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 CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

MAY/JUNE 2013

INTEGRATED SCIENCE (SINGLE AWARD) GENERAL PROFICIENCY EXAMINATION

GENERAL COMMENTS

The CSEC examination in Integrated Science was again offered at the General Proficiency in 2013. The June 2013 examination consisted of three papers, Paper 01 — Multiple Choice; Paper 02 — a data analysis question, short response questions, and essay questions, and Paper 031 — School-Based Assessment. Paper 032, the alternative to the School-Based Assessment is a Practical Paper written by private candidates.

The number of candidates entering for this examination was 22,967 compared to 23,790 in 2012, a four per cent decrease in candidate entries. The overall performance of candidates in the 2013 examinations was comparable with the performance in 2012. Seventy-nine per cent of the candidates earned Grades I to III.

DETAILED COMMENTS

Paper 01 — Multiple Choice

Paper 01 consisted of 60 multiple choice items with a total weighted score of 90 marks. The mean score of 53.35 was similar to that of 2012 which was 52.77.

Paper 02 — Structured Paper

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 to 6 were worth 15 marks each, a maximum of 100 marks with a total weighted score of 150 marks. The mean score earned on this paper was approximately 59.04 and is similar to mean score for 2012 which was 60.68.

Paper 02

Question 1

This question tested the candidates' understanding of breathing, and respiration and their ability to apply their scientific knowledge and skills in interpreting tabulated information and a graph that compared the number of deaths of smokers and non-smokers. Overall this question was fairly well done by few candidates.

For Part (a) (i), which required candidates to describe how the chest muscles and rib-cage moved during inhalation and exhalation, some candidates provided complete and acceptable responses that indicated how the muscles contract and relax, and the up and out and the down and in movement of the ribs/rib-cage corresponding to inhalation and exhalation. Many candidates focused on the movement of the diaphragm although the question focused on the intercostal muscles; also, many candidates were not clear in indicating which action was associated with inhalation or exhalation, they mentioned 'in and out' and 'up and down' instead of 'up and out' and 'down and in' which more accurately describe the movement of the ribs/ribcage during inhalation and exhalation respectively.

For Part (a) (ii), where the candidates were required to suggest how Riki's breathing rate changed while running up and down the hill, many responses inadequately indicated that the rate changed instead of providing the expected response "breathing rate increased", clearly indicating how the rate changed.

For Part (a) (iii) in which candidates were required to give a reason for their answer in (a) (ii), satisfactory responses indicated that the body would require more energy and/ or oxygen. For Part (a) (iv), in which candidates were required to explain how the movement of Riki's diaphragm allowed breathing in during singing or strenuous activities, many candidates did not mention the role of

pressure changes and mainly focused on the movement of the diaphragm and the volume/space created. Good responses to this part indicated that during strenuous exercise the diagram moves down, resulting in an increase in volume of the lungs and lowering its pressure; air rushes into the lungs with the greater pressure on the outside of the lungs.

Most candidates attempted Part (b) and correctly responded that a higher percentage of oxygen is present in inhaled air than in exhaled air, and a lower percentage of carbon dioxide would be found in inhaled air in comparison with higher percentage of carbon dioxide in exhaled air. However, there is the need for candidates to pay greater attention to the gases involved in respiration. Some candidates appeared to confuse oxygen with carbon dioxide.

For Part (c) (i) many candidates did not display knowledge of the type of respiration associated with the production of lactic acid; only a few candidates correctly stated the expected response of 'anaerobic respiration'.

For Part (c) (ii) many candidates correctly wrote the word equation for the process of respiration that involves oxygen. For Part (c) (iii) many candidates correctly wrote carbohydrates; however, quite a few candidates inadequately stated 'protein'. Some responses were inadequately stated as food examples such as 'orange' 'fruit' and 'energy drinks'.

Part (d) (i) to (vii) required candidates to plot a graph from the data provided in a table, label the axes on the graph, and state its title, infer information from the graph, draw conclusions based on the trend of the graph and state a comparison of the lungs of smokers and non-smokers.

Overall, the candidates' responses to this part reflected a need for improvement in their graph skills. Some candidates accurately labelled the y – axis as "number of smokers" and correctly made readings from their graphs. For Part (d) (vi), most candidates accurately concluded that smoking tobacco lowers life expectancy. For Part (d) (vii) most candidates correctly indicated that the lungs of smokers were more likely to be blackened, develop cancer and have reduced breathing capacity. A large number of candidates responsed that the lungs would become damaged, which was too vague an answer and needed further elaboration. Also some candidates said the lungs would become 'weak' which also needed elaboration.

Recommendations

- Students need to practice drawing graphs, paying attention to the quality of the lines resulting from the connection of the points.
- Students could benefit from more guidance or practice in writing appropriate titles for graphs as well as reading off the points on the graph.

Question 2

This question tested candidates' understanding and ability to apply their knowledge relative to the benefits of alloys and plastics as well as conditions that cause rusting. This question was widely attempted; however, it was not very well done by many candidates.

In Part (a), in which candidates were required to distinguish between corrosion and rusting, some candidates confused corrosion with corruption, collision, erosion, irritation, and explosion. Acceptable answers indicated that corrosion involves the chemical reaction between any metal and any substance in the environment; while rusting requires oxygen and it is the oxidation of iron.

Some aspects of Part (b) (i) to (vii) were not well done by candidates. For Part (b) (i), many candidates did not indicate B, which was the acceptable response. In providing the reason required in (b) (ii) some candidates inappropriately included as the cause of rusting: the presence of carbon dioxide; only water; only oxygen and salt. Acceptable responses pointed to the presence of both water and oxygen as the cause of rusting. For Part (b) (iii), many candidates appeared not to be aware that calcium chloride is used as a drying agent.

For Part (b) (iv), the acceptable responses were C or A. For Part (b) (v) many candidates gave the first part of the answer indicating that rusting would not occur with exposed stainless steel nails. The majority of the candidates seemed not to have known the relevant properties of an alloy; stainless steel being an alloy could account for a tendency to resist rusting was the expected response. Only a few responses linked the absence of rusting with the fact that steel is an alloy.

For Part (b) (vi) some candidates provided acceptable responses, which included pot, pans, knives and refrigerator. For (b) (vii) acceptable responses included painting, oiling, plastic coating, electroplating, galvanizing, or tin plating as a method for preventing rusting.

For Part (c), based on the scenario provided, candidates were required to indicate the advantages and disadvantages of using a plastic tap instead of brass tap. Many of the candidates provided acceptable responses indicating advantages of plastic such as usually *less expensive and does not corrode* and disadvantages such as plastic is usually *non-biodegradable and produces toxic fumes when burnt*.

Recommendation

- To facilitate a deeper understanding of experimental procedures and the uses of functions of reagents/materials such as calcium chloride, students need to be exposed to the practical aspects of topics as much as possible as the topic is taught.

- Through recommended practical activities and planning and designing experiences, students could develop a better grasp of experimental controls and identifying controlled variables in an experiment.

Question 3

This question tested candidates' understanding of reproduction in plants and human beings, their ability to interpret and infer from plant growth patterns as well as their ability to apply population control strategies for problem solving.

This question was well done by many candidates. For Parts (a) (i) and (ii), the responses were fair. Many candidates showed weaknesses relative to spelling, labelling and differentiating the different parts of the female and male reproductive systems.

For (i) the acceptable responses were: X = ovary; Y = uterus; Z = cervix. For (ii) the most common acceptable responses were: Testes, penis, prostate gland and scrotum.

Part (b) was not very well done by many candidates. This part required candidates to explain how a plant presented in a drawing may be reproduced asexually and sexually. Some candidates appeared not to be clear about the meanings or difference between the terms **asexual and sexual** reproduction. Many candidates confused self-pollination and asexual reproduction. Candidates seemed to be more knowledgeable about sexual reproduction in plants than asexual reproduction. Acceptable responses for asexual reproduction usually included the planting of cuttings from the branch. Acceptable responses for sexual reproduction identified the salient points such as pollination, the recognition of both male and female sexual reproductive structures of the flower, seed production and the involvement of the ovary. Commendably, a few candidates expressed clear statements describing the

entire process of sexual reproduction in plants notably pollination followed by fertilization and germination.

Part (c) was fairly well done by some candidates. Acceptable responses indicated that to assist with overpopulation in a country, individuals in a country could practise family planning and the government could encourage education programmes about contraceptives.

Part (d) was fairly well done by most candidates. Candidates were able to read and deduce information from the graph as required in Parts (i), (ii) and (iii) and to accurately provide reasons for the difference in the minimum heights reached by the two seedlings.

Recommendation

- To support instruction, activities could be organized to allow students to translate the recommended biological terms for the reproductive organs from the colloquial terms or jargon used within their region. It is recommended that students be more exposed to models, drawings, and computer software in order to assist in memorizing correct terms.
- It is recommended that when teaching the topic drawings and flowcharts be used to show processes such as sexual reproduction in plants.

Question 4

This question tested candidates' understanding of the methods of heat transfer and their applications as well as candidates' understanding of the need for proper ventilation.

Part (a) (i) required candidates to distinguish among conduction, convection and radiation of heat energy. The acceptable responses included an indication that conduction involves the transfer of heat energy from molecule to molecule, or from particle to particle; convection involves the transfer of heat energy by movement of the fluid (liquid or gas) while radiation involves the transfer of heat energy via electromagnetic waves. Not many responses referred to the movement of particles as required for conduction.

For Part (a) (ii), which required examples of a conductor and an insulator, acceptable responses were pots and electrical wires for conductors, and rubber and cloth for insulators.

Part (b) was fairly well done by many candidates. For Part (b) (i) which required candidates to indicate the method by which the heat energy is transferred from outside of the pot to the inside of the pot, many candidates correctly indicated 'conduction'. For (b) (ii) some candidates also provided the expected response of 'convection', correctly indicating the method by which heat energy is transferred from the bottom of the water to the top of the water. Some incorrect responses were: transpiration, evaporation and boiling.

Part (c) (i) required candidates to suggest the aim of the experiment. The acceptable response was: "To determine the rate of conduction of different materials". This part was fairly well done by candidates. For Parts (c) (ii) and (iii) most candidates responded correctly, identifying Rod C in the figure as the best conductor and Rod E the best insulator.

For (c) (iv), in which candidates were required to list two variables that must be held constant in the experiment, the acceptable responses included two of the following points: Rods of equal length and thickness, rods exposed to same amount of heat energy, same amount of wax used and/or thumbtack of same size used. For (c) (v), which required an explanation for the constant heating of the beaker in the experiment, the acceptable responses pointed to the need for the heat energy to be transferred to the other end of the rods as a result of the end in the water being hotter than the end out of the beaker for the duration of the experiment.

Part (d) required candidates to provide a scientific explanation for a warehouse becoming cooler after its renovation involving the construction of a higher roof. This part was fairly well done by many candidates. The acceptable response was: "Hot air rises (from the bottom) by convection and cool air replaces the hot air (at the bottom) making it cooler".

Recommendation

- Regarding conduction, it is recommended that attention be given to the required level of detail (making reference to particles of the substance) during instruction, to facilitate the development of students' understanding of conduction and convection to the appropriate depth.

- During instruction students could benefit from being engaged in activities that emphasize the scientific explanation for everyday life observations resulting from processes such as convection.

Question 5

This question tested candidates' knowledge of the respiratory, circulatory and nervous systems and their ability to apply their knowledge to a practical life situation. It tested candidates' ability to relate the uses of metals and non-metals to their properties. It also tested their understanding of the advantages and disadvantages of using plastics.

Part (a), which required candidates to state three differences between transport of nutrients in plants and humans, was widely known by candidates. The acceptable responses included an indication of: A heart in humans, while there is no heart in plants but transpiration pull (in plants); xylem and phloem in plants but veins, arteries, capillaries in animals; blood/blood cells in humans while instead of blood, there is water and cell sap in plants.

Part (b) required candidates to explain how a person's circulatory and respiratory systems enabled the performance of daily rides in a rocky terrain. Complete responses included a candidates' recognition that the respiratory system facilitates release of energy, increased breathing, increased blood flow or more oxygen; that the circulatory system transports blood with oxygen and glucose to muscles and removes waste, such as carbon dioxide.

Very few candidates were able to distinguish between the circulatory and respiratory systems. Although the systems are interrelated in their functions in some respects, many responses reflected a confusion of the specific functions of these systems. In many responses candidates did not indicate the increase in activities associated with the increased energy demands as expected, although some responses reflected knowledge about oxygen and blood flow to support general activities.

Part (c) required candidates to describe the role of the nervous system in facilitating the ride. Acceptable responses indicated that the eye receives light (stimulus); the brain interprets or processes information relative to seeing; nerve cells conduct messages to and from the brain and the brain coordinates for appropriate balance or movement.

Part (d) required candidates to identify two materials for making the bicycle frame as well as to indicate the properties that make these materials suitable. This part of the question was correctly answered by many candidates. Acceptable answers included metal (e.g. iron) for its high tensile strength or being malleable; and plastic for being light weight.

Question 6

This question tested candidates' understanding of electricity and lighting, and devices and their applications in household appliances as well as safety. It also tested candidates' understanding of the separation of the colours of light.

Most candidates attempted this question, however only a few responses were satisfactory. Part (a), in which candidates were required to name three primary colours of light in the rainbow, was generally well done with most candidates correctly indicating at least two of the primary colours. Many candidates named red, green and blue. However a common incorrect response was yellow.

For Part (b), in which candidates were required to indicate how secondary colours could be created with spotlights on a white wall, some candidates provided acceptable responses that included: the shining of spotlights to get cyan from blue and green; yellow from red and green and magenta from red and blue. Many of the candidates' responses confused the mixing of light with the mixing of pigments.

Part (c) was not well done by many candidates. For Part (c) (i), in which candidates were required to calculate the current in an extension cord that was used to power a 60W bulb, the formula of I=W/V to provide an answer of 0.5 A was correctly applied by some candidates. Many candidates provided incorrect units such as ohms and volts for current. In addition, an incorrect equation was used by some candidates.

For Part (c) (ii), in which candidates were required to explain the safety of the situation based on the information provided, acceptable responses included the danger of overloading the small wires in the electrical extension cord and the possibility of water getting into contact with the electrical circuit thus causing a fire or resulting in electrical shock.

For Part (c) (iii), in which candidates were required to indicate a device that prevents house wiring from burning and to explain how it works, fuse or circuit breakers were acceptable devices.

Paper 031 – School-Based Assessment

The overall performance was satisfactory. However greater focus and effort need to be placed on Analysis and Interpretation (AI) and Planning and Designing (PD) skills.

The general recommendations below, which were also provided in previous reports, for improving practical or inquiry skills, continue to be applicable. Much attention needs to be given to developing the planning and designing skills.

General Recommendations to Teachers (*refer to previous reports***)**

All laboratory report books should have a content page with the following format and headings.

Lab No	Page	Description of Laboratory Exercise	Date	Skills Assessed

- The pages of the laboratory notebook should be numbered.
- Each activity should begin on a new page and be properly dated.

- The skills assessed and marks allocated should be written next to the laboratory report and on the contents page.
- The maximum mark to be awarded to each skill is 10 marks. Skills marked out of other totals should be scaled to 10.
- Dates when each practical was assessed should be included in laboratory reports.

Observations, Recording and reporting (ORR)

- Proper laboratory format should be used, for example:

  Title
  Aim
  Apparatus/Material
  Diagram
  Method
  Results/Observation
  Discussion
  Conclusion

- Reporting should be concise and observations should be recorded in a suitable format. The use of tables is recommended whenever possible.
- Numerical tables should have the physical quantities and units stated in the heading, and the number of decimal places should be consistent.
- Non-numerical tables should have appropriate headings. Details of data recorded should include all observations, for example, the solution turned from blue to green to orange upon heating.
- Graphs should have axes labelled, appropriate scales, points plotted accurately and a smooth **curve or best fit line drawn.** (Only growth curves should have the points joined dot to dot.)
- Where prose is used to record observations, details of data are necessary.

Analysis and Interpretation (A/I)

- Laboratory exercises must lend themselves to the identification of trends, patterns and relationships.
- Inferences must be linked to the results/ observations.
- Evaluation should not be general statements. Conclusions need to be linked to the aim of the lab stated 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 exercise must be carried out and the data generated must be analysed and interpreted.

Planning and Design (P/D)

- P/D laboratory exercises need to be original. Students are required to formulate a hypothesis and design a scientific experiment to test the hypothesis.
- P/D laboratory exercise does not have to be done to prove a scientific fact. If they are carried out they can be used to assess other skills and the plan can be modified as necessary.
- **Textbook laboratory exercises are not acceptable as P/D experiments**.
- Some laboratory exercises did not lend themselves for assessment as P/D laboratory exercises, for example ‘making soap’, ‘reactivity of metals’ and model of lungs’.
- **A hypothesis is a statement and should not be written in the form of a question**.
- Procedures should reflect a direct link with the hypothesis.
- Procedures should include the number of times the experiment is to be repeated and any precautions to be taken.

Drawings

- 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 arrow-heads 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. The label lines should touch the appropriate parts of the drawings.
- 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 mixture 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.
- The drawings should be two dimensional.
- Drawing should preferably be done from specimens. Diagrams and natural cycles are not to be presented as SBA drawings.

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

Paper 032 consisted of three questions and was designed to test the skills normally assessed by the SBA component of the syllabus. The following skills were assessed: Drawing, Observation/Recording/Reporting, Manipulation/Measurement, Planning/Designing, and Analysis & Interpretation. Most candidates attempted the questions.

Question 1 provided candidates with a diagram of fruits, including a cut tomato. Candidates were required to measure the diameter of the tomato. They were required to write an aim for an experiment involving the placing of iodine solutions on each fruit. They were also required to construct a table for recording the data, to formulate conclusions based on the colour changes provided, as well as plan and design an experiment. This question was fairly well done by a few candidates.

Question 2 required the reading of volumes from diagrams of measuring cylinders, description of the procedure for verifying Archimedes' principle using the list of materials provided, as well as drawing a diagram to illustrate the procedure, and stating an appropriate title. They were also required to draw a graph from the data provided, label the axes, calculate slope and write a statement on the relationship between the mass of an object and the volume of water displaced by that object. This question was poorly done, as candidates were unable to demonstrate their knowledge and use of critical SBA skills.

Question 3 involved the investigation of the relationship between the load-to-effort ratio and the ratio of the distance A to the distance B in first-class levers. It involved taking measurements, constructing a table, making calculations, and identifying the position of the centre of gravity on a rule. This question was poorly done. Most candidates were unable to show their use of the relevant SBA skills to answer the question.

Overall, the performance of candidates on the Paper 032 was poor. Most candidates were unable to demonstrate the required SBA skills. Recommendations for skill development are provided in the general feedback on SBA.

COMMENTS

The attainment of scientific literacy for all learners continues to be an essential objective in the 21st century. Across our region, the CSEC Integrated Science syllabus is intended to contribute to science education for promoting the development of problem- solving and investigative skills: This subject allows Caribbean secondary students the opportunity "to pursue a science course in the interest of a

well-rounded general education"; providing support for science related subjects and further studies related to certain careers (CXC Integrated Science Syllabus, 2009, p. 1).

Integrated Science is a popular choice in many secondary schools. As a single science or complementary subject it continues to be well received across the Caribbean as evident through its wide access by students and schools from across our region. To facilitate the implementation of the CSEC Integrated Science syllabus it is important that within the school system, a variety of strategies for optimally benefiting from the presence of teachers with specialization in different areas of science continue to be explored.

Relative to CSEC Integrated Science within the school, two areas for special attention are: (a) the utilization of syllabus guidance on improving the quality of candidates' responses; and (b) collaboration in the promotion of strategies to strengthen an integrated approach to instruction by teachers who are often subject-specialists.

- *Syllabus guidance*: In implementing the syllabus during instruction, greater attention needs to be given to the explanatory notes and activities which provide some guidance for the scope and level of treatment of the topics and objectives outlined in the syllabus. This can assist candidates to provide more adequate and scientific responses; and may also guard against the provision of responses that may be too vague, unscientific or below the expected level of the syllabus.

- *Collaboration to support unpopular content areas*: Some areas/topics in science may be more popular than others among science educators who are often subject specialists in the areas of Biology, Chemistry and/or Physics. Collaborative strategies that incorporate sharing of resources and teaching strategies could provide instructional support among educators. Team planning and/or teaching could be encouraged to allow for enhanced integration among science topics often associated with the single subjects.

Recommendations

The following recommendations can be considered for shaping instruction that addresses some of the weaknesses reflected in the candidates' responses, as well as to support teaching and learning in general, as guided by the syllabus:

1. *Using scientific knowledge in everyday life contexts*

   With reference to the biological systems, students appear to require more instruction in developing and applying scientific knowledge to everyday life situations. In addition to using diagrams and models to understand structures and functions, learners at this level, appear to need more practice through relevant structured questions that focus on the relative demands and involvement of body structures and specific systems in real life activities.

   The use of selected authentic experiences online, and incorporating relevant multimedia presentations and three-dimensional illustrations could support interesting discussions and contribute to better understanding of the body in a dynamic and more realistic sense.

2. *Improving language skills: Spelling of scientific words*

   Students need to be reminded about the need for correct spelling of scientific words. Responses are enhanced when answers are communicated effectively, and words are recognizable. Incorrect spelling of terms may distort answers beyond recognition.

3. *Understanding and using scientific terms*

   The use of scientific terms (to the level guided by the syllabus should be encouraged). Terms such as the scientific names of human reproductive parts (including the genitals) need to be used in responses instead of a range of unscientific terms that may be used across the territories.

4. *Distinguishing between terms*

   In comparing or distinguishing between terms, students also need to be guided (through practice) in expressing differences (or points) in terms of parallel points to improve completeness of responses.

   Among other terms of the syllabus, students need to be guided towards understanding clearly the differences between the following listed pairs of terms*:*

   - Corrosion and rusting
   - Materials and property
   - Metal and alloy
   - Iron and steel
   - Industrial and household equipment
   - Intercostal muscles and ribs
   - Asexual and sexual reproduction
   - Self-pollination and asexual reproduction
   - Ohms and amps
   - Nutrient and food name

5. *Selecting appropriate formulae and using correct units:*

   For problem solving, students require practice in using formulae for working out values.

   Accuracy in calculations and use of appropriate units should be encouraged.