CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2011

PHYSICS

GENERAL COMMENTS

There was an increase in the number of candidates writing the Unit 1 examination from 2,982 in 2010 to 3,208 in 2011. However, the number of Unit 2 candidates decreased from 2,143 in 2010 to 2,079 in 2011.

In both units, a major concern was the failure of candidates to pay attention to significant figures in spite of the warning of penalties stated at the front of the exam papers. There were cases where the question data was given with three significant figures but candidates gave answers with only one figure, for example, 0.01 mol instead of 0.0114 mol [Question6, Unit 1], causing all subsequent calculations to be inaccurate. Additionally, in responses to the same question the examiners also saw pressures written as 21 382.82 Pa. It is important that teachers stress the use of significant figures rather than merely the simplistic instruction '*Answer to two decimal places'*.

Physical quantities usually consist of a number and a unit but candidates at both levels were frequently omitting the units in their responses. Some candidates added 90 J + 475 K to get 565 J [Question 6 Unit 1] or subtracted distance in cm from the count rate, for example, 427 counts per minute - 30 cm = 397 counts per minute [Question3 Unit 2]. These errors were very common. Teachers need to be aware of this problem and, throughout the course, emphasize the requirement that all physical quantities have a magnitude and a unit and that all equations have consistent units in each term.

Using the gradient of a graph to get an accurate mean value of a quantity is standard practice in Physics; however, many candidates in both units lacked this skill. In many cases, they were content to take two values from the table and substitute in the given formula, defeating the object of plotting a graph. Better candidates used the equation to find the significance of the gradient and hence the value of the required quantity (for example, Question 2 Unit 1 where the gradient was $\frac{1}{2}\sqrt{(T/\mu)}$). However, many forfeited marks by using points from the table rather than a large triangle on the graph for the calculation of the gradient.

DETAILED COMMENTS

UNIT 1
Paper 02 – Structured and Free Response Questions

Question 1

A weakness in deriving equations for a given situation was evident in this item about falling under the influence of gravity with a non-zero drag force. Candidates were expected to use the free body diagram in (a) (i) as a starting point but many of them tried to work backwards from the final equation for the acceleration.

The graph plotting was not, in general, of a high standard: the scales chosen for the log graph sometimes made the positioning of points difficult and the weaker candidates were unable to cope with lg *(g-a)* having both positive and negative values.

Question 2

The phenomenon called ‘resonance’ was known by most candidates but the concept of a standing wave being produced in the air column above the water and producing a loud sound was not well explained.

The graph required in Part (b) was drawn accurately by the majority of candidates but many of them subsequently lost marks by not getting an accurate value for the gradient or by not using it to determine the mass per unit length of the wire.

Question 3

Writing the definition of specific latent heat of fusion was expected to give candidates an easy mark. However, several candidates lost marks as a result of omitting fundamental parts of the definition such as ‘per kilogram’ or ‘at constant temperature’.

The use of a large gradient triangle for the two gradients would have given candidates full marks but some of them used points too close together or even points which were not actually on the line. Linking the slower temperature rise per minute for the liquid to the specific heat capacity also proved to be challenging for many candidates.

The calculations based on the graph in Parts (iv) and (v) were not well done: the use of unconventional units like J per minute should not be beyond the ability of candidates at this level. Teachers might need to give their students more practice to develop problem-solving skills, rather than simple questions which just require equation substitution.

Question 4

There were many good responses to this question about conservation of mechanical energy and projectile motion. Marks were lost by those candidates who, without explanation, used equations of linear vertical motion to calculate a horizontal velocity instead of energy conservation, used the wrong height in the energy calculation (this was quite common) or failed to apply $s + U_v t + ½at^2$ correctly with $U_v = 0$ for the vertical component of the motion of the skier.

Question 5

Candidates did not perform satisfactorily on this question. The idea that refraction is a *bending* of light caused by transition into a different medium and diffraction is the *spreading* of light due to an obstacle or gap was poorly understood and the discussions of the action of a grating were consequently poor.

Part (b) was a standard diffraction grating calculation. Obviously, some candidates did not have adequate experience of this type of problem and found it very difficult.

Question 6

In general, candidates' responses in this thermodynamics question were very poor. The few marks gained were usually for the calculations in Part (a) and Part (c) involving the application of the gas laws.

There seemed to be great difficulty in using the kinetic theory of gases and also in grasping the meaning of the first law of thermodynamics. Many candidates confused the concepts of heat, temperature and internal energy and used them interchangeably. On several occasions, the examiners came across equations similar to

$$\Delta U = \Delta\theta + \Delta W$$

(either written explicitly or implied) and some candidates even wrote "Heat energy evolved from the work done on the gas is 790 K -315 K" and proceeded in Part (d) to add 90 J + 475 K to get an increase in internal energy of 565J.

Teachers need to be aware that they cannot assume that, having passed CSEC Physics, all of their students will have understood the difference between *heat* and *temperature*. Without this concept it is going to be very difficult to get across the idea that the internal energy (and temperature) of a substance can be raised when the substance has not been heated. It would also help if teachers used the form of thermodynamic law stated in the syllabus $\Delta U = Q + W$ (sic, with no extra deltas) which can be read as *the internal energy can be raised either by heating or by doing work on it*, thus emphasizing the fact that doing work can also raise the temperature.

UNIT 2
Paper 02 – Structured and Essay Questions

Question 1

Magnetic flux density is defined from the equation $F=BIL$ where B and I are at right angles. Many candidates lost marks by not paying attention to details in their definitions omitting *per unit current* or *per unit length.* Some defined the tesla or the weber instead.

The drawings of the 'catapult' field around the current-carrying wire in a uniform field were extremely poor: most candidates had little idea of how the fields interacted to give an upward force on the conductor.

More care should have been taken with the derivation of the relationship between the crossed fields when the beam of electrons was undeflected. Many candidates' working could not be followed because they used the same symbol F for both types of force. However, the subsequent calculations were usually done accurately.

Question 2

A number of candidates were either unable to attempt this question or were only able to score one mark. This may have occurred if Module 2 was the last module taught and therefore teachers rushed through this portion of the syllabus. Based on the responses, what was evident was that candidates require more help understanding digital electronics. Teachers need to be aware that there is a problem and seek to remedy this.

An RS flip-flop has the strange property that for *the same input* there are two different complementary output states. Most candidates who attempted this question did not understand this and performed poorly on Part (a).

Candidates experienced difficulties in attempting to show the connection of NOR gates to form a bistable. Many of them tried to use all four NOR gates on the Quad-NOR chip even if their rough work showed the correct circuit. Schools must find ways of purchasing the equipment needed for this section of the syllabus, if their students are to gain a full understanding of these circuits.

Overall, candidates were able to score better on the other parts of the question and showed a good grasp of the use of timing diagrams.

<u>Question 3</u>

The majority of the marks were awarded for adding radiation labels to an 'absorption' diagram and plotting a straight line graph. Candidates scored well on these aspects. They lost marks, however, for not being able to find the corrected count rate from the given data, and not manipulating the information to come up with the correct equation for the linear graph.

<u>Question 4</u>

The formula for the capacitance of a combination of capacitors in series was well known though candidates' 'proofs' were not well set out or had no diagram. Many candidates misread Part (a) and had three capacitors even though the instructions were in bold.

Candidates' charge/discharge circuits often included irrelevant components (for example, ammeters) and many of the circuits shown would not have worked. More circuit work in the laboratory would probably improve candidates' ability to 'read' diagrams and set up circuits correctly.

The analysis of the graphical data provided proved to be challenging for some candidates. Only the better candidates understood the concept of a time-constant in seconds and were able to interpret the gradient correctly to obtain the value of C for the combined capacitors.

<u>Question 5</u>

Like the corresponding question on Module 2, the performance of candidates was very poor. Few candidates understood the principle of the operational amp. comparator and so they were unable to recognize that saturation occurs when one input voltage exceeds the other by a few microvolts. The production of a square wave with a non-unity mark to space ratio by changing the reference voltage was therefore beyond the experience of most candidates.

From the more well-prepared candidates there were some good diagrams of the non-inverting amplifier in Part (c) and most of these were able to make good attempts at solving the numerical problems.

Question 6

Teachers will need to pay more attention to the teaching of the physics of nuclear fission judging from the many poor attempts at the first part of this question.

The calculations based on the comparison of nuclear fuel with fossil fuel were performed successfully by many. Weaker candidates had difficulty with using powers of ten on their calculators and quite a few were confused by the 25 per cent efficiency and as a result had an energy output greater than the input.

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

UNIT 1

Only eight candidates wrote this paper. Overall their performance was rather weak.
Question 1, which concerned the data collected from an experiment on the collision of two pendulums, was not well done because, it seemed, candidates could not handle the trigonometry required.

The collection of data for the path of light through a prism in Question 2 using pins was not done carefully enough for candidates to plot good graphs from their data and so the submitted values of the refractive index were quite inaccurate. Perhaps these candidates lacked experience in doing simple optical experiments.

Question 3 which focused on finding absolute zero using a gas thermometer also proved to be unfamiliar to most of the candidates and their efforts were not very convincing.

UNIT 2

Most CAPE candidates are able to do the internal assessment at school and this paper continues to attract a very small number of entrants (that is, six candidates). Like the Unit 1 paper, there was one actual experiment and two written structured questions on this paper.

Question 1 required clear descriptions of how an electrolysis experiment would be conducted but candidates' poor English let them down.

The experiment in Question 2 was performed fairly well though some candidates had to enlist the supervisor's help in connecting the potential divider to the diode.

Similarly, the descriptions of experiments to illustrate exponential decay in Question 3 were poorly written but candidates were able to recover to some extent by drawing good graphs in Part (b) and concluding that the experiment showed the random nature of radioactive decay.

Paper 031 – School-Based Assessment (SBA)

Across both Unit 1 and 2, performance on the SBA component of the examination was consistent with that of 2010. However, there is one particular area of concern that has been noticed and needs to be addressed. There are numerous cases where only two assessments are done for a particular skill. This is inadequate. This stems from a misinterpretation of the CXC CAPE syllabus, (page 67, specific guidelines for teachers #3), which reads *The marks recorded for each skill must be the average of at least two separate assessments.* As a result, some centres submitted two assessments in each skill.

In some cases, those exercises did not meet CAPE standards and therefore moderators were hard-pressed to find legitimate exercises to review.

There has also been a noticeable increase in the number of centres for which adverse comments had to be made. These comments were directed at concerns that were addressed over the years. There was a recurrence of some of these concerns. These include:

Planning and Design (P/D) exercises

- Many of the exercises chosen could be found in a textbook. These types of exercises cannot be done as P/D exercises without modification.
- There was an apparent lack of guidance from the teacher. Some procedures were totally far-fetched and well nigh impossible.
- Most P/D exercises involved and were limited to the theoretical testing of a hypothesis. The team noted that very few P/D exercises were executed.
- There was an absence of mathematical concepts in those exercises that were executed.
- There were some exercises that were trivial. Invariably, teachers awarded full marks for these exercises.

Analysis and Interpretation (A&I) exercises

- Some centres tried to apply the same mark scheme to all A/I exercises.
- Some Observation/Recording/Reporting (O/R/R) criteria were mistakenly used as A/I criteria. This occurred most frequently in the exercises that involved the plotting of graphs.
- There was a general lack of discussion of errors that were peculiar to certain exercises. The analysis aspect of the skill was therefore lost.
- Significant figures were incorrectly applied.
- Units were omitted where they were required and inserted where they were not required.

There were instances where there was no evidence that the other skills Manipulation/Measurement and Observation/Recording/Reporting were assessed. Yet still candidates were awarded full marks by their teacher. This inflates the marks and distorts the entire picture.

It should be stated that there were some positive indicators that should be noted, namely:

- There was some improvement in the quality of mark schemes in some centres.
- There is some evidence of communication among teachers who participate in the CXC marking exercises. However, the message has not gone to those who do not participate.