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 2014

INTEGRATED SCIENCE
(SINGLE AWARD)
GENERAL PROFICIENCY EXAMINATION

GENERAL COMMENTS

The CSEC examination in Integrated Science was again offered at the General Proficiency in 2014. The June 2014 examinations 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 03/2, the alternative to the School-Based Assessment is a Practical Paper written by private candidates.

The number of candidates entered for this examination was 21,737 compared to 22,967 in 2013, a five per cent decrease in candidate entries. The overall performance of candidates in the 2014 examinations was comparable with the performance in 2013. Seventy-eight 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 54.93 was similar to that of 2013 which was 53.35.

Paper 02 — Structured Paper

Paper 02 consisted of one data analysis question, three short-answer, structured questions 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 59.24 and is similar to mean score for 2013 which was 59.04.

Question 1

This question tested candidates' understanding and ability to use knowledge about water cycle, water purification, metals, and electricity. In general, this question was fairly well done.

For Part (a) (i), in the diagram of the water cycle, many candidates correctly identified "A" as condensation, "B" as precipitation and "C" as evaporation. For Part (a) (ii) the use of water was correctly stated by many candidates; uses such as cooking, bathing, washing and agricultural uses were acceptable.

For Part (a) (iii) many candidates correctly indicated that sickness can result from the presence of bacteria, harmful microorganisms or pathogenic organisms found in the water. There were a few students that were quite general in stating that the water was "not clean", "dirty" or "contaminated"; these responses could be more precise, although they hint at the expected responses.

For Part (a) (iv) many candidates adequately named TWO methods involved in the treating of river water: the common responses included boiling, filtration, chlorination, and distillation.

For Part (b) (i), one effect that the cutting of the forest could have on the water cycle was correctly indicated by some candidates who suggested that it would reduce the water vapour entering the atmosphere; and reduce precipitation. For this part, the expected responses should be relevant to the water cycle. However some responses were not specific to water cycle inadequately stating instead, the general effects of the cutting of the forest.

For Part (b) (ii), candidates were required to indicate how the planting of the poisonous trees would affect the food webs in the forest. Among the acceptable responses were less herbivores, less carnivores, less omnivores and consumers turning to other sources of food.

Part (c) required an understanding of problems associated with the use of fossil fuels.

Candidates were asked to state ONE benefit to the environment of using hydroelectric power in Part (c) (i). Lower levels of carbon dioxide, or less global warming, were acceptable responses. Part (c) (ii), required ONE negative effect on the environment, of building the dam. Acceptable responses were deforestation, disruption of ecosystems, and soil erosion.

More water vapour in the air or more precipitation, were acceptable responses for Part (c) (iii) which asked candidates to state ONE way the dam may affect the water cycle.

For making the uninsulated electrical lines, copper or aluminium are acceptable responses for Part (c) (iv). Electrical shock or danger to low flying aircraft were acceptable responses for electrical hazards in Part (v).

Part (d) required the plotting, reading, and interpretation of a graph.

Acceptable graphs were smooth curve with fine line marks.

For Part (iv) that required candidates to state an appropriate title of the graph, the expected response was "Graph of carbon dioxide dissolved in the oceans vs. year"

For Part (vi) many candidates correctly concluded that the level of carbon dioxide increased over the period.

Question 2

This question tested candidates' understanding and ability to use knowledge about acids, bases and salts, digestion in human beings, the action of a solvent in stain removal and safety practices associated with working with chemicals.

For Part (a), examples of acceptable responses for properties of acids included: "has a pH of less than 7; has a sour taste; and react with a base to form salt and water". Acceptable responses for properties of bases

included: “has a pH greater than 7; has a soapy feel; and react with an acid to form salt and water”. A common *erroneous* response was “acids have a *pH of 7* and under”.

For Part (b) hydrochloric acid was a common correct response for ONE example of acid in the digestive system, while for a base bile was an expected response.

For Part (c) (i) many candidates appeared not to be aware of pH as “concentration of hydrogen ions” in solution; many candidates instead acceptably referred to pH as an indication of alkalinity/acidity of substances.

For Part (c) (ii), the correct response for the substance that is not an acid was baking soda.

For Part (d) (i) many candidates correctly indicated that bleach would discolour a coloured garment and not dissolve the paint. In some responses, although appropriate substances were suggested to remove paint for Part (d) (ii), some candidates seemed not to have recognized that such substances acted as solvents.

Part (e) required two safety precautions that can be taken during the removal of the paint. Masks, goggles and gloves were the most common safety equipment correctly named. Many candidates however indicated vague or incorrect actions such as “keep away from eyes” or “face” but did not suggest what the safety precaution might be in order to effect this.

Candidates’ performance on this question was less than satisfactory.

Recommendations

- A simple treatment of the chemical properties of acids and bases should be undertaken including neutralisation reactions. During lessons students could be engaged in discussions and activities aimed at highlighting the significance of a pH of 7 (indicating neutral; which is not acidic, nor basic).

- An integrated approach taking into consideration the application of knowledge about “acids”, “bases” and their properties while teaching and learning the topic of digestion, can be helpful for facilitating the development of students’ ability to use knowledge in this area.

- The link between effectiveness of digestive enzymes and pH should be emphasized during teaching of the digestive process.

- The concept of pH may be approached from a practical standpoint by examining a variety of common household substances including neutral substances.

Question 3

This question was fairly well done. It tested the candidates’ ability to distinguish between a plant cell and an animal cell and their knowledge about the storage of genetic information. Candidates were also required to distinguish between osmosis and diffusion and use this knowledge to suggest a solution to the problem of wilting lettuce. Finally, the question tested the candidates’ knowledge of the likely effects of damaged heart and stomach muscles on the structure and function of these two organs and the overall body.

Part (a) was generally well answered: Cell B or Figure 4 was the correct response for Part (a) (i). Among the correct responses for Part (a) (ii) were: “Cell A has no cell wall, while Cell B has a cell wall; Chloroplast absent in Cell A, while present in Cell B; Smaller vacuole(s) in Cell A while large vacuole in Cell B; or central nucleus in Cell A, while nucleus at side in Cell B. For Part (b) (iii), many candidates correctly indicated “nucleus”; For Part (iv) the expected response, “red blood cell” was provided by some candidates, however many candidates inadequately stated “blood cells”.

In Part (b) (i) many incomplete contrasts were made by candidates in distinguishing between “diffusion” and “osmosis”. The expected responses indicated that “osmosis occurs across selectively (or partially) permeable

membrane while diffusion does not require a membrane". For Part (b) (ii) some candidates were able to identify osmosis as the process that resulted in lettuce becoming firm.

For Part (b) (iii) many candidates seemed unable to apply the key concepts relating to osmosis with some inadequately citing the water "feeding" and "providing nutrients" for the lettuce. Acceptable responses included: "water entered through a cell membrane" as well as "movement of the water across a concentration gradient."

Part (b) (iv) was well answered by many candidates who correctly stated "refrigeration" or "placing in a bowl/ bucket of water". Most candidates attempted Part (c). However, only a fraction of these responses adequately related to the effect on the structure of the stomach due to damage from the stomach muscle. Acceptable responses included "damaged or deformed walls and glands", "wall perforation" and "ulcers". For the effect on the function, many candidates inadequately stated the normal functions of organs and not the **effect** of the defect on the functioning of organs. Some candidates inadequately attributed the fitting responses for the "Effect on the function of the organ" to the "overall effect on the body".

Recommendations

- During instruction, increased attention needs to be given to addressing possible misconceptions of students relating to osmosis and diffusion; some candidates erroneously viewed diffusion as being relevant only to gases.

- When teaching "cells" (plant and animal cells), the functions/importance of the organelles as outlined in the syllabus should be emphasized.

Question 4

This question tested candidates' understanding of the use of good and poor conductors of electricity, colour code in wiring a plug and energy consumption of different electrical appliances. Overall, this question was poorly done.

For Part (a) most candidates correctly distinguished between a conductor and an insulator. Acceptable contrasts included: "conductor as a material which readily allows an electric current or heat energy to flow"; while "insulator is a material that does not readily allow an electric current or heat energy to flow".

Part (b) was fairly well done with many candidates identifying a pot as an example of the use of a conductor in the kitchen. A kitchen towel, mittens or pot handles made out of wood or plastic were acceptable responses as examples of insulators in the kitchen.

For Part (c) many candidates correctly identified the colours of the earth wire as yellow/green as well as the neutral wire as being blue in colour. The expected response/colour for live wire was brown.

Part (d) was not well done by many candidates. Many candidates did not (as was necessary) convert the power rating of the appliances from watts to kilowatts by dividing by 1000; then multiplying the answer by the time used to obtain the energy consumed per day by each appliance. However many candidates added as required, the individual energy consumption values to obtain the total energy consumption values.

Part (e) was well done by many candidates. Most candidates were able to correctly identify TWO ways in which energy can be conserved in the home. For this part, the most popular acceptable responses were to (1) unplug appliances that are not in use; (2) use energy saving bulbs (fluorescent bulbs); (3) turn off lights when not in use; and (4) hand wash clothes instead of using the washing machine.

Question 5

This question was an essay type question that tested candidates' knowledge of the components of air. It also tested their knowledge and understanding of causes/sources of pollution and its effects on organisms in two specified communities. Overall, this question was poorly done.

Part (a) was generally well done. Most candidates scored full marks for this part. The most popular responses for components of air included oxygen, nitrogen and carbon dioxide.

Part (b) (i) required candidates to suggest two likely pollutants that would be present in each of the two different communities presented. For Community A (agricultural community) acceptable pollutants indicated by some candidates included: fertilizers, pesticides and organic waste; and for Community B (near an industrial town); acceptable pollutants included carbon monoxides, sulphur dioxide, oxides of nitrogen, smoke and industrial chemicals.

Part (b) (ii) required candidates to describe the source(s) of **one** pollutant and how it could be distributed in the environment for **each** community. In this part, many candidates' responses were either incomplete with only the source or one community being discussed. Generally, candidates who named an appropriate pollutant, were able to identify its source. However, how the pollutant may be distributed (example by wind or by entering river) was frequently omitted by candidates. Distribution methods such as by the wind, diffusion, and convection currents were acceptable for the air pollutants.

Part (b) (iii) asked for effects that pollutants would have on the organisms in the two communities. Descriptions of eutrophication resulting from the use of fertilizers were very popular responses. The effects of sulphur dioxide and nitrogen oxides, pollutants from the industrial community were generally well explained.

Many candidates related death and sickness to every suggested pollutant. Only a small percentage of these candidates identified as required specific effects. For example, in relation to Community A, respiratory

ailments resulting from smoke; cancers or poisoning due to pesticides, disease or death linked to organic waste; in relation to Community B, death and poisoning due to Carbon monoxide; and acid rain and the effects of acid rain, due to oxides of sulphur.

Recommendations

- The distribution of common pollutants and their effects in the environment do not seem to be well known by students. Lessons on pollution could engage students in case studies that can facilitate each learner making a clear link between pollutants and their effects on organisms. Activities can encourage students to provide more than simple/vague general statements such as “the organisms will be affected” or “get sick”, but specify the effects.

Question 6

This question tested candidates’ understanding and ability to use knowledge relevant to the transfer of heat energy, variables affecting solar energy transfer and the extent to which solar energy can be used as an alternative source of energy. Overall this question was poorly done.

For Part (a) many candidates were able to correctly identify the methods by which heat energy is transferred as conduction, convection and radiation. However the descriptions of the processes provided by many candidates were either incorrect or incomplete.

For Part (b)-(c) many candidates did not use the information provided to answer the question but instead opted inadequately to write about an experimental procedure that was familiar to them like using 'clothing', 'paints' and even information about 'chromatography' instead of the "coloured solutions". Also inadequately, some candidates wrote about temperature measurements that were not clearly initial or final temperatures and there was no controlling for time in many answers. Few candidates included most of the following points to provide an acceptable response:

- Placing containers with coloured water in sunlight
- Taking initial temperature of water in each container
- Leaving the samples in the sunlight for a fixed period of time
- Taking final temperatures of the sample
- Using containers of identical/the same size
- Using the same amount of each coloured sample
- Leaving all the samples in sunlight for the same period of time
- Exposing all the containers to the same intensity of light

For Part (d), candidates appeared not to be familiar with solar energy use in the Caribbean. This part of the question required candidates to describe TWO problems that may be faced by people who want to use solar energy in the Caribbean.

Example of acceptable responses include: "Costly to store the solar energy because devices are large or use costly materials; and solar energy is not available during the night or heavy overcast conditions because of day and night cycle as well as weather. Some candidates who pointed to the expense did not relate this expense to the technology, and cost of the panels.

General Recommendations

- Students may need increased practice in answering structured or essay questions; giving attention to all instructional words before answering a question. These practice items could incorporate case studies (relevant to local and international situations), or relate to practical or hands-on experiences to facilitate understanding of concrete and abstract science concepts. It may be useful to engage learners in case studies and discussions that allow them to apply their knowledge relative to:

    - Self (the human body)
    - Community (varying types as necessary)
    - Caribbean region

- *Addressing misconceptions*:

  Increased attention may need to be given to addressing possible misconceptions or erroneous ideas about relevant science concepts. This may require the use of strategies that engage learners in appropriate hands-on and minds-on activities.

- *Including unit where applicable and improving mathematical skills*

  Students need to be reminded about the need for performing accurate calculations, and including units, as well as showing working where required.

- *Distinguishing between terms*

  More practice may be needed by students in distinguishing between some pairs of scientific terms as well as some non-technical terms. Students may need guidance for understanding the difference between the following pairs of terms:

  - Diffusion and osmosis
  - Acid and base
  - Conductor and insulator
  - Pollution and pollutants
  - Watts and Amps
  - Component and property

- More practice may also be needed by students in using and explaining these terms:

  - Precaution
  - Description

- Ozone layer
- Greenhouse effect

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

Part (a) required candidates to measure, from a diagram provided, the height and width of a fruit. Candidates were also required to make a drawing of the fruit.

Good drawings were proportional, of an appropriate size, and drawn with clear/tidy lines.

For Part (b) candidates were required to infer from observations of food tests the nutrient(s) present or absent and to record the inferences in a table. Part (c) required the naming of the process photosynthesis for Part (c) (i) and the identification of nutrients, based on the information provided for Part (c) (ii).

Part (d) (i) required candidates to formulate a hypothesis, state variables to be held constant and precautions to be taken. Good hypotheses were testable, manageable and linked two relevant variables. For Part (d) (ii) acceptable variables that could be controlled included temperature, humidity, size of fruit, and stage of

development of fruit. Overall performance on this question was poor as candidates were unable to demonstrate their knowledge and use of critical SBA skills.

Question 2

This question tested the candidates' understanding of how to plan and design an experiment. It required the candidates to write an aim and outline a suitable procedure for carrying out an activity to find out which of four unknown metals is the best conductor of heat energy. It also required the candidates to state THREE variables that are to be kept constant and precautions that should be taken. For part (a) (iii) acceptable variables that must be kept constant included length and thickness of rod, temperature of water, amount of paraffin used, size of thumbtack and same depth of immersion of all the rods. Overall performance on this question was poor as candidates were unable to demonstrate their knowledge and use of critical SBA skills.

Question 3

This question tested the candidates' ability to measure, and use readings to plot a graph. They were also required to draw a two dimensional diagram of a pulley system from a diagram. Overall performance on this question was satisfactory, most candidates were able to take accurate measurements and plot the graph.

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 leave 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*:*

(a) Corrosion and rusting

(b) Materials and property

(c) Metal and alloy

(d) Iron and steel

(e) Industrial and household equipment

(f) Intercostal muscles and ribs

(g) Asexual and sexual reproduction

(h) Self-pollination and asexual reproduction

(i) Ohms and amps

(j) 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.