



**CARIBBEAN
EXAMINATIONS
COUNCIL**

CSEC[®] CHEMISTRY



**Subject Report
with
Exemplars**

May/June 2024

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN SECONDARY EDUCATION CERTIFICATE[®]
EXAMINATION**

MAY/JUNE 2024

**CHEMISTRY
GENERAL PROFICIENCY**

**Copyright © 2024 Caribbean Examinations Council
St Michael, Barbados
All rights reserved.**

Table of Contents

| | |
|---|----|
| INTRODUCTION | 1 |
| PAPER 01 — MULTIPLE CHOICE | 2 |
| PAPER 02 — STRUCTURED/EXTENDED ESSAY | 3 |
| Question 1 | 3 |
| Question 2 | 13 |
| Question 3 | 19 |
| Question 4 | 25 |
| Question 5 | 31 |
| Question 6 | 39 |
| PAPER 031 — SCHOOL-BASED ASSESSMENT (SBA) | 45 |
| PAPER 032 — ALTERNATIVE TO SCHOOL-BASED ASSESSMENT (SBA) | 46 |
| Question 1 | 46 |
| Question 2 | 56 |
| Question 3 | 59 |

INTRODUCTION

This guide has been compiled using candidates' responses from the 2024 May/June examination in CSEC Chemistry.

The examination comprised the following papers.

- Paper 01 — Multiple Choice
- Paper 02 — Structured Essay
- Paper 031 — School-Based Assessment (SBA)
- Paper 032 — Alternative to School-Based Assessment (private candidates)

In addition, candidates' performance was assessed across three key profile areas: Knowledge and Comprehension, Use of Knowledge, and Experimental Skills.

In 2024, approximately 14 844 candidates sat the CSEC Chemistry General Proficiency examination. Overall, 64.49 per cent of candidates earned acceptable grades (Grades I–III).

PAPER 01 — MULTIPLE CHOICE

Paper 01 consisted of 60 multiple choice items, which were based on all sections of the syllabus.

Generally, candidates' performance was satisfactory. The maximum score obtained was 60 out of 60 marks and the mean score was 36.35 marks.

PAPER 02 — STRUCTURED/EXTENDED ESSAY

Paper 02 consisted of one compulsory data analysis question, two structured questions and three extended response questions.

Generally, candidates' performance was satisfactory. The maximum score obtained was 96 out of 100 marks and the mean score was 38.19 marks.

Question 1

This question tested the following specific objectives from Section A (Principles of Chemistry) of the syllabus: A 6.2, 6.3, 6.5, 10.1, 10.2, 10.3, 10.4 and C 6.3.

Candidates were required to

- perform calculations involving the mole
- state Avogadro's law
- write balanced equations
- define rate of reaction
- identify the factors which affect the rate of reaction
- predict the effect of factors on rates of reaction from given data
- interpret data obtained in relation to rates of reaction
- identify gases — H_2 , O_2 , CO_2 , NH_3 , SO_2 , Cl_2 , NO_2 , H_2O .

The maximum score obtained was 25 out of 25 marks. This mark was achieved by 1.74 per cent of candidates. The mean score was 14.81 marks. Approximately 1.65 per cent of candidates attained no marks.

Candidate's Response to Part (a)

Sodium thiosulfate solution ($\text{Na}_2\text{S}_2\text{O}_3$) reacts with dilute hydrochloric acid to produce sodium chloride solution, sulfur dioxide gas, solid sulfur, and water.

To investigate the effect of temperature on the rate of reaction, Paul performed different experiments using sodium thiosulfate and dilute hydrochloric acid. For each experiment, the same volume and concentration of sodium thiosulfate and dilute hydrochloric acid were reacted but at different temperatures.

The temperature was measured at the start of each experiment and the thermometer readings for Experiments 3–7 are shown in Figure 1.

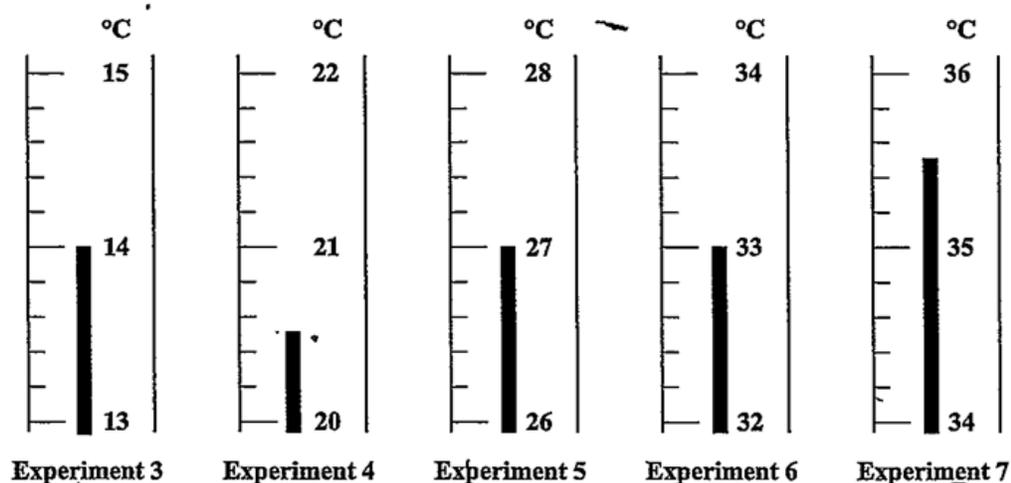


Figure 1. Temperature readings

- (a) Define the term 'rate of reaction'.

Rate of reaction is described as the change in reactant concentration or product concentration with time during a chemical reaction at a specified temperature.

(1 mark)

Examiner's Comments

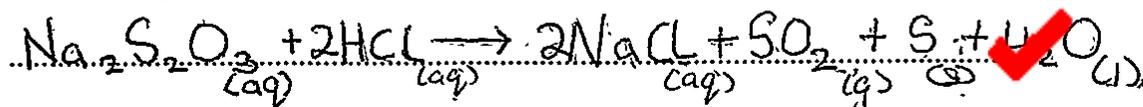
In the exemplar, the candidate provided an accurate definition.

Generally, many candidates were unable to correctly and completely define the term *rate of reaction*. Common incorrect responses included the following.

- The rate of conversion of reactants to products
- Change in the concentration of reactant and products
- How fast or slow a reaction takes place
- The speed of a reaction

Candidate's Response to Part (b) (i)

- (b) (i) Write a balanced chemical equation for the reaction between sodium thiosulfate and dilute hydrochloric acid.



(2 marks)

Examiner's Comments

Candidates responded fairly well. They lost marks for providing the incorrect formula for sulfur dioxide gas and for their inability to balance the equation.

Candidate's Response to Part (b) (ii) — Sample 1

- (ii) Describe a test and state the observation that can be used to confirm the presence of the sulfur dioxide gas produced from the reaction.

Test

Bubble gas collected through acidified potassium manganate(VII) solution.

Observation

The potassium manganate will be decolorized from purple to colourless if Sulphur dioxide is present.

(2 marks)

Candidate's Response to Part (b) (ii) — Sample 2

- (ii) Describe a test and state the observation that can be used to confirm the presence of the sulfur dioxide gas produced from the reaction.

Test

Bubble the gas through acidified potassium dichromate solution.

Observation

If sulfur dioxide present, the solution will turn from orange to green.

(2 marks)

Examiner's Comments

This part was not well done. Most candidates could not describe an appropriate test that could be used to confirm the presence of sulfur dioxide gas. Quite often, candidates were able to identify the correct reagent or material but did not give the correct conditions for use. For example, if a candidate indicated that potassium manganate (VII) or potassium chromate (VI) would be used as reagents, they did not indicate that these substances should be acidified to test for SO_2 . Moreover, candidates who suggested using litmus paper did not indicate that it should be damp blue litmus paper nor did they suggest a method for dampening the gas. Teachers need to spend time highlighting the reagents and conditions when instructing students on testing for different gases.

In the exemplars, the candidates described appropriate tests that could be used to confirm the presence of sulfur dioxide gas.

Common incomplete responses included the following.

- Litmus paper test
- KMnO_4
- $\text{K}_2\text{Cr}_2\text{O}_7$

Common incorrect responses included the following.

- Red litmus paper
- Lighted/glowing splint
- Bubble through lime water
- HCl

Candidate's Response to Part (b) (iii)

- (iii) Determine the mass of sulfur dioxide produced when 50 cm^3 of the gas was collected at STP.

[RAM. S = 32, O = 16; 1 mole of a gas occupies $22\,400 \text{ cm}^3$ at STP.]

Volume \rightarrow moles \therefore moles \rightarrow mass

molar mass $\text{SO}_2 = (32 \times 1) + (16 \times 2) = 64 \text{ g/mol}$ $0.0022 \text{ mol} \times 64 \text{ g/mol} = 0.141 \text{ g}$

50 cm^3 of SO_2 at STP $\text{ans} = 0.141 \text{ g}$ of SO_2 gas at STP from 50 cm^3

$50 \text{ cm}^3 \times \frac{1 \text{ mol}}{22400 \text{ cm}^3} = 0.0022 \text{ mol SO}_2$

(3 marks)

Examiner's Comments

Most candidates scored one out of three marks for their ability to correctly calculate the molar mass or relative molecular mass. Candidates had difficulty calculating the moles of sulfur dioxide gas from the molar volume.

The exemplar shows an accurate response.

Candidate's Response to Part (c) (i)

- (c) (i) In Table 1, record the temperature readings for each of the experiments shown in Figure 1 on page 4.

TABLE 1: THE EFFECT OF TEMPERATURE ON THE RATE OF REACTION

| Experiment Number | Temperature (°C) | Time (s) | Rate of Reaction (s ⁻¹) |
|-------------------|------------------|----------|-------------------------------------|
| 1 | 5.0 | 59 | 0.017 |
| 2 | 10.0 | 50 | 0.020 |
| 3 | 14 ✓ | 40 | 0.025 |
| 4 | 20.5 ✓ | 24 | 0.042 |
| 5 | ✓ 27.0 | 15 | 0.067 |
| 6 | 33.0 ✓ | 11 | 0.091 |
| 7 | ✓ 35.5 | 10 | 0.100 |

(5 marks)

Examiner's Comments

This part was very well done. Most candidates were able to read the values from the thermometers displayed.

However, many candidates did not follow the instructions or they misunderstood what they were required to do. After recording the first two values in the temperature column as 5 and 10, some candidates assumed that the remaining figures were supposed to be multiples of 5. However, the correct values were 14, 20.5, 27, 33, 30.5.

In the exemplar, the candidate provided an accurate response.

Candidate's Response to Part (c) (ii)

TABLE 1: THE EFFECT OF TEMPERATURE ON THE RATE OF REACTION

| Experiment Number | Temperature (°C) | Time (s) | Rate of Reaction (s ⁻¹) |
|-------------------|------------------|----------|-------------------------------------|
| 1 | 5.0 | 59 | 0.017 |
| 2 | 10.0 | 50 | 0.020 |
| 3 | 14.0 | 40 | 0.025 ✓ |
| 4 | 20.5 | 24 | 0.042 ✓ |
| 5 | 27.0 | 15 | 0.067 ✓ |
| 6 | 33.0 | 11 | 0.091 ✓ |
| 7 | 35.5 | 10 | 0.100 ✓ |

(5 marks)

- (ii) Calculate, to three decimal places, the rate of reaction for EACH experiment, given that the rate is 1/Time. Record your results in Column 4 of Table 1: (5 marks)

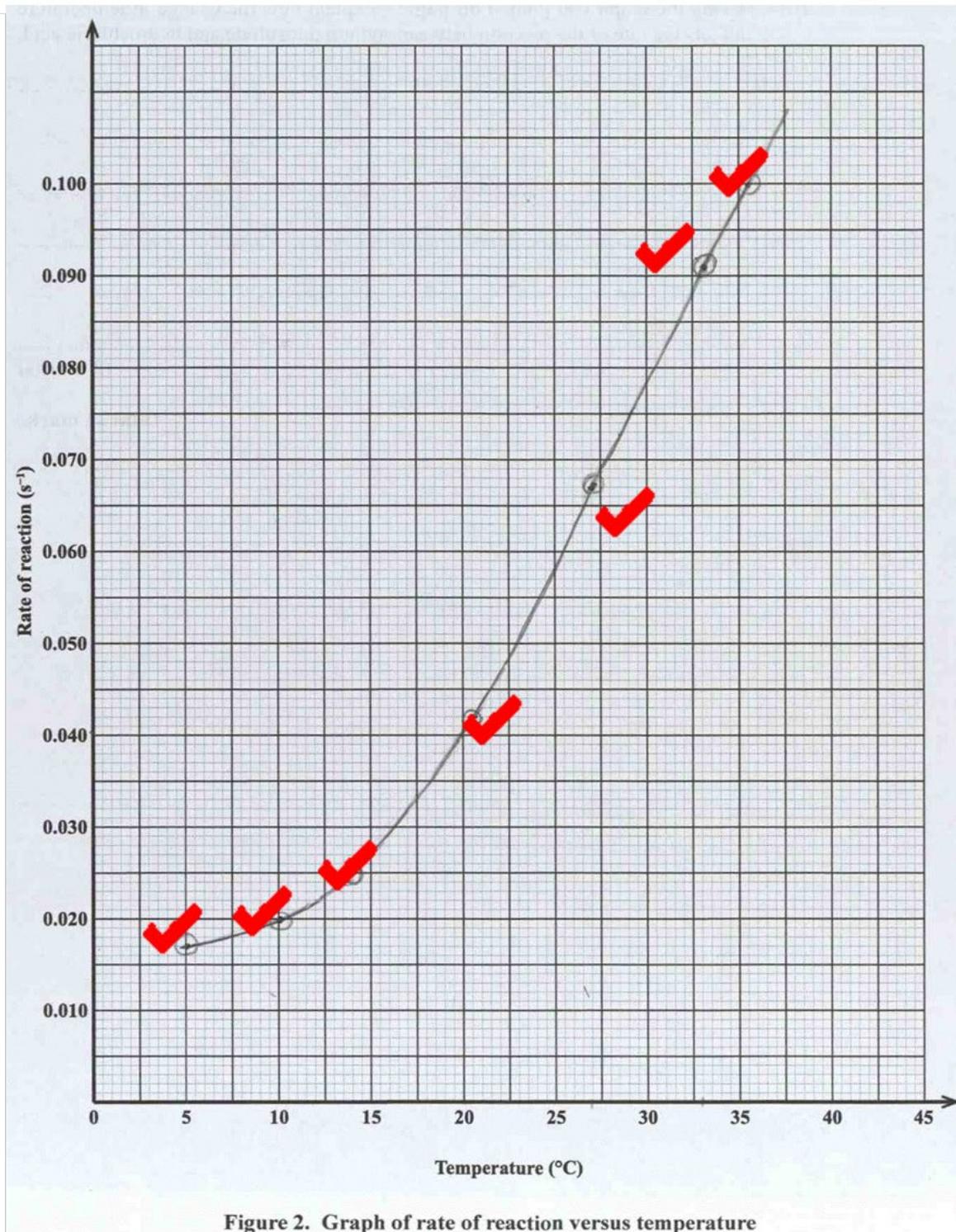
Examiner's Comments

Most candidates were able to calculate the rates of reaction of the experiments using the time values provided. Candidates had difficulty rounding the rates they calculated to three decimal places. For example, a rate value of 0.0416666667 was written as 0.041 instead of the correctly rounded value, 0.042.

In the exemplar, the candidate provided an accurate response and so he/she gained full marks.

Candidate's Response to Part (d) (i)

- (d) (i) Using the axes provided in Figure 2 on page 7, plot a graph of rate of reaction versus temperature for Experiments 1–7. Draw a smooth curve through the points. (5 marks)



Examiner's Comments

This part was well done. Candidates were able to score marks for plotting the graph.

Teachers need to provide more opportunities for students to practise plotting and drawing curves so that they can develop their skills in these areas.

Some candidates used a ruler to draw the curve. However, curves should not be drawn with a ruler; they should be drawn freehand. In addition, candidates should use a sharpened pencil and exercise precision and control in order to produce a smooth, clean curve.

The exemplar shows a response that earned full marks.

Candidate's Response to Part (d) (ii)

- (ii) Using the graph you plotted on page 7, explain how the change in temperature affects the rate of the reaction between sodium thiosulfate and hydrochloric acid.

As temperature of the reaction increases, the rate of reaction increases,
~~here~~ This is due to more heat energy being supplied to the reactant
molecules, they will therefore have more kinetic energy and more
faster as a result, this added kinetic energy helps the ^{reactant} particles
reach the minimum ^{activation} energy ^{required} to break bonds and form products
and ^{it} also increases the speed of the particles so they collide faster,
and more frequently, leading to more effective collisions (2 marks)
and hence a faster rate of reaction.

Examiner's Comments

This part was well done. Candidates were able to correctly describe how the change in temperature affects the rate of the reaction between the two chemicals as displayed in the graph.

The exemplar shows a response in which the candidate captured the important points.

Question 2

This question tested the following specific objectives from Section A (Principles of Chemistry) of the syllabus: A 3.3, 3.6, 3.7, 5.1, and 6.5.

Candidates were required to

- define atomic number and mass number
- define isotopy
- list uses of radioactive isotopes
- explain the formation of ionic and covalent bonds
- write balanced equations

The maximum score obtained was 15 out of 15 marks, with 2.76 per cent of the candidates achieving this mark. The mean score was 5.42 marks. Approximately 15.02 per cent of candidates attained no marks.

Candidate's Response to Part (a) (i)

The most stable form of the element oxygen has a mass number of 16 and an atomic number of 8. It can also exist as a radioactive isotope.

(a) Define the following terms.

(i) Atomic number

Atomic number refers to the number of
protons or electrons in an element.

(1 mark)

Examiner's Comments

This part was not well done. Most candidates did not correctly define atomic number as the number of protons in an atom.

Common responses included the following.

- The number of protons and electrons in the atom
- The placement of the element in the periodic table
- The number at the bottom of the symbol

Definitions should be conceptually taught and reinforced in classroom practice.

Candidate's Response to Part (a) (ii)

(ii) Mass number

Combined number of protons and neutrons
of an element

(1 mark)

Examiner's Comments

This part was not well done. The expected response was *the sum of protons and neutrons/nucleon number*.

Common responses included the following.

- The number at the bottom of the element in the periodic table
- The number of protons and electrons and neutrons

Definitions should be conceptually taught and reinforced in classroom practice.

Candidate's Response to Part (a) (iii)

(iii) Isotopes

..Atoms of the same element (same
..number of protons) which contain
..different number of neutrons (different
..mass numbers).

(2 marks)

Examiner's Comments

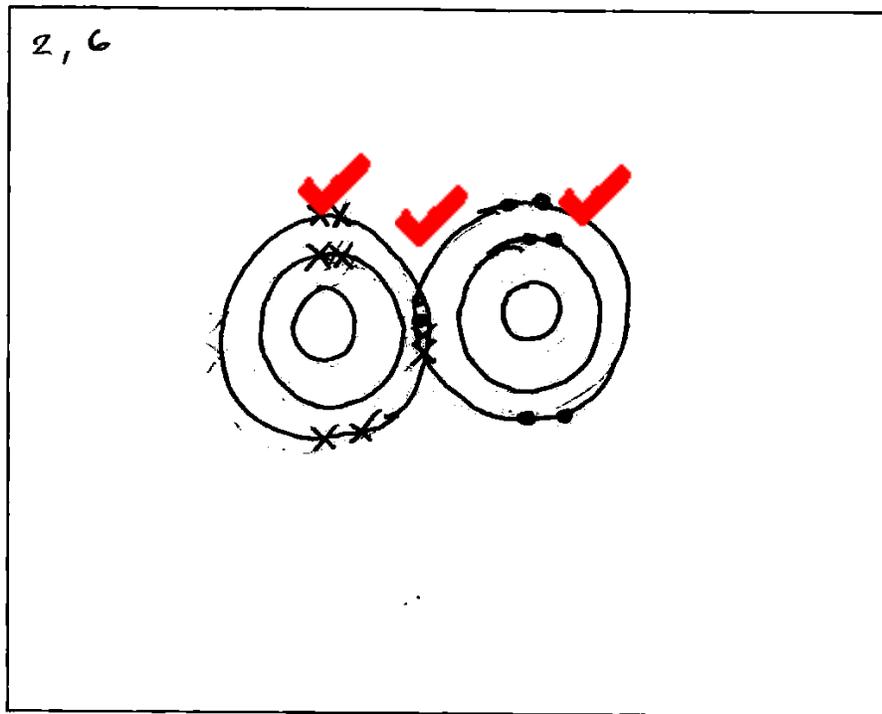
Though this part was well done, there was some confusion regarding the definition of isotopes. The required response was *an isotope is a form of a chemical element that has same number of protons but different number of neutrons*.

The exemplar shows a well-articulated response that shows that the candidate had a clear understanding of the concept. He/she received full marks.

Candidates gave incorrect responses such as the following: 'same mass number', 'different number of protons (different atomic number)'.

Candidate's Response to Part (b)

(b) Use a dot and cross diagram to show the bonding present in oxygen gas.



(3 marks)

Examiner's Comments

Candidates were asked to draw a dot and cross diagram to show the bonding present in oxygen gas. Many candidates did not follow the instructions but were still able to obtain at least one mark.

Candidates should be given more practice in drawing bonding diagrams for all types of bonding — metallic, ionic and covalent — involving both hetero-nuclear and homo-nuclear molecules/compounds.

In the exemplars, the candidates showed the bonding present in oxygen gas.

Candidate's Response to Part (c) — Sample 1

- (c) There are many uses of radioactive isotopes in everyday life. List ANY THREE uses of radioactive isotopes.

They are used in cancer treatment, to
make pacemakers and in nuclear reactors
to produce energy.

(3 marks)

Candidate's Response to Part (c) — Sample 2

- (c) There are many uses of radioactive isotopes in everyday life. List ANY THREE uses of radioactive isotopes.

Carbon-14 → Carbon dating
Uranium-235 → ^{Energy} fuel generation in nuclear plants
Cobalt-60 → killing cancer cells.

(3 marks)

Examiner's Comments

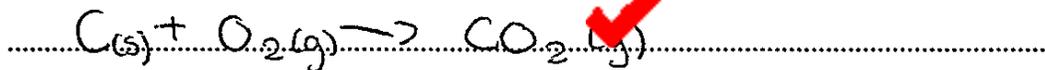
Generally, candidates were able to give uses of radioactive isotopes. Some correct responses included

- cancer treatment
- tracers
- carbon dating
- pacemakers
- energy generation.

Some incorrect responses given were: x-rays; microwaves; chemotherapy and cell phones. When discussing cancer treatment, teachers should explain the difference between chemotherapy and radiotherapy

Candidate's Response to Part (d)

- (d) Carbon burns completely in excess oxygen to produce carbon dioxide. Write a balanced chemical equation, including state symbols, to show this reaction.



.....

.....

.....

(2 marks)

Examiner's Comments

Candidates did well in this part. They were able to write a balanced equation for the complete combustion of carbon in excess oxygen.

Candidates commonly portrayed the state of carbon as a gas. Doing so was incorrect.

Candidate's Response to Part (e)

- (e) Carbon burns in limited oxygen supply to produce carbon monoxide. Write a balanced chemical equation, including state symbols, to show this reaction.



.....

.....

.....

(3 marks)

Examiner's Comments

Overall, this part was poorly done. Common errors included the following.

- Giving the state of carbon as gas ($C_{(g)}$) instead of solid ($C_{(s)}$)
- Writing the formula for oxygen incorrectly
- Writing equations that were not balanced

In the exemplar, the candidate correctly identified carbon monoxide as the product of incomplete combustion, balanced the equation and included appropriate state symbols.

Question 3

This question tested the following specific objectives from Section B (Organic Chemistry) of the syllabus: B 1.1, 1.2, 2.2, 2.3, 2.5, and 3.1.

Candidates were required to

- identify natural gas and petroleum as natural sources of hydrocarbons
- list the main uses of at least three fractions obtained from the fractional distillation of petroleum
- write formulae to represent simple organic compounds
- list the general characteristics of a homologous series
- deduce the homologous series given the fully displayed and condensed formulae of compounds
- describe the reactions of alkanes and alkenes.

The maximum score obtained was 15 out of 15 marks, with one candidate achieving this mark. The mean score was 6.43 marks. Approximately 10.66 per cent of candidates attained no marks.

Candidate's Response to Part (a) (i) — Sample 1

(a) Compounds A and B are straight-chain hydrocarbons whose molecular formulas are C_5H_{12} and C_6H_{14} respectively.

(i) State ONE natural source of hydrocarbons.

Petroleum (Crude oil)

(1 mark)

Candidate's Response to Part (a) (i) — Sample 2

(a) Compounds A and B are straight-chain hydrocarbons whose molecular formulas are C_5H_{12} and C_6H_{14} respectively.

(i) State ONE natural source of hydrocarbons.

Natural gas is a source of hydrocarbons.

(1 mark)

Examiner's Comments

Generally, this part was well done. In the exemplars, the candidates gave correct responses.

Common incorrect responses included the following.

- Gasoline
- Petrol
- Water

Candidate's Response to Part (a) (ii)

(ii) State TWO uses of Compound B.

- As fuels 
- As a solvent (non-polar) 
.....
.....
.....

(2 marks)

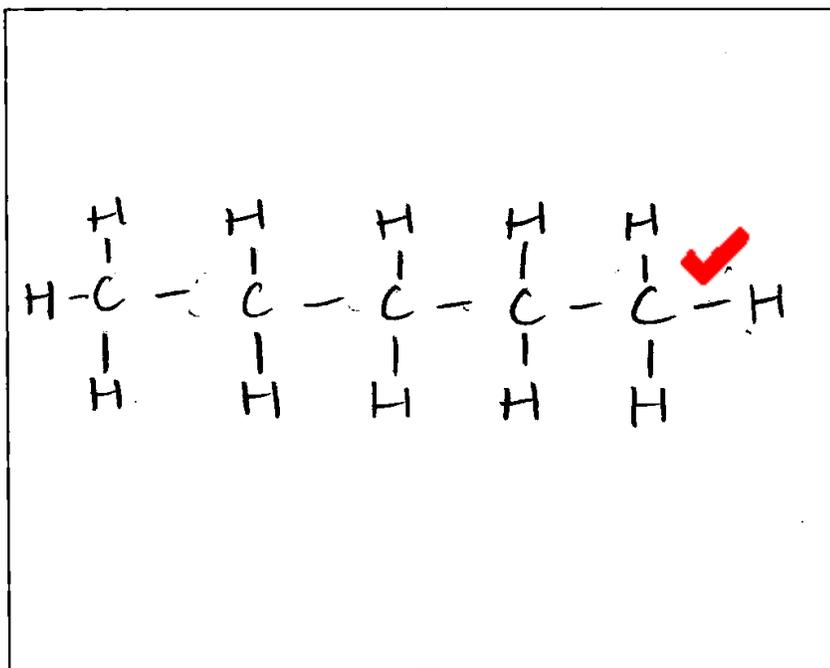
Examiner's Comments

This part was very poorly done. In the exemplar, the candidate gained one mark. Common incorrect responses included the following.

- Hexane is used as a fuel.
- Hexane is used for cooking gas.

Candidate's Response to Part (b) (i)

(b) (i) Draw the FULLY displayed structure of Compound A.



(2 marks)

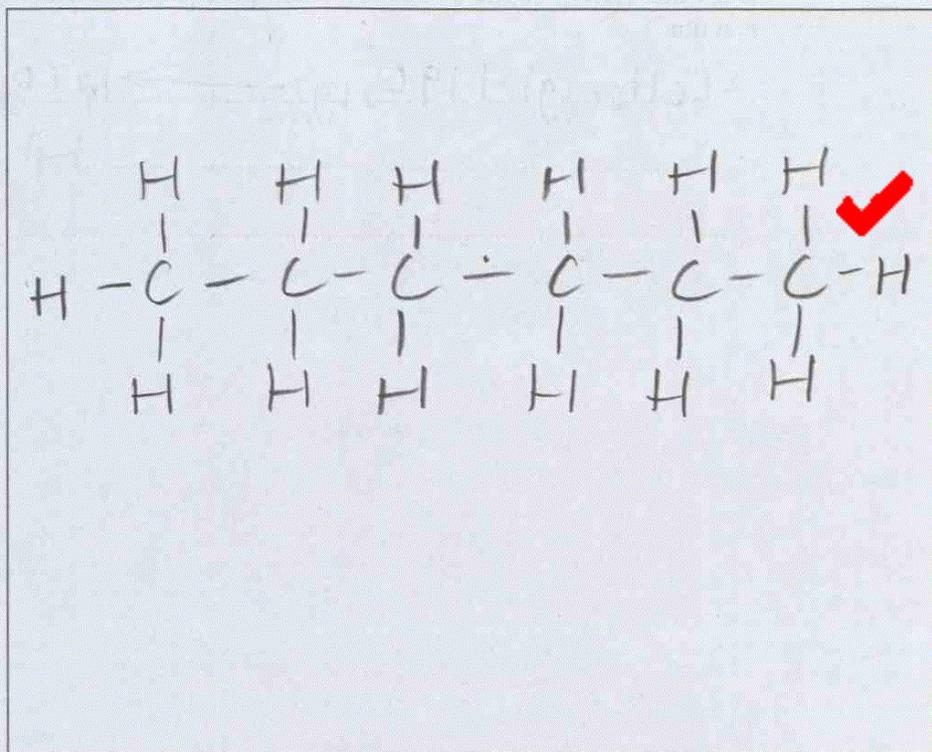
Examiner's Comments

This question was very well done. Some candidates lost marks for not drawing in all the hydrogen atoms around the carbon atoms or for missing bonds around the carbon atoms.

The exemplar shows a correct response.

Candidate's Response to Part (b) (ii)

(ii) Draw the FULLY displayed structure of Compound B.



(2 marks)

Examiner's Comments

This part was very well done. Some candidates lost marks for not drawing all the hydrogen atoms around the carbon atoms or for missing bonds around the carbon atoms. A few candidates drew double bonds.

In the exemplar, the candidate gave a correct response.

Candidate's Response to Part (c) (i)

(c) (i) List ANY FOUR general characteristics of a homologous series.

- Same functional group ✓ ^{properties}
- Same general formula ✓
- Same chemical properties ✗ similar chemical properties
- They differ by CH_2 (eg C_5H_{12} and C_6H_{14})
- The n that comes ~~before~~ ^{compound} before ^{differs} by CH_2 ✓

(4 marks)

Examiner's Comments

This part was satisfactorily done. Most candidates were able to give at least one characteristic of a homologous series. Candidates often interchanged words such as 'same' and 'similar' when giving the characteristics of a homologous series. For example, many candidates incorrectly stated that members of a homologous series have the same chemical formula, when in fact they have similar chemical formulas that follow the same general formula such as $\text{C}_n\text{H}_{2n+2}$ for alkanes.

Common errors included stating members have the same empirical formula or name ending. Empirical formulas show the simplest atom ratio and can differ. For example, methane is CH_4 while ethane is CH_3 . While members often share a suffix such as -ane this is a naming rule and not a defining chemical feature. Thus, members are similar but not identical in these aspects.

Candidate's Response to Part (c) (ii)

- (ii) Deduce the homologous series to which Compounds A and B belong.

The homologous series for Compound A and B are alkanes. ✓
(1 mark)

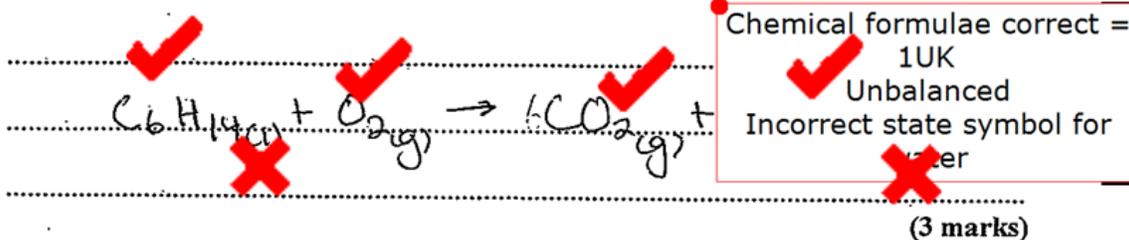
Examiner's Comments

This part was very well done. Most candidates were able to identify Compounds A and B as alkanes.

In the exemplar, the candidate gave a correct response.

Candidate's Response to Part (d)

- (d) Compound B (C_6H_{14}) burns completely in oxygen to produce carbon dioxide (CO_2) and water (H_2O). Write a balanced chemical equation, including state symbols, for this reaction.



Examiner's Comments

This part was poorly done. Many candidates struggled to write the equation for the combustion of hexane. In cases where candidates wrote the correct formulae for the reactants and products, they were not able to balance the equation. Candidates tended to have the correct number of carbon, hydrogen and oxygen atoms on the right-hand side of the equation but used an incorrect coefficient in front of oxygen on the left-hand side when balancing the equation.

Most candidates did not include the correct state symbols for hexane and water vapour and therefore they were unable to score full marks. Teachers need to emphasize that all alkanes are not gases. There is a gradual change in state as the number of carbon atoms increase and water vapour [$H_2O(g)$] is produced from combustion reactions.

The exemplar shows some of the errors made by candidates.

Question 4

This question tested the following specific objectives from Section A (Principles of Chemistry) and Section C (Inorganic Chemistry) of the syllabus: A 9.1, 9.2, 5.4, 4.2, 6.5; C 1.1, 4.3.

Candidates were required to

- explain metallic bonding
- conduct investigations leading to the classification of substances as conductors or non-conductors
- discuss the harmful effect of metals and their compounds on living systems and the environment
- distinguish between metallic and electrolytic conduction and explain trends in Group II
- write balanced equations
- describe the physical and chemical properties of metals.

The maximum score obtained was 15 out of 15 marks. The mean score was 4.86 marks. Approximately 8.40 per cent of candidates attained no marks.

Candidate's Response to Part (a) (i)

Magnesium and lead are metals often found in living things and in the environment.

- (a) (i) Explain metallic bonding in metals.

Positive cations in metals are surrounded
by a 'sea' of delocalized mobile electrons.

(2 marks)

Examiner's Comments

In the exemplar, the candidate was able to correctly explain metallic bonding in metals. Generally, this part was not well done. Most candidates were able to identify *the sea of delocalized electrons* but made no reference to the cations. Candidates seemed to be confused about metallic bonding. They tended to indicate that it is the bonding of two metals. Misconceptions such as these must be addressed by teachers as they guide students in understanding that metallic bonding is the bonding within the metal.

More time should be devoted to exploring the differences among the concepts: metallic bonding, ionic bonding and covalent bonding. The latter two concepts occur in compounds whilst the first occurs in metal elements only.

Candidate's Response to Part (a) (ii)

- (ii) Give the reason why metals conduct electricity in solid form.

Metals contain mobile, delocalized electrons which are free to move and conduct electricity.

(1 mark)

Examiner's Comments

Most candidates responded correctly to this part, provided answers such as *delocalized electrons*, *mobile electrons*, *sea of electrons*, as shown in the exemplar.

Candidate's Response to Part (a) (iii)

- (iii) State ANY TWO harmful effects of lead and its compounds on living things and their environment.

Lead can: 1) Cause a decrease in IQ in young children ^{which} ~~and~~ can cause learning problems and 2) It affects the normal formation of red blood cells which can lead to anaemia.

(2 marks)

Examiner's Comments

Most candidates were able to identify two harmful effects of lead and its compounds. These included *decreased IQ*, *anaemia*, *lead poisoning*, *pollution of water bodies*.

In the exemplar, the candidate gave a correct response.

Candidate's Response to Part (b) (i)

- (b) A chemistry student conducted a series of experiments using an electrolytic cell to test the conductivity of magnesium chloride. The materials used to set up the apparatus and the student's observations were recorded in Table 2 below.

TABLE 2: MATERIALS USED TO SET UP EXPERIMENTS AND OBSERVATIONS

| Experiment Number | Electrodes Used | Electrolyte | Bulb | Observations at Electrodes |
|-------------------|-----------------|-----------------------------------|--------------------|---|
| 1 | PVC Plastic | Dilute aqueous magnesium chloride | Bulb did not light | No visible reaction |
| 2 | Graphite | Dilute aqueous magnesium chloride | Bulb lit | Gases produced at the cathode and the anode |
| 3 | Platinum | Solid magnesium chloride | Bulb did not light | No visible reaction |

- (i) Explain why the bulb did not light in Experiments 1 and 3.

Experiment 1

~~Tonic~~ Plastic ~~is~~ cannot conduct electricity, i.e. it is an insulator, so electric current will not be able to pass through it and therefore the bulb will not light.

Experiment 3

Tonic substances do not conduct electricity in their solid form. Magnesium chloride is an ionic substance. There are no free ^{ions} electrons in the solid form to carry the current, so the bulb will not light.

(4 marks)

Examiner's Comments

In the exemplar, the candidate gave correct explanations. However, most candidates had difficulty providing an explanation for both experiments. For Experiment 1, candidates gained marks for providing the following responses: *PVC is an insulator* and *PVC prevents the flow of electricity*.

A common misconception was that PVC conducted electricity. Some candidates stated that it was a poor conductor. Teachers are encouraged to increase students' time in the lab so that they can have more opportunities to be shown the differences between non-conductors, poor conductors and conductors.

For Experiment 3, candidates knew that electricity could not be conducted in solid MgCl_2 but they provided no explanation as to why this is so. Candidates were unable to fully explain that the ions within the ionic compound are immobile. There was also the misconception that MgCl_2 had electrons and not ions.

Candidate's Response to Part (b) (ii)

(ii) Explain why the bulb lit in Experiment 2.

Graphite is able to conduct electricity due to
and free electrons
its bonding, so electricity would be able to pass
through to charge the electrodes. Also, electricity would
be able to pass through the electrolyte as there are
free ions (because it is in solution) to carry the
electric current.

(3 marks)

Examiner's Comments

Most candidates were able to identify graphite and aqueous MgCl_2 as electrical conductors but failed to explain that aqueous MgCl_2 conducts electricity due to its free ions.

In the exemplar, the candidate provided a correct response.

Candidate's Response to Part (b) (iii)

(iii) State the process that took place in Experiment 2.

Electrolysis took place. ✓

(1 mark)

Examiner's Comments

Most candidates responded correctly.

Candidate's Response to Part (c)

(c) Magnesium readily reacts with oxygen in the air. Write a balanced chemical equation for this reaction.



(2 marks)

Examiner's Comments

This part was well done. Candidates were able to give a balanced equation. However, there was some misunderstanding regarding the writing of the formula for oxygen. Some candidates wrote 'O' and not the molecular form O_2 . Also, the formula for magnesium oxide was written as ' MgO_2 ' and not MgO . There were also instances where candidates used the ion form of magnesium as the reactant, Mg^{2+} , and not the elemental form, Mg.

Ensuring that students can write simple chemical equations should be a priority for teachers from the early introductory classes until the completion of the syllabus.

The exemplar shows a correct response.

Question 5

This question was based on Section B (Organic Chemistry) and Section A (Principles of Chemistry) of the syllabus: B 2.2, 3.8, 4.1, 4.2; A 2.5, 6.5.

It tested candidates' ability to

- define polymers
- distinguish between addition and condensation as reactions in the formation of polymers
- write formulae to represent simple organic compounds
- describe the fermentation process by which ethanol is produced from carbohydrates
- apply suitable separation techniques based on differences in the properties of the components of mixtures
- write balanced equations.

The maximum score obtained was 15 out of 15 marks. The mean score was 3.88 marks. Approximately 24.62 per cent of candidates obtained no marks.

Candidate's Response to Part (a) (i) — Sample 1

- (a) Proteins and starch are examples of natural polymers which are formed through the process of condensation polymerization.

- (i) Define the term 'polymer'.

A polymer is a macromolecule, made up of ^{thousands} smaller repeating units called monomers.

(2 marks)

Candidate's Response to Part (a) (i) — Sample 2

(a) Proteins and starch are examples of natural polymers which are formed through the process of condensation polymerization.

(i) Define the term 'polymer'.

A polymer is a macromolecule made up of 50 or more monomers.

(2 marks)

Examiner's Comments

This question was well done. Most candidates were able to correctly define the term *polymer*. Common correct responses included the following.

- A macromolecule is made up of thousands of smaller repeating units called monomers.
- A polymer is a macromolecule made up of 50 or more monomers.

Both exemplars show correct responses.

It was clear from the following responses that there were some misconceptions.

- Polymers are macronutrients.
- A single bond chain to chain.
- An element that is connected by 50 or more monomers usually in chains.

An example of a common incorrect response is as follows.

- Polymer refers to alkanes, alkenes, alcohols, acids and esters.

Teachers are encouraged to spend more time on the delivery of the content that is related to this syllabus objective.

Candidate's Response to Part (a) (ii)

(ii) Define the term 'condensation polymerization'.

..... This is polymerization that occurs by the removal
..... of a water molecule.....
.....

(1 mark)

Examiner's Comments

This question proved to be difficult for candidates and was poorly done by most of them. However, some candidates were able to obtain at least one mark for stating that condensation polymerization occurs via the removal of a water molecule.

Some incorrect responses included the following.

- The sequence of molecules and mass of a polymer
- The process of creating polymers

Candidate's Response to Part (b) (i)

(b) The manufacture of ethanol makes use of the fermentation process.

(i) Define the term 'fermentation'.

Fermentation is the process by which glucose is converted to ethanol and carbon dioxide with the aid of the enzyme ^{zymase} zymase in yeast with the absence of alcohol oxygen.

$2 C_2H_5OH + 2 CO_2$ (3 marks)

Examiner's Comments

Most candidates obtained at least one mark. In the exemplar, the candidate provided a fully correct response.

A common incorrect response is as follows.

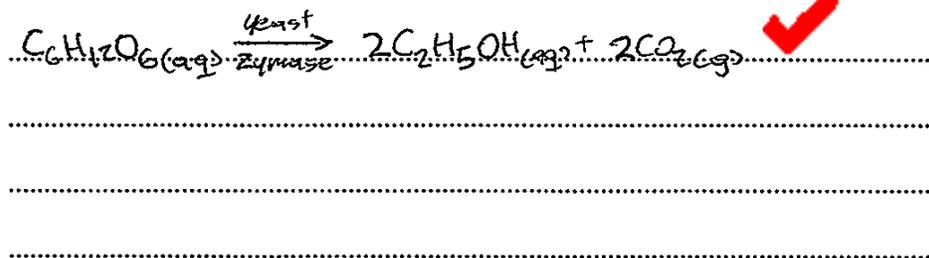
- Fermentation is the process by which substances ferment to form alcohols.

It was clear from the following responses that there were some misconceptions.

- Removal of ethanol from a substance by attaining the boiling point of the ethanol.
- In the fermentation process, hydrocarbons can pick up an OH molecule.
- Fermentation is a separation process.

Candidate's Response to Part (b) (ii)

- (ii) Write a balanced chemical equation, including state symbols, to show the process of fermentation.

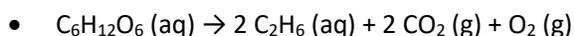


(3 marks)

Examiner's Comments

Overall, candidates' performance was poor. Most candidates had difficulty writing a balanced chemical equation to show the process of fermentation. One common error was using the incorrect state symbols for glucose and ethanol. Many candidates also had difficulty writing the correct formulae for reactants and products.

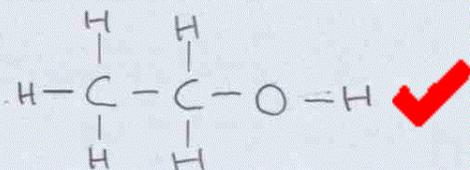
A common incorrect response is as follows.



The exemplar shows a correct response. Teachers are encouraged to spend more time teaching students how to write balanced chemical equations.

Candidate's Response to Part (b) (iii)

(iii) Draw the FULLY displayed structure of ethanol.



(2 marks)

Examiner's Comments

Most candidates were able to score two marks for the fully displayed structure of ethanol, as shown in the exemplar. A few candidates drew the structure of methanol or propanol.

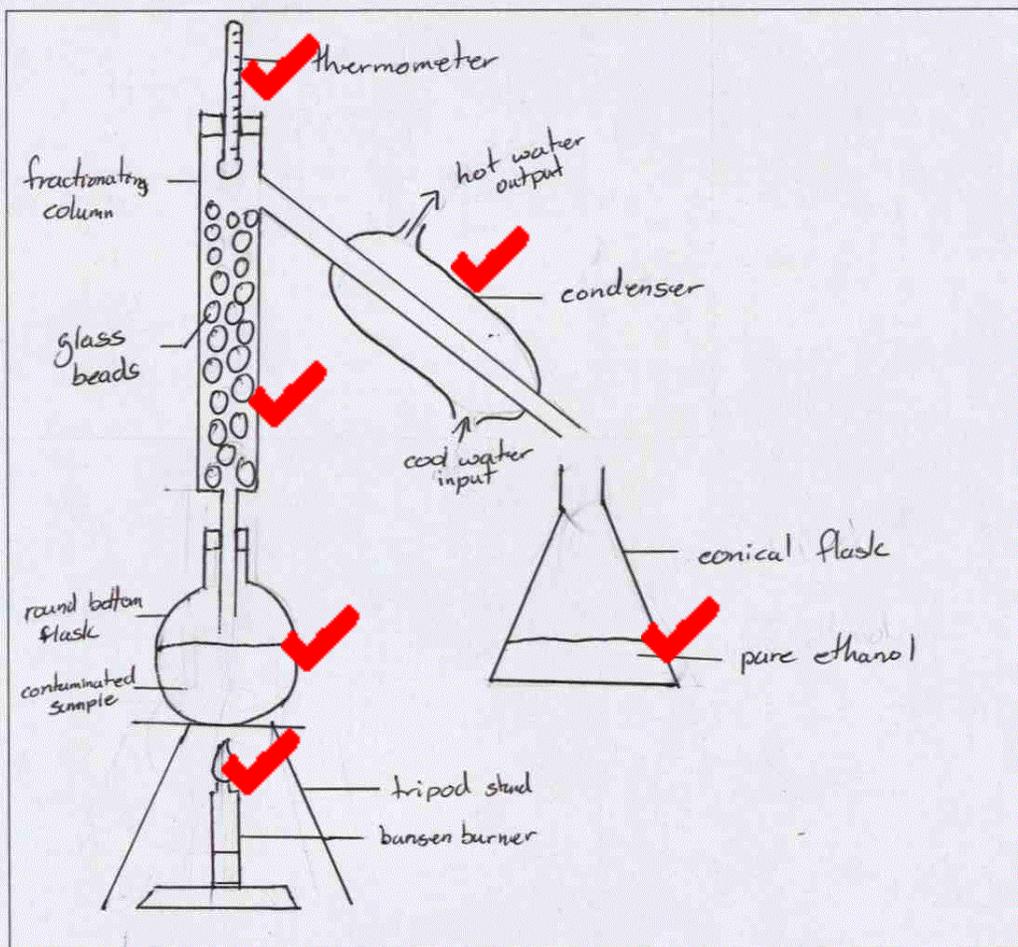
There is a misconception among some candidates that atom connectivity in bonding does not matter. This is false. When writing the structure of ethanol, the bond should be drawn between carbon and oxygen, and not between the carbon and hydrogen of that functional group.

Teachers are encouraged to allocate more time to teaching students how to write fully displayed structural formulae.

Candidate's Response to Part (b) (iv)

- (iv) During a demonstration of the wine-making process in the school's food laboratory, a technician separated a pure sample of ethanol. However, the flask was not labelled and water was accidentally poured into the sample.

Using a line diagram, draw and label the apparatus that could be set up in the chemistry laboratory to obtain the pure ethanol from the contaminated sample.



(4 marks)

Examiner's Comments

Candidates found this part challenging. A few candidates were able to score four marks for providing an accurate and well-labelled line diagram of the setup to obtain pure ethanol.

In the exemplar, the candidate gave a correct response. Common errors included the following.

- The fractional distillation diagram was not closed; no rubber bung was shown.
- The condenser did not include the inner sleeve as well as show the inlet and outlet of the water jacket.
- A beaker was used as the reaction flask.

Teachers are encouraged to allocate more time for students to practice drawing line diagrams of commonly used laboratory setup.

Question 6

This question tested the following specific objectives from Section C (Inorganic Chemistry) and Section A (Principles of Chemistry) of the syllabus: C 5.6, 5.7, 5.8; A 6.3.

Candidates were required to

- relate the unique properties of water to its functions in living systems
- discuss the solvent properties of water
- describe the methods used in the treatment of water for domestic purposes
- write balanced equations

The maximum score obtained was 15 out of 15 marks and one candidate achieved this mark. The mean score was 2.80 marks. Approximately 13.31 per cent of candidates attained no marks.

Candidate's Response to Part (a) (i)

Alka Seltzer[®] and Epsom[®] salt are common remedies used in the Caribbean. Alka Seltzer[®] is an antacid used to treat upset stomach and Epsom[®] salt is used to treat sprains and muscle pain. The active ingredient in Alka Seltzer[®] is sodium bicarbonate (NaHCO_3) and in Epsom[®] salt, magnesium sulfate.

(a) Water is called the universal solvent because it dissolves many substances. Epsom[®] salt and Alka Seltzer[®] work by dissolving in water.

(i) Explain why water is a good solvent.

*Water is a good solvent because it is a polar molecule and therefore can.....
bond with ionic compounds and polar covalent substances which are also polar..
causing them to dissolve in water.*

(2 marks)

Examiner's Comments

This question was poorly done and not many candidates attempted it. Candidates who scored marks earned only one mark for stating that water is polar. The second mark was more challenging to achieve since candidates were unable to link the polar nature of water with its ability to dissolve both ionic and polar covalent substances.

It was clear that there were some misconceptions as candidates stated that water is a good solvent because it can dissolve any substance and create a solution. They also said that water is a good solvent because it has a neutral pH. Another misconception was that water can be used for cooking, washing and bathing, thus making it a good solvent.

In the exemplar, the candidate was able to correctly explain why water is a good solvent.

Candidate's Response to Part (a) (ii)

(ii) State TWO properties of water **other than** it is a good solvent.

- High Melting point and boiling point ✓

- High specific heat capacity ✓

.....

.....

.....

(2 marks)

Examiner's Comments

This question was well done. Candidates were able to earn the two marks. Many candidates were able to correctly state two properties of water including some of the following: *high specific heat capacity, high boiling point, neutral pH*. Incorrect responses included 'used to dilute other compounds', 'reacts better with most compounds', 'it is an oxidizing and reducing agent'.

In the exemplar, the candidate gave a correct response.

Candidate's Response to Part (a) (iii)

(iii) State ANY TWO other compounds that dissolve in water.

Na_2SO_4 ✓
 NaCl ✓
.....
.....
.....

(2 marks)

Examiner's Comments

In the exemplar, the candidate provided a correct response. Generally, this question was well done. Most candidates were able to earn full marks. However, it was clear that there were some misconceptions as one of the responses provided by candidates was salt. This response was not accepted as it was too vague. Additionally, a few candidates considered bromine, chlorine and magnesium to be ionic or polar covalent compounds.

Candidates are still finding it challenging to write a correct formula, for example, they wrote NaSO_4 instead of Na_2SO_4 . Teachers preparing students for this exam are encouraged to allocate sufficient time for practice, to ensure that competency in this vital area is achieved.

Candidate's Response to Part (b) (i)

(b) Continuous use of Epsom[®] salt in water may cause hardness of water. This does not happen with Alka Seltzer[®].

Temporary / permanent

(i) State the type of water hardness caused by dissolving Epsom[®] salt in water.

Epsom salt causes permanent hardness ✓

(1 mark)

Examiner's Comments

This question required candidates to state the type of water hardness caused by dissolving Epsom[®] salt in water. It was poorly done and so many candidates earned no marks. Some incorrect responses included 'condensation', 'mineral hardness', 'hard water', 'chemical hardness.'

In some cases, candidates were unable to link Epsom[®] salt to its main chemical ingredient magnesium ions (Mg^{2+}), which are responsible for causing permanent hardness in water.

The exemplar shows a correct response.

Candidate's Response to Part (b) (ii)

(ii) Explain why Epsom[®] salt causes hardness of water.

- epsom salt is composed of magnesium sulphate. The Mg^{2+} cation dissolves in the water which makes it hard. Hard water ~~reacts~~ forms unpleasant scum, wastes soap and blocks hot water pipes.
- When the epsom salts dissolve in water the $MgSO_4$ reacts to form insoluble (2 marks)

Examiner's Comments

This question was poorly done. Many candidates failed to score any marks. Some candidates were able to score a mark for mentioning that dissolved magnesium ions cause the hardness of the water. There was a misconception among candidates in that they failed to link the solubility of the Epsom salt with the solubility of Mg^{2+} ions, resulting in the loss of one mark. To earn the second mark, candidates had to state that Mg^{2+} ions will not lather easily with soap thus causing a scum to form.

Candidate's Response to Part (b) (iii)

- (iii) Explain why boiling the water will not remove the hardness caused by Epsom[®] salt.

Boiling the water will not remove Epsom salt because it is fully dissolved in the water, so by boiling the water it would not be removed. The salts being in the water would not allow them to crystallize and be removed.

(2 marks)

Examiner's Comments

This question was poorly done. Many candidates did not earn any marks. Some candidates scored a mark for mentioning that magnesium salts are completely soluble in water. However, some candidates failed to state that the salt does not precipitate with an increase in temperature.

Candidate's Response to Part (b) (iv)

- (iv) Identify TWO salts that cause hardness of water and can be removed by boiling.

~~CaCO₃~~ and ~~MgSO₄~~ Ca(HCO₃)₂
Mg(HCO₃)₂

(2 marks)

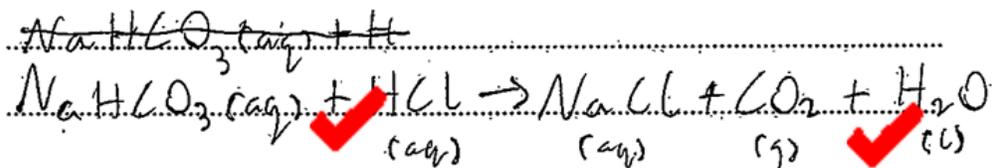
Examiner's Comments

This question was poorly done, with very few candidates attempting it. Incorrect responses included 'sea salt', 'table salt', 'NaCl' and 'MgSO₄'. Some candidates thought that any named general salt would have earned them the mark and they failed to link removal of hardness by boiling with the chemical/compound that caused temporary hardness.

In the exemplar, the candidate correctly identified calcium hydrogen carbonate, Ca(HCO₃)₂ and magnesium hydrogen carbonate, Mg(HCO₃)₂ as the two salts that cause temporary hardness and that can be removed by boiling. This shows that the candidate had a clear understanding of the cause of temporary hardness and the effect of boiling.

Candidate's Response to Part (b) (v)

- (v) When used as an antacid, Alka Seltzer® neutralizes the hydrochloric acid (HCl) in the stomach. Write a balanced chemical equation, including state symbols, to illustrate this process.



(2 marks)

Examiner's Comments

This question was fairly well done. Some candidates were able to score one mark for balancing the equation. Many candidate lost the second mark because they wrote the incorrect state symbols such as (i) instead of (aq) for dilute HCl and (l) instead of (s) for sodium chloride. Some candidates gave 'NaHCl' instead of HCl and gave the state symbol for dilute HCl as '(l)' and the state symbol for sodium chloride as '(l)'.

Teachers need to ensure that candidates are given greater practice in writing balanced equations which include state symbols. The concept of hardness (temporary and permanent) also requires greater attention.

In the exemplar, the candidate's response is accurate and complete and it includes the correct balanced equation and appropriate state symbols. This shows that the candidate had a clear understanding of the concept.

PAPER 031 — SCHOOL-BASED ASSESSMENT (SBA)

The School-Based Assessment (SBA) evaluates candidates' experimental, analysis and interpretation skills with respect to the laboratory and fieldwork. SBAs are marked out of a total of 40 marks.

The maximum score obtained on Paper 031 was 40 out of 40 marks and the mean score was 32.43 marks.

PAPER 032 — ALTERNATIVE TO SCHOOL-BASED ASSESSMENT (SBA)

Paper 032, the Alternative to School-Based Assessment, is written by private candidates. This paper examines the same skills as those tested in Paper 031. The focus, therefore, is on candidates' experimental skills and their use of knowledge (Analysis and Interpretation).

Paper 032 consists of one practical question (conducted in a laboratory), one structured question and one planning and design question.

In 2024, approximately 232 candidates sat Paper 032. Generally, their performance was satisfactory. The maximum score obtained was 36 out of 48 marks and the mean score was 14.78 marks.

Question 1

This question tested the following specific objectives from Section A (Principles of Chemistry) of the syllabus: A 6.2, 6.5, 7.10, 7.11. It consisted of a practical component that candidates were expected to carry out in a laboratory setting.

The question tested candidates' ability to

- investigate neutralization reactions using indicators and temperature changes
- perform calculations using volumetric analysis data
- perform calculations involving the mole
- write balanced equations.

The highest score obtained was 22 out of 26 marks, which was achieved by one candidate. The mean score was 7.64 marks. Approximately 2.16 per cent of candidates attained no marks.

Candidate's Response to Part (a) (i)

1. You are provided with a sample of sodium hydroxide solution labelled **Solution A**, and a sample of **Solution B**, containing 4.38 g dm^{-3} hydrochloric acid. You are required to determine the molar concentration and mass concentration of **Solution A**.

Materials

You are provided with the following chemicals and apparatus.

- Sodium hydroxide solution (150 cm^3), labelled **Solution A**
- 4.38 g dm^{-3} hydrochloric acid solution (150 cm^3), labelled **Solution B**
- Burette (50 cm^3)
- Retort stand and clamp
- Pipette (25 cm^3)
- Phenolphthalein indicator (bottle with dropper)
- 3 conical flasks
- Bottle of distilled water
- White tile
- Pipette filler

Procedure

1. Rinse and fill your burette with **Solution A**. NaOH
2. Pipette 25 cm^3 of **Solution B** into a conical flask and add two drops of phenolphthalein indicator.
3. Titrate the contents of the conical flask from Step 2 with **Solution A** until a permanent pale pink colour change is observed.
4. In Table 1 on page 6, record your results to 2 decimal places.
5. Repeat Steps 2 to 4 until two consistent results are obtained but do NO MORE than THREE titrations. Refill your burette EACH time.

(a) Treatment of results

- (i) In Table 1, record your burette volume readings to two decimal places.

TABLE 1: TITRATION OF SOLUTION B WITH SOLUTION A

| Burette Reading (cm ³) | Titration 1 | Titration 2 | Titration 3 |
|------------------------------------|-------------|-------------|-------------|
| Final volume | 40.00 | 41.00 | 41.00 |
| Initial volume | 0.00 | 0.00 | 0.00 |
| Volume of Solution A used | 40.00 | 41.00 * | 41.00 * |

(9 marks)

Examiner's Comments

This part was not well done. The maximum score was five out of nine marks. Many candidates did not write the titre values to two decimal places. Some candidates did not perform the titration accurately and this produced values way beyond what was expected. It is strongly recommended that private candidates be given more practice in performing titration to ensure that they develop greater competency.

Candidate's Response to Part (a) (ii)

TABLE 1: TITRATION OF SOLUTION B WITH SOLUTION A

| Burette Reading (cm ³) | Titration 1 | Titration 2 | Titration 3 |
|------------------------------------|-------------|-------------|-------------|
| Final volume | 40.00 | 41.00 | 41.00 |
| Initial volume | 0.00 | 0.00 | 0.00 |
| Volume of Solution A used | 40.00 | 41.00 * | 41.00 * |

(9 marks)

- (ii) In Table 1, use asterisks (*) to indicate the titration volumes that will be used to calculate the average volume of Solution A.

(1 mark)

Examiner's Comments

This part was answered fairly well. Candidates were able to accurately identify the two closest values. However, there were some candidates who identified all three values without taking into account that the two closest values were required to provide an answer.

Candidate's Response to Part (a) (iii)

- (iii) Determine the average volume of Solution A that is required to react with 25 cm³ of Solution B.

$$\frac{41.00 + 41.00}{2} = 41.00 \text{ cm}^3$$

.....

.....

.....

(1 mark)

Examiner's Comments

This part was generally well done and most candidates were able to find the average titre value based on the values chosen previously.

Candidate's Response to Part (a) (iv) — Sample 1

- (iv) Calculate the molar concentration of Solution B. (RAM. of H = 1, Cl = 35.5)

RAM: H = 1, Cl = 35.5
H + 35.5 = 36.5 ✓
17 cm³ has 0.1 mole of HCl
Per 18.40 ^{has} (0.1 = 1000) × 18.40 cm³ = 0.018 mol
of HCl. (2 marks)

Candidate's Response to Part (a) (iv) — Sample 2

- (iv) Calculate the molar concentration of Solution B. (RAM. of H = 1, Cl = 35.5)

HCl molar mass = (1 × 1) + (1 × 35.5) = 36.5 g
1 mol = 36.5 g / 36.5 g = 1 mol
1 g = $\frac{1}{36.5}$ mol
4.38 g = $\frac{1}{36.5} \times 4.38$ g = 0.12 mol
Concentration of HCl = 0.12 mol / dm³ (2 marks)

Examiner's Comments

This part was not very well done as most candidates were unable to gain a mark. Most candidates were able to successfully calculate the molar mass of hydrochloric acid but were unable to use the value to calculate the molar concentration of Solution B. Students should be given more opportunities to practice titration calculations.

Candidate's Response to Part (a) (v) — Sample 1

- (v) Calculate the number of moles of HCl, in 25 cm³ of **Solution B**.

$$\begin{aligned} 1 \text{ dm}^3 &= 0.137 \text{ mol} \\ 1000 \text{ cm}^3 &= 0.137 \text{ mol} \\ 1 \text{ cm}^3 &= \frac{0.137}{1000} \\ 25 \text{ cm}^3 &= \frac{0.137}{1000} \times \frac{25}{1} = 3.425 \times 10^{-3} \text{ mol} \end{aligned}$$

(2 marks)

Candidate's Response to Part (a) (v) — Sample 2

- (v) Calculate the number of moles of HCl, in 25 cm³ of **Solution B**.

$$\begin{aligned} 1 \text{ dm}^3 &= 0.12 \text{ mol} \\ 1000 \text{ cm}^3 &= 0.12 \text{ mol} \\ 1 \text{ cm}^3 &= \frac{0.12}{1000} \\ 25 \text{ cm}^3 &= 25 \times \frac{0.12}{1000} = 3 \times 10^{-3} \text{ mol} \end{aligned}$$

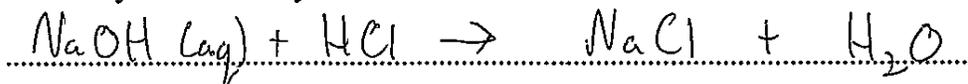
(2 marks)

Examiner's Comments

Candidates did not complete this part very well. While some were able to do the correct operation, most did not use the answer from Part (a) (iv). However, they were credited for performing part of the operation successfully. There needs to be greater emphasis on the stepwise calculations involved in titrations.

Candidate's Response to Part (a) (vi) — Sample 1

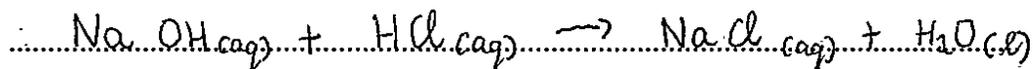
- (vi) Write the balanced equation, including state symbols, for the reaction between sodium hydroxide and hydrochloric acid.



(2 marks)

Candidate's Response to Part (a) (vi) — Sample 2

- (vi) Write the balanced equation, including state symbols, for the reaction between sodium hydroxide and hydrochloric acid.



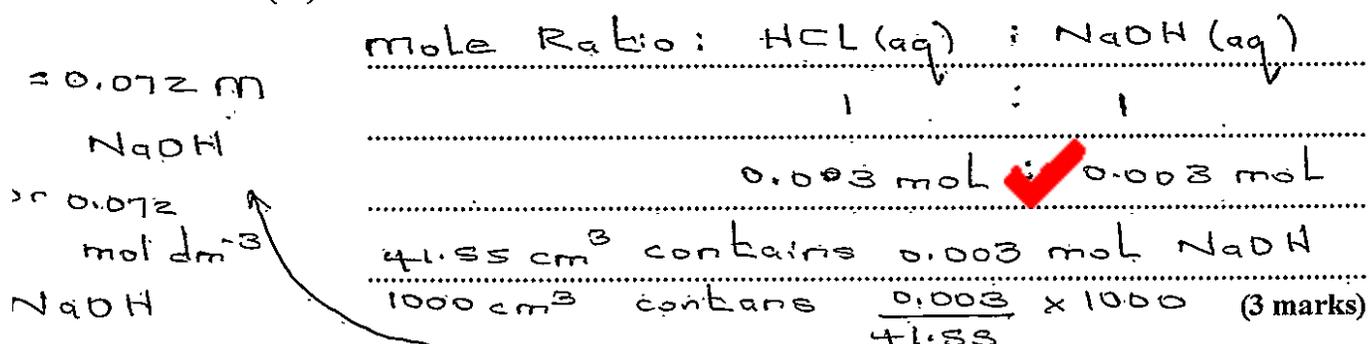
(2 marks)

Examiner's Comments

Most candidates did not perform well. Some candidates wrote balance equations but they struggled to write accurate state symbols for the reactants and products. In most cases, candidates still earned one out of the two possible marks. Reactions in solutions should be reinforced during laboratory time and candidates should be guided in providing state symbols based on the reaction taking place.

Candidate's Response to Part (a) (vii)

(vii) Calculate the molar concentration of Solution A.

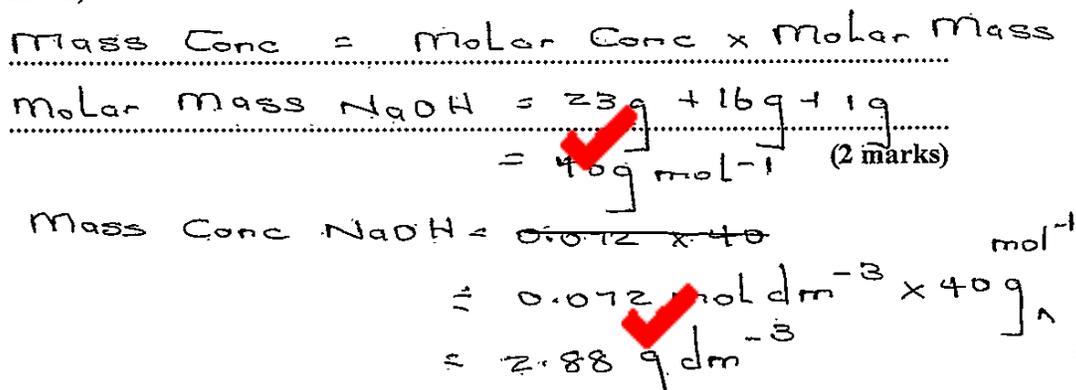


Examiner's Comments

This part was not very well done by candidates. Some candidates did not attempt the question and those who attempted it did not recognize that the molar ratio was needed in order to continue with the calculation. Additionally, some candidates did not make use of the titre value obtained in Part (a) (iii). It is recommended that responses for this type of question be laid out very clearly, as shown in the exemplar.

Candidate's Response to Part (a) (viii)

(viii) Calculate the mass concentration of Solution A. (RAM. of Na = 23, O = 16 and H = 1.)



Examiner's Comments

Most candidates were able to earn at least one out of the two possible marks. Most candidates were able to calculate the relative molecular mass of sodium hydroxide but did not go on to use the answer from Part (a) (vii) to complete the full calculation.

Candidate's Response to Part (b) — Sample 1

- (b) State the source of TWO errors that can occur during the experiment.

Two errors are improper readings of the pipetted burette (readings not at eye level) or improper use of apparatus leading to more or less of a solution being added.

(2 marks)

Candidate's Response to Part (b) — Sample 2

- (b) State the source of TWO errors that can occur during the experiment.

Two sources of error are: getting air bubbles into burette and leaving funnel in the burette while titrating.

(2 marks)

Examiner's Comments

This part was not well done. Some candidates mentioned safety precautions for this response rather than practical sources of errors, demonstrating that there are misconceptions regarding procedural errors and safety precautions. Other candidates mentioned parallax errors while there were some who indicated not reading the burette at eye level. Some candidates earned a mark for a partial response. Titrations can have procedural errors and candidates should be made aware of these as they conduct titrations.

Candidate's Response to Part (c)

- (c) State TWO safety precautions that should have been followed when conducting the experiment. .

1) Eye goggles should be worn

2) Gloves to protect hands.

(2 marks)

Examiner's Comments

This part was very well done as most candidates were able to list the safety precautions that should be observed during the experiment. Candidates are encouraged to put into practice these safety measures especially while conducting experiments in the laboratory.

Question 2

This question was based on Section C, Inorganic Chemistry of the syllabus, specific objective C 6.1. It tested candidates' ability to identify cations — Pb^{2+} , Al^{3+} , Ca^{2+} , Zn^{2+} , Fe^{3+} , Fe^{2+} , NH_4^+ , Cu^{2+} .

Approximately 1.00 per cent of candidates achieved the highest obtained by any candidate, which was 8 out of 10 marks. The mean score was 2.61 marks. Approximately 32.00 per cent of candidates attained no marks.

Candidate's Response to Part (a) (i)

2. Table 2 shows the tests carried out on a solid, Y, which is a mixture of two compounds. Complete Table 2 by inserting the observations for each test.

TABLE 2: RESULTS OF VARIOUS TESTS ON SOLID Y

| Test | Observation | Inference |
|--|---|---|
| (a) The sample of Solid Y is divided into TWO equal parts. To the first part of Solid Y, dilute nitric acid is added. It is boiled and filtered. The filtrate is divided into THREE equal portions, for Tests (a) (i) to (iii) below. | | |
| (i) To the first portion of the filtrate, aqueous sodium hydroxide is added slowly until in excess. | <ul style="list-style-type: none"> • dropwise - white precipitate formed • in excess - precipitate dissolves <p style="text-align: center;">(2 marks)</p> | The solution contains Al^{3+} , Pb^{2+} or Zn^{2+} ions. |

Examiner's Comments

Overall, candidates' performance was fair. Some incorrect responses included 'No precipitate'; 'No colour change'; 'More white precipitate formed in excess NaOH'. Candidates thought that the white precipitate remained insoluble in excess NaOH. This was a common misconception.

Candidate's Response to Part (a) (ii)

| | | | |
|------|---|---|--|
| (ii) | To the second portion of the filtrate, aqueous potassium iodide is added. | <ul style="list-style-type: none"> No precipitate formed ✓ <p>(1 mark)</p> | <p>Pb²⁺ ions are absent.</p> <p>✓✓✓</p> |
|------|---|---|--|

Examiner's Comments

This part was poorly done. Some incorrect responses included 'blue colour observed', 'bright yellow precipitate formed' and 'white precipitate'.

Candidate's Response to Part (a) (iii)

| | | | |
|-------|---|---|--|
| (iii) | To the third portion of the filtrate, aqueous ammonia is added until in excess. | <ul style="list-style-type: none"> white precipitate ✓ Colourless solution ✓ <p>(2 marks)</p> | <p>Zn²⁺ ions are present.</p> |
|-------|---|---|--|

Examiner's Comments

The candidate earned full marks for the response shown in the exemplar. A common misconception was that candidates did not recognize that the solid mixture was partially soluble.

Candidate's Response to Part (b)

| | | | |
|-----|---|--|--|
| (b) | <p>To the second part of Solid Y, approximately 8 cm³ of water is added.</p> <p>It is stirred and then filtered. The filtrate is tested below.</p> | <ul style="list-style-type: none"> Residue is is obtained Filtrate is obtained and colourless (3 marks) | <p>One of the compounds in the mixture is soluble in water.</p> <p>Sodium, potassium, or ammonium salt, or nitrate may be present.</p> |
|-----|---|--|--|

Examiner's Comments

This part was poorly done. Candidates were credited with a mark for recognizing that Solid Y was partially soluble. To earn the other mark, candidates were expected to state that a solid residue and a colourless filtrate would be obtained. Incorrect responses included 'white precipitate', 'the filtrate remained the same', 'no observable changes' and 'filtrate was a deep red solution'.

Candidate's Response to Part (c)

| | | | |
|-----|---|---|--|
| (c) | <p>To the portion of the filtrate from (b) above, aqueous silver nitrate is added, followed by aqueous ammonia.</p> | <ul style="list-style-type: none"> white precipitate formed ✓ precipitate dissolved in ammonia solution ✓ (2 marks) | <p>Chloride (Cl⁻) ions are present.</p> |
|-----|---|---|--|

Examiner's Comments

In the exemplar, the candidate shows a correct response. Generally, this part was poorly done. Some incorrect responses included 'no change occurs', 'greenish-yellow precipitate' and 'gas forms'.

There is need for students to be given greater practice in responding to qualitative analysis questions.

Question 3

This question was based on Section A of the syllabus, Principles of Chemistry, specific objective: A 2.5. It tested candidates' ability to apply suitable separation techniques based on differences in the properties of the components of mixtures.

The maximum score, 12 out of 12 marks, was achieved by one candidate. The mean score was 4.53 marks. Approximately 8.62 per cent of candidates attained no marks.

Candidate's Response to Part (a)

James and Janet observed that two spatulas in the chemistry lab were at different stages of corrosion. One spatula was more corroded than the other. Janet suggested that the spatulas are made from two different metals, Metal A and Metal B, one more reactive than the other.

Plan and design an experiment to determine which of the metals, A or B, is more reactive.

The hypothesis is given below.

Hypothesis: Metal A is more reactive towards acids than Metal B.

Your answer should include the following.

(a) Apparatus and materials

- ① ~~hydrochloric acid~~ ^{con.} sulphuric acid ✓
- ② beakers ✓
- ③ stirring rod ✓
- ④ Metals A & B ✓
- ⑤ Distilled water ✓
- ⑥ Stop watch ✓
- ⑦ PPE (goggles/lab coat with long sleeve/gloves etc) ✓

(3 marks)

Examiner's Comments

Most candidates were able to identify the apparatus required to perform the experiment. However, they did not identify Metals A and B in their list.

Candidate's Response to Part (b) — Sample 1

(b) Procedure

- ① Collect two samples of ^{metal} the same size from both metal A & B. (Label both metals)
- ② Rinse the beakers with distilled water.
- ③ Pour the same volume of ^{con. sulphuric} hydrochloric acid into both beakers.
- ④ Place Metals A and B into the separate beakers.
- ⑤ Use stirring rod to stir acid to encourage reaction.
- ⑥ Let the metals sit in the acid for 30 minutes approximately so reaction can take place. (Time with stopwatch)
- ⑦ Observe the both beakers on how each metal reacted to the acid (Look for bubbles etc).
- ⑧ Record Observations.

(4 marks)

Candidate's Response to Part (b) — Sample 2

(b) Procedure

- Place two glass bowls and label them Spatula A and Spatula B.
- Place the two spatula's into the glass bowls.
- Using latex gloves; measure out 2.0 ml of Hydrochloric Acid Solution into a pyrex glass.
- Pour the solution into the glass bowl.
- Observe corrosion of Spatula A and B over a period of 10 days.
- Record observations in tablet form.

(4 marks)

Candidate's Response to Part (b) — Sample 3

(b) Procedure

- 1) Measure 2cm^3 of hydrochloric acid and pour it in a test tube.
- 2) Add a small piece of magnesium ribbon to the test tube with the HCl.
- 3) Place a lighted splint over the mouth of test tube.
- 4) Observe and record results.
- 5) Repeat steps 1-4 using the calcium pellets, zinc, aluminium and copper metal.
- 6) Repeat steps 1-5 using water.

(4 marks)

Examiner's Comments

Many candidates were distracted by the preamble provided for the question and they did pay attention to the hypothesis. Consequently, they presented a procedure in which they wanted to find out which metal had a higher rate of corrosion.

Many candidates did not include time measurements in their procedure, which was necessary if a comparison of reactivity had to be made.

In the experiment, time could have been used in two ways.

- As a control, where both Metals A and B were placed in acid for the same duration, allowing candidates to observe and compare the amount of metal remaining or the level of effervescence.
- To measure the time each metal took to completely react with the acid, thus collecting comparative reactivity data.

Some candidates indicated that the lighted splint test should be carried out for the metals.

Candidate's Response to Part (c)

(c) TWO variables to be controlled

① Volume of acid used in both beakers

② Time

③ Length of metals

(2 marks)

Examiner's Comments

Candidates who attempted this part were able to score some marks. Candidates must be very specific when identifying the controlled variables in an experiment. Using the word 'amount' will not yield any marks.

Common vague or incorrect responses included the following.

- Amount of acid
- Type of metal

Candidate's Response to Part (d)

(d) Data to be collected

① Time, observations ② physical observations
(bubbles, foam etc)

(1 mark)

Examiner's Comments

Candidates who attempted this part were able to identify the data to be collected based on their stated procedure.

Candidate's Response to Part (e)

(e) Discussion of results as they relate to the hypothesis

Metals A and B are both samples from spatulas
~~spatulas that~~ where one was more corroded
than the other. Since Metal A should be more
reactive to acids than metal B, ~~two~~
the two will be fully submerged into
^{con. sulphuric} hydrochloric acid for the same period of
time. After the time, the more reactive
metal to the acid will be identified.

(2 marks)

Examiner's Comments

This question was poorly done. Many candidates did not attempt to provide a response and most of those who did, scored no marks. Candidates could not explain the expected results based on their procedure and could not explain how the results should be interpreted. They mentioned that the observation would say which metal is more reactive; however, they did not give any details regarding the differences in the expected observation.

Overall, instructors should place more emphasis on having candidates conduct actual experiments so that candidates can see the logical steps involved. This is useful with respect to planning and designing. Laboratory practice should involve simple experimental designs with implementation, followed by more complex experimental designs in accordance with syllabus guidelines.