CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2008

PHYSICS
(REGION EXCLUDING TRINIDAD AND TOBAGO)

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CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2008

GENERAL COMMENTS

The performance of candidates in the 2008 examination was similar to that of 2007 with the mean score of the Multiple Choice papers significantly higher than that on the written papers.

The examiners see the need for candidates to gain more experience in problem solving and in analysis and interpretation of graph data. In the latter case, they would like to emphasise the syllabus' call for four or five practical exercises to be performed in each module, including some experiments which test hypotheses.

DETAILED COMMENTS

PAPER 01

Multiple Choice

There were several items in which candidates showed poor reasoning skills and could not select the best response.

Module 1

1. Less than 30 per cent of candidates knew that if xy = constant and graph of y against x would be a curve. Most thought it would be a straight line through the origin.

2. Few candidates could work out how gravitational field strength 'g' would vary with height above the Earth's surface.

3. There were instances when candidates were tempted into choosing options for which quantities which they should know are constant changes, for example, the acceleration due to gravity at the Earth's surface, or the work done on various masses when a constant force moves through the same distance.

Module 2

4. The formula for the period of a mass on a spring is $T = 2\pi\sqrt{\frac{m}{k}}$: it does not depend on the value of g. But more than 80 per cent of candidates thought it did.

5. When students learn a formula it is essential that they also understand all of the terms. In the interference equation $\frac{\lambda}{\alpha} = \frac{x}{D}, X$ is the fringe spacing, that is, the distance between two adjacent fringes and should not be confused with the total width of the pattern.

6. The relationship between the number of lines per metre and the spacing of the lines in a diffraction grating was poorly understood by a majority of candidates.

Module 3

7. Candidates ought to realise that in a composite thermal conductor the largest temperature difference occurs across the portions with the lowest conductivity. In this exam most of them opted for the opposite conclusion.

8. Confusion between the molar value and molecular value of the kinetic energy of a gas caused about half of the candidates to choose the wrong response for any item on this topic.

9. Few candidates knew the meaning of the term "isothermal".

Unit 1

PAPER 02

Section A

<u>Question 1</u>

The graph in this terminal velocity question was drawn competently by the majority of candidates but the explanation of its shape which followed was often poor, many candidates gave a description rather than an explanation. A good answer would have mentioned that the acceleration was decreasing as the resistance to motion increased as the sphere moved faster.

Many candidates were able to successfully calculate the mean acceleration by using the graph to find the change of velocity and dividing by the time interval. Those who tried to estimate the gradient were less successful.

In Part (b) the inability to manipulate the formula was the downfall of a significant percentage of candidates. (Mean score 8.2/15)

<u>Question 2</u>

Some of the responses to Part (a) were rather vague and did not contain much physics. The examiners were expecting candidates to know that a standing wave is set up on a guitar string and that this vibration then causes a longitudinal sound wave to be transmitted through the air to the air.

The first two sections of Part (b) were fairly well understood but in Part (b) (iii) candidates struggled, with many candidates not knowing how to set out a (mathematical) derivation.

Having been given the relevant formula candidates were expected in Part (c) to find the velocity of the wave from the gradient ($= v/2L$) of a graph but most candidates, though able to plot the graph were, disappointingly, unable to make any further headway. (Mean score 7.1/15)

<u>Question 3</u>

The mean score on this thermometer question was significantly lower that the other questions in Section A, only a minority of candidates seemed to have understood the principle of the use of a constant-volume thermometer. Indeed, very few candidates even knew how to achieve a constant volume of gas by adjusting the height of the mercury. Instead they talked about avoiding leaks in the glass bulb or the rubber tube.

The attempts at calculating the pressure of the gas Part (c) were also very disappointing, the minority of candidates who used $p = pgh$ either forgot to add on the atmospheric pressure or simply added 76 to the answer in pascals! (Mean score 4.6/15)

Section B

For all of the questions in Section B, candidates' responses were generally poor, seeming to indicate a lack of preparation for this type of free-response question. Each question required first demonstration of knowledge of a key topic in the respective module but candidates' writing and explanations were so poor that they gained few marks. The application of basic principles to the solution of numerical problems was not much better and the scores in the second part of these questions were also low. Perhaps candidates need to be reminded that they must practise doing these longer questions during their revision rather than merely reading their notes or text books and hoping it will all work out in the exam.

Question 4

In Part (a), candidates were expected to show an understanding of the vector nature of the quantities involved in circular motion, the velocity changes directions and so are not constant and no work is done by the centripetal force since there is no displacement in the direction of the force. Many candidates gained marks only for the formula in Part (a) (ii).

Some candidates confused the conical pendulum in Part (b) with the simple pendulum and wrote $T = 2\pi$ √L/g and then proceeded to interpret *T* as the tension in the string! Others did not recognise that there were only two forces acting, the weight and the tension and found difficulty proceeding. There were only a few better candidates who were able to resolve the forces successfully and calculate the tension in the string and the speed of the mass.

Most candidates recognised that if the string breaks the mass will fall to the ground as a projectile. However, only a minority were able to see that the initial vertical velocity would be zero and that the time of fall could be calculated from $s = \frac{1}{2}at^2$. (Mean score 2.3/15)

Question 5

The principle of the diffraction grating is that each fine slit, by diffraction, becomes the source of light waves which then interfere with waves from the other slits to produce spectra. Though there were some good responses to Part (a), often candidates' discussion of this principle was sketchy and many candidates did not produce the required wave diagrams to show their understanding of *diffraction* and *interference*.

The calculations in Part (b) were generally poorly done. The most common error being the substitution of the number of lines per metre for the value of *a* in the formula $a \sin \theta = n\lambda$.
(Mean score 3.3/15)

Question 6

In spite of Rumford's historic experiments, the caloric theory still lives on the minds of this year's CAPE candidates. No matter how many times their teachers must have told them that "heat" is not a thing but, like work, a description of a way of transferring energy, they are still unable to differentiate between Q *and* ΔU in the first law of thermodynamics. This difficulty in many cases permeated the whole of their response to this question and caused the mean score to be very low.

In Part (b), candidates were generally unfamiliar with the fact that the work done in a cycle may be found from the area enclosed on a p-V diagram. The use of the gas law in (ii) was much better but few candidates were able to use the molar heat capacities to find the energy added as heat and hence the efficiency. (Mean score 3.1/15)

Unit 2

PAPER 01/Multiple Choice

The paper was well designed and did not pose too many problems for a candidate who was well prepared for the exam.

Module 1

Question 1

In Module 1, only two of the fifteen questions had a high number of incorrect responses associated with a particular key.

Question 14: 33 per cent of the candidates chose Key B instead of Key D, because they chose the ratio as 1 : 8000 instead of 1800 : 1 even though it was clearly stated in the stem of the question what was required.

Question 6: 45 per cent of the candidates chose Key B instead of Key C from a question based on the unit of permittivity. They were unfamiliar with the physical quantity permittivity and could not deduce $C^2\ N^{-1}\ m^{-2}$ as the correct response; the majority chose $N\ m^{-2}\ C^{-1}$

Module 2

Most of the questions in this module carried a diagram which the students had to interpret in order to choose the correct key. Only one of the questions in this module had a large number of incorrect responses. The use of a potential divider seems not to be clearly understood.

Questions involving logic gates were well done with many correct responses (constructing Truth tables is always an easy task), while questions on the op-amps obviously proved to be more challenging and requires a lot more thought and application of knowledge.

Module 3

The most challenging questions in Module 3 were both on Millikan's oil drop experiment. The concept of a changed oil drop and quantization of charge is not clearly understood. Perhaps this experiment is too difficult to visualize and few students have even done this experiment.

Unit 2

PAPER 02

Section A

Question 1

This question tested candidates' understanding of the standard technique for dealing with exponential data, that is, the use of linear natural log graph. Though few candidates used irregular scales or scales made too small by the inclusion of the origin, the plotting was for the most part quite satisfactory. However, the overall scores on this question were low due to poor interpretation of the significance of the intercept and gradient of the graph.

In Part (d), candidates were expected to see that the voltage would fall from the 3 v provided by the battery in the same exponential manner as the current. This proved to be surprisingly challenging. (Mean score 5.7/15)

Question 2

This question was mainly about the implementation of logic circuits using NANS gates. Many candidates seemed not to have studied this topic and could make little progress.

For some candidates the only marks gained would have been for the Truth table in Part (b) and perhaps the drawing of the flip-flop in Part (c). Even those who could draw the NAND bistable often showed little understanding of its operation. (Mean score 5.7/15)

Question 3

The current in a photocell remains constant once the voltage is sufficient to attract all of the produced electrons to the anode, further increases in the p.d. can have no effect on the current. This principle was not familiar to most candidates but they scored well on the other parts of Part (a).

In Part (b), the graph plotting was fine but again the extraction of values from the graph was very poorly done. (Mean score 6.4/15)

Question 4

Though Lenz's law was known by almost all the candidates, its application to the "jumping ring" demonstration proved to be beyond all but a few. Even those candidates who did explain that an induced current in the ring would cause a field which opposed the field in the iron core could not take the argument further to say that a slot cut in the ring would prevent current flow and hence the ruing would no linger jump.

Most candidates knew that flux was defined by the equation $\varphi = BA$ but they forgot to multiply by the number of turns when calculating the total flux through the coil in Part (c). Although the examiners applied "error carried forward" in the remainder of Part (c) the marks were still mediocre as candidates failed to recognise the fact that the maximum value to the e.m.f. offered when the sine of the angle was equal to 1. (Mean score 3.5/15)

Question 5

Imprecision caused candidates to lose credit in Part (a). Only the better candidates used Kirchoff's law correctly at Point X in the op.amp. circuit and then stated that $I_1 = I_2$ since I_3 would be zero if one assumed the op.amp. had infinite input impedance. Many candidates carelessly wrote $I_1 = I_2$. Later in their derivations they would "fudge" another incorrect sign to obtain the required answer.

Only a few candidates plotted the required *suitable graph* in Part (b) – the examiners expected candidates to be familiar with the standard techniques of data analysis at this stage in their physics education but were sorely disappointed. Perhaps teachers need to provide more exercises in the laboratory which involve plotting *linear* graphs to test hypotheses – candidates should not be plotting curves from raw data and then concluding, by inspection, that the relationship is true because "R goes up when A goes down". (Mean score 5.3/15)

Question 6

There were some good attempts at dealing with the concept of binding energy in Part (a) though the last part proved difficult since candidates did not picture Helium-4 as an alpha-particle which could be emitted whole in a radioactive decay.

The radioactive decay equation for radon in Part (i) was understood by most candidates and the attempts in Part (ii) to find the number of atoms present were creditable though tended to lose marks through careless calculations. However, Part (iii) confused most candidates, they knew that power was energy divided by time but the time they used was the half-life! Only the more thoughtful noticed that every decay would release 6.3 MeV (= 1.06×10^{-12} J) and so they merely had to multiply by the number of decays per second. (Mean score 4.2/15)