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

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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

$$\text{Speed of the laser light} = \frac{2 \text{ x distance travelled by the light}}{\text{Time}}$$

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 Strontium Iodine	
	Organ disorders	Iodine Technetium	
	Kill cancer cells	Cobalt	γ - radiation
	Kill germs/ bacteria		γ - radiation
Agriculture	Detect leaks	Sodium	β - radiation
	Monitor food uptake in plants	Phosphorous	γ - radiation
	Test welds	cobalt	α, β - thin sheets
	Measure sheet thickness		γ - 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.