CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2010

PHYSICS

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GENERAL COMMENTS

The number of candidates registered for CAPE Physics in 2010 increased from 2790 to 2999 and 1795 to 2330 for Units 1 and 2 respectively. For Unit 1, ninety-one per cent of the candidates earned Grades I – III and for Unit 2, eighty-two per cent of the candidates earned Grades I – III.

Some areas of poor performance were:

- Newton's laws of motion and their application
- Simple Harmonic Motion
- The explanation of the First Law of Thermodynamics

DETAILED COMMENTS

UNIT 1

Paper 02 – Structured Questions and Essay Questions

<u>Question 1</u>

Part (a) (i) was easy and straightforward and most candidates were able to plot the graph.

Part (a) (ii) required candidates to describe 'qualitatively'; it was expected that they would recognize that the ball rolled down the plane with uniform acceleration, collided with the block and rebounded up the plane, eventually coming to rest. In Part (a) (iii), the instruction given was to 'calculate', but it was expected that the graph would be used to determine the answers by working out the gradient and area under the graph. A few candidates recognized that the force was related to Newton's second Law:

$$F = \frac{mv - mu}{t}$$

Teachers should remember to emphasize that energy is conserved during an elastic collision.

Answer: a (iii) 3.5 m s^2; 2.5 m; 91.2N

<u>Question 2</u>

In Part (a), candidates failed to draw rays of light through a rectangular block and a triangular prism correctly. Very few were able to show what happens with white light as it passes through a diffraction grating. In Part (b) (ii), the majority of candidates were able to recognize the action of 'total internal reflection'. Too many candidates complicated matters because they learnt the formula n = Sin θ_1/Sin θ_2 or n = Sin i/Sin r, without a clear understanding of its use. When teaching this topic, teachers should be sure to emphasise what is meant by the *refractive index* of a medium like glass:

$${}_{air}n_{glass} = \frac{\text{Sin } \theta_{air}}{\text{Sin } \theta_{glass}} \quad \text{or} \quad n, \text{Sin } \theta, = n_2 \text{ Sin } \theta_2$$

The ability to read off values from the graph scales to fill in the table and to determine the gradient seemed a difficult task for some candidates.

Answer: (b) (iii) 1.45

Question 3

All candidates seemed familiar with this topic relating to Young's modulus. It was easy for them to gain a few marks from Part (a) for defining the terms 'stress' and 'strain', and sketching at least one of the graphs correctly. It was disappointing to see that many candidates could not fill in the missing values of Extension, ΔL/m correctly. In addition, there were those candidates who knew how to calculate the extension but ignored the units given in the table. Almost every candidate could recall Young's modulus = $\frac{stress}{strain}$. However, getting past there to Part (iii) E = $\frac{MgL}{A\Delta L}$ and Part (iv) E = gradient X $\frac{gL}{A}$ proved to be difficult for many.

Answer: (b) (iv) 1.82 x 10^6 Nm^{-2}

Question 4

It was surprising that many candidates could not answer Part (a) which required that they express the ideas that 'resultant force must be zero' and 'the resultant torque must be zero'. Instead, candidates wrote about 'upward forces being equal to downward forces' as if forces only act in a vertical plane.

Part (b) tested candidates' understanding of the vector nature of velocity; many candidates failed to apply a sign convention, so that even though they knew the equations of motion, they failed to apply them correctly to the given situation. At this level, candidates should be exposed to a wider range of examples on this topic especially involving motion in a vertical plane under the influence of gravity.

Answers: (a) (ii) 167N, 73N; (b) (i) 1.5 m s^{-1}, 0.55 m s^{-1} (b) (ii) 0.735 (b) (iii) 1.1 m

Question 5

Teachers need to define clearly for students the threshold of hearing and threshold of pain. For Part (a) (i), many candidates defined those terms as a range of frequencies or as a point rather than a specific intensity.

Most candidates were not aware that the answer for Part (a) (ii) was that *the ear responds to a wide range of intensities of sound* or that *the ear's response to sound intensity is logarithmic*. Many candidates also misinterpreted the phrase 'property of the ear' to mean 'a physical feature of the ear'.

In Part (a) (iii), many candidates did not know the expression $\beta = 10 \log_{10} (l/l_o)$. Some were not able to write $\log_{10}$ and instead wrote log 10 which is, of course, incorrect. Others wrote 1 as the subject of the equation instead of β.

For Part (a) (iv), several candidates did not recognize 3.82 mWm^{-2} as 3.82 x 10^{-3} Wm^{-2}, where the first m in the unit was the prefix milli = 10^{-3}.

Part (a) (v) was fairly well answered. Most candidates understood that there would be a reduced ability to hear frequencies and that the audible range of frequencies will decrease especially at the upper end. However, they did not recognize that the threshold of hearing would increase, not decrease, since the intensity that you would need to hear a particular frequency would increase. There were candidates who did not know that 10^{-8} was greater than 10^{-12}. Candidates misused frequency for intensity.

In Part (b) (i), the majority of candidates did not recognize that upon reflection that the reflected sound would have a smaller amplitude than the incident sound wave due to loss of energy and hence upon destructive interference, the wave would not completely cancel out. Some candidates did not recognize that the destructive interference is caused by the interaction between the incident wave and the reflected wave and not interference between the incident wavefronts.

For Part (b) (ii), a fair number of candidates calculated λ and subsequently the frequency, f, based on their interpretation of the diagram drawn in the question. However, there were some candidates who were not able to calculate λ. Some candidates did not even know the formula $v = f\lambda$. Many used λ as 2.25m.

In Part (b) (iii), the vast majority of candidates calculated λ correctly but were not able to go on and determine the distance from the wall. They did not recognize that there was a node at the wall and that the distance between the node (which occurred at the wall) and the next node was $\lambda/2 = 1$ m and hence the maxima in between would be $\lambda/4 = 2/4 = 0.5$ m from the wall.

Answer: (a) (iii) 96dB

Question 6

The examiners were dismayed by the number of candidates who could not use their knowledge of the transfer of energy by radiation to give an adequate explanation of the greenhouse effect in Part (a).

The conduction of heat through the walls of a stove and the subsequent loss of this energy to the surroundings was the subject of calculations in Part (b). The majority of candidates had little difficulty calculating the rate of conduction, 277 kW, and scored well.

Few candidates scored more than one or two marks for the remainder of Part (b). Even though candidates were able to write the equation for Stefan’s law, they were unable in most cases, to use it: they either selected the wrong temperatures or failed to convert correctly to Kelvins. Only the very best candidates obtained the correct answer of *185 kW.*

Part (b) (iii) seemed to be misunderstood. It was expected that candidates would see that the rate of radiation away from the stove was 92 kW less than the rate of conduction to the outside of the stove and that this difference must be accounted for by conduction to the surrounding air and subsequent convection currents.

Paper 03/2 – Alternative to Internal Assessment

This was the second year that this paper was offered. Seven candidates wrote Unit 1 and six wrote Unit 2. Unfortunately, there was no improvement when compared with 2009. The responses were poor and again supervisors failed to submit the required information needed by the examiner to assist with the marking. Entries were from three different centres and only one of these centres submitted a Supervisor’s Report.

UNIT 2

Paper 02 – Structured Questions and Essay Questions

Question 1

Candidates found it relatively easy to score more than half of the mark on this question. Once they had studied the topic on capacitors in the syllabus, it was easy to apply the formulae to Parts (a) (i) and (a) (ii) even if the definition for capacitance was not accurately stated. Part (b) involved taking data from one graph and completing a table to plot another graph. This task could be carried out with any knowledge of capacitors. Where candidates fell down, however, was in making the conclusion in Part (b) (ii). Every Physics student should be able to make a conclusion such as '*y* is directly proportional to *x* if the graph is a straight line passing through the origin'.

Answers: (a) (ii) 13×10^{-3} C; (iii) 38×10^{-3}J]

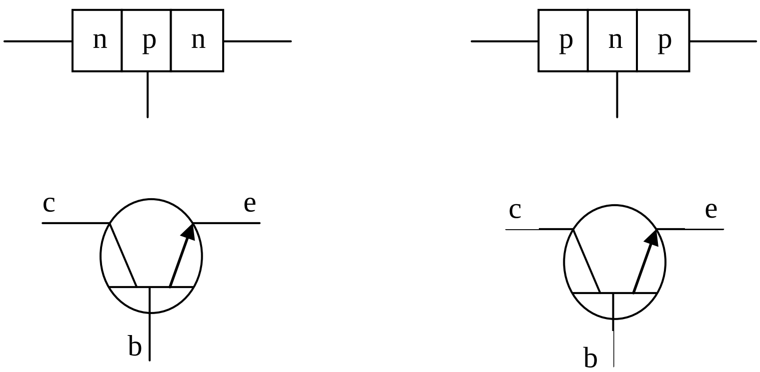
Question 2

In Part (a) (i) a), it was not enough to say that p-type materials had positive charge carriers; these carriers had to be identified. Therefore, few candidates could state a p-type material as a semiconductor material in which holes are the majority charge carriers.

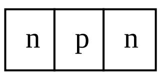
For Part (a) (i) b), candidates found it difficult to explain that n-type material has electrons as the majority charge carriers.

For Part (a) (i) c), many candidates were not aware that the depletion region is an area where there are no charge carriers, that is, it is devoid of charge carriers.

With regard to the diagram of a junction transistor, Part (a) (ii) was poorly done. Many candidates were not able to correctly draw the diagram along with the corresponding symbol for it.



Many candidates drew the diagram incorrectly with no connections, for example:



Most candidates drew the symbol for the semiconductor diode instead of the transistor and some candidates did not place the arrow on the emitter for the symbol.

The majority of candidates completed the table correctly in Part (b) (i). However, some of them did not know how to find the ℓn of numbers, while others converted the values of ℓn μA to Amperes and then tried finding ℓn, hence getting negative values for the table.

In Part (b) (ii), the majority of candidates were able to plot the graph, however, the major problem with the graph was the choosing of an appropriate scale for the axes. Teachers need to focus on this aspect of graph plotting with their students and also on the drawing of the line of best fit.

Some candidates plotted V against ℓnI, showing clearly that they were not aware as to which variable goes on which axis.

There were candidates who tried to use the power of 10 on the axes to convert the decimal to whole numbers but used the wrong power. More care is required when plotting the points since many candidates plotted the last point incorrectly.

Many candidates were able to write the correct equations for Part (b) (iii). However, some of them wrote expression or proportional relationships. Teachers should remind students that equations have an equal sign. More emphasis needs to be placed on showing students how to manipulate terms with natural logs and exponents.

Although some candidates got the correct equation in Part (b) (iv), they were not able to figure out the gradient of the line m = e/nkt. They included the variable V in the expression for the gradient. With regard to the calculation of the gradient, most candidates were able to accomplish this, although some candidates were not able to correctly read off one or more of the values from the graph, or took values from the graph or table which were not on the line drawn. Hence, they calculated the wrong value for the gradient.

Of those candidates who were able to recognize the gradient as m = e/nkt, some of them were not able to transpose correctly to get n = e/mkt. There were candidates who, in calculating the gradient, multiplied the values of ℓnI by 10^{-6} in an attempt to convert to Amperes, which was incorrect. They did not recognize that the log of a quantity does not have a unit.

Teachers need to help students to sharpen their algebraic skills so that they are able to gain maximum marks for questions. Some candidates mixed up the natural log with the e, the charge of an electron (1.6×10^{-19}C).

Answer: (b) (iv) 1.4)

<u>Question 3</u>

This question focused on the concept of radioactive half-life. Part (a) required candidates to describe how to determine the half-life of a sample of radon-220 gas, whilst Part (b) involved calculations on the decay of the same gas.

A suitable method for finding the half-life of radon-220 is described in the CAPE syllabus on page 62 and in most of the texts used at this level. It was therefore very disappointing to see so many scripts in which candidates scored zero.

The calculations in Part (b) were also poorly done. Far too many candidates abandoned the half-life concept and resorted to using the exponential decay formula: surely the recognition that 108 seconds is two half-life periods and the amount remaining as radon is reduced to one quarter is much simpler. The number of α-particles emitted is then simply the number of atoms in 3 mg of radon-220.

In Part (b) (ii), many candidates used the concept correctly and reduced the activity by a half, n times either 'long-hand' or by saying that $\left(\frac{1}{2}\right)^n = \frac{1}{1000}$.

However, those candidates who used the exponential equation made the exercise much longer and were prone to making errors along the way and losing marks.

Question 4

Most candidates were able to state Kirchoffs Laws and the physical principles on which they are based. Beyond this, the weaknesses started to show up. There was difficulty distinguishing between the e.m.f and the p.d of a cell. Part (c), applying Kirchoffs Laws to the network given was a problem for many. Some candidates, after writing the equations correctly, exhibited poor mathematical skills and failed to reach the correct solution. A few of the more able candidates scored full marks on this question.

Answers: (c) (i) 0.5A; (ii) 1A

Question 5

The responses to this question reflected a complete lack of knowledge of the op-amp. Candidates either did not respond to the question or scored zero when they attempted an answer. This suggests that the topic was not taught. Scores in the range 1–4 marks were earned from b (i) – (iii), implying that some attempt might have been made at teaching the topic, but it was not clearly understood by the candidates. This is a serious omission which needs to be corrected.

Answers: (b) (i) 3.0V; (ii) 0.42V

Question 6

The number of candidate who did not respond to this question and the low scores attained by those who responded suggests that this topic was not taught or was inadequately covered. In Part (a), the sketch graph should have been labelled and not left for the examiner to interpret; some of the sketches were very poorly drawn. Part (b) was also on the topic of x-rays. Throughout the entire question, reference was made to x-rays, yet some candidates tried to do the calculations using the formulae associated with photo-electric effect. For many candidates, the only part of the entire question that was attempted was b (i) where they used P = IV. This question is a good example of why teachers should emphasize the general approach to questions involving calculations as: step 1, state equations to be used; step 2, substitute values in equation; step 3, state calculated value with unit where applicable. Candidates must not be allowed to juggle with numbers and then state an answer. Instruction 4 on the front page of the question paper reads: All working MUST be CLEARLY shown.

Answers: (b) (i) 60 W; (ii) 1.33×10^{8} m s^{-1}; (iii) 24.9×10^{-12} m

Report on Internal Assessment Moderation

The following issues arose out of the moderation exercise.

a) Number of Assessments

There were numerous cases where only two assessments were done for each skill. The moderation team thought that this was inadequate and did not represent an advanced level assessment of the course. The team recognized that this action could have originated from a misinterpretation of a clause in the CAPE Physics Syllabus (p. 67), Specific Guidelines for Teachers #5, which states:

> The mark recorded for each skill assessed by practical exercises should be the average of at least two separate assessments.

As a result, many centres submitted two assessments for each skill. In some of these situations, the two exercises did not meet the basic CAPE standards and therefore moderators were hard pressed to find legitimate exercises to moderate.

b) No Assessment of Manipulation and Measurement

In some cases, there was no way of verifying how the manipulation and measurement scores were determined. There was no record of the marks in candidates' books.

c) No Mark Schemes Submitted

The number of cases where mark schemes were not submitted diminished over the previous year. However, there are still some occurrences.

d) Mark Schemes Inadequate for Some Skills

Some centres continue to assess exercises using criteria that do not match the skill, for example, many centres include 'plotting points' as Analysis/Interpretation criteria when it is an Observation/ Recording/Reporting skill. Invariably, an inordinate number of marks were assigned to these criteria. This inflated candidates' marks.

Some centres failed to show how marks were assigned to the criteria. While marks were assigned, it was unclear how the marks were awarded and almost always, candidates were awarded full marks. The team also noted that the criteria must be specific to the task at hand. In an attempt to use the same criteria for more than one exercise, some centres allowed the use of a common mark scheme. There were cases in which one mark scheme was constructed to 'fit' all exercises. This is not recommended.