# CARIBBEAN EXAMINATIONS COUNCIL

## REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

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**PHYSICS**

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## GENERAL COMMENTS

In 2014, the number of candidates writing the CAPE Physics examinations was as follows:

Unit 1: 3372 candidates
Unit 2: 2637 candidates

This reflected a decrease in the numbers writing the CAPE Physics 2013 examinations in which case the numbers were 3621 (Unit 1) and 2659 (Unit).

A recurring problem in both units is the large number of candidates who have not mastered fundamentals such as:

- *Unit conversion* — this occurs in every area of physics, even in linear units where converting between different divisions of a meter millimeter – meter, nanometers – micrometers - centimeters defeats candidates
- *Transposing of algebraic expressions* : especially where other operations such as square roots are involved, for example: to make T the subject of the formula $\frac{\lambda}{T} = \sqrt{\frac{g\lambda}{2\pi}}$ expressing derived units in terms of fundamental units (for example: capacitance in terms of fundamental SI units)

Teachers should place emphasis on completely eliminating these weaknesses.

The number of null responses in the Atomic and Nuclear Physics Module (Unit 2, Module 3) continues to be alarming. Some attention could be given to teaching these topics earlier in the year.

## DETAILED COMMENTS

### UNIT 1

### Paper 02 – Structured and Free Response Questions

<u>Question 1</u>

This question was fairly well done. The topic appeared to be well known and the only section which presented major difficulty was the one which required candidates to find the horizontal range of a projectile. The most common error was where candidates used the velocity of projection multiplied by the time of flight to find the horizontal range.

Teachers are encouraged to remind their students that most projectile calculations require the horizontal and vertical components of the motion to be treated separately and independently.

Question 2

There was generally weak performance on this question. One area of weakness was algebra. Given two algebraic equations, one of which included a square root, and asked to combine them and manipulate into a given form, the majority of candidates got lost in the algebra and could not obtain the result.

Teachers should assign a significant number of problems involving algebraic manipulation so that their students get the required practice. They should also encourage students to practise on their own as facility with algebraic manipulation comes with practice.

A majority of candidates did not know the components of the e/m spectrum nor the wavelength boundaries of the different components. This is important general knowledge and teachers should devise creative methods of ensuring that this is studied and learned. The mnemonic used to memorize the colours of the visible spectrum has been outstandingly successful. Perhaps a similar mnemonic could be developed for the entire e/m spectrum.

Most candidates knew how substitute in the given equation and use their calculators to find the result.

Question 3

For Part (a), a majority of students were able to calculate the volume inside a cylindrical glass tube given appropriate data about the geometry of the tube. In Part (b), candidates were given graphical data and were required to decide which variable should be assigned to the x-axis and which to the y-axis. A large number of candidates made the assignment incorrectly.

Teachers are encouraged to make sure that their students first of all, know how to distinguish between the independent variable and the dependent variable. It should then be stressed that the independent variable is the one which is assigned to the x-axis (abscissa) and the dependent variable to the y-axis (ordinate).

A majority of candidates did not elaborate on the answer when asked what happened to the volume of a real gas as its temperature was decreased towards absolute zero. It appears that students are not being taught to visualize the conditions inside a gas in accordance with kinetic theory. Kinetic theory lends itself to visualization. It is very important when teaching the gas laws and kinetic theory, that teachers help their students create a visual picture of what is happening inside a gas, that is, the microscopic view. There are many applets online which can help with this.

Question 4

This question was poorly done despite its focus on fundamental thinking skills. A large number of candidates could not explain why an object would be accelerating while going around a circle at constant speed, suggesting that their concept of acceleration was not fully established. It is expected that teachers make every effort to ensure that concepts such as these are internalized at the CSEC level.

The dimensional analysis using base units was also poorly done. Many candidates were unable to use the equations of kinematics to find the velocity of a car with a given initial velocity and constant

acceleration over a specified distance. Here again, fundamental concepts which should have been established at a lower level are missing. Perhaps some coordination between CAPE and CSEC teachers would assist in ensuring that these lacunae in basic understanding are not propagated.
In the section requiring candidates to indicate the forces acting on an object undergoing circular motion in a vertical circle, candidates' drawings indicated that they thought of the centripetal force as one of the active forces and not as a requirement for circular motion.

Responses to this question suggest that circular motion is not a clearly understood concept and that teachers should devote special effort towards ensuring that more of their students develop a thorough understanding of the topic.

Question 5

This question was very poorly done. Most of the formulae relevant to this question were recalled accurately by the majority of candidates. In one special case where a formula was to be derived from a diagram, there was the peculiar situation of candidates being able to recall the derivation but unable to recall the diagram on which it was based.

Unit conversion continues to present a problem and it was particularly apparent in this question. Conversions between mm and metres were most often incorrectly done and so was the conversion between metres and nanometers. This difficulty would be considerably diminished if teachers habitually use scientific notation and encourage/require the use of such notation by their students. Along with this, there should be a thorough (recitative) grounding in the meaning and expression of the scientific prefixes: micro- milli- centi- kilo- mega- etc.

Particularly evident in the responses to this question was the perennial problem of transposing of variables in a given equation, that is, changing the subject variable. This problem is eminently soluble and whichever technique is used, the brute force solution of drills will definitely work. Every physics teacher should commit to ensuring that no student leaves class without mastering this basic algebraic skill.

Question 6

Students demonstrated fundamental knowledge of the heat transfer processes and of the greenhouse effect. A vast majority of candidates were unable to make the link between the processes and their application to the design of solar water heaters. Many candidates, although knowing the formula for thermal conduction through a regular solid, were unable to apply it to the practical situation presented in this problem. It appears that although candidates can quote the formula quite accurately, there is a gap in their understanding of the meaning of each term. Teachers should be aware of this gap and endeavor to close it. One possible way of accomplishing this is by identifying, correctly, the troublesome variables in a wide variety of situations. The internet and the problems at the end of chapter in any of the well-known Physics texts can be of great assistance. Remember, the student does not necessarily have to solve the problem. The purpose of the exercise would be to correctly identify which item of given data corresponds to which variable in the formula being studied.

## UNIT 2

### Paper 02 – Structured and Free Response Questions

Question 1

This question was well done indicating that the topic was properly taught and well understood. A number of candidates experienced difficulty in finding the time constant of the given exponential decay curve. Some were not able to draw a proper tangent and even among those who drew the tangent competently, many did not realize that it could be read off directly from the time axis. Those who attempted to calculate it directly did not do so well either.

Drawing a tangent to a curve, that is, variable slope, is a skill which all students should acquire. Teachers should drive home the main features of this exercise by reducing it to a set of sequential steps and having their students master each step.

There were still a number of candidates who appeared to have difficulty drawing a proper graph and ended up with inappropriate scales making the extraction of data from the graph exceedingly difficult.

Although overall performance on this question was good, there were a fair number of candidates who did not know the SI unit for capacitance.

Question 2

This question had the best performance on the entire paper. The data for the graph was calculated and recorded accurately and for the most part the graphs were properly drawn and well presented. There were still a number of candidates who had difficulty choosing proper scales for their graph.

Question 3

This question had one of the worst performances on the entire paper. The majority of candidates could not derive the nuclear absorption equation given the initial isotope, the bombarding particles and the final product. There is very little intrinsic difficulty in this exercise and so the remaining conclusion must be that some candidates were not properly prepared or not prepared at all for this topic. The examining committee encourages all teachers of CAPE Physics to plan and execute their teaching schedule effectively so that all topics are covered.

Similarly, the vast majority of candidates could not describe a laboratory experiment to measure the half-life of a given radionuclide. Many candidates were able to give examples of the properties of a radioisotope which were employed in radiotherapy but there was an overwhelming bias toward diagnostic radiotherapy applications. Teachers should make sure that their students are exposed to the requirements of curative or corrective radiotherapies.

Question 4

This was the worst performing question on this paper. Approximately 29 per cent of candidates scored zero. Most candidates could calculate the electric field between parallel plates. The parallels between the motion of charged particles in a uniform electric field and that of a mass in a uniform gravitational field appear to be unfamiliar to a large number of students. This parallel is expressly stated in the Unit 2 syllabus. In cases where Unit 2 is taught before Unit 1 or where candidates are doing Unit 2 alone, teachers have the responsibility to teach parabolic motion in Unit 2.

Question 5

This was the second best performing question on the paper. The modal score of 15 out of 15 suggests that there are many candidates for whom this topic is well taught and well understood. Among the more poorly performing candidates, there were many who could recognize or draw the basic logic gates and who could derive a truth table from a given logic circuit. Some candidates submitted responses with 3 and 4-input logic gates. Teachers should frequently refer their students to the syllabus which is available online. In this case, the CAPE syllabus states that all logic circuits examined at CAPE will be restricted to two inputs.

Question 6

Performance on this question was generally poor with approximately 25 per cent of candidates earning the modal score of zero and nearly 20 per cent not attempting the question at all.

Experience continues to show that the topics at the back of the syllabus are most likely to produce these poor responses. A likely reason for this is that many teachers arrange the syllabus material in chronological order and topics at the back of the syllabus, thus assigned to the end of the teaching period, are sometimes omitted. We recommend that teachers bear this in mind when planning their teaching schedule for the term.

Conversion from joules to eV and vice versa: these conversion problems can be easily solved by giving students a sufficient number of practice examples for the process to be imprinted on their subconscious.

## Paper 032 – Alternative to School-Based Assessment (SBA)

A catalog of the problems encountered in SBA assessment is presented below. Teachers are asked to note them carefully and to take appropriate remedial action where necessary.

Standard of the Labs

- Too many standard experiments used for Planning and Design
- Poor hypotheses accepted for Planning and Design
- Planning and Design experiments should be written up in two parts:
  Part A in which the exercise is planned in its entirety
  Part B in which the execution of the experiment is recorded
- Too few basic Analysis and Interpretation exercises

Mark Schemes and Marking

- Not enough breakdown for each criterion
- Teachers not following their own mark schemes
- Mark schemes with more than 24 points used and submitted
- Mismatched criteria – Analysis and Interpretation actually belonged to Observation Recording and Reporting.
- Wrong mark schemes submitted – mark schemes received did not correspond to the labs that were in the candidates' books.
- Inconsistent marking – some candidates were awarded a mark for satisfying a particular assessment criterion while other candidates did not receive the mark for similar or almost identical work.
- Little or no feedback comments in lab books.

Disorganized Presentation

- No dates on lab reports
- Lab reports not indexed
- Pages not numbered
- Reports presented in random order in each lab book

**Improvements**

It is pleasing to note that:

- Some schools are reading the subject report and are making improvements to their SBA performance.
- Some very original, non-standard Planning and Design experiments are being done.
- More schools are sending in acceptable mark schemes.