correct substitution presented a problem. Either the wrong mass was used or the wrong change in temperature. Too many candidates subtracted the temperatures and then went on to convert this change to Kelvin before substituting. It was very disappointing to see so many simply subtracting the temperatures and giving this as the "heat loss".

Candidates were able to use the formula $E = mc\Delta\theta$, but made simple errors in the substitution. The incorrect mass or incorrect change in temperature was used.

**Recommendations**

Candidates should be encouraged to learn and appreciate accurate definitions and link their knowledge of definitions with the units that, inevitably, must come from the definition.

It was disturbing to see several candidates following the correct process, getting the correct answer, and then crossing it out. Teachers should encourage students to check their work carefully before crossing it out.

Students should be encouraged to draw “a story board” of the stages in multi-stage processes, such as the heating or cooling of substances involving a phase change. They can then put in the formulas applicable to each stage.

**SECTION B**

Question 4

The question dealt with

- Types of e.m. waves according to their wavelengths and their uses
- Calculating the wavelength corresponding to a particular frequency of an e.m. wave
- Determining the speed of sound given information about a lightning event

**Areas of Good Performance**

Part (c), which dealt with determining the speed of sound, was the best answered part of the question.

**Areas of Weak Performance**

In Part (a), there was some confusion in the understanding of the various electromagnetic waves as opposed to the different types of waves (longitudinal, transverse, etc.)

Also in Part (a) many candidates did not understand or recognize the order in which the waves were to be listed.

In Part (b) many candidates failed to demonstrate competence in the transposition of equations. Additionally, some candidates seemed to be uncomfortable with the idea of standard form.

**Recommendations**

Teachers are advised to go through the e.m. spectrum - perhaps as a group or individual project or as a presentation with their students. It appears that some candidates had no idea of what the e.m. spectrum entailed.

The mathematics required for Physics needs to be taught and practised regularly in Physics class. The assumption that the relevant material is covered adequately in Mathematics class is often not verified by experience.

Teachers are encouraged to review practice examination questions with students, paying special attention to the careful reading of questions in order to fully understanding what is required in the question.

Question 5

The question dealt with charge, charge carriers and currents in various conducting media.

**Areas of Good Performance**

Part (b) was particularly well done. Candidates were generally acquainted with the formula $Q = I\,t$ and were able to manipulate it to find the required answers.

Part (a) was quite a challenge for a large number of candidates. In Part (a) (i) many candidates knew that current flow in metals was due to electrons and in electrolytes was due to ions but were not able to comprehensively communicate this in their answers and compare the movement of the charges with 'conventional current'.

In Part (a) (ii) very few candidates were able to come up with the expected response, which was that electrolytes and semiconductors both had two charge carriers, unlike metals.

**Recommendations**

Teachers need to spend time getting students to understand and communicate their understanding of concepts more comprehensively.

All objectives in the syllabus need to be addressed and, where necessary, taught with concrete examples and illustrations.

Question 6

Candidates were expected to describe an experiment to demonstrate that temperature remains constant during a phase change and a particular alternative energy process (namely, hydroelectricity) and to explore its advantages and importance to a Caribbean island (Dominica)

**Areas of Good Performance**

For Part (b) (i), candidates were, for the most part, able to explain how electricity is generated using hydroelectricity. In Part (b) (ii), candidates were able to mention at least three points in support of the use of hydroelectricity as an alternative energy source.

**Areas of Weak Performance**

For Part (a) candidates were generally unable to describe the experiment involving the heating/ cooling curve.

In Part (b) (ii), candidates were generally unable to give an explanation to support the points stated for the use of hydroelectricity as a viable alternative energy source.

**Recommendations**

Teachers should include in their lesson planning

- more practical activities employing heating and cooling curves, especially simulations which can be found online
- more practice questions involving three-stage energy conversions
- assignments to write essays on the various forms of alternative energy sources (advantages and disadvantages); especially those forms applicable to the Caribbean
- assignments to produce tables of comparison between the various alternative energy sources
- viewing of online simulations/videos of the production of electricity from each of the alternative energy sources applicable to the Caribbean
- activities to build model power stations as replicas of each of the alternative energy sources applicable to the Caribbean.

**Paper 032 – Alternative to School-Based Assessment (SBA)**

<u>Question 1</u>

The question dealt with:

- Investigating how the period of a pendulum varies with length
- Altering the length of the string from $0.2<l<0.9$m and so determining the time for 20 oscillations for small angles
- Calculating the period (T) and $T^2$ with appropriate units and significant figures
- Plotting a graph of $T^2$ vs l
- Determining the gradient of the graph with correct unit
- Identifying correctly the relationship between $T^2$ and l
- Stating precautions taken in conducting a simple pendulum experiment

**Areas of Good Performance**

Candidates determined the time for 20 oscillations for at least three lengths, 0.2m, 0.5m and 0.9m. In Part (a) candidates showed competency in using the pendulum, adjusting its length, and using the stop watch to time 20 oscillations. Most candidates were able to determine correctly periodic time by dividing the time for 20 oscillations by 20. Candidates did include the $T^2$ even if many did not correctly calculate it from the periodic time.

Overall, for Part (b), candidates showed a good grasp of plotting a graph. Most candidates were awarded marks ranging from 5 to 7. Candidates used correct orientation of axes, good scale, plotting marks and best fit line. Marks were lost due to failure to state the correct units for the graph labels.

In Part (c), candidates were able to correctly recall the formula for gradient. There were many cases of errors carried forward (ECF) from the graph. The candidates were able to gain at least 3 out of the 4 available marks for proving the correct formula, and for substitution and calculation. Candidates also showed good read-off skills for points derived from line of best fit. Most candidates obtained at least one out of two marks.

For Part (d), approximately half of the responses indicated a correctly proportional relationship between $T^2$ and *l*.

For Part (e), candidates were able to offer a suitable precaution to obtain easily their 1 mark. Responses ranged from no wind or draft on the pendulum, using small angles of oscillation, repeating the experiment and eye-level reading to avoiding parallax.

**Areas of Weak Performance**

For Part (a), candidates failed to correctly calculate $T^2$. Some candidates found $(t_{20})^2$ losing the mark. Candidates also failed to correctly state the relevant units in the headings of the columns. For a small percentage of candidates, there was misinterpretation of the range of lengths for the pendulum. These candidates used only three lengths and so lost the 'R' mark.

For Part (b), some candidates failed to plot $T^2$ but used T or plotted $l$ vs $T^2$. Candidates also did not clearly identify the correct unit with the labels. While the formula was correctly stated for gradient, candidates failed to use points very far apart. Very few candidates were able to correctly identify the unit for gradient as $s^2m^{-1}$. Many responses identified the relationship between $T^2$ and $l$ as inversely proportional rather than directly proportional.

**Recommendations**

Emphasis by teachers on ORR skills involving presentation of findings would be beneficial. Overall, an improvement can be made by candidates in tabulating results using appropriate headings with units and appropriate significant figures. There should be more practice in the calculation of periodic time, T and $T^2$. With gradient calculations, class activities should focus on formula substitution with points from the line drawn and units.

<u>Question 2</u>

The question dealt with:

- Extracting and tabulating data from a cooling curve
- Determining from the graph the time taken for the substance to change phase
- Identifying on the graph when the substance is in a particular phase

**Areas of Good Performance**

This question was done satisfactorily by most candidates.

**Areas of Weak Performance**

There was some confusion as to the stages indicating solid and liquid on the graph.

**Recommendations**

Candidates must be advised that lines are necessary for a table and the quantities MUST have names and, where applicable, units.

<u>Question 3</u>

Candidates were expected to plan and design an experiment to relate the pressure at a point in a liquid to its density.

**Area of Good Performance**

Part (a), where candidates were asked to formulate an aim out of the proposed plan, was where the majority of candidates obtained their only mark.

**Area of Weak Performance**

The question was poorly done by most candidates.

**Recommendations**

Candidates who are prepared for this paper must become familiar with basic experiments as detailed in the syllabus.

# CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION**

**JANUARY 2017**

**PHYSICS**
**GENERAL PROFICIENCY EXAMINATION**

## GENERAL COMMENTS

This year 487 candidates wrote the examination. This represented a 47 per cent increase in the candidate population compared with 331 in January 2016. The percentage of candidates earning Grades I – III was 65.2 per cent compared with 57.5 per cent in 2016.

## DETAILED COMMENTS

### Paper 01 — Multiple Choice

Performance on the multiple-choice paper showed a slight improvement in terms of means. This year, the mean score was 28.72 with a standard deviation of 7.00, compared with a mean score of 33.57 and a standard deviation of 9.87 in January 2015.

### Paper 02 — Structured and Extended Response Questions

This paper consisted of one data analysis question, two structured and three extended response questions. All questions were compulsory. Performance on Paper 02 improved over January 2016 and even January 2015. This year the mean score was 42.70 with a standard deviation of 18.64, compared with a mean score of 36.36 and a standard deviation of 15.33 in 2016.

**Section A**

Question 1

This question was based on Section B — Thermal Physics and Kinetic Theory. It dealt with the following:

- Application of experimental skills via the plotting of electrical energy versus temperature change
- Application of the gradient formula to determine the heat capacity of the material
- Application of the relationship between heat capacity and specific heat capacity to determine specific heat capacity of the material
- Transposing and substitution of data into the formula Power = Energy/Time to calculate the time taken for the energy to be supplied

The mean for this question was 49.44 per cent, while the standard deviation was 5.18.

In Part (a), many candidates were able to plot the points correctly and draw a best fit line for the data. However, some candidates plotted the data on the graph with an incorrect orientation. For Part (b), most candidates were able to use the gradient formula appropriately.

In Part (c), the understanding that the gradient of the graph was C, the heat capacity of the material was not recognized by many candidates. For Part (d), many candidates did not apply C = mc to determine the specific heat capacity of the material.

In Part (e), an appropriate list of precautions for the experiment was also identified by a majority of the candidates. For Part (f), the conversion of 18kW to 18000W was not done by many candidates.

**Recommendations**

- Educators need to emphasize the following with graphs:
    - Manipulated variable, *x*-axis; responding variable, *y*-axis
    - The gradient of the graph which can be translated to usable information, for example, Gradient = $E/\Delta T = C$
- Educators need to emphasize calculations with students such as converting to SI where necessary.

  For example, $P = E/t \ldots t = E/W$, so units in J/W, not kJ/W

<u>Question 2</u>

This question was based on Section D — Electricity and Magnetism. Candidates were required to recall parts of the zinc-carbon cell and distinguish between primary and secondary cells. Candidates also had to calculate the amount of charge and energy added to a battery over a certain time period.

The mean for this question was 25.20 per cent, while the standard deviation was 3.93.

Part (a) was poorly answered as students could not identify the parts of the zinc-carbon cell. Thus, they lost at least one mark in this part. In Part (b), candidates were not able to identify relevant differences between the lead acid cell and the zinc carbon cell.

For Part (c) (i), candidates were able to correctly calculate the charge added to the battery as 14 400 C. At least one mark was obtained for stating the formula. In Part (c) (ii), candidates failed to recall the equation $E = VIt$. They were not able to correctly substitute into this formula. Candidates also forgot to convert to kJ, losing one mark.

**Recommendations**

- More emphasis should be placed on the parts of the zinc-carbon cell.
- Teachers should have a more practical approach to the primary and secondary cells, highlighting the differences between them.
- More practice questions could be given to students to incorporate the use of the following formulas:

  $Q = It$

  $E = QV$

  $E = IVt$

<u>Question 3</u>

This question was based on Section A — Mechanics. It required candidates to recall and apply the principle of moments.

The mean for this question was 41.67 per cent, while the standard deviation was 3.86.

Candidates performed well on Parts (a) (i) and (ii). Many seemed comfortable with using moments to determine the required distance, x, for balance on the seesaw. Performance on Parts (b) (ii) and (iii) was poor. Many candidates did not know how to calculate the reaction force at the pivot using total upward forces = total downward forces.

**Recommendation**

Teachers are advised to expose students to do more application practice questions that use both of the conditions for equilibrium (that is, using conservation of moments and forces).

**Section B**

Question 4

This question was drawn from material in Section C — Waves and Optics. It tested candidates' knowledge of the refraction of light rays.

The mean for this question was 43.67 per cent, while the standard deviation was 3.70.

In Part (a) (i), most candidates were able to state examples of observations which indicate that light can be refracted. For Part (a) (ii), candidates had difficulty correctly naming the angles of incidence and refraction, and quite a few had the refracted ray bending away from, instead of towards, the normal.

In Parts (b) (i) and (ii), candidates found tracing the path of white light into and out of the triangular glass prism and naming the effect created challenging.

**Recommendation**

Teachers are encouraged to ensure that students practise drawing ray diagrams according to the principles being taught.

Question 5

This question was based on Section D — Electricity and Magnetism. This was a logic gates question.

The mean for this question was 61.67 per cent, while the standard deviation was 3.85.

The majority of the candidates were able to answer this question satisfactorily. Most were able to identify the logic gates given and recall the truth tables in Parts (a) and (b). Part (c) (ii) where candidates were required to state three ways in which advances in electronics, such as the introduction of logic gates, have made a positive impact on society, proved to be the most challenging.

**Recommendations**

Discussions and research should form a logical part of student preparation for final examinations. Teachers should ensure that students are guided according to syllabus requirements.

Question 6

This question was based on Section E — The Physics of the Atom. Candidates had to answer questions on the Geiger–Marsden experiment then represent nuclear reactions correctly in the standard form.

The mean for this question was 30.01 per cent, while the standard deviation was 3.04.
Many candidates did not perform well in Part (a), especially Part (a) (ii). They were unable to propose a good reason for using gold as the target in the experiment. Candidates were able to o obtain marks

in Parts (b) and (c). The vast majority were able to correctly determine the number of neutrons, given the symbol for the nuclide, and suggest a possible isotope.

In Part (b) (ii), candidates had difficulty manipulating the negative sign (-1) for charge of the beta particle in the equation. Some added the beta particle to the parent nucleus on the LHS of the equation, instead of to the daughter nucleus on the RHS of the equation and so obtained incorrect values.

**Recommendations**

Candidates need more practice with nuclear reactions involving all types of radiation — alpha, beta and gamma. Teachers may wish to challenge students to think about the critical importance of using gold as the target. Greater attention may also need to be paid to the Atomic Physics section of the syllabus.

**Paper 032 – Alternative to School-Based Assessment (SBA)**

Question 1

This question was based on Section A — Mechanics. It was a practical question. A mass-spring system was set up for candidates and they were required to use it to assist in finding a relationship between extension and applied force.

The mean for this question was 78.10 per cent, while the standard deviation was 4.15.

For Part (a), most candidates were able to accurately read off the original length of the spring. In Part (b), most candidates were able to choose a wide range of values for force. They were able to convert the mass to force accurately and measured the new length of the spring with values consistent with the original length. The extension was determined by most candidates. However, there were some candidates who were unable to record the new length and provide the correct extension.

Part (c) was well answered. Most candidates were able to state relevant precautions that can be taken in the lab. For Part (d), the majority of candidates was able to obtain most of the available marks. Marks were most frequently obtained for plotting of points, fine points and the scale. There were, however, some candidates who lost marks for labelling and orientation — they plotted force on the *y*-axis and extension on the *x*-axis. There were also those who did not construct a line of best fit.

For Part (e), most candidates obtained at least one mark. They were able to correctly state the formula for finding the gradient and read off values. Candidates also showed a clear understanding of using points far apart in order to determine the gradient. However, some candidates read off two points from the table; marks were deducted for this. There were also a few candidates who did not use the correct unit for gradient.

Candidates responded well to Part (f). They were able to identify a proportional relationship between force and extension. Candidates also stated that Hooke's law was obeyed.

**Recommendations**

- Teachers are encouraged to place more emphasis on Hooke's law in the classroom, especially with reference to the graph.
- Candidates must gain more practice in constructing lines of best fit and deducing units for gradient based on the variables plotted.
- Teachers are encouraged to engage students in more practical applications of Hooke's law, using lab exercises.

<u>Question 2</u>

This question was based on Section B – Thermal Physics and Kinetic Theory. Candidates were given graphical data for a Boyle's law experiment. They were required to describe the experiment and read off the data points from the graph.

The mean for this question was 65.88, while the standard deviation was 3.78.

Though most candidates seemed to be able to correctly identify that the aim should involve an investigation to determine a relationship between pressure and volume, or correctly identified that Boyle's law was involved, some candidates merely aimed to obtain readings/observations for pressure and/or volume. Hence, they did not necessarily seek to find out *how* these two quantities were linked or related to each other.

This is an investigation that most schools probably do not actually perform (due to a lack of equipment), so students use a theoretical approach rather than a practical one. Teachers might find YouTube clips or demonstrations useful in helping students to appreciate what is involved in obtaining changes in pressure and observing the corresponding changes in volume of a trapped gas.

Candidates may find it easier to take a step-by-step approach in stating the method involved in obtaining readings of pressure and volume rather than writing in paragraph/prose form.

Most candidates were able to score high marks in Part (a) (iii) for tabulating the plotted points from the graph. Some candidates continue to write units within the table instead of in the headings only. Proper format for stating the table headings should be taught (quantity/unit).

Parts (a) (iv) and (b) were also well done. In Part (a) (iv), though most candidates correctly identified valid errors such as *keeping constant temperature/waiting for temperature to stabilize; avoiding parallax errors and ensuring that no air bubbles were present in the oil;* some alluded to other error sources that were *not relevant* here — for example, zero errors on the pressure gauge; not allowing pressure to get too high; placing the apparatus on a flat, level surface.

Candidates were able to correctly infer that there was an inverse relationship with pressure and volume for the air. However, several candidates incorrectly referred to the 'volume of oil' instead of the *volume of gas* (air).

<u>Question 3</u>

In this question based on Section C, Waves and Optics, candidates had to plan and design an experiment to demonstrate the diffraction of water waves.

The mean for this question was 52.56 per cent, while the standard deviation was 3.44.

A number of candidates recognized that a basic demonstration with a ripple tank would suffice and hence many were able to obtain full marks.

Candidates who performed poorly did not seem to know the meaning of diffraction or confused it with interference.

**Recommendation**

Candidates are encouraged to prepare adequately for this paper and to practise writing up practical activities.

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

**MAY/JUNE 2017**

**PHYSICS**
**GENERAL PROFICIENCY EXAMINATION**

## GENERAL COMMENTS

In 2017, 14 464 candidates sat the examination. This represented a 2.35 per cent increase in candidates compared with 14 124 in June 2016. The examination consisted of the following papers:

Paper 01 -
Multiple Choice Paper 01
Paper 02 – Structured Essay Questions
Paper 031 – School-Based Assessment
Paper 032 –Alternative to School-Based Assessment (private candidates)

There were 544 candidates who wrote Paper 032.

Candidates' performance reflected a slight decline in 2017 with 61 per cent of the candidates achieving Grades I to III, compared with 64 per cent in 2016.

## DETAILED COMMENTS

### Paper 01 — Multiple Choice

Performance on the multiple choice paper was comparable with that of June 2016. The mean score for June 2017 was 34.45 and the standard deviation 9.88, compared with a mean score of 34.38 and a standard deviation of 9.97 in June 2016.

This paper consisted of one graphical and data analysis question, two structured and three extended response questions. All questions were compulsory. With respect to performance, on Paper 02, there was a decline in mean compared with June 2016. This year, the mean score was 35.65 with a standard deviation of 20.39 compared with a mean score of 39.08 and a standard deviation of 20.56 in June 2016.

**Section A**

<u>Question 1</u>

The question tested candidates' ability to

- apply experimental skills via plotting of the values for the induced current produced versus time when a magnet was 'allowed to fall through' a coil
- utilize experimental skills by extrapolating data from the graph
- apply knowledge as it relates to Lenz's law, direction of flow of induced current through a simple coil and then the coil
- apply knowledge of frequency as it related to the rotation of the alternating current generator shown
- analyse expected waveforms for the voltage output of a generator.

**Areas of Good Performance**

In Part (a), candidates were able to use appropriate scales, correctly plot a graph. Part (b) was relatively well done, as candidates were able to extrapolate information from their graph.

Part (c) (iv) was done well, as the majority of candidates recognized that the induced current flowed in the direction opposite to that in Part (c) (i). There was a fair attempt at Part (c) (v), as most candidates were able to give two changes to the experiment.

For Part (d) (ii), determining the period of rotation of 50 Hz was the most popular answer, where candidates used the correct formula. There were, however, instances where the wave formula was used.

**Areas of Weak Performance**

For Part (a), drawing a smooth curve was one of the most challenging parts of this question. Candidates incorrectly used rulers to connect some of the points and a curve for the part of the same graph, or drew portions of best fit lines **not** using Xs or dots with circles. Also, plotting the negative values proved challenging for some candidates.

In Part (c) (i), numerous responses had arrows in the galvanometer for induced current incorrect. In Part (c) (ii), many candidates were unable to give accurate explanations as to why an induced current is produced. Most candidates only received marks for knowing that some movement between the coil and magnet was involved but few were also able to indicate that there was a change in magnetic flux.

For Part (c) (iii), many candidates did not answer the question effectively since the responses did not state a sensitive galvanometer. In Part (c) (iv), it was evident that candidates lacked the knowledge that no current would have been flowing. Candidates gave answers with the correct shape but incorrect phase in Part (d) (iii). Line graphs and velocity–time graphs were also given as incorrect responses.

**Recommendations**

- Students should be encouraged to write clearly and legibly especially when drawing a graph. (Marking graphs on a screen can be challenging when graphs are drawn with light pencils. Use 3B pencils or darker.)
- Teachers should give students opportunities to study Lenz's law, Faraday's law and graphs showing velocitytime graphs for different positions of a coil of wire and to recognize the type of graph that is expected (straight line, sinusoidal curve, etc.) so they are able to connect points accordingly.
- Students should be given opportunities to conduct experiments on the relationship between induced current, magnetism and hand motion.
- Teachers should remind students to plot points either with a small dot or an x.

Question 2

The question tested candidates' ability to

- distinguish between transverse and longitudinal waves
- provide examples of transverse and longitudinal waves
- state and apply the wave equation
- extrapolate wave parameters from the waveform
- convert wave parameters extrapolated to SI units
- determine the frequency of rotation for an AC generator coil
- identify a property of electromagnetic waves (EM waves).

**Areas of Good Performance**

In Part (a) (i), many candidates recognized the *perpendicular and parallel* motion of the relevant waves and hence scored one out of the two marks awarded. For Part (a) (ii), the majority of candidates were able to provide one example each of transverse and longitudinal waves. In Part (a) (iii), there was evidence that students were taught to use the triangle to remember the wave equation but some could not use it to write the correct relationship. Substitution in Part (a) (iv) earned candidates the relevant.

Candidates performed relatively well in Part (c) when stating a property of EM waves (*limited to being transverse waves, travel at the speed of light in a vacuum* or *can be polarized*).

**Areas of Weak Performance**

In Part (a) (i), many candidates failed to state that it is the vibration of particles which are perpendicular/parallel to wave motion. For Part (a) (iv), a large number of candidates used the incorrect formula. If this section did not have the formula separate, all marks for Part (a) (iv) would have been lost. Many candidates also had the wrong units.

In Part (b) (i), the majority of candidates did not identify the amplitude on the waveform and of the small number who did, many did not draw their arrows to represent the correct position of the maximum displacement from rest position, labelling the amplitude as the crest or trough.

For Part (b) (ii), the read-off of the amplitude from the waveform, proved challenging for many candidates and even more so the conversion to SI units. No marks were awarded if candidates did not show their working and stated the wrong conversion value (it cannot be assumed that candidates started from 0.5mm). In Part (b) (iii), a vast number of candidates read the period incorrectly as 6 ms and could not convert to seconds from milliseconds (divided by 60 or 100 in many cases).

In Part (b) (iv), numerous candidates recognized that $f = 1/T$ and were able to score this formula mark but could not score the second mark. In Part (c), candidates who stated that EM waves travel at the speed of light but did not state *in a vacuum* lost the mark.

NOTE: There was an obvious misconception for numerous candidates that electromagnetic waves dealt with electromagnetism and provided answers relevant to magnets and current in circuits.

**Recommendations**

Teachers should

- ensure that students are able to define the types of waves and describe properties of waves
- give students adequate practice in the conversion of units and standard form
- provide more opportunities for students to represent data concerning amplitude, period and the parts of a wave on wave form, and to extrapolate information from the same
- insist that students represent their answers with units
- emphasize Mathematics skills in transposing formulas including the 'triangle' representation.

Question 3

The question tested candidates' ability to

- describe fission
- cite arguments for and against the utilization of nuclear energy
- state the environmental impact, disposal concerns and safety measures associated with nuclear energy
- interpret nuclear reactions in standard form
- apply Einstein's equation: $\Delta E = \Delta mc^2$.

**Areas of Good Performance**

For Part (b) (i), most candidates scored 100 per cent. Part (c) (i) was generally well done. Most candidates were able to correctly calculate the missing value. Part (c) (iii) was also fairly well done. However, candidates must pay attention to exponents and the correct use of units. Some candidates used the mass for only one neutron rather than accounting for all three. In Part (c) (v), most candidates were able to give good responses. The most popular answer was *the generation of electricity*.

**Areas of Weak Performance**

In Part (a) (i), the definition of nuclear fission was often confused with radioactive decay. For Part (a) (ii), the majority of candidates misunderstood what was being asked. They gave uses of nuclear energy and not advantages of its use. In Part (b) (ii), the responses were vague and superficial with little or no elaboration or comparative data to identify legitimate disadvantages. Most candidates scored no marks for disadvantages of nuclear energy use.

Part (c) (ii) was frequently answered incorrectly. Many candidates had no idea that 'c' in the equation referred to the speed of light. In Part (c) (iv), the concept of mass difference was not well understood. Candidates too often neglected to identify the change in mass in order to correctly determine energy produced. There were many calculation errors.

**Recommendations**

Teachers are encouraged to

- assist students in identifying or determining advantages and disadvantages associated with devices and systems
- clarify the difference between an advantage and a use
- place more emphasis on distinguishing between radioactive decay and nuclear fission/fusion
- give students more practice applying Einstein's equation.

**Section B**

Question 4

This question tested candidates' ability to

- name and state appropriate Newton's laws which apply to given situations
- calculate the time and the distance for free fall given acceleration due to gravity, initial and final velocities.

**Area of Good Performance**

Most candidates did well with the Newton's second law, correctly stated the law and gave the relationship *F = [mv-mu]/t or F = ma*.

**Area of Weak Performance**

In Part (a), athough candidates seemed familiar with Newton's laws, their responses were not adequate and they gave incomplete statements, particularly of the first law. For example, many simply wrote, 'a body in motion remains in motion' or neglected to include *at rest* or *speed in a straight line* for Newton's first law. All pertinent parts of these statements needed to be included in responses. Some candidates stated the laws but omitted to *name* the law as required in the question. Some knew the statements for the laws but confused the laws which applied to each situation.

In Part (b) (i), the conversion of units from $kmh^{-1}$ to $ms^{-1}$ proved to be extremely challenging for many candidates. Changing the subject of simple formulae, for example, *s = d/t* and *t = v/a*, also posed problems for many candidates.

**Recommendations**

Teachers are encouraged to consider the following suggestions:

- Ensure that students are familiar with ample examples that deal with the application of all of Newton's laws.
- Help students learn to include the pertinent parts in definitions. They also need to be reminded to read the questions properly and to give responses to all that is asked — too many students neglected to include the names of the laws.
- Ensure that students are provided with the opportunity to perform calculations involving unit conversions. Teachers need to ensure that students are proficient in mathematical techniques involved in changing the subject of a formula.
- Challenge students to be more aware of the order of magnitude of values that may be expected/normal for given situations.
- Review the graphical method to solve for distance by finding the area under a v–t sketch graph.
- Underscore the fact that v = s/t is used only when there is constant speed and/or for average speed.

Question 5

The question tested candidates' ability to

- determine factors on which absorption and emission of radiation depend
- calculate the specific latent heat of vaporization ($l_v$).

**Areas of Good Performance**

Part (a) which dealt with the absorption, emission and reflection of radiation was fairly well done, although quite a number of candidates were not sure what response was required. The formula for specific latent heat of vaporization ($l_v$) in Part (b) (i) was fairly well known.

**Area of Weak Performance**

Many candidates realized in Part (b) (ii) that energy would be lost to the environment, but could not explain satisfactorily the effect on $l_v$.

**Recommendations**

- Students should be encouraged to use terms correctly, for example, 'to emit radiation' is not the same as 'to reflect radiation'.
- Students should be guided to discuss and interpret various phenomena according to syllabus requirements.

Question 6

The question tested candidates' ability to

- recall definitions of the principal focus of convex and concave lenses
- use and manipulate formulas to find magnification and image distance using a convex lens.

**Areas of Good Performance**

For Part (a) (i), the diagrams to show light rays parallel to the principal axis converging through the focal point were generally well done, though arrows were missing in many responses.

In Part (b) (i), the formulas for magnification and focal length and the lens equation in Part (b) (ii) were widely known. The correct response was found most frequently in Part (b) (iv), whether the lens was real or virtual.

**Areas of Weak Performance**

Very few candidates were able to state a comprehensively correct definition of the principal focus in Parts (a) (i) and (ii). Candidates generally knew the lens equation in Part (b) (ii) but many had difficulty manipulating the formula to find the image distance. Candidates who used a scale diagram did not do so accurately.

**Recommendations**

- Students must practice the diagrams, equations etc. which have been taught.
- Students need to be engaged in discussions on the interpretation of questions.

**Paper 032 – Alternative to School-Based Assessment (SBA)**

This paper consisted of three questions which tested the same skills as Paper 031 (SBA). One question was a practical question and one was a plan and design question. All questions were compulsory. With respect to performance on this paper, there was a slight increase in mean from June 2016. In 2017, the mean score was 20.06 with a standard deviation of 5.94, compared with a mean score of 19.74 and a standard deviation of 6.79 in June 2016.

Question 1

The question tested candidates' ability to

- set up equipment correctly and record readings of current and voltage at various positions in a circuit with the respective units of A and V
- state three applicable precautions to the practical
- use the obtained data to determine the total resistance in the circuit
- analyse the data to conclude that the current remains the same throughout the series circuit, but that the total voltage is the sum of the voltages across each device
- apply knowledge that if another resistive device is added to the circuit, the current will decrease but the total voltage remains the same.

**Areas of Good Performance**

Most candidates were familiar with V = IR. The majority also understood that the total voltage would have been the sum across each device.

**Areas of Weak Performance**

Numerous candidates were unable to identify the necessary precautions that should have been undertaken for this lab. Some candidates were unable to say how the current and voltage were affected if resistance was increased.

**Recommendations**

- Students should be allowed to practice the set up of equipment individually, identifying each component, its function and the relevance of its placement.
- Teachers are encouraged to ensure that students understand the need for precautions relevant to the lab.
- Teachers are encouraged to facilitate more practice labs in electricity that would demonstrate how I and V are affected by the addition of more resistors.

Question 2

In this question, candidates were required to:

- complete a table on an activity to demonstrate the random nature of radioactive decay
- plot a graph from the results
- use the graph to find the half-life of the process.

**Areas of Good Performance**

In Part (a), most candidates were able to complete the table correctly. In Part (b) for the graph, the axes were, in most cases, labelled properly, scales chosen suitably and points plotted correctly.

**Areas of Weak Performance**

In Part (b), the majority of candidates did not draw a line of best fit but followed points. For Part (c), most candidates seemed unfamiliar with the concept of half-life.

**Recommendations**

- Teachers need to ensure that students practice drawing graphs with straight lines as well as curves, and should place emphasis on the idea of 'line of best fit'.

Question 3

The question tested candidates' ability to

- list apparatus required for an experiment to verify Archimedes' principle
- describe the method used for an experiment to verify Archimedes' principle
- explain how the data collected from the experiment may be used to verify Archimedes' principle.

**Area of Good Performance**

The vast majority of candidates who attempted the question was able to obtain marks for the listing of the apparatus.

**Areas of Weak Performance**

In describing the experiment, many candidates used a displacement method to find the change in volume of fluid only, and neglected to determine the weight of object in air or fluid, or the weight of fluid displaced. Of those candidates who seemed to have some knowledge of Archimedes' principle, very few ventured to draw a diagram to assist with their method description.

Very few candidates were able to score marks for the explanation of how the data collected was to be used to verify the principle. Candidates who simply stated Archimedes' principle were not rewarded. To obtain marks, candidates first needed to find the weight/mass of the object in air and water to obtain the upthrust, then compare it with the weight of displaced fluid. Since many did not find the mass/weight of anything, they gained no marks.

**Recommendations**

- Teachers are encouraged to provide students with more practical experience in physics to complement the theory.
- Teachers are urged to explain Archimedes' principle in terms of forces, that is, upthrust and weight of fluid displaced.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

**JANUARY 2018**

**PHYSICS**
**GENERAL PROFICIENCY EXAMINATION**

## General Comments

This year 681 candidates wrote the examination. This represented a 43.7 per cent increase in the candidate population compared with 474 in January 2017. This continued the upward trend from 331 in January 2016. The percentage of candidates earning Grades I – III was 64.72 compared with 65.2 per cent in January 2017 and 57.5 per cent in January 2016.

## Detailed Comments

## Paper 01 — Multiple-Choice

Performance in the multiple-choice paper showed a slight improvement as evidenced by the mean scores in 2017 and 2018. This year, the mean score was 32.37 with a standard deviation of 9.07, compared with a mean score of 29.77 and a standard deviation of 9.28 in January 2017.

## Paper 02 — Structured and Extended Response Questions

This paper consisted of one data analysis question, two structured and three extended response questions. All questions were compulsory. Performance on Paper 02 improved compared with performance in January 2016 and was comparable with the performance in 2017. This year the mean score was 40.67 with a standard deviation of 16.37, compared with a mean score of 42.70 and a standard deviation of 18.64 in 2017.

### Section A

Question 1

This question was drawn from objectives in Section C – Waves and Optics. The question dealt with:

- The application of experimental skills via plotting of sin $\hat{r}$ versus sin $\hat{\imath}$ values.
- The application of the gradient formula to determine the refractive index of the medium.
- Application of relationship between refractive index and critical angle to determine the critical angle in the core of a fibre optic cable.

The mean for this question was 14.3 out of 25 while the standard deviation was 6.05.

### Areas of Good Performance

(i) Most candidates were able to complete the table by calculating sin $\hat{\imath}$ and sin $\hat{r}$.
(ii) Most candidates were able to select an appropriate scale and plot the graph.
(iii) Recall and application of the gradient formula was known/done by majority of the candidates.

**Areas of Weak Performance**

(i) Many candidates did not maintain the number of significant figures for their calculated values for sin *i* and sin *r*.
(ii) Reading off points from graph – numerous candidates were unable to read off points that were actually plotted.
(iii) Many candidates had difficulty expressing that the refractive index represented the gradient of the graph.
(iv) Definition of critical angle – most candidates were unable to give a full definition.
(v) Stating the critical angle from the table was a difficult task for the majority of candidates.
(vi) Numerous candidates applied Snell's law formula to calculate the critical angle.

**Recommendations**

(i) Teachers are encouraged to emphasize the importance of significant figures.
(ii) Candidates should practise drawing a best fit line.
(iii) Teachers should emphasize use of non-plotted points for gradient calculations.
(iv) Candidates should use a large triangle for gradient calculation to minimize errors.
(v) Teachers should encourage candidates to show dotted lines on graph to indicate points read off.
(vi) Teachers should provide opportunities for the meaning of the gradient of any graph to be discussed, possibly by encouraging students to work out units in order to aid students in figuring out what it means.
(vii) Teachers should explain the concept of critical angle and make specific reference to media the ray is travelling from and entering. Also assist students to recognize the situations where critical angles are relevant.
(viii) Teachers should emphasize the application of critical angle to everyday life. Many candidates seem to have little idea of what is happening in a fibre optic cable.
(ix) Students can be given mini quizzes as the topic is taught to enhance their recall of definitions.
(x) Students should be provided opportunities for more practice on responding to questions and solving equations.

Question 2

This question was based on Section B – Thermal Physics and Kinetic Theory. Candidates were required to distinguish among solids, liquids and gases with reference to differences in intermolecular forces, motion of molecules, shape and volume of matter. Candidates were also required to apply the relationship $E_H = ml_v$ to determine the specific latent heat of vaporization of water.

The mean for this question was 9.11 out of 15, while the standard deviation was 2.74.

**Areas of Good Performance**

(i) The majority of candidates were able to complete the table on the characteristics of solids, liquids and gases

(ii) Conversion of the time from hours and minutes to seconds was done satisfactorily by most candidates.

(iii) Read-off and subtraction of the different masses were calculated correctly by most of the candidates.

**Areas of Poor Performance**

(i) Numerous candidates were unable to equate Power x time to the energy required.

(ii) Transposing the formula to calculate the latent heat of vaporization was not done correctly by a number of candidates.

(iii) Many candidates stated the incorrect units for latent heat of vaporization (or matched J/Kg instead of J/g or vice versa for their calculations).

**Recommendations**

(i) Teachers should provide practice on questions requiring the application of power x time for specific heat capacity/latent heat of fusion/vaporization calculations.

(ii) Teachers should encourage students to revise units applicable to specific heat capacity/latent heat of fusion/vaporization calculations.

<u>Question 3</u>

This question was based on Section A – Mechanics. It required candidates to define energy and recall various forms including potential energy and kinetic energy. Candidates were also required to apply conservation of energy to solve a problem with a simple pendulum. The mean for this question was 6.48 out of 15, while the standard deviation was 4.20.

**Areas of Good Performance**

Candidates performed best in Part (a), where they were able to obtain a suitable definition for energy and state its unit, and Part (b) (i), where many were able to identify objects in motion as having kinetic energy.

**Areas of Poor Performance**

Many candidates in (b) (ii) incorrectly identified heat energy as one of the main forms to which energy is converted when a flashlight is turned on.

Candidates were often unable to apply their knowledge of the principle of conservation of energy to identify the maximum kinetic and gravitational potential energies of the pendulum to be the same value. In many instances, they just stated the principle of conservation of energy.

**Recommendation**

(i) Through the use of everyday examples, students should become aware of energy conversion situations where heat energy is a useful energy output versus a wasted energy output.

(ii) Teachers should provide students with opportunities to apply their knowledge of the principle of conservation of energy to real life situations and to problems. Electromagnetism should be included.

**Section B**

<u>Question 4</u>

This question was drawn from material in section E–The Physics of the Atom. It tested candidates' ability to cite arguments for and against the utilization of nuclear energy. Candidates were also required to apply Einstein's Equation and interpret nuclear reactions in the standard form.

The mean for this question was 5.34 out of 15, while the standard deviation was 3.32.

**Areas of Good Performance**

Many candidates were able to give plausible arguments for and against the use of nuclear fission reactors in Part a (i). They were also able to give at least one advantage of the use of fusion over fission in Part (b). In Part (d) many candidates were able to recall Einstein's Equation, $E = mc^2$.

**Areas of Weak Performance**

For Part (c) many candidates had difficulty in correctly completing the nuclear equation.

In Part (d), candidates had difficulty in making the correct substitutions in Einstein's equation to obtain the energy released in the reaction.

**Recommendations**

Teachers are encouraged to provide students with practice worksheets involving the balancing of nuclear reactions in the standard form and also the calculation of the energy released in a nuclear reaction using Einstein's equation.

Question 5

This question was based on Section C – Waves and Optics. Candidates were required to compare rival theories of light held by Newton and Huygens.

Candidates were also required to apply the lens formula for a converging lens.

The mean for this question was 2.75 out of 15, while the standard deviation was 2.76.

**Areas of Good Performance**

A fair percentage of the candidates were able to answer the questions asked in Parts (b) (ii) – (iv) pertaining to focus and magnification.

**Areas of Weak Performance**

The response to this question was generally below the expected standard. Many candidates did not even attempt Part (a) and the answers in Parts (b) (i) and (b) (v) - (vi) showed a clear lack of understanding of the application of lenses.

**Recommendation**

Teachers should ensure that students understand concepts and are able to make relevant applications.

Question 6

This question was based on Section D – Electricity and Magnetism. This question tested candidates' ability to map the magnetic field for a straight wire, sketch the resultant flux pattern when a current-carrying conductor is placed perpendicular to a uniform magnetic field and explain the action of a D.C. motor.

The mean for this question was 2.35 out of 15, while the standard deviation was 2.61.

**Areas of Good Performance**

Many candidates were able to identify the commutator in Part (b) (i).

**Areas of Weak Performance**

The question was poorly done in general. Very few candidates were able to sketch the magnetic field satisfactorily due to a current carrying conductor in a magnetic field as well as explain the action of a d.c. motor.

**Recommendation**

Students should be taught the discipline of communicating clearly the principles being taught.

## Paper 032 – Alternative to School-Based Assessment (SBA)

Question 1

The question was based on Section A – Mechanics. This was a practical question. Candidates were required to determine the density of plasticine, given plasticine, string, a balance, a measuring cylinder and water.

The mean for this question was 15.92 out of 21, while the standard deviation was 4.09.

**Areas of Good Performance**

(i) Most of the candidates were able to record their values for mass and volume consistently to match the supervisor's report.
(ii) Calculation of the differences for volume was done accurately by most candidates.
(iii) The graph plotting and gradient calculations were done well by numerous candidates.
(iv) Almost all candidates stated an appropriate precaution.

**Areas of Poor Performance**

(i) Some candidates had difficulty reading off correct values from the graph to determine the gradient
(ii) A few candidates did not use values that were more than 50 per cent of the line apart.
(iii) The orientation of the axes was incorrect for some candidates.

**Recommendations**

(i) Teachers should provide practice in graph plotting for as many topics as possible so students can practise their understanding of applicable formulas (density = mass/volume, gradient for this graph= $\Delta$mass/$\Delta$volume).
(ii) During graph plotting teachers should ask students to read off values that were not from the table to encourage students to demonstrate their ability to read off the values correctly.

Question 2

This question was based on Section D – Electricity and Magnetism. Candidates were expected to demonstrate a practical understanding of circuits and to apply the relationship between power, voltage and current.

The mean for this question was 11.29 out of 17, while the standard deviation was 3.56.

**Area of Good Performance**

A commendable number of candidates were able to obtain most of the marks available on this question.

**Area of Weak Performance**

Many candidates could not correctly indicate the polarities of the ammeter and the voltmeter in Part (a).

Candidates who performed poorly did not seem to have covered this part of the syllabus.

**Recommendation**

Adequate preparation with appropriate practical activities must be emphasized.

<u>Question 3</u>

In this question, based on Section B – Thermal Physics and Kinetic Theory, candidates had to plan and design an experiment to demonstrate which of two liquids provided would be better for obtaining more precise readings of temperature.

The mean for this question was 3.96 out of 10, while the standard deviation was 1.74.

**Area of Good Performance**

Most candidates were able to successfully state an appropriate aim for the experiment. The statement of appropriate apparatus was also adequate.

**Area of Weak Performance**

Unfortunately, many candidates did not specify the same procedure for each liquid to represent a logical comparison of the two. For example, it was not clear in many cases that the two liquids were heated to the same degree.

**Recommendation**

Plan and design activities need to be practised. Teachers need to guide students to develop a logical procedure with sufficient detail to achieve the objective of an experiment. Also, the relating of the conclusion to the aim must be practised.

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

## MAY/JUNE 2018

## PHYSICS
## GENERAL PROFICIENCY EXAMINATION

## GENERAL COMMENTS

Fourteen thousand, two hundred and nineteen candidates sat the examination in May/June 2018. This represented a 0.017 per cent decrease in candidates compared with 14465 in June 2017. The examination consisted of the following papers:

Paper 01 – Multiple Choice

Paper 02 – Structured Essay

Paper 031 - School-Based Assessment (SBA),

Paper 032 – Alternative School-Based Assessment (SBA).

Candidates with acceptable SBA scores were exempted from Paper 032. This year 537 candidates wrote Paper 032.

Candidates' performance reflected an improvement. In 2018 with 69 per cent of the candidates achieved Grades I to III, compared with 61 per cent in 2017.

## DETAILED COMMENTS

### Paper 01 – Multiple Choice

Performance in the multiple choice paper was comparable with that of June 2017. The mean score for June 2018 was 35.18 with a standard deviation of 11.07, compared with a mean score of 34.44 and a standard deviation of 9.88 in June 2017.

### Paper 02 – Structured Essays

This paper consisted of one graphical and data analysis question, three structured and two essay-type questions. All questions were compulsory. With respect to performance, there was an improvement in the mean score when compared with June 2017. In 2018, the mean score was 43.69 with a standard deviation of 23.84 compared with a mean score of 35.69 and a standard deviation of 20.69 in June 2017.

<u>Question 1</u>

This question was based on Sections A and C of syllabus. The question dealt with the following:

- Candidates' use of experimental skills to draw a line of best fit for a set of plotted values
- Candidates' use of experimental skills to determine the gradient of the straight line graph and
- Candidates' ability to express the result of a measurement or calculation to an appropriate number of significant figures
- Candidates' ability to illustrate the effect of converging and diverging lenses on a beam of parallel rays
- Candidates' ability to determine the focal length of a converging lens

The mean for this question was 12.52, while the standard deviation was 5.82.

**Areas of Good Performance**

For Part (a), most candidates were able to complete the table with values for 1/u and 1/v (most using decimal representation). In Part (b), the majority of candidates who were able to complete Part (a) were able to plot their points on the graph correctly using regular/appropriate scales with plotted points being small ʘ or x. (The use of + is NOT acceptable). For Part (c) (i), many candidates were familiar with the gradient formula, using two points that were far apart (large triangle) and correctly reading off. In Part (c) (ii), some candidates were able to extract values from their graph to use y = mx + c to determine c. Many candidates were able to carry forward their value from Part (c) (ii) to Part(d) to obtain f.

**Areas of Weak Performance**

In Part (a), the majority of candidates did not complete the table to three significant figures but to three decimal places. For Part (b), many candidates could not find suitable scales and/or represent their values stated in the table. For Part (c), numerous candidates were unable to draw a best fit straight line for their plotted values. Fort Part (d), the transposing of the value, c, extrapolated from the graph proved challenging for some candidates. In Part (e), the ray diagram was done poorly by majority of the candidates. Very few were able to obtain the three marks available.

**Recommendations to Teachers**

- Encourage students to complete tables with consistent significant figures and to practise using various significant figures.
- Remind students to plot points with a small dot and circle only or an x only, as identified in the syllabus.
- Allow students to practice extrapolation of data from graph and interpretation of that data into relevant information.
- Provide opportunities for students to practise drawing ray diagrams to cement the rules of rays and optics.

<u>Question 2</u>

This question focused on the basics physics of the atom. Candidates were expected to

- describe the Geiger–Marsden experiment: to consider, specifically that the nuclear structure of the atom contains protons and neutrons
- apply the relationship A = Z + N
- explain what is meant by the term *isotope*
- define the term *half-life*
- solve problems involving half-life.

The mean for this question was 8.65, while the standard deviation was 4.62.

**Areas of Good Performance**

In Part (a) (i), many candidates were able to represent the respective charge for the proton, neutron and electron. Generally, candidates were able to define the half-life of a radioactive substance for Part (b)(i).

**Areas of Poor Performance**

In Part (a) (iii), many candidates were unable to state one difference and one similarity between the isotopes of an element. For Part (b) (ii), although candidates were able to define half-life, many were unable to apply their knowledge to calculate the time it would have taken the Thorium to decay to 1.25g. Many candidates determined half the time and not half the material.

**Recommendations to Teachers**

- The topic of Isotopes should be addressed in detail, especially for the benefit of non-Chemistry students, so that they gain a good understanding of the topic.
- Teachers should assist students by practising various calculations to determining not only the amount of material remaining but also the time required to obtain this amount.

<u>Question 3</u>

This question required candidates to define an electric field; draw the field between charged parallel plates; state one hazard and one useful application of static charge; and analyse a voltage- time graph.

The mean for this question was 5.62, while the standard deviation was 3.66.

**Areas of Good Performance**

In Part (a), candidates were able to identify an electric field as a region and were aware that electric fields are associated with electric charges. For Part (b), candidates were able to identifying the direction of field lines. In Part (c), candidates identified electric shocks/electrocution as a possible hazard associated with static charges. For Part (d) (iii), candidates were able to state the equation relating frequency and period, identify the unit of frequency and calculate the frequency from their stated value of the period.

**Areas of Weak Performance**

In Part (d) (i) and (ii), candidates were unable to extend the concept of peak voltage to peak to peak voltage. Whereas candidates were able to correctly identify the portion of the graph that represents one period as eight on the horizontal (time) axis, using the unit on the label of the time axis to correctly/fully represent the value of the period and converting from ms to s proved quite a challenge.

**Recommendation to Teachers**

Teachers should provide students with greater practice in reading off graphs and converting from one unit to another.

Question 4

The focus of this question was heat capacity, specific heat capacity and specific latent heat. The mean was 5.55, while the standard deviation was 4.97.

**Areas of Good Performance**

In Part (a), candidates were able to identify the equations for heat capacity and specific heat capacity.

**Areas of Weak Performance**

For Part (b), many candidates identified c in the equation $E = mc\Delta T$ as the current. However, they could not recall the equation that relates power to current and voltage ($P = IV$). Candidates used the terms *energy* and *power* interchangeably in equations and mistakenly stated the equation relating energy, power and time as $E = P/t$. Candidates also had difficulty transposing equations and failed to recognize that a temperature change in degrees Celsius and in Kelvin is the same.

**Recommendation to Teachers**

Every effort should be made to ensure that students are provided with sufficient practice in the application of formulae learnt. This practice may be obtained through the use of worked examples and in the process of engaging in laboratory work.

Question 5

For this question, candidates were expected to recall and use the definition of Hooke's law. They were also required to solve a problem relating velocity, acceleration and time.

The mean for this question was 5.57, while the standard deviation was 4.48.

**Areas of Good Performance**

In Part (a), although a clear comprehensive statement was not given, many candidates were familiar with Hooke's law and were able to sketch a reasonably accurate graph. Many candidates drew a diagram of the apparatus instead of a graph.

**Areas of Weak Performance**

In Part (b) (i), candidates had difficulty in converting the units and transposing the equation. Many did not recognise that stretching force was the weight.

Part (c) was poorly done. Few candidates were able to choose the correct formula.

**Recommendation to Teachers**

More practice with using and transposing applicable formulas is necessary.

Question 6

This question tested candidates' understanding of the operation of a simple transformer. They were also required to use the ideal transformer equation to solve problems.

The mean for this question was 5.78, while the standard deviation was 4.80.

**Areas of Good Performance**

It would appear that a large number of candidates had not covered this topic. Those who were familiar with the topic were able to easily identify the parts listed in Part (a) (i), the type in Part (a) (ii) and the turns ratio formula in Part (a) (iii).

Finding the power in Part (b) (i) was easily the best handled part of the question.

**Areas of Weak Performance**

Candidates had difficulties in Parts (b) (i) and (ii). Many could not transpose properly. Formulae were not known or understood, and many candidates were trying to add various figures.

**Recommendation to Teachers**

Teachers could allow students to learn by making their own transformers — this gives a very clear route to understanding.

**Paper 032 – Alternative to School Based Assessment**

Question 1

This question was based on Section E of the syllabus: The Physics of the Atom.

Candidates were required to:

- complete a table on an activity to demonstrate the random nature of radioactive decay
- plot a graph from the results
- use the graph to find the half-life of the process.

The mean for this question was 9.79, while the standard deviation was 5.13.

**Areas of Good Performance**

In Part (a) most candidates were able to complete the table correctly. For the graph in Part (b), the axes were, in most cases, labelled properly, scales chosen suitably and points plotted correctly.

**Areas of Weak Performance**

A majority of candidates did not draw a line of best fit in Part (b) but followed points. In Part (c), most candidates seemed unfamiliar with the concept of half-life.

**Recommendations to Teachers**

Teachers need to ensure that students practise drawing graphs with straight lines, as well as curves, and should place emphasis on the idea of line of best fit.

Question 2

This question was based on Section B of the syllabus: Thermal physics and Kinetic Theory. Candidates were required to interpret and analyse a graph of pressure versus temperature in degrees Celsius. The mean for this question was 10.10, while the standard deviation was 4.60.

**Areas of Good Performance**

Part (a), where candidates were asked to record the points plotted on the graph was generally well done, as was Part (b) where they required to find the gradient.

**Areas of Weak Performance**

Parts (c) to (e) were the more challenging areas as many candidates seemed not to understand what was required of them.

**Recommendation to Teachers**

More familiarity with the syllabus requirements conducting and interpreting practical activities is advised.

Question 3

This question was based on Sections A and C of the syllabus. Candidates were required to plan and design an experiment, given a particular stimulus. The mean for this question was 4.08, while the standard deviation was 2.19.

**Areas of Good Performance**

In Part (b), many candidates were able to identify a stopwatch as one device/piece of equipment required for carrying out the experiment. In Part (c), many candidates identified the need to start the stopwatch on seeing the lightning and stop it on hearing the thunder in order to determine the lag time. In Part (d), candidates were also able to identify slow reaction time as a possible source of error in the experiment.

**Areas of Weak Performance**

In Part (a), candidates did not state the objective/aim of the experiment in a way that suggested a statement was being tested or a claim was being investigated. For Part (c), candidates did not, recognize the need to divide the lag time obtained by three, so that later on a comparison could be made between their findings and the candidate's claim. In Part (e), candidates often stated possible conclusions to the experiment instead of stating how they would arrive at a conclusion.

**Recommendations to Teachers**

- Teachers should engage students in activities that allow them to make hypotheses, and plan and design experiments to test their hypotheses.

- Teachers should ensure that students understand the process of writing up a laboratory report/designing an experiment, and are aware of the relationship between the different components of the report/design.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

**REPORT ON CANDIDATES' WORK IN THE**

**CARIBBEAN SECONDARY EDUCATION CERTIFICATE®**

**EXAMINATION**

**JANUARY 2019**

**PHYSICS**
**GENERAL PROFICIENCY**

## GENERAL COMMENTS

In January 2019, 658 candidates wrote the examination. This represented a 5.8 per cent increase in the candidate population compared with 622 in January 2018. The percentage of candidates earning Grades I–III was 60.61 per cent compared with 64.72 per cent in January 2018 and 65.52 per cent in January 2017.

## DETAILED COMMENTS

### Paper 01 — Multiple Choice

Performance in the multiple-choice paper showed slight improvement in terms of the mean. In January 2019, the mean score was 34.62 with a standard deviation of 10.7, compared with a mean score of 32.37 and a standard deviation of 9.07 in January 2018.

### Paper 02 — Structured and Extended Response

This paper consisted of one data analysis question, two structured and three extended response questions. All questions were compulsory. Performance on Paper 02 remained on par with performance in 2018. In January 2019, the mean score was 43.01 with a standard deviation of 21.38, compared with a mean score of 40.67 and a standard deviation of 16.37 in 2018.

**Section A**

Question 1

This question was drawn from objectives in Section A of the syllabus — Mechanics, and Section D — Electricity and Magnetism. The question dealt with the application of experimental skills whereby candidates were required to plot a graph of electrical power against the cube of the flow rate for a body of water channelled through a turbine. Candidates were also required to use their knowledge to deduce from the graph the gradient and power, given the flow rate. The question also examined the principle of energy conversion and the technical skills/precautions needed to reduce the errors encountered in the experiment so as to improve the accuracy of the results. The mean for this question was 16.60 out of 25 while the standard deviation was 5.91.

Areas where candidates performed well include the following:

- Completing the table by calculating *F*, the flow rate cubed, to the appropriate number of decimal places required
- Selecting appropriate scales when drawing their graphs and correctly plotting the values from their tables

- Stating the formula used for finding the gradient and using their 'read–off' values to determine a value for the gradient
- Reading off a value for P from their graph and then calculating the corresponding value of $F^3$
- Using the formula E = Pt to calculate a value for the electrical energy and expressing the answer in joules

Areas where candidates performed poorly include the following:

- In Part (d), many candidates did not recognize that they had to cube the given value of *F* before they could determine the corresponding value of the electric power, P, from their graph.
- Many candidates gave vague answers and often did not relate their precautions to what was actually occurring in the experiment.
- The majority of candidates had difficulty correctly identifying both forms of energy involved in the conversion. In a few cases, some candidates were able to identify both forms of energy but stated them in reverse order.

**Exemplars from Candidates' Work**

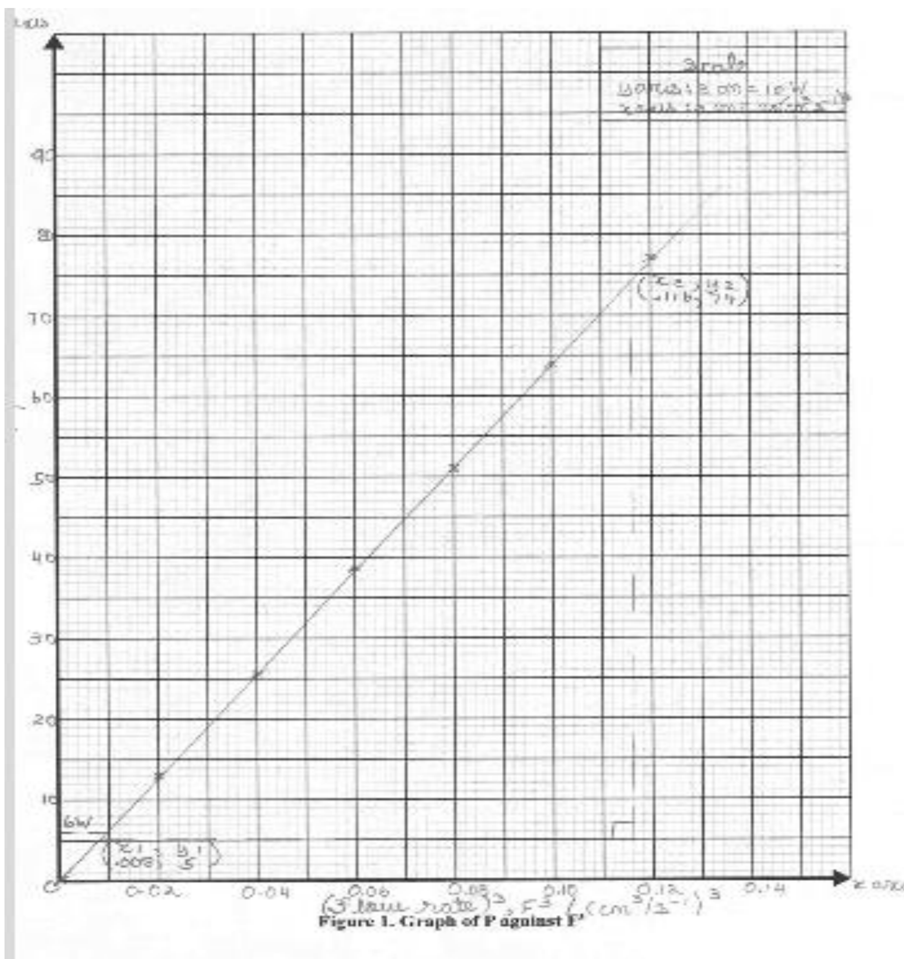


Figure 1. Graph of P against $F^3$

**Recommendations**

Teachers are encouraged to

- emphasize the importance of significant figures or decimal places in measurements
- give students practice in drawing a best fit line
- emphasize the use of non-plotted points for gradient calculations
- use a large triangle for gradient calculation to minimize errors
- train students to show dotted lines on a graph to indicate 'read-off' points
- point out to students that *errors* and *precautions* should be not be vague but should be specific to the activity and the measurements being taken
- make students aware that each axis should be labelled with both quantity and unit.

<u>Question 2</u>

This question was based on Section C of the syllabus — Waves and Optics.

Candidates were required to

- solve a problem involving the wave parameters, period and frequency; relate the terms *pitch* and *loudness* to wave parameters
- show an understanding of critical angle and total internal reflection.

The mean for this question was 3.50 out of 15, while the standard deviation was 4.10.

Areas where candidates performed well include the following:

- Relating *pitch* to *frequency* and *loudness* to *amplitude* in Parts (a) (i) and (ii)
- Calculating the critical angle given the refractive index for glass in Part (c) (ii)

Areas where candidates performed poorly include the following:

- Calculating the period and hence the frequency, using the information given in the question
- Drawing diagrams to show the critical angle and the conditions relating to total internal reflection

**Exemplars from Candidates' Work**

(b) A sound wave completes three cycles in 6 ms. Calculate its frequency.

3 cycles $= 6 \times 10^{-3}$ s

$\therefore$ 1 cycle / 1 oscillation $= \frac{6 \times 10^{-3}}{3}$ s

$T = 2 \times 10^{-3}$ s ✓

$f = \frac{1}{T}$ ✓

$f = \frac{1}{2 \times 10^{-3}}$ s

**(4 marks)**

$= 500$ ✓ Hz ✓

(c) (i) Figure 2 shows the side AB of a rectangular glass block and CD which is the normal at the point O. Draw the path taken by a ray of light which meets the glass-air boundary at the point O at an angle of incidence equal to the critical angle.

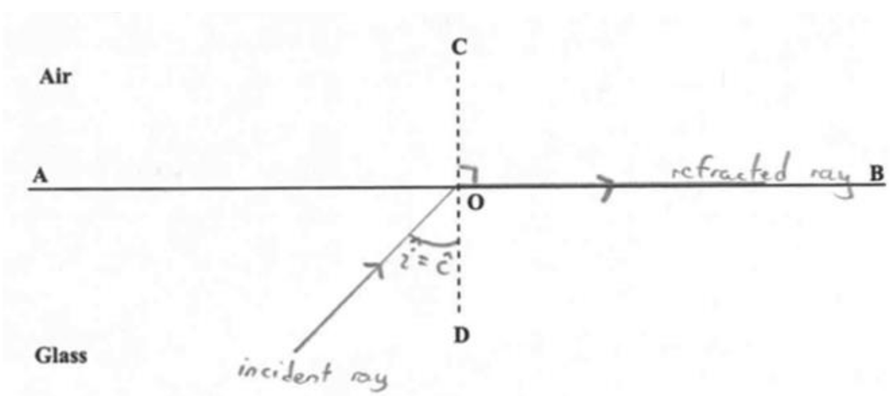



**Figure 2. Glass block**

(ii) The glass block has a refractive index of 1.5. Determine the value of the critical angle of the glass.

Using formula $\sin \hat{c} = \frac{1}{n_g}$

$\sin \hat{c} = \frac{1}{1.5}$ ✓

$= 0.667$ ✓

$\therefore \hat{c} = \sin^{-1} 0.667$ ✓

$= 41.8^\circ$ ✓

**(4 marks)**

(iii) The ray of light now meets the glass–air boundary at the point O at an angle of incidence greater than the critical angle. On Figure 3, draw a diagram to show the new path taken by the ray of light.

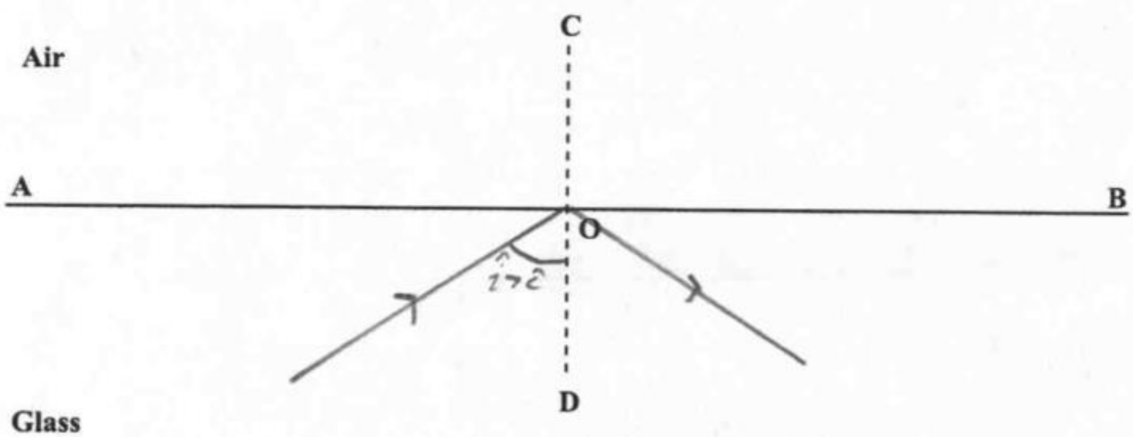



**Figure 3. Glass block**

**Recommendation**

Teachers should give students opportunities to practise answering questions based on a clear understanding of the concepts involved.

Question 3

This question was based on Section A — Mechanics.

Part (a) was based on energy conservation and required candidates to state the law of conservation of energy and to apply the conservation of energy principle in the interchanging form of gravitational potential energy and kinetic energy to solve for the speed of a dropped ball. Part (b) required candidates to define what is a force, to identify and give examples of different types of forces, and to apply their understanding of Hooke's law to a rubber band. The mean for this question was 7.45 out of 15, while the standard deviation was 3.76.

Areas where candidates performed well include the following:

- Stating clearly the law of conservation of energy
- Identifying that *a force is push or pull*
- Providing the type of force for a satellite
- Relaying that force was directly proportional to extension and explaining that the elastic limit was at A
- Identifying the curved portion of the sketch as indicative of permanent deformation since the elastic limit of the material was exceeded

Areas where candidates performed poorly include the following:

- Including the statement that a force is an action that can cause a change in the size or motion of an object
- Completing the question by equating the potential energy to the kinetic energy to solve for the velocity
- Communicating effectively that the type of force for the second example was electrostatic/electric force/static electricity and that an example of magnetic force needs to be described effectively

**Exemplars from Candidates' Work**

3. (a) (i) State the law of conservation of energy.

Energy can neither be created nor destroyed, only changed from one form to another. ✓ ✓

(2 marks)

(ii) A goalkeeper drops a football of mass 0.43 kg vertically downwards from rest at a height of 1.5 m.

Calculate the velocity of the ball as it makes contact with the ground. (Assume no air resistance or wind is present.)

from law of conservation of energy

KE = GPE ✓

$\frac{1}{2} mv^2 = mgh$

$\frac{1}{2} (0.43) v^2 = (0.43)(10)(1.5)$ ✓

$\frac{1}{2} v^2 = 15 \ m^2 s^{-2}$

$v^2 = 30 \ m^2 s^{-2}$

$v = \sqrt{30} \ m^2 s^{-2}$

$= 5.48 \ ms^{-1}$ (3 sf) ✓

✓

(b) (i) Define the term 'force'. ✓

a movement (push or pull) ~~than~~ that can start or stop the motion of a body, change the direction of said motion, or change the body's shape or increase speed of a body

**(1 mark)**

(ii) Many types of forces are applied in various situations.

Complete Table 2 by inserting the appropriate types of forces and examples.

**TABLE 2: TYPES OF FORCES AND EXAMPLES OF WHERE THE FORCES ARE EXPERIENCED**

| Type of Force | Example of Where the Force is Experienced |
|---|---|
| Gravitational ✓ | A satellite falling in the earth's atmosphere |
| Nuclear ✓ | between protons and neutrons in the nucleus of an atom |
| Frictional / Electrostatic ✓ | When a rubbed comb picks up a small piece of paper |
| Magnetic ✓ | when a magnet attracts a paper clip. |

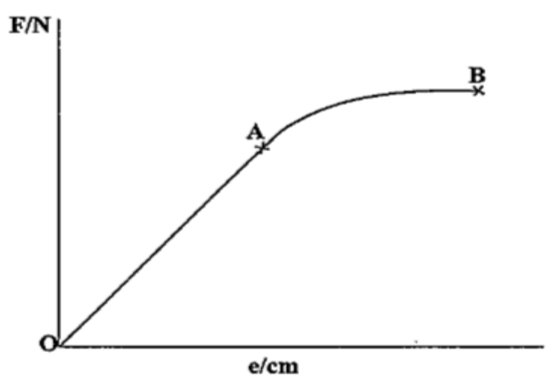



**Figure 4. Graph of Force (F) against extension (e)**

(i) State the mathematical relationship between force and extension in the segment OA.

$F \propto e$ ✓

$\therefore$ $F = ke$ where $k$ is the spring constant

(ii) State the point at which the elastic limit is located.

at point A ✓

(1 mark)

(iii) Give a reason for the shape of the segment AB in the graph.

the elastic limit has been exceeded so Hookes Law ( F ∝ e ) no ✓

longer applies

(1 mark)

**Total 15 marks**

**Section B**

Question 4

This question was drawn from Section B — Thermal Physics and Kinetic Theory. It tested candidates' ability to recall the definition of specific latent heat of vaporization of water and to recall and use the equation *E = ml*. It also tested their ability to recall the definition of the pressure law and to recall and use the equation p / T = p / T.

The mean for this question was 4.68 out of 15, while the standard deviation was 3.92.

Areas where candidates performed well include the following:

- Recognizing that vaporization involved a change of state from a liquid to a gas and that the specific latent heat of vaporization is defined for unit mass
- Using the equation E = ml to calculate the heat energy required
- Recognizing that the pressure law involved a proportional relationship and that a conversion from degrees Celsius to Kelvin was required

Areas where candidates performed poorly include the following:

- Explaining or defining, in its entirety, the specific latent heat of vaporization of water or the pressure law

- Realizing that the change of state occurred at 100°C or the boiling point of water
- Stating, in the definition of *the pressure law*, that pressure is directly proportional to the temperature; in many cases *absolute* was often omitted
- Obtaining the correct answer for energy needed; quite a few candidates either did not state the equation or used the wrong equation, $E = mc\Delta\theta$
- Failing, in Part (b) (ii), to convert the initial temperature from degrees Celsius to Kelvin and hence obtaining the incorrect value for the final temperature

**Exemplars from Candidates' Work**

**4.** (a) (i) Explain what is meant by the term 'the specific latent heat of vaporization of water'.

The specific latent heat of vaporization of water is the amount of heat energy required to convert one kilogram of water at 100° c to steam at 100° c without producing a change in temperature

**(3 marks)**

(ii) Calculate the heat energy required to convert 8 kg of water at 100 °C to steam at 100 °C.

$E = lv\, m$

$= 2300000 \times 8$

$= 18400000$ J

$= 1{\cdot}84 \times 10^7$ J

(b) (i) Define the pressure law.

Pressure law states that for a fixed mass of gas the pressure of the gas is directly proportional to the thermodynamic temperature of the gas provided that the volume of the gas is kept constant.

**(3 marks)**

(ii) The initial pressure of a sample of gas is 3 Pa, the final pressure is 9 Pa, while its volume remains unchanged.

If the initial temperature of the gas was 27 °C, calculate the final temperature of the gas.

$P_1 = 3$

$P_2 = 9$

$V_1 = V_2$

$T_1 = 27\ ^\circ C$

$= 27 + 273$ ✓

$= 300\ K$ ✓

$T_2 = ?$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{3V_1}{300} = \frac{9V_2}{T_2}$$

$$\frac{3}{300} = \frac{9}{T_2}$$ ✓ ✓

$3T_2 = 9 \times 300$

$$T_2 = \frac{9 \times 300}{3}$$

$= 900\ K$ ✓ ✓

$T_2 = 900 - 273$

$= 627\ ^\circ C.$

**Recommendations**

- Teachers are encouraged to provide students with a significant number of relevant examples and practice questions so that they are well equipped with the necessary skills to solve problems efficiently.
- Teachers must impress on students the importance of recalling and understanding definitions and the need to recall and use equations to solve problems.

- Teachers should also stress that when solving problems involving the gas laws, the temperatures should be expressed in Kelvin.

Question 5

This question was based on Section D — Electricity and Magnetism. It tested candidates' knowledge of fuses and earth wires in circuits and their ability to analyse series – parallel circuits. The mean for this question was 5.41 out of 15, while the standard deviation was 4.45.

Areas where candidates performed well include the ability to answer the questions pertaining to finding the current using the formula V = IR. However, transposing the formula to find I presented difficulty for some candidates.

Areas where candidates performed poorly include the following:

- Stating reasons for using the fuse in the circuit, for using the earth wire and for connecting appliances in parallel
- Analysing the series–parallel combination circuit

**Exemplars from Candidates' Work**

**5.** House wiring circuits contain fuses and earth wires. Appliances are connected to these circuits in parallel.

(a) (i) What is the purpose of the fuse in a circuit?

To ~~p~~ act as a safety device when the current is to high, so that it melts and causes the flow of current to cease before a fire starts. **(2 marks)**

**(ii) What is the purpose of the earth wire?**

~~The earth~~ ~~Fi~~ If the live wire breaks, and touches the metal body of an object, the current is diverted in to the ~~live~~ earth wire which is attached to that metal body. The current is then carried down into the earth and it does not electrocute the user. **(2 marks)**

(iii) State TWO reasons why appliances are connected to the circuit in parallel.

When connected in parallel many appliances can be used simultaneously, without the need to take off one, so that if one appliance is damaged and not working other appliances can still function since if it was series no other appliance would be able to function since there is a break in the circuit. Another reason is that a parallel connection allows for each appliance to get the full voltage supplied through the mains and would not have to split up the voltage as needed if it was a series connection. **(2 marks)**

(b) Figure 5 shows a circuit diagram.

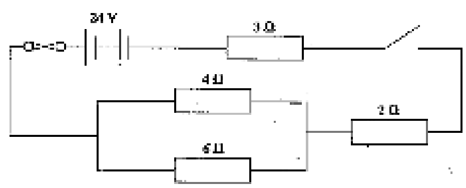



Figure 5. Circuit diagram

Use the circuit diagram in Figure 5 to determine

(i) the TOTAL resistance in the circuit

Resistance in branches

$\frac{1}{R_{TE}} = \frac{1}{4} + \frac{1}{6}$

$= \frac{5}{12}$

$R_{TE} = \frac{12}{5}\ \Omega$

Resistance in circuit

$R_T = R_1 + R_2 + R_3$

$= \frac{12}{5} + 2 + 3$

$= \frac{37}{5}$

$= 7.4\ \Omega$

(6 marks)

- 18 -

(ii) the TOTAL current in the circuit.

$V = IR$ ✓

$24 = I \times \frac{37}{5}$ ✓

$24 \div \frac{37}{5} = I$

$\frac{120}{37} = I$

$3\frac{9}{37} A = I$ ✓

$3.24 A = I$

(2 marks)

(iii) Which fuse, a 2A fuse, a 3A fuse or a 4A fuse, is the most suitable to use in the circuit shown in Figure 5?

A 4A since the fuse rating must be greater than the current flowing through the circuit

(1 mark)

**Total 15 marks**

**Recommendation**

Teachers should ensure that students understand concepts and are able to apply relevant knowledge.

Question 6

This question was based on Section E — The Physics of the Atom. It tested candidates' ability to identify the types of charges that are associated with the three forms of radioactive emissions and their relative ionizing abilities. Candidates were also required to complete nuclear equations for the decay, and to determine the half-life of a radioactive sample based on the temporal count rate of a Geiger–Müller counter. The mean for this question was 5.34 out of 15, while the standard deviation was 4.46.

Areas where candidates performed well include the following:

- Identifying the correct charge for Alpha, Beta and Gamma
- Writing in the missing radioactive particle atomic number and mass number

Areas where candidates performed poorly include the following:

- While many candidates were able to complete the table based on charge, numerous candidates demonstrated a lack of knowledge of the ionizing ability of each type of radioactive particle.

- Although the atomic numbers and the mass numbers were widely known for the Alpha and Beta particles, the symbols for Alpha and Beta were not generally known by candidates.
- Some candidates could not determine the half-life of the sample, showing all working; in some cases, alternative working was accepted.

**Exemplars from Candidates' Work**

**6.** (a) Complete Table 3 below to show the properties of the THREE types of radioactive emissions.

**TABLE 3: PROPERTIES OF RADIOACTIVE EMISSIONS**

| Type of Radioactive Emission | Charge | Ionizing Ability |
|---|---|---|
| Alpha/α | Positive ✓ | Strong ✓ |
| Beta/β | Negative ✓ | Moderate (Compared to α) ✓ |
| Gamma/ϒ | None ✓ | Weak ✓ |

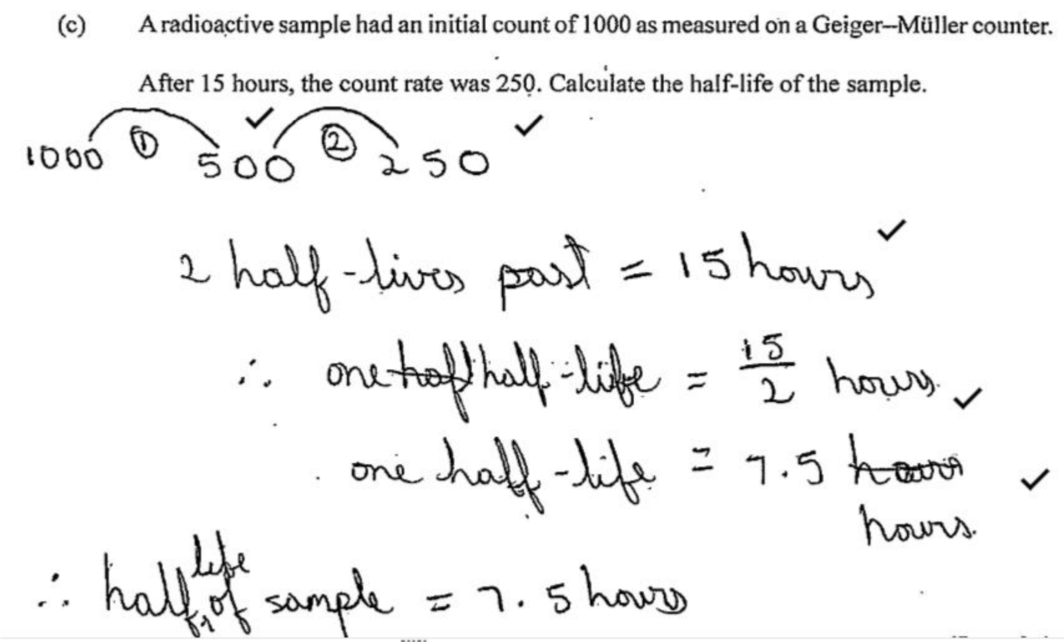
**(6 marks)**

(b) Complete the following nuclear equations.

(i) $^{14}_{6}C \dashrightarrow {}^{14}_{7}N + \boxed{{}^{0}_{-1}\beta}$ ✓ ✓

(ii) $^{226}_{88}Ra \dashrightarrow {}^{222}_{86}Rn + \boxed{{}^{4}_{2}\alpha}$ ✓ ✓

**(4 marks)**



(c) A radioactive sample had an initial count of 1000 as measured on a Geiger–Müller counter.

After 15 hours, the count rate was 250. Calculate the half-life of the sample.

1000 ① 500 ② 250

2 half-lives past = 15 hours

∴ one ~~half~~ half-life = $\frac{15}{2}$ hours

one half-life = 7.5 ~~hours~~ hours

∴ half-life of sample = 7.5 hours

**Recommendations**

The theory and practice regarding radioactivity need to be completed in order for candidates to fully answer questions. It should be emphasized that the particles resulting from a radioactive decay are different from that of the parent nucleus. Also, the conservation of a nuclear number should be emphasized to show that the sum of protons and neutrons before and after a nuclear reaction will be the same.

**Paper 032 — Alternative to School-Based Assessment (SBA)**

Question 1

The question was based on Section A – Mechanics. It was a practical one.

Candidates were required to

- take readings to calculate the period of a simple pendulum for various lengths
- plot a graph of the square of the period ($T^2$) versus the length ($l$) and determine the relationship between $T^2$ and $l$
- calculate the gradient of a straight line
- state one precaution necessary to obtain accurate results.

The mean for this question was 12.83 out of 21, while the standard deviation was 5.44.

Areas where candidates performed well include the following:

- Recording readings consistent with the supervisor's report
- Calculating the period correctly
- Plotting the graph and gradient
- Stating an appropriate precaution

Areas where candidates performed poorly include the following:

- Some candidates found it difficult to correctly read off values from the graph to determine the gradient.
- A few candidates did not use values that were more than 50 per cent of the line apart.
- The orientation of the axes was incorrect for some candidates.

**Exemplars from Candidates' Work**

(a) Record the times for 20 oscillations, t, in Table 1 below. **(2 marks)**

**TABLE 1: RESULTS**

| Length, *l*/m | Time, t/s | Period, T/s | Period², T²/s² |
|---|---|---|---|
| 0.10 | 12.85 | 0.64 | 0.41 |
| 0.20 | 18.10 | 0.91 | 0.83 |
| 0.25 | 20.19 | 1.01 | 1.02 |
| 0.50 | 28.63 | 1.43 | 2.04 |
| 0.60 | 31.31 | 1.57 | 2.46 |
| 0.75 | 35.03 | 1.75 | 3.06 |

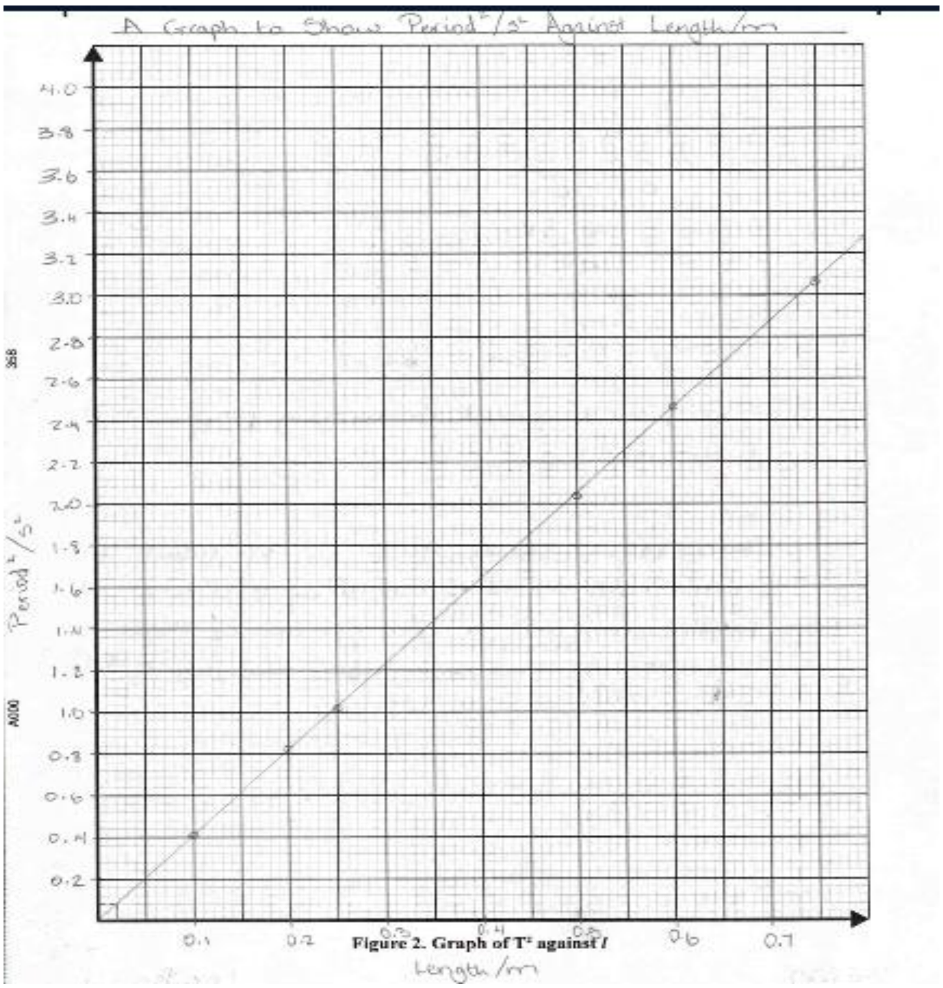



Figure 2. Graph of T² against *l*

(d) Calculate the gradient, S, of the graph.

$S = \frac{T_2 - T_1}{L_2 - L_1}$

$S = \frac{3.00 - 0.80}{0.73 - 0.02}$

~~= 0.31 s²/m~~

$= 3.10\ s^2/m$

**(5 marks)**

The period squared is directly proportional to the length.

(2 marks)

(f) State TWO precautions that should be taken in this experiment.

When taking the length of the pendulum the metre rule should be read at eye level to avoid parallax error and a countdown of three oscillations should occur before the stopwatch is started.

(2 marks)

**Total 21 marks**

**Recommendations**

- Teachers should have students practise graph plotting for as many topics as possible, to demonstrate their understanding of applicable formulae. During graph plotting, teachers should ask students to read off values that are not from the table to encourage them to practise and to demonstrate their ability to read off values correctly. Teachers should also emphasize the importance of significant figures or decimal places in measurements and calculations.

- Students should be taught the practice of drawing a line of best fit and using non-plotted points and a large triangle for gradient calculations. They should also be taught to show dotted lines on a graph to indicate the coordinates of the points read off.

- Teachers should explain clearly to students that *errors* and *precautions* should not be vague but should be specific to the activity and the measurements being taken. Students should also be made aware that each axis should be labelled with both quantity and unit.

Question 2

This question was based on Section D – Electricity and Magnetism. Candidates were expected to use symbols to construct circuit diagrams; investigate the relationship between current and potential difference; and apply the relationship $R = \frac{V}{I}$. The mean for this question was 12.60 out of 17, while the standard deviation was 3.54.

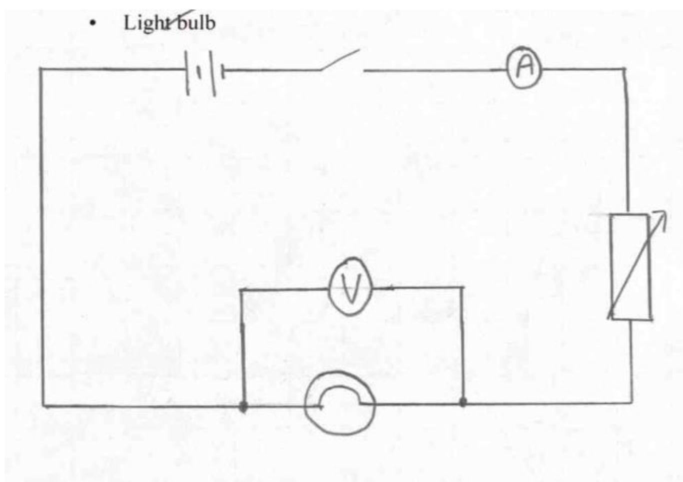
Areas where candidates performed well include the following:

- In Part (a), candidates were able to draw the circuit and identify the components.
- Candidates were able to read off the values from the graph to complete the table in Part (c) (i) and to find the respective resistances and then the average resistance in Parts (c) (ii) and (iii).
- Many candidates were able to find the current based on the values given for the resistance and voltage in Part (d).

Areas where candidates performed poorly include the following:

- Describing the procedure required to carry out the experiment; descriptions were not clear
- Placing the voltmeter in series with the components or placing it across the variable resistor instead of across the lamp being investigated

**Exemplars from Candidates' Work**




② (b) · The DC current, switch, Ammeter, rheostat and bulb are in series.

· The voltmeter is in parallel

· Pass a DC current, ~~varying~~ increasing the amount of current being ~~passed through~~ allowed to pass using the rheostat.

· Record the voltage and current for each reading.

· Plot an IV graph and determine the gradient which is Resistance.

TABLE 2: VOLTAGE AND CURRENT

V=IR
R=V/I

| Voltage, V/V | Current, I/A | Resistance, R/Ω |
|---|---|---|
| 0.50 | ~~1.5~~ ~~1.45~~ 0.15 | ~~0.33~~ 3.33 |
| 0.64 | 0.20 | 3.20 |
| 0.78 | 0.25 | 3.12 |
| 1.00 | 0.32 | 3.13 |
| 1.20 | 0.39 | 3.08 |
| 1.50 | 0.50 | 3.00 |

(4 marks)

(d) The present light bulb is replaced with a resistor of resistance 3.96 Ω. The circuit is closed and the voltage is recorded as 1.9 V. Calculate the current passing through this new resistor.

V=IR
I = V/R

bulb = 3.96 Ω
voltage = 1.9V

Current (I) = Voltage (V) / Resistance (R)
= 1.9 / 3.96
= 0.48A

**Recommendation**

Adequate preparation with appropriate practical activities must be emphasized.

Question 3

This question was based on Section E – The Physics of the Atom. It tested candidates' ability to design an experiment to distinguish among the three forms of radioactive emissions based on barrier materials that are designed to stop them.

The mean for this question was 3.73 out of 10, while the standard deviation was 2.80.

Areas where candidates performed well include the following:

- Using relevant barriers for testing penetration of the sources
- Identifying a precaution when handling a radioactive source
- Identifying the penetration ability of each radioactive type, even when an appropriate procedure was not stated in Part (b)

Areas where candidates performed poorly include the following:

- Numerous candidates were unable to commit to the use of an appropriate detector and hence were unable to answer Part (b) effectively, with a suitable procedure.
- Many candidates did not show a logical process to assess the initial radiation measurement and the radiation measurement after the insertion of the barrier.
- Candidates lacked knowledge regarding the necessity of the measurement of background radiation in order to find the correct rate for a radioactive source.
- Many candidates lacked knowledge with regard to the measurement of background radiation without any radioactive source present and the measurement of the count without any barrier (paper, foil or lead) present between the source and the counter.

**Exemplars from Candidates' Work**

**3.** A student is provided with three unlabelled radioactive sources: an alpha particle emitter, a beta particle emitter and a gamma ray emitter.

Design an experiment which will help the student to identify EACH radioactive source based on its penetrating properties. Your answer should include the following:

(a) Apparatus

- A beta partile emitter, an alpha partile emitter and a gamma ray emitter. - a 7.5 mm thick sheet of paper
- 50 mm thick aluminium sheet ~~[illegible]~~
- ~~xx cm thick slab of lead~~ - a metre rule
- a geiger-müller counter, - a marker pen

(3 marks)

(b) Method (i) Measure the background radiation ~~using~~ using the G-M counter ✓

Steps:- (ii) Using a metre rule, place the one of the emitters 5 cm - 7.5 cm away from the geiger - muller counter. (iii) Place the 7.5mm thick sheet of paper between the emitter and the G-M ~~tube~~ counter. (iv) Record the value and repeat for the other 2 emitters. (v) Place aside the emitter which the G-M counter had the background radiation value on it and label it alpha. (vi) Place one of the 2 emitters left 5 cm away from the G-M counter and place the 5mm of aluminium between it and record the counts. (vii) Repeat step vi with the remaining emitter. (viii) Place aside the emitter which has the counts of the background radiation and label it beta, and the other with more counts gamma. ✓ ✓

(3 marks)

(c) ONE safety precaution

~~With~~ Keep the emitters as far away from your body as possible using forceps and place back in its container when not in use. ✓

**(1 mark)**

(d) Expected results

The emitter which would not penetrate the 7.5mm of paper would be the alpha (α) ~~emitter~~ emitter. ✓ The emitter which penetrated the 7.5 mm of paper but not the 5 mm of aluminium is the beta (β) emitter. ✓ The emitter which penetrated both the 7.5 mm of paper and the 5 mm of aluminium is the gamma (γ) emitter. ✓ ~~This~~ Note that the values off the G-M counter for each emitter was compared to the background radiation recorded to identify which penetrated the material.

**(3 marks)**

**Total 10 marks**

**Recommendations for Teachers**

The theory and practice regarding radioactivity need to be completed in order for students to fully answer questions. It should be emphasized that the particles resulting from a radioactive decay are different from that of the parent nucleus. Also, conservation of nuclear number should be emphasized to show that the sum of protons and neutrons before and after a nuclear reaction will be the same.

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

# REPORT ON CANDIDATES' WORK IN THE

# CARIBBEAN SECONDARY EDUCATION CERTIFICATE®

# EXAMINATION

## MAY/JUNE 2019

## PHYSICS
## GENERAL PROFICIENCY

## GENERAL COMMENTS

A total of 14 589 candidates registered for the examination in May/June 2019. This represented a 3.0 per cent decrease in candidates compared with 15 026 in June 2018. Of the 14 589 candidates, however, only 13 825 scripts were received for candidates who wrote the examinations. The examination consisted of Paper 01 (Multiple Choice), Paper 02 (Structured Essays) and Paper 032 (Alternative to School-Based Assessment), which is written by private candidates. A total of 602 candidates registered for Paper 032. In 2019, there was an improvement in candidates' performance, with 73.1 per cent of candidates achieving Grades I to III compared with 68.6 per cent in 2018.

## DETAILED COMMENTS

### Paper 01 — Multiple Choice

Performance on the multiple choice paper was comparable with that of June 2018. The mean score for June 2019 was 36.78 with a standard deviation of 11.69, compared with a mean score of 35.18 and a standard deviation of 11.07 in June 2018.

### Paper 02 — Structured Essays

This paper consisted of one graphical and data analysis question, two structured and three essay-type questions. All questions were compulsory. With respect to performance, there was an improvement in the mean score compared with June 2018. In 2019, the mean score was 47.81 with a standard deviation of 23.91, compared with a mean score of 43.69 and a standard deviation of 23.84 in June 2018.

Question 1

This question was based on Sections A and D of the syllabus.

The question dealt with the following:

Section A/Mechanics (Objectives 1.4, 1.5, 1.6)

- Use of experimental skills to draw a line of 'best fit' for a set of plotted values
- Experimental skills again used to determine the gradient of the straight line graph
- The ability to express the result of a measurement or calculation to an appropriate number of significant figures

Section D/Electricity and Magnetism (Objectives 7.13, 7.15)

- Diagram of a simple transformer
- Apply the ideal transformer formula and solve problems

The mean for this question was 14.26, while the standard deviation was 5.89.

**Areas of Good Performance**

In Part (a), the majority of candidates demonstrated basic knowledge of the transformer by correctly identifying the secondary coil. Approximately 50 per cent of candidates were able to identify *X* as the primary input and *Z* as the (laminated) soft iron core.

Candidates demonstrated good graphical skills in Part (b) as most were able to identify the correct axes for the data, accurately plot the points and use their data to calculate the gradient.

In Parts (c) and (d), many candidates were able to apply their knowledge by utilizing the value calculated for the gradient to determine $N_s$ and $I_s$.

For Part (e), many candidates used the expected formula, $P_{out} = V_s I_s$, and correctly substituted their calculated value for $I_s$. Alternatively, some candidates used the equation $P_{out} = P_{in}$ and substituted the relevant $V_s I_s = V_p I_p$ to determine the $P_{out}$.

**Areas of Weak Performance**

For Part (a), a significant number of candidates were not able to identify the components *X* and *Z*, primary input and (laminated) soft iron core. Some candidates identified what the core is made of rather than what it is. In Part (b), the labels of the axes with units, appropriate scales and axes orientation proved the most neglected details in the graph plotting component of the question. Additionally, some candidates had difficulty interpreting their own scale and plotted the points inaccurately.

For Part (c), although many candidates were able to correctly state the equation $\frac{V_s}{V_p} = \frac{N_s}{\mathrm{N_p}}$, and plotted $V_p$ against $V_s$, they did not invert the value of the gradient when using the relationship $\frac{V_s}{V_p} = \frac{N_s}{\mathrm{N_p}}$, to calculate $N_s$. Furthermore, in many instances, of those candidates who plotted $V_s$ against $V_p$ correctly, some did not utilize the gradient to determine $N_s$ as specified in the question. Those candidates who were able to recognize (deduce) the relationship between the gradient of the graph and the formula of the ideal transformer made fewer mistakes with their calculations.

In Part (d), many candidates incorrectly stated the equation showing the relationship between voltage ratio (or turns ratio) and current ratio, $\frac{V_s}{V_p} = \frac{N_s}{\mathrm{N_p}} = \frac{I_p}{I_s}$. Candidates also had difficulty manipulating the formula to correctly determine the value of $I_s$.

**Recommendations for Teachers**

Teachers are encouraged to use technology including multimedia, to demonstrate graph plotting and to reinforce these skills by engaging students in ongoing graph plotting exercises. They are also reminded to continuously reinforce key/basic skills such as the following:

- Fine points/lines ( x or ⨀).
- Lines drawn with a straight edge instrument, for example, 30 cm ruler or large set square.
- Scales that cover more than half the graph page that are easy to plot and easy to read off (avoid scales with ratios using odd numbers/multiple of odd numbers, with the exception of 1 and 5).
- Selection of points that lie on the line for read-off to calculate gradient. The points selected must have a length/range between them that is greater than half the length of the line drawn.
- Candidates should know when (0, 0) is a relevant and legitimate point that needs to be included in plotting directly proportional relationships between two quantities. This knowledge should also be demonstrated when (0, 0) is not provided in the question. *Compression of scales* or *broken scales* will not provide sufficient evidence to analyse the graph and conclude if a directly proportional relationship exists between the two quantities.
- Inter-curriculum collaboration, especially with Mathematics will further assist candidates in linking knowledge in both subjects and in building the skill sets tested in each.
- Teachers need to reinforce to students that they should show *all* working, including stating the formula, substituting into the formula and stating the answer to the correct number of significant figures with units (*state* formula, *substitute* quantities correctly, *solve* for answer with units).
- Detailed demonstrations and repetitive practice in every topic on the syllabus in applying formulae, manipulating/transposing such formulae and relating details via graphical representation and analysis need to be components of each class in the teaching of the curriculum.

<u>Question 2</u>

This tested candidates' understanding of the concepts of density, weight and pressure. Candidates were required to

- apply the formula for density
- recall the special name given to the unit for the derived quantity *Pressure*
- define and apply the definition of pressure.

The mean for the question was 6.77, while the standard deviation was 4.36.

**Areas of Good Performance**

Many candidates were able to recall the SI units for volume, density, force and pressure, as required in Part (a).

Generally, candidates were able to correctly state the formula for density and to perform the substitution in the formula to get the correct answer in Part (b) (i).

**Areas of Poor Performance**

Very few candidates were able to give a comprehensive definition of pressure in Part (b) (ii). Calculating the pressure in Part (b) (iii) also proved to be quite a challenge for many candidates.

**Recommendations for Teachers**

- Educators/teachers should address the issue of definitions with more detail. This should give students a better understanding of the concepts.
- Teachers should assist students by giving them more practice with calculations.

Question 3

Parts (a) (i) and (ii) asked candidates to define *heat capacity* and *specific latent heat capacity*. Most candidates were able to give correct definitions for these two terms. However, fewer candidates were able to give the definition of heat capacity. Part (b) assessed candidates' knowledge of a cooling curve for a substance, as it is cooled to a solid. Generally, candidates were able to correctly sketch the cooling curve.

In Parts (c) (i), (ii) and (iii), candidates were assessed on their ability to perform computations regarding heat exchange problems which account for temperature and phase changes. Most candidates were able to state whether a phase change occurred to use the correct equation to compute the answer.

The mean for the question was 7.68, while the standard deviation was 4.59.

**Areas of Good Performance**

Candidates who gave the correct definitions for both the *heat capacity* and *specific latent heat of vaporization*, were able to articulate the importance of mass, temperature and a phase change between the respective definitions. Successful candidates were able to ascertain the correct form for the curve as decreasing in temperature to the cooling point and remaining at the freezing point (a horizontal line). A few candidates did not start their cooling curve at an initial time of 0 s. This was acceptable and may be realistic with respect to laboratory conditions.

Additionally, some candidates showed a decreasing curve after the freezing, as an extension to their graphs. Candidates who successfully computed the quantities sought for in the questions were able to do so based on (i) identifying the correct equations and (ii) solving said equations through a methodological process.

**Areas of Poor Performance**

Those candidates who lost marks for the definitions were those who confused the definitions for *specific heat* and *heat capacity* and who did not recognize the importance of a phase change and the temperatures at which phase changes occur. Some candidates drew a heating curve with no visual indication of the latent heat of fusion process that was occurring at 80 °C. Others were careless when drawing the fusion part of the curve and gave curves that were non-horizontal. A ruler should be used for these types of graphs.

Too many candidates did not realize that a temperature change of 1 degree Celsius is equivalent to a temperature change of 1 Kelvin. Therefore it was incorrect for candidates to convert to Kelvin temperature after taking the difference between the final and initial temperatures. Too many candidates stated variables and their results with incorrect units or showed no units at all.

**Recommendations for Teachers**

- The distinction between *heat capacity* and *specific heat capacity* must be emphasized. It would be a good exercise for students to write out these definitions and commit them to memory since these definitions form the bases for computations.
- Emphasis should be placed on the correct shapes of cooling and heating graphs in addition to identifying the region of the graph at which the phase changes occur.
- It should be emphasized that any change in degrees Celsius is the same as a change in Kelvin. Alternatively, if students wish to do conversions to Kelvin temperatures, the conversions for all temperatures must be done prior to any arithmetic manipulations.
- The explicit writing of the formulae to be used, the substitution of the values for the variables in the formulae, and correctly solving the equations are skills which the students should acquire.

<u>Question 4</u>

Candidates were expected to recall the characteristics of the image formed in a plane mirror, demonstrate an understanding of the action of lenses and solve problems related to the formation of images in convex lenses.

The mean for the question was 5.05, while the standard deviation was 4.37.

**Areas of Good Performance**

Part (a) (ii) required that candidates explain why the word *police* was written laterally inverted on the front of some emergency vehicles. Many candidates were able to identify that the underlying principle had to do with a mirror or a mirror effect. Quite a few went on to state that the mirror would make the word appear correctly as *police*.

Part (b) (ii) required that candidates complete the ray diagram for the diverging lens shown and label the focal length. Approximately 50 per cent of the candidates were able to show the ray diverged from the optical axis of the lens.

For Part (c) (i), candidates were required to use the lens formula/equation to determine the image distance for an object placed in front of a converging lens. Candidates who were able to correctly recall the equation were often able to apply it correctly to determine the image distance.

In Part (c) (ii), candidates were required to determine the magnification of the image formed. Candidates who were able to recall the equation were often able to apply it correctly to determine the magnification.

**Areas of Poor Performance**

For Part (a) (i), candidates were required to identify three features of an image formed in a plane mirror. Generally, candidates performed below average on this part of the question. Most of them were unable to identify all three correct properties. Often, there was no differentiation between the image and the actual object from which it is formed (e.g. candidates saying - same size). Many students seemed unaware of the difference between inverted and laterally inverted. Frequently, they incorrectly identified inverted as one of the properties.

Part (a) (ii) required that candidates explain why the word *police* was written laterally inverted on the front of some emergency vehicles. Candidates again had difficulty using the term *lateral inversion* and expressing the principle as lateral inversion. Many candidates lacked knowledge of practical applications of lateral inversion such as emergency signs painted on emergency vehicles and their observance by *drivers* in the rear view mirror in *another* vehicle *in front of the emergency vehicle*.

Parts (b) (i) and (ii) required that candidates complete the ray diagram for the diverging lens shown and label the focal length. Many candidates completed the diagram as though it was a converging lens. Additionally, some candidates drew both convergent and divergent rays. Most candidates who drew a divergent ray did not draw it such that it appeared to come from the principal focus. Many candidates labelled the focal length as the distance between the principal focus and the edge of the lens instead of the optical axis of the lens.

For Part (c) (i), candidates were required to use the lens formula/equation to determine the image distance for an object placed in front of a converging lens. Many candidates were unable to recall the correct equation and scored zero for this part of the question. Those candidates who were able to recall the formula used *v* and *u* interchangeably. In Part (c) (ii), candidates were required to determine the magnification of the image formed.

While many candidates seemed to be aware that magnification is the ratio of image height to object height, too often they were unable to identify magnification as the ratio of image distance to object distance, as was required by the question. Additionally, those candidates who confused *v* and *u* in Part c (i) also confused the symbols in Part (c) (ii).

**Recommendations for Teachers**

- Mirrors are examples of objects that students use on a daily basis. However, teachers should not take it for granted that students are aware of the scientific concepts associated with such objects. In order that students gain a better understanding of scientific concepts, emphasis should be placed on engaging in activities that require them to use and manipulate objects/materials during instruction.
- Teachers must ensure that when students draw/copy diagrams, they have a clear understanding of what is actually happening so that diagrams may be drawn accurately. This should also include basic drawing principles for Ray diagrams such as arrows and straight lines to represent rays.
- Students should be able to recall equations/formulae used throughout the syllabus and should be provided with adequate opportunities to apply them during instruction.
- Teachers need to reinforce that students show *all* working, including stating the formula, substituting into the formula and stating the answer to the correct number of significant figures with units (*state* formula*, substitute* quantities correctly, *solve* for answer with units).

<u>Question 5</u>

This question required candidates to draw the I–V relationship for a semiconductor diode, solve problems involving series and parallel circuits, and recall the truth table for the NAND gate. The mean for the question was 7.72, while the standard deviation was 4.22.

**Areas of Good Performance**

Many candidates were able to recall the truth table for the NAND gate in Part (b).

In Part (c) (i), calculating the total resistance for resistors in series was easily done by the majority of candidates.

Candidates, for the most part, were able to recognize and use Ohm’s law in Part (c) (iii).

**Areas of Poor Performance**

A large number of candidates used the formula for parallel resistors as:
$R_p = 1/R_1 + 1/R_2 + 1/R_3$ instead of $1/R_p = 1/R_1 + 1/R_2 + 1/R_3$

Many used the correct formula for $1/R_p$ but did not then go on to find $R_p$.

**Recommendations for Teachers**

Teachers need to reinforce to students that they need to show *all* working, including stating the formula, substituting into the formula and stating the answer to the correct number of significant figures with units (*state* formula, *substitute* quantities correctly, *rearrange* where necessary, *solve* for answer with units).

<u>Question 6</u>

This question assessed candidates' understanding of introductory nuclear science. It specifically tested their knowledge of isotopes and the classic representation of the atomic and nuclear structures, and required them to define the half-life of an element, and calculate the half-life and energy given off in a nuclear reaction when the change in mass is known.

The mean for this question was 6.33, while the standard deviation was 4.43.

**Areas of Good Performance**

In Part (a) (i), the majority of candidates was able to correctly determine the number of neutrons and protons in the nucleus of an isotope. For Part (a) (ii), successful candidates were able to correctly draw a clearly labelled diagram of the Li – 7 isotope. They were able to correctly place the requisite number of electrons in their correct orbitals around a clearly defined nucleus containing the correct number of nucleons. In Part (b) (i), the majority of candidates was able to correctly define the term *half-life*.

Candidates who successfully completed Part (b) (ii) used either logical deduction or formula to correctly calculate the half-life.

**Areas of Poor Performance**

In Part (a) (i), a few candidates were unsure of how to compute the number of protons and neutrons given the mass number and the atomic number. Others who lost marks for this part of the question did so because of basic arithmetic mistakes. Several candidates used the mass number for the number of electrons. Some candidates placed the first orbital electrons on the expressed boundary of the nucleus. Other candidates placed the number of nucleons outside a clearly labelled nuclear structure.

For Part (b) (i), candidates were able to correctly identify a time factor associated with the *half-life*, but were unable to correctly state how much of the material remains after one half-life.

Most candidates did not complete Part (b) (ii) because they were unable to systematically link the meaning of half-life and time. Some candidates sought to write an equation for a decay scheme for lithium which did not help them to answer the question.

**Recommendations for Teachers**

The planetary model for the nucleus of an element should be emphasized for its uniqueness regarding the number of nucleons, especially the number of protons. Emphasis must also be placed on the proper construction and labelling of the constituents. Distinctions should be made on the specific information inherent in the values of the mass number and atomic number as they pertain to the information for the number of protons, neutrons, and electrons.

## Paper 032 — Alternative to School-Based Assessment

<u>Question 1</u>

This question tested candidates' knowledge of voltage and current. The mean for this question was 9.91, while the standard deviation was 5.32.

In Part (a), candidates were required to obtain three pairs of experimental data for voltage and current as outlined in the procedure. Candidates were further asked to obtain three pairs of readings when the connections to X were reversed. Instructions were also provided to not exceed 1 A.

**Areas of Good Performance**

In Part (a), candidates were able to acquire six pairs of readings with a suitable range of 0.6 A. These candidates also did not exceed the recommended 1 A and documented the values with consistent significant figures/decimal places.

Those candidates who successfully transitioned from collecting the data to plotting the graph had all the basic/key features required in graph plotting: labels with units, correct orientation, fine points, best fit straight line and appropriate scales.

The determination of the gradient in Part (c) was fairly well answered by candidates. Many candidates were able to recall the gradient formula and follow through with values for $I$ and $V$ to determine the gradient of the graph.

For Part (e), many candidates were able to identify if the device was ohmic.

**Areas of Poor Performance**

The majority of candidates did not record negative values for the second set of readings in Part (a). A significant portion of these candidates did not record values to the appropriate and/or consistent number of significant figures. A few candidates incorrectly interchanged the values of current and voltage and some recorded some values that were not consistent with the range of the ammeter or voltmeter.

In Part (b), the plotting of the graph was not well done. Many candidates were unable to plot the values obtained for *V* and *I*. Those who were able to choose an appropriate scale plotted *V* against *I* and not what was outlined in the question: *I* against *V*.

For Part (c), a significant number of candidates used values they obtained and recorded in the table to determine the gradient. This practice included use of the tabular values that were not on the best fit line. Some candidates did not choose a suitable range of values between the pairs of coordinates they used to determine the gradient.

The resistance of the device used was required in Part (d). Many candidates appeared to be oblivious to the fact that the graph they plotted was *I* against *V* and that the resistance of the device is given by the inverse of the gradient. As such, candidates proceeded to state that the gradient is equal to the gradient of the graph.

In Part (e), interpreting the data in order to determine whether the device was Ohmic proved challenging for a significant number of candidates. Candidates were unable to express effectively why a device may or may not be ohmic. Numerous candidates just cited Ohm's law, without authentically applying it to their results or their graphs.

**Recommendations for Teachers**

- Use of multimedia and additional technology to demonstrate graph plotting and reinforcing such demonstrations with continuous graph plotting exercises will assist students who are visual, auditory and/or kinesthetic (or any combination of these) learners. Teachers also need to continuously reinforce key/basic skills such as the following:
  - Fine points/lines ( X or ⊙ ).
  - Lines drawn with a straight edge instrument, for example, 30 cm rulers or a large set square.
  - Scales that cover more than half the graph page that are easy to plot and easy to read off. (Avoid scales with ratios using odd numbers/multiples of odd numbers, with the exception of 1 and 5.)
  - Selection of points that lie on the line for *read-offs* to calculate the gradient. The points selected must have a length/range between them that is greater than half the length of the line drawn.

- Students should know when (0,0) is a relevant and legitimate point that needs to be included in plotting directly proportional relationships between two quantities. This knowledge should also be demonstrated when (0,0) is not provided in the question. 'Compression of scales' or 'broken scales' will not provide sufficient evidence to analyse the graph and conclude if a directly proportional relationship exists between the two quantities.
- Inter-curriculum collaboration, especially with instructors of Mathematics, will further assist students with linking knowledge in both subjects and in helping to build the skill sets tested in each subject.
- Teachers need to reinforce to students that they should show *all* working, including stating the formula, substituting into the formula and stating the answer to the correct number of significant figures with units (*state* formula, *substitute* quantities correctly, *solve* for answer with units).
- Detailed demonstrations and repetitive practice in every topic on the syllabus in applying formulae, manipulating/transposing such formulae and relating details via graphical representation and analysis need to be components of each class in the teaching of the curriculum.
- Practice in experimental procedures has been a recommendation for the past ten years. However, many students still seem to lack the necessary basic skills to conduct a lab, especially electricity labs.
- Students should be made aware that the range of readings should be as wide as possible, consistent with the scale of the measuring instruments being used. The range should not be less than 70 per cent of the scale on the measuring instruments.
- When students complete the collection of data phase they should be prepared to apply their knowledge and analyse their data in the form of a graph, to effectively express what the gradient represents.
- Teachers should emphasize that inferences from graphs should be determined by the shape of the graph and its location relative to the origin (0,0). For example, if a graph of 'y' against 'x' yields a straight line, passing through the origin, then 'y' is directly proportional to 'x'. That is, $y = mx$, where m is a constant (the gradient). However, if the straight line does not pass through the origin, then 'y' is not proportional to 'x'. The equation is of the form $y = mx + c$, where m = gradient and c = y − intercept. The equation may simply be described as a linear one.

Question 2

This was based on Section C of the syllabus: Waves and Optics. Generally, this question was fairly well done. The mean for the question was 10.51, while the standard deviation was 4.06.

**Areas of Good Performance**

In Part (a), most candidates were able to draw in the refracted ray and the emergent ray.

Candidates were able to acquire most of the marks for Parts (b) and (c) by correctly reading off the coordinates from the graph provided. They were also able to utilize these values to choose two appropriate coordinates to determine the gradient accurately.

For Part (e), many candidates were able to make the link that the gradient was 'n' without knowing that 'n' is the symbol used to represent the refractive index. They used the value calculated for the gradient in Part (c) and determined the speed of the wave in the second medium.

**Areas of Poor Performance**

In Part (a), many candidates were unable to draw the emergent ray parallel to the incident ray.

In Part (d), many candidates were unaware that the quantity the gradient represented was the refractive index, n. This, however, did not affect their attempt in Part (e) to use the gradient.

Part (f) was poorly done. Candidates were unfamiliar with the fact that they had to look through the side of the glass block to view the image of the pins and made reference to eye level without indicating that the reason for looking at the image of the pins was to ensure that they were aligned vertically. Candidates seemed to be more familiar with the use of lasers or an incandescent source such as ray boxes.

**Recommendations for Teachers**

Since a large number of students were unaware of the relevant precautions in a standard waves and optics lab and simply identified these precautions 'to avoid parallax error' or 'view at eye level', teachers need to advise students that they need to be more specific when identifying precautions; for example, *Ensure that the image of the straight (upright) pins are aligned when viewed through the side of the block to avoid parallax error*.

<u>Question 3</u>

This question was based on Section A 6.2 of the syllabus. It specifically sought to assess candidates' understanding of the relationship between pressure and depth in a fluid. It was not very well done by most candidates. The mean for the question was 3.67, while the standard deviation was 2.73.

**Areas of Good Performance**

Most candidates were able to identify the correct apparatus needed. Successful candidates were those who used the classical method for observing and documenting the range a stream of liquid would traverse based on the depth of the exit in the container through which the fluid passed. Most of these candidates were also able to identify the manipulated variable and the responding variable and were specific concerning the variables to be recorded.

Few candidates included a sketch of the apparatus used to show the relationship between pressure and depth.

**Areas of Poor Performance**

Most candidates lacked the essential knowledge to describe the sequential steps to be taken when conducting an experiment. Several candidates referenced the use of a 'pressure sensor' (maybe electronic) without any description of the sensor capabilities and limitations.

Most candidates ended their description in the Method section with the phrase 'record results' without being specific about the particular data to be recorded. They were also unable to state that experimental precautions constitute those actions of the experimenter which are intended to reduce any adverse impact on the results of the experiment. Many candidates were unable to clearly state the Expected results for their experiment.

**Recommendations for Teachers**

- It is important for teachers to introduce to students current electronic devices that are being used to gather different types of data (in this case pressure). However, teachers must make students aware of the operation, limitations and sensitivity of these devices. This is important in order for students to be able to describe how these devices are used to record the values for the variables that they are measuring.

- Emphasis should be placed on identifying possible sources of errors and how laboratory precautions may minimize these errors.