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

MAY/JUNE 2011

INTEGRATED SCIENCE
(SINGLE AWARD)
GENERAL PROFICIENCY EXAMINATION

GENERAL COMMENTS

The CSEC examination in Integrated Science (Single Award) was offered at the General Proficiency level in 2011. The June 2011 examination consisted of the following papers: Paper 01 — Multiple Choice; Paper 02 — Short-Response Questions; Paper 03 — School-Based Assessment and Paper 032 — Practical Paper (taken by private candidates)

Approximately 22,822 candidates sat the examination. There was an increase in the number of candidates entered for the examination when compared with 2010. Performance in 2011 was comparable with that of 2010.

Integrated Science continues to be well received across the Caribbean, as indicated by its increasing population over the years. This subject therefore contributes, as intended, to meeting the needs of our secondary level schools in the area of science education.

The CSEC Integrated Science syllabus is designed to *allow students to work individually and cooperatively, utilizing theoretical concepts of the course in interactive and practical activities* (CXC Integrated Science Syllabus, 2011, p.1).

There has been a noticeable improvement in candidates' performance in some physics-based topics (for example, electricity). It is important that within the school system, a variety of strategies continue to be explored for optimizing the benefits that may be derived from implementing the CSEC Integrated Science syllabus. Strategies promoting collaboration among teachers who are often subject specialists in the areas of Biology. Chemistry and/or Physics are anticipated to be beneficial to students as they could facilitate team planning and/or teaching and encourage adequate integration among topics often associated with the single subjects. Analysing environmental scenarios and phenomena as a whole, in an integrated manner, relevant to the syllabus may, further assist students in appreciating the relevance of science to everyday life.

DETAILED COMMENTS

Paper 01 – Multiple Choice

Paper 01 consisted of 60 multiple-choice items. The mean score earned at the General Proficiency level decreased by approximately 4 per cent from 61 per cent in 2010 to 57 per cent in 2011.

Paper 02 – Short-Response Questions

Paper 02 consisted of three short-answer, structured questions, one data analysis question and two essay questions. The maximum mark for Question 1, the data analysis question, was 25 marks while Questions 2–6 were worth 15 marks each; the maximum marks for the paper was 100. The mean score earned on this paper was approximately 56 per cent.

Question 1

This question tested candidates' understanding of the process of photosynthesis, energy, alternative sources of energy and pollution. In addition, this question tested candidates' data analysis skills. The question was fairly well answered with many candidates scoring most of the available marks.

For Part (a) (i), many candidates correctly identified chemical energy as the kind of energy that is stored when green plants make food. Some responses incorrectly identified kinetic energy.

For Part (a) (ii), in which candidates were asked to name the substance that is combined with carbon dioxide during photosynthesis, many responses correctly indicated water but others though reflecting an acquaintance with the equation for photosynthesis, incorrectly pointed to reactants (input/output substances or energy) such as sunlight, glucose, oxygen and chlorophyll, rather than water.

For Part (b), in which candidates were asked to describe how plants and animals may become fossil fuels, some responses showed a fair idea of how fossil fuels were formed, but few candidates gave complete answers. Many of the responses indicated only one part of the process, that is, either *buried in the soil* or *decayed and left in the soil/earth*. Few candidates indicated *heat energy* and *pressure* as conditions involved in fossil fuel formation. Many candidates stated that it was simply 'death and decay/decomposition of plants and animals'. Many candidates ignored the time — *millions of years* as a factor in the formation of fossil fuels. Only a small number of candidates included correctly that *plants became coal* and *animals became oil*.

For Part (c), in which candidates were required to name two alternative sources of energy which may be used for generating electricity for a flat tropical country, some candidates gave appropriate responses such as *solar*, *geothermal*, *wave*, *tides*, *nuclear* and *biomass* sources. However, some responses indicated inappropriately 'water energy/hydroelectricity', not factoring in the fact that the country was flat or that water needed to fall from a height in order to generate hydroelectricity. This part of the question was generally well done.

For Part (d), which required candidates to give a disadvantage of each alternative energy source given in Part (c), many responses were satisfactory and were followed in many instances by appropriate disadvantages. Unsatisfactory responses did not link the alternative energy sources to the disadvantages. For example, in Part (c), a typical response may be *solar energy* as an alternative energy source and in Part (d), an appropriate response would be *during periods of bad weather or during the rainy season, less solar energy would be captured*.

Part (e) tested candidates' understanding and ability to use knowledge about fossil fuels and problems associated with them. For Part (e) (i), the most common correct response was *carbon monoxide*, one of the pollutants added to the atmosphere because of the increase in the number of vehicles. *Noise pollution, smoke, fumes from petrol and lubricants* as well as *oxides of nitrogen* were among the appropriate/acceptable responses.

For Part (e) (ii), some candidates were not able to link the pollutant to its negative effect on the environment as required. While some candidates were able to state *acid rain*, *global warming*, *death of plants* and *animals* (loss of biodiversity), they were unable to make the link between specific pollutants and their negative effect.

For Part (e) (iii), some candidates indicated two of the following points as expected for the two negative effects of increased levels of carbon dioxide on the Caribbean environment: *global warming, climate change, rise in sea level, increasing acidity of oceans, increased erosion of limestone*. For Part (e) (iv), common correct responses included *skin cancer*, *cancer*, *various respiratory infections*/*diseases* and *death* (effects of the pollutants on health).

For Part (f) (i), candidates were required to plot and interpret a graph. This part of the question was generally well done. A smooth curve (fine line) was expected and not broken, thick, jagged or double lines as seen in some cases.

Parts (f) (ii) and (f) (iii) were generally well done. For Part (f) (iv) the expected response was 1977–1983.
The correct response for (f) (vi) was China.

Recommendations

- Students could benefit from practice in answering questions relating to different contexts; teachers should give them opportunities to apply their knowledge paying attention to certain key conditions and elements.
- Candidates need more practice analysing data from graphs.

Question 2

This question tested candidates' understanding of the structural similarities and differences of cells of two common organisms: plant (grass) and animal (rabbit), as well as their understanding of food chains and the structure of a tooth. This question was fairly well answered by most candidates.

For Part (a) (i), many candidates correctly stated similarities between the cells of plants (grass) and animals (rabbit). Acceptable answers included *presence of nucleus*, *a vacuole*, *cytoplasm* and *cell membrane* in both cases.

For Part (a) (ii), many candidates correctly stated differences between the cells of plants (grass) and animals (rabbit). Acceptable answers included *cell wall, larger vacuole,* and *chloroplast,* found in plant cells

For Part (b) (i), many responses correctly indicated grass as the producer; and correctly explained as required in Part (b) (ii), that the grass is a producer *because it manufactures food through photosynthesis*.

For Part (b) (iii), the likely effect on the food chain if a drought kills all the grass in that area was satisfactorily indicated by many candidates. Satisfactory responses included *the rabbits will eventually die* or *there would be a decrease in the number of rabbits*.

Part (c) (i), was fairly well done by many candidates, however much attention needs to be given to the spelling of the names of the parts of the tooth. The expected responses were:

- A: Crown
- B: Root
- C: Dentine
- D: Enamel

For Part (c) (ii), the type of tooth shown was correctly identified by many candidates as a *molar*.

In Part (c) (iii), one other type of tooth was also correctly identified by most candidates.

For Part (c) (iv), many candidates correctly suggested two features of a rabbit's tooth that make them suitable for its diet. Acceptable responses included *flat surface for crushing and grinding*; and *sharp teeth for cutting* .

Question 3

This question tested candidates' understanding of heat transfer, reflex action and sea breeze formation. Overall, this question which was highly integrated was not well done.

For Part (a) (i), in which candidates were required to suggest how energy is transferred, many responses contained merely the definition of heat transfer methods and not the expected *radiation* as well as by *absorption of heat energy by the handle of the hammer*.

Part (a) (ii), which required candidates to explain the difference in the temperature of the handle of the hammer and the nail, was not well done. The appropriate response was: *More of the heat energy absorbed is stored inside the nail than the wood because the nail is a better conductor of heat energy. This heat energy is easily conducted to the hand by the nail.*

Part (a) (iii), which required candidates to explain how the nervous system caused the carpenter to automatically drop the hot nail, was not well done. An acceptable response was:

- The nervous system controls reflex action
- Receptors stimulated by the hot nail
- Impulses/messages pass along nerve cells to the spinal cord and signals to the muscles in hand/effector to move the hand

Part (a) (iv) required candidates to name the process by which heat energy is transferred from the nail to the carpenter's hand. The process of conduction was correctly named by some candidates.
For Part (a) (v), in which candidates were required to explain the role of the gloves in preventing the carpenters hand from being burnt by the hot nail, some responses correctly indicated that the *glove acted as an insulator to prevent the transfer of heat energy to the skin.*

Part (b) (i) required the meaning for the term *convection* as it relates to heat energy. The acceptable responses indicated that *convection occurs when heat energy is transferred (transported) as fluid/liquid or gas from one place to another.*

For Part (b) (ii), candidates were required to indicate the most likely direction of airflow by placing arrows in the diagram provided to represent the formation of sea breeze. Many candidates correctly placed the arrows in the clockwise direction.

For Part (b) (iii), candidates were required to explain why air flows in the direction that they indicated in the diagram. An acceptable response for this part was:

> *During the day the sun warms the land faster than the sea; the land heats up the air above it; warm air above the land rises into the atmosphere; the air from the sea is cooler than the land and moves onto the land to replace the air that had risen.*

While many candidates showed some knowledge of the formation of sea breezes, only a few candidates correctly suggested that *during the day the sun warms the land faster than the sea, and that the land heats up the air above it*.

Question 4

This question tested candidates' knowledge of good conductors and insulators as well as the relationship among voltage, current and resistance in circuits and safety in the use of electrical equipment and appliances.
Most candidates attempted this question. Many candidates correctly indicated *aluminum and copper* for Part (a) (i) and *plastic, rubber or wood for* Part (a) (ii).

Part (b) required an understanding of calculating voltage and current. For Part (b) (i), the correct value was given by many candidates. Some candidates however wrote the calculation 1.5V x 4 cells but provided the incorrect answer or left off the unit. The correct answer is *6V.*

Part (b) (ii) was not well done as candidates wrote incorrect values (for example, 0.25, 0.625, 2000) and some of them showed inappropriate calculations. Correct and acceptable responses included: *0V, 0A, no current, no voltage, circuit open* so no current obtained/flowing. For Part b (iii), some candidates indicated the acceptable response of the *reading on the ammeter would increase* when the circuit was closed.

For Part (b) (iv), the expected formula was (V=IR, I=V/R or R=V/I) Some candidates provided one of these formulas. Popular incorrect responses included 'Ohm's Law', 'Power and Wattage' or 'Watts'.

In Part b (v), candidates were required to substitute the correct values in the formula provided in Part (b) (iv), to calculate the current in the circuit and to include the correct unit. This part was fairly well done.

Many candidates provided one of the following correct responses as a reason why it is beneficial to use a fuse in the circuit in (b) (vi):

- To protect from overheating
- Limit, control or reduce the flow of current or electricity
- Prevent short circuit

A popular incorrect response was 'the prevention of shock/electric shock'.
For Parts (c) (i) and (ii) which required two precautions for preventing electrical shock or fire when the radio is connected to the electrical outlets, many candidates inappropriately gave responses related to the conservation of energy or the reduction of energy consumption for example, *do not play the radio all day, unplug the radio once not in use.*

Acceptable responses included:

- Avoid wetting the radio
- Check the power cord to ensure there are no breaks
- Pull plug out of the outlet by holding the plug and not the wire
- If the radio is dropped and parts become exposed, do not touch the parts
- Check that the input voltage of the mains and radio match
- Do not overload the circuit
- Use a surge protector

For Part (d), some responses did not appear to reflect an understanding of the difference between an electrical fire and other types of fires. In this part, candidates were required to identify the most appropriate fire extinguisher to put out an electrical fire. Popular incorrect responses included;

- Water
- Gas extinguisher
- Wet cloth
- Cloth
- Bush/green bush
- Carbon monoxide
- Carbonate/carbonated/hydrogenated
- Oxygen/oxygenated
- Nitrogen

Correct responses included:

- Use a carbon dioxide extinguisher
- Use a powder extinguisher
- Use sand

Part (e) was fairly well done by some candidates. Some responses however suggested that some candidates inadequately/incorrectly interpreted protective gear as any equipment for example, fire hoses and fire extinguishers.

Recommendations

- Candidates could be further guided in practising simple calculations using the required equations.
- Candidates need to be encouraged to read questions clearly, paying attention to key words that should guide responses.
- Candidates require more practice in using scientific expressions that are related to the content of the syllabus.

Question 5

This question tested candidates' understanding and ability to use their knowledge of respiration, physiological effects of exercise, sense organs and coordination.
Part (a) was generally well done. The correct labels for the diagram of the eye were:

- A: Lens
- B: Iris
- C: Retina

For Part (b), many candidates reflected very limited knowledge of the function of the lens and iris. Many of them inadequately indicated that the lens merely allowed light to enter the eye and only a small percentage of candidates used the terms *refract*, *focus*, or *image*. For the iris, there were many candidates who inappropriately wrote that its function was to 'protect the eye' rather than the correct response that *it controls the amount of light entering the eye*.

Part (c) (i) was extremely well done with many candidates scoring full marks. The function of the lungs and heart, circulation of the blood, and need for oxygenated blood to release energy, were well known. Many candidates were able to relate this to the physical exertion implied in the question.

Part (c) (ii) was not done as well, with some candidates describing general body structures such as the arms and legs and other candidates describing the nose or mouth instead of the sense organs, eye, ear and skin. For Part (c) (ii), *eye for seeing and determining direction* and *ear for balance* were acceptable responses for explaining which two sense organs enabled Fred to run up the slope.

Candidates who scored highly on this question displayed an ability to be creative in coordinating the functions of the senses with a physical activity, so that information about structure and function was linked with an understanding of the interaction of body systems.

Recommendations

- In general, candidates require more practice in spelling the names of the organs of the body
- Students can be engaged in activities and discussions about sense organs and their functions.
- Teachers could include in classroom activities, the use of models or interactive software so the structure and function of parts of the eye can be demonstrated to students in a practical way. The role of the lens and the iris can be given more attention.

Question 6

This question tested candidates' understanding and ability to use knowledge relevant to properties of metals, factors affecting rate of rusting and methods used to reduce the rusting of iron. Most candidates attempted this question, however, only some responses were satisfactory overall.

For Part (a), candidates' knowledge of the reaction of metals with acids and the relative reactivity of aluminium, iron and copper was very limited. This part in general was not well done with many candidates using inappropriate terms such as, 'rust', 'melt' and 'dissolve' to describe the reaction of the metals with dilute sulphuric acid. Some candidates stated the uses of the three metals although this was not related to the question. Other candidates simply stated that there was a change with no explanation. Frequent erroneous responses in comparing the reactivity of the metals with acid included:

- The reaction got hot
- Electricity was generated
- The metals rusted
- It exploded

Few candidates were able to give an adequate comparison of the reactions of the three metals with sulphuric acid and relate this to their position in the reactivity series. The better responses noted that *aluminium reacts very rapidly with sulphuric acid giving off hydrogen gas, because it is very high in the reactivity series compared to iron whereas copper had no reaction with the acid since it is lower than hydrogen in the reactivity series.*

Part (b) required candidates to suggest two precautions that should be taken when carrying out the reaction of aluminium with sulphuric acid, giving reasons. Many candidates gained full marks for this part of the question. Some candidates inadequately stated general laboratory safety rules as precautions for this experiment. The acceptable responses included:

- Pour acid carefully (reason — to avoid burns)
- Point the mouth of the test tube away from people (reason — to avoid accidents)
- Use protective gear (reason — to protect the body)

For Part (c), candidates were required to indicate why it is dangerous to react sodium and potassium with sulphuric acid. Many of the responses correctly noted that the reaction was dangerous because it would cause an explosion or a fire. Many responses seemed not to recognize that this danger was related to the high position and thus reactivity of sodium and potassium in the reactivity series. A common error was that the metals were strong acids.

Part (d) was the most popular part of this question with most candidates being able to identify *rusting* as the threat to the iron windows. Some candidates did not identify that *oxygen and water contributed to rusting* as required, while other candidates stated that sea salt present in the sea blast/air causes rust rather than accelerates the rusting process. Many of the better responses stated that *the paint slowed down the rusting process by forming a barrier between the iron and the oxygen and water.*

Recommendation

Scientific vocabulary must be used and emphasized in the teaching and learning of scientific concepts; for example, in this question, some candidates inappropriately used words such as 'hard' and 'big' reaction to mean a *violent/vigorous reaction*; 'rot' and 'deteriorate' were used to describe the *rusting of iron*; 'bubbles of gas' was inadequately used to describe the *evolution of hydrogen gas*.

General Recommendations for Teachers

- Overall, students could benefit from more practice on relevant structured questions, essays and data analysis items. These items could relate to practical or hands-on experiences to facilitate understanding of concrete and abstract scientific concepts and an improvement in their ability to apply their scientific knowledge to everyday life situations.

- Using models of organs where necessary, safe improvised equipment and appropriate software, students, guided by teachers could benefit from greater exposure to the practical areas of topics.

- As much as possible emphasis should be placed on the importance and functions of components as required in the syllabus. For example, attention should be given to providing examples of simple circuits, switches and fuses (exercising all safety precautions).

- Students need to be reminded about the need for performing accurate calculations and including units where required. A response is not complete without the required unit (where unit(s) is applicable). Students also require practice in using formulae for working out values.

- Students need to be reminded about the need for communicating clearly in responding to questions; they should use the appropriate scientific terms and labels where required. Attention should be paid to spelling, and unscientific abbreviations and shortened terms should be avoided. The use of scientific terms (to the level guided by the syllabus) should be encouraged.

- Students could be reminded during assessment activities to clearly number each question and its parts as they write their responses. They could also be reminded to write in the space provided for the question being answered.

There continues to be a need to guide students through the appropriate activities to distinguish between certain problematic pairs of terms. Students need more practice distinguishing between these related and sometimes unrelated concepts. *Among other terms of the syllabus, students need to be guided towards understanding clearly the differences between:*

- Eye and sight
- Skin and feel
- Rot and rust
- Protective gear and general equipment
- Reactants and factors that change the rate of a reaction

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

Paper 032 consisted of three questions; this was the first year that candidates did not have to perform a practical examination but rather were given a practical-based paper to sit in an examination room to write. This paper was designed to engage and test the skills normally assessed over approximately two years by the SBA component of the syllabus. The following skills were assessed: ORR, PD, D, AI, and MM.

Question 1

This question was well done by a few candidates. It required the drawing of a home-made balance, in two dimensions, assembled from the materials provided in a figure.

Good diagrams had correct labels, clear lines, were two-dimensional and carried an appropriate title.
For Part (b), both arrows (for A and B), should have pointed down from the dot. For Part (c) (i), the correct answer was *clockwise* to describe the side to which A would fall when released.

For Part (c) (ii), the expected response was *it experiences only a clockwise moment*. *Anticlockwise* was the expected response for Part (c) (iii).

For Part (d), candidates were required to plot a line graph using data provided, draw the best-fit straight line and extend the line to cut the vertical axis. Many candidates were able to construct the graph and gained points here. Responses could be improved with greater attention to more accurate scales, correct axes and title.

Question 2

Part (a) required candidates to measure, from a figure, the length of potato strips that were placed in a Petri dish containing water. In Part (b), candidates were required to account for the recorded changes in length at the beginning and end of the experiment and to name the process that is responsible for the change in length of the potato strips.

Parts (c), (d) and (e) required candidates to display knowledge of critical practical skills in relation to the experimental set-up in the question. The overall performance on this question was fair.

Question 3

This question tested candidates' drawing skills and the ability to measure, record and report in tabular form. For Part (a), candidates were required to draw and label a diagram of one of the measuring cylinders used in the experiment.

For Part (b) (i), candidates were required to state clearly, *it is more appropriate to use measuring cylinders in the experiment* and for Part (b) (ii), they were required to state three precautions to be taken when using measuring cylinders to ensure accurate results. Responses to Part (b) reflected limited knowledge of critical practical skills.

In Parts (c) and (d), candidates were required to display knowledge of critical practical skills in relation to the experiment set-up in one question.

The overall performance on this question was poor as candidates were unable to display knowledge of critical practical skills as they related to the specific experiment.

Paper 031 – School-Based Assessment

Overall, performance was satisfactory. However, greater effort is needed in developing drawing skills. The following comments should be borne in mind:

- Generally, notebooks and mark schemes were submitted. In some cases, student instruction sheets were not submitted.
- Generally, marks were recorded in the laboratory exercise books.
- A wide range of items were assessed for drawing.
- There were quite a few innovative ideas used for planning and designing
- Many centres provided laboratory notebooks that were not very neat, well organized and easy to mark. Many SBAs needed to be tidier and more organized. A few centres provided some acceptable books. Many centres provided laboratory notebooks that needed to include a table of contents with the date, page number and the skills assessed for each assignment.
- Generally, students' spelling required much improvement
- Many books did not reflect the provision of appropriate feedback to students. It is likely that this accounted for the fact that there was no noticeable improvement over the assessment period for some students.

Drawing (D)

Key Positive Points

The majority of drawings were of adequate size.

The label lines, in most cases, touched the correct parts of the drawings.

The majority of drawings were two-dimensional

Key Negative Points

- There is a need for the drawing of more biological specimens
- In a few cases, arrowheads were attached to label lines.
- Titles in many cases were inappropriately written and positioned
- Many students did not demonstrate an adequate understanding of how to calculate magnification.
- The various parts in a drawing must be proportional.

Recommendations

- All titles should be placed at the bottom of each drawing and there should be a statement informing the reader of what the drawing represents. In addition, the view and accurate magnification should be clearly identified within the title.
- The use of arrowheads should be avoided, In addition, a ruler should be used to draw all label lines and they should be parallel to each other. Label lines on the same side of the drawing should stop at the same point.
- To make provisions for larger drawings, each drawing should be restricted to a single page.
- The labels, written in print (script), should be started at the end of the label line. They should never be printed on the label line. The labels should either be upper or lower case but *never* a combination of both.
- The lines of the drawings should always be clear, distinct and continuous; that is, students should avoid shading, double lines and sketching at all times.
- Drawings should be about half page or more.
- Illustrations such as flow charts and cycles should not be submitted as drawings.

<u>Planning and Design (PD)</u>

Key Positive Points

- The assignments chosen for planning and design reflected a clear understanding of what is acceptable for such assignments.
- Most planning and design assignments were generally workable.
- Most assignments assessed in this category illustrated a clear role of the control.
- Most hypotheses were tenable

Key Negative Points

- Verification assignments (laboratory exercise where concepts and known principles are proven) should not be assessed for PD.

- Critical aspects of planning and design such as precautions, controls, limitations and repeated measurements were omitted.

Recommendations

- The hypothesis should be clearly stated and should be a specific statement or prediction which is different from the aim of the experiment. Also, it should be: (a) suitable, that is, an experiment can be performed to test the hypothesis, and (b) manageable, that is, it should be realistic.

- The procedure of the experiment should be clearly written and demonstrate scientific skills which can be used to prove or disprove the hypothesis.

- In regard to attention to detail, students should be precise and concise. For example, there should be specific quantities assigned to each type of measurement used such as volume, temperature, length and mass.

- The steps of the procedure should be in logical sequence.

- Format of expected data/results should be clearly presented. Students are not expected to carry out the experiment; however, the way in which they intend to present their results should be written clearly, for example, tables can be used with the appropriate headings and title, prose can also be used to identify the expected data.

- Precautions refer to the steps used to ensure accuracy and safety, which do not affect the experiment. They should also be clearly identified.

- In instances where students actually carried out the activity, they should indicate if the entire procedure or measurements of the experiment were repeated to verify consistency and accuracy.

<u>Analysis and Interpretation (AI)</u>

Key Positive Points

The use of guided questions for the A/I has been reduced and students are being encouraged to evaluate their results and observations.

Key Negative Points

Predictions and inferences were not directly linked to trends, patterns and relationships in the laboratory exercises.

Critical aspects such as sources of error, precautions and limitations were omitted.

Recommendations

- Laboratory exercises must lend themselves to the identification of trends, patterns and relationships.
- Inferences must be linked to the results/observations.
- Evaluations should not be general statements; conclusions need to be linked to the aim of the lab and the data obtained.
- Calculations shown must include formulae and units.
- Questions from the textbook should not be used as A/I laboratory exercises.
- Laboratory exercises must be carried out and the data generated, analysed and interpreted.
- At least two A/I laboratory exercises must be assessed per year.