



# CARIBBEAN EXAMINATIONS COUNCIL

## CAPE<sup>®</sup> CHEMISTRY UNIT 1



## Subject Report

*May–June 2025*

**CARIBBEAN EXAMINATIONS COUNCIL**

**REPORT ON CANDIDATES' WORK IN THE  
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION<sup>®</sup>**

**MAY–JUNE 2025**

**CHEMISTRY  
UNIT 1**

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## INTRODUCTION

This guide has been compiled using candidates' responses from the May–June 2025 CAPE Chemistry examination. In 2025, a total of 3582 candidates sat Unit 1 of CAPE Chemistry, representing a decline of 295 candidates when compared with 2024. Overall, candidates' performance in Unit 1 showed improvement when compared to 2024. There was also an increase in the percentage of candidates earning acceptable grades (Grades I–V). In 2025, the percentage of candidates gaining such grades was 91.26 per cent. This was slightly greater than the 88.99 per cent recorded in 2024, though still below the 94.22 per cent achieved in 2023.

Unit 1: Chemical Principles and Applications I is divided into three modules. These modules are

- Module 1: Fundamentals in Chemistry
- Module 2: Kinetics and Equilibria
- Module 3: Chemistry of the Elements.

The examination comprised the following papers.

- Paper 01 — Multiple Choice
- Paper 02 — Structured Essay Questions
- Paper 031 — School-Based Assessment (SBA)
- Paper 032 — Alternative to School-Based Assessment (Private Candidates)

The results from Paper 01 and Paper 02 showed that some candidates continue experience difficulty with selected topics.

## PAPER 01 — MULTIPLE CHOICE

Paper 01 consisted of 45 multiple-choice items designed to assess the syllabus content comprehensively. The mean score was 63.70 out of a possible 90 marks and the standard deviation was 15.21.

## PAPER 02 — STRUCTURED ESSAY

Paper 02 comprises three compulsory questions, consisting of one question per module. Each question is worth 30 marks. This paper is worth 40 per cent of the overall grade.

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### Question 1

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This question assessed specific objectives 1.11, 1.12, 1.13, 2.2, 2.3, 5.4 and 5.5 from Module 1: Fundamentals of Chemistry. The mean score was 42.34 and the standard deviation 9.66.

#### Part (a)

For Part (a), candidates were presented with a sketch that showed the first ionization energy of the eight elements of Period 3. For Part (a) (i), most candidates demonstrated that they had satisfactory knowledge by correctly stating two factors that influence first ionization energy such as nuclear charge, the distance of the outer electrons from the nucleus and shielding.

In Part (a) (ii), many candidates accurately explained how the ionization energy data provided evidence for the existence of subshells, using appropriate elements from the sketch. Several candidates gave responses similar to the expected explanation.

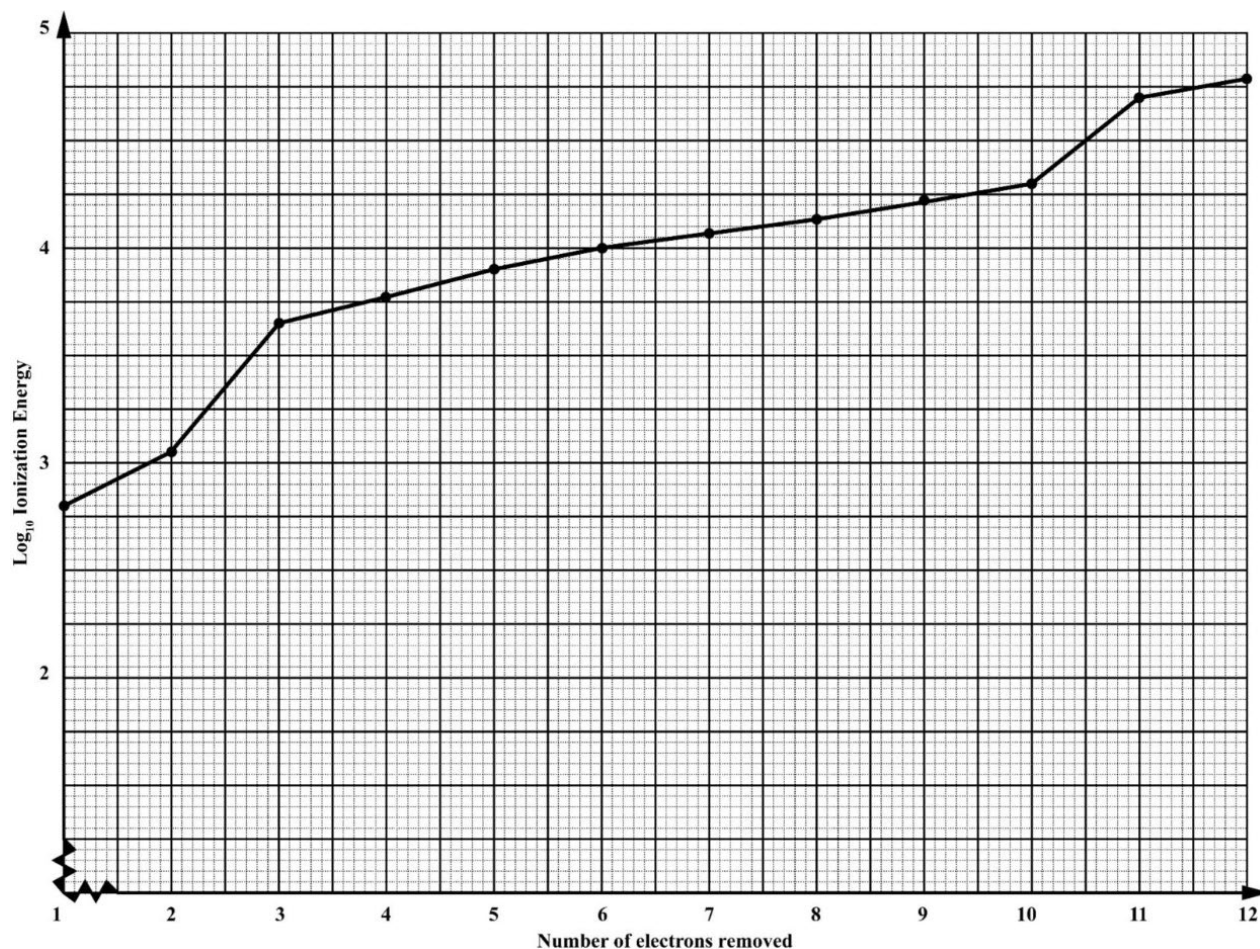
The first ionization energy of aluminium is lower than that of magnesium because the thirteenth electron in aluminium enters a new subshell. This indicates that the completed 3s orbital of magnesium shields the thirteenth electron in the 3p orbital. Within the third orbital, there are two subshells, 3s and 3p.

However, some candidates exhibited limited knowledge and understanding and were only able to state that the first ionization energy of magnesium is higher than that of aluminium. Other candidates attempted to describe shielding effects but did not link these observations to the presence of 3s and 3p subshells within the third shell.

#### Part (b)

A table showing the successive ionization energies for an element was provided and candidates were required to answer the parts that followed. In Part (b) (i), most candidates correctly calculated the values of  $\log_{10}(\text{IE})$  and completed the table accurately.

Part (b) (ii) required candidates to plot a graph using the data from the table. Some candidates were able to plot the points correctly and produce an appropriate graph. The expected graph is shown below.



Part (b) (iii) required candidates to explain the shape of the graph. Using the values of the ionization energies, candidates were expected to identify the orbitals in the shells. The expected response was that *the first two electrons are in the same energy level; the third to the tenth electrons are in a lower energy level, and the final two electrons are in a different energy level closer to the nucleus.*

For Part (b) (iv), candidates generally demonstrated their level of understanding by referring to the graph and correctly deducing the electronic configuration of the element. Electronic configurations must be written in terms of s and p orbitals; therefore, responses such as '2.8.2' and '[Ne]3s<sup>2</sup>' were not acceptable. The correct configuration for Element D is  $1s^2 2s^2 2p^6 3s^2$

### Part (c)

In Part (c) (i), the candidate demonstrated the required knowledge of experimental skills and described three acceptable steps involved in the procedure to obtain the melting point of the solid, Substance S. The expected procedure is outlined below.

- The solid is placed in the capillary tube.

- The tube is then attached to a thermometer which is clamped and placed in a heated water bath.
- As the solid melts, the thermometer is removed from the water bath and the temperature at which the liquid begins to solidify is recorded.

Part (c) (ii) required candidates to state whether Substance S would dissolve in water or tetrachloromethane. Candidates demonstrated sound experimental understanding by selecting *tetrachloromethane* as the solvent.

In Part (c) (iii), candidates displayed a clear understanding of the type of forces present between the molecules of Substance S. Most candidates correctly stated that the forces are *weak van der Waals forces, caused by temporary or instantaneous induced dipoles, also known as London dispersion forces*.

### **Part (d)**

This part tested candidates' understanding of the kinetic theory by requiring them to explain the relevant concept.

In Part (d) (i), candidates displayed the appropriate knowledge by correctly describing the change of a solid to a liquid. Many candidates stated that *the solid gains energy, causing its particles to vibrate faster. As a result, the particles overcome the forces of attraction and the solid changes into a liquid*.

In Part (d) (ii), candidates showed appropriate understanding of the nature of the liquid state. The expected response was that *in the liquid state, particles are not closely packed and are held together by moderate intermolecular forces. Additionally, particles in the liquid state have more kinetic energy than particles in the solid state*.

In Part (d) (iii), candidates showed the required knowledge and understanding of the change of a liquid to a gaseous state. Most of them correctly stated that *an increase in thermal energy results in greater movement and energy of the liquid particles. The molecules eventually gain enough energy to overcome the forces of attraction and the particles escape from the liquid state into the vapour or gaseous state*.

### **Part (e)**

For Part (e) (i), candidates were expected to use the increase in gas volume, along with the given temperature and pressure to calculate the molar mass of the volatile liquid by applying the ideal gas equation. Many candidates displayed the required knowledge and understanding to correctly complete the calculation. They provided the expected steps, which are as follows.

Using the formula  $PV = nRT$ , where

$$P = 1.01 \times 10^5 \text{ Pa}$$

$$V = 54.5 - 18.2 = 36.3 \text{ cm}^3 = 36.3 \times 10^{-6} \text{ m}^3$$

$$T = 273 + 55 = 328 \text{ K}$$

$$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\text{Using } n = \frac{m}{M}$$

$$1.01 \times 10^5 \times 36.3 \times 10^{-6} = \frac{0.185}{M} \times 8.314 \times 328$$

$$M = \frac{504.4935}{3.6663}$$

$$M = 137.60 \text{ g/mol(1)}$$

In Part (e) (ii), candidates were asked to identify which measurement was most likely to be subject to the greatest error. Many candidates correctly suggested that *the mass measurement was subject to significant error*. Acceptable alternatives included responses such as

- mass of gas
- mass of liquid
- mass of volatile liquid
- 0.185 g.

However, the expected response was that *the mass of the gas is subject to the greatest error because the value measured is very small*.

## Recommendations

The method for this experiment was not well understood by many candidates. Teachers are encouraged to ensure that the suggested practical activities outlined in the syllabus are thoroughly discussed, especially in cases where they are not carried out as laboratory exercises

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## Question 2

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This question assessed specific objectives 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 5.1, 5.2, 5.3, 5.4, 4.1, 4.2, 4.3 and 4.5 from Module 2: Kinetics and Equilibria. The mean score was 43.14 and the standard deviation 11.45.

### Part (a)

Part (a) (i) required candidates to state the four key characteristics of a dynamic equilibrium for a gaseous reaction occurring in a closed system at constant temperature. The four expected characteristics were as follows.

- The concentration of reactants and products remain constant under given conditions of temperature and pressure.
- Molecules of reactants are continually being converted to products and molecules of products are continually being converted to reactants.
- The rate of the forward reaction is equal to the rate of the backward reaction.
- Equilibrium can be achieved in a closed system.

Part (a) (ii) asked candidates to write the balanced chemical equation for the reaction between hydrogen gas and iodine gas to form hydrogen iodide. Many candidates responded correctly by stating  $\text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g)$ . Marks were awarded for correct formulas, a balanced equation, the use of a reversible arrow and the inclusion of physical states.

In Part (a) (iii), candidates were required to use the equilibrium partial pressures of the gases provided in the table to calculate the equilibrium constant  $K_p$  for the reaction mixture at 450 °C.

The expected calculation was

$$K_p = \frac{(P_{\text{HI}})^2}{P_{\text{H}_2} \times P_{\text{I}_2}}$$

Substituting the values

$$K_p = \frac{(4.0 \times 10^4)^2}{(2.5 \times 10^4)(1.6 \times 10^4)} = 4$$

### Part (b)

In Part (b) (i), candidates were required to define the terms *solubility product* and *common ion effect*. The expected responses were as follows.

- Solubility Product — Solubility product is the product of the concentration of each ion in a saturated solution of a sparingly soluble salt raised to the power of their relative concentrations.
- Common ion effect
  - Common ion effect is the reduction of solubility of a dissolved compound by adding a solution of another compound which has an ion in common with the dissolved compound.
  - The solubility of a sparingly soluble compound is reduced further if another compound is added that contains an ion in common with it.

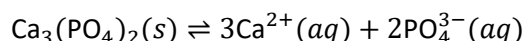
In Part (b) (ii), candidates were asked to use the equilibrium concentrations of calcium and phosphate ions to calculate the solubility product,  $K_{sp}$ , of calcium phosphate. Candidates are required to give the expression and substitute the values to be used for the calculation.

The correct calculation is as follows.

$$Ca_3(PO_4)_2 = (2 \times 10^{-8})^3 \times (1 \times 10^{-9})^2$$

$$= 8 \times 10^{-33} \text{ mol}^{-5} \text{ dm}^{-15}$$

Part (b) (iii) required candidates to write the balanced equilibrium equation showing the dissociation of solid calcium phosphate into its aqueous calcium and phosphate ions. The balanced equation for the formation of calcium and phosphate ions from calcium phosphate is as follows.



Candidates were awarded marks for using the reversible arrow, providing the correct balanced equation, and including the physical states.

### Part (c)

This part required candidates to compare the solubility of silver chloride in pure water with its solubility in dilute hydrochloric acid and to justify any difference observed using relevant chemical principles. Most candidates correctly stated that *the solubility of silver chloride is lower in dilute hydrochloric acid than in pure water. The hydrochloric acid has the common chloride ion and this effect would reduce the solubility of silver chloride.*

### Part (d)

This part asked candidates to outline the steps in the experimental procedure for determining the solubility product constant of barium hydroxide,  $Ba(OH)_2$ .

The following were the expected steps.

- Prepare a saturated solution of barium hydroxide in water and leave it for several hours.
- Filter the solution to remove any excess solid.
- Titrate 20 cm<sup>3</sup> of the barium hydroxide solution with standard hydrochloric acid.
- Determine the concentration of barium hydroxide from the results.
- Find the K<sub>sp</sub> from the formula  $[\text{Ba}^{2+}][\text{OH}^-]^2$

### Part (e)

In Part (e) (i), candidates were required to define the term *buffer solution*. Many candidates were able to do so correctly by stating that *a buffer solution is one which resists a change in pH when small amounts of acid or base are added*.

Part (e) (ii) asked candidates to explain how the molecular structure of amino acids relates to their function as buffer solutions in human blood. Candidates were expected to refer to the zwitterion structure, in which the positively charged end can donate a proton and the negatively charged end can accept a proton.

The expected explanation is as follows.

- In solution, the structure of an amino acid exists as a dipolar ion, also known as a zwitterion.  
 $\text{H}_3\text{N}^+ - \text{R} - \text{COO}^-$
- If acid enters the blood, the added H<sup>+</sup> ions are neutralised by the carboxylate (-COO<sup>-</sup>) group  
 $\text{H}_3\text{N}^+ - \text{R} - \text{COO}^- + \text{H}^+ \rightleftharpoons \text{H}_3\text{N}^+ - \text{R} - \text{COOH}$
- If base is added it is neutralised by the H<sub>3</sub>N<sup>+</sup> groups  
 $\text{H}_3\text{N}^+ - \text{R} - \text{COO}^- + \text{OH}^- \rightleftharpoons \text{H}_2\text{N} - \text{R} - \text{COO}^- + \text{H}_2\text{O}$

Part (e) (iii) required candidates to name one industry in which buffer solutions are commonly used. Candidates who provided any one of the following responses were awarded full marks.

- Electroplating
- Manufacturing of dyes, detergents, soaps or shampoos
- Treatment of leather

## Recommendations

Generally, this question was well done. It is recommended that parentheses, ( ), and not concentration brackets, [ ], be used with partial pressures in the equilibrium expression, particularly in Part (a) (ii).

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## Question 3

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This question assessed specific objectives 3.1, 3.2, 3.3, 3.4,3.5, 2.1, 2.2, 2.3, 2.4 and 2.5 from Module 3: Chemistry of the Elements. The mean was 44.22 and the standard deviation 9.63.

### Part (a)

Part (a) (i) required candidates to describe the trends in electrical conductivity and melting point of the Group IV elements (silicon to lead) based on the data provided. Most candidates were able to state the following.

- The electrical conductivity increases from silicon to tin and then decreases from tin to lead.
- The melting point decreases from silicon to tin and then increases from tin to lead.

In Part (a) (ii), candidates were asked to explain the variation in melting points from diamond (carbon) to tin using ideas of structure and bonding found in Group IV elements.

Candidates were expected to relate the high melting point of carbon, the decreased melting points of silicon and germanium and the further decrease in the melting point of tin to the structure and bonding present in the solid state. The expected response was as follows.

- Carbon has a giant atomic structure with strong covalent bonding, resulting in a very high melting point.
- Silicon and germanium are metalloids with larger atomic radii, which causes a reduction in their melting points.
- Tin is a metal, but its ions are larger, which weakens metallic bonding, resulting in a lower melting point.

### Part (b)

In Part (b) (i), candidates were required to describe the reaction that occurs when lead (IV) chloride reacts with water. Candidates who correctly stated that *lead (IV) chloride dissolves in water to produce a white precipitate and acidic fumes of hydrogen chloride* were awarded full marks.

For Part (b) (ii), candidates were asked to *write the balanced chemical equation* for the reaction described in Part (b) (i). The correct response was  $\text{PbCl}_4(l) + 2\text{H}_2\text{O}(l) \rightarrow \text{PbO}_2(s) + 4\text{HCl}(g)$ . Marks were awarded for the use of correct formulas, a properly balanced equation and inclusion of physical states.

### Part (c)

Part (c) (i) required candidates to state the trends in density and atomic radii of the Group II elements (beryllium to barium) using the information supplied. Candidates who stated the following were awarded full marks.

- The density generally increases down the group.
- The atomic radii increase down the group.

In Part (c) (ii) candidates were asked to explain the trend in atomic radii by referring to nuclear charge and the screening effect. Candidates were expected to account for the increase in atomic radii of the elements by explaining that the number of filled electron shells increases down the group. The expected response includes the following explanations.

- The atomic radii increases due to the fact that the number of filled electron shells increases
- The screening effect increases as the number of filled electron shells increases and shields the outer electrons
- The increasing nuclear charge has little effect on the outer electrons due to the screening effect so the atomic radii increases.

### Part (d)

A table was provided in Part (d) (i). Candidates were required to complete the table by recording the observations when 1M sodium sulfate solution was added to solutions of Group II cations ( $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ ). The expected response is shown below.

Group II Cations	Observations When 1M $\text{Na}_2\text{SO}_4$ Solution is Added
$\text{Mg}^{2+}$	No visible change/no precipitate
$\text{Ca}^{2+}$	Thin white precipitate
$\text{Sr}^{2+}$	White precipitate
$\text{Ba}^{2+}$	Thick white precipitate

The relative amount of precipitate increases from  $\text{Ca}^{2+}$  to  $\text{Ba}^{2+}$ .

In Part (d) (ii), candidates were asked to account for the observations in Part (d) (i) using the solubility patterns of Group II sulfates. The expected explanation included the following.

Solubility is dependent on the enthalpy of solution, which is dependent on the enthalpy of hydration and enthalpy of lattice energy of the salts. There is a decrease in the enthalpy

of hydration due to the increase in the ionic radii from magnesium to barium but a smaller decrease of the lattice energy of the sulphates in going down the group. As a result, the overall enthalpy of solution becomes more positive (endothermic) and the solubility of the sulfates decreases down the group.

Candidates were expected to use the enthalpy of hydration and lattice energy to explain the overall enthalpy of solution and how these factors account for the decrease in solubility of Group II sulfates from magnesium to barium.

Part (d) (iii) required candidates to write the ionic equation for the reaction between  $\text{Ba}^{2+}$  ions and sulfate ions. Those who wrote the equation  $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$  were awarded full marks.

### Part (e)

For this part, candidates were required to name one compound of any two of the metals (aluminium, calcium or magnesium) and to state a use for each compound in the table provided.

The expected responses included the following.

Metal	Name of Metallic Compound	Use of Metallic Compound
Magnesium	<ul style="list-style-type: none"> <li>Magnesium oxide</li> <li>Magnesium hydroxide</li> <li>Magnesium sulfate</li> </ul>	<ul style="list-style-type: none"> <li>Lining for high temperature furnaces</li> <li>Toothpaste/milk of magnesia</li> <li>Laxative/Epsom salts</li> </ul>
Calcium	<ul style="list-style-type: none"> <li>Calcium oxide</li> <li>Calcium carbonate</li> <li>Name of any Calcium salt</li> </ul>	<ul style="list-style-type: none"> <li>Lime used to counteract soil acidity</li> <li>Used in cement/plaster mortar</li> <li>Fireworks/coloured flares</li> </ul>
Aluminium	Aluminium oxide	<ul style="list-style-type: none"> <li>Saucepans</li> <li>Aircrafts</li> <li>Vehicle bodywork</li> <li>Window frames</li> </ul>

## Recommendations

Candidates lost marks for giving incomplete answers in some parts. They are expected to be familiar with the parameters required.

## PAPER 032 — ALTERNATIVE TO THE SCHOOL-BASED ASSESSMENT

Paper 032 comprises three compulsory questions that test candidates' laboratory skills. Candidates' performance continues to improve. The mean percentage in 2025 was 58.52 per cent, compared with 47.78 per cent in 2024 and 37.30 per cent in 2023.

For Module 1, candidates' mean performance was consistent when compared with 2024 and 2023. Their performance on Module 2 improved over 2024 but remained lower than 2023. Candidates' performance also improved on Module 3 when compared with 2024 and 2023.

The maximum mark achieved was 40 out of 45. The mean score was 26.33 and the standard deviation was 5.98.

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### Question 1

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This question was generally well done. Overall, it assessed candidates' ability to perform basic qualitative analysis and accurately record experimental observations.

#### Part (a)

In this part, a table was provided and candidates were required to carry out a series of simple laboratory tests on three unknown solids (L, M, and N) and record their observations in it. The following table shows the expected observations.

Test	Observations		
	L	M	N
i. Appearance	Shiny grey solid	White crystalline solid	White powdery solid
ii. Add 5 cm <sup>3</sup> of distilled water and shake.	A suspension was formed. The solid did not dissolve.	A colourless solution was formed.	A colourless solution was formed.
iii. Add 5 cm <sup>3</sup> of ethanol to a spatula full of the solid in a test tube and shake.  Place each labelled test tube in a gently heated water bath for 2 minutes.	Either a suspension was formed OR the solid did not dissolve.	Either a suspension was formed OR the solid did not dissolve.	Either a suspension was formed OR the solid did not dissolve.
iv. Heat strongly a spatula of the solid in a hard glass tube for two to three minutes, until the sample melts.	The solid does not melt.	The solid does not melt.	The solid melted.

### Part (b)

This part required candidates to suggest the type of bonding present in each of the solids (L, M, and N) based on the observations made in Part (a).

The following are the expected responses.

- Solid L
  - Bonding in L: Metallic bonding
  - Reason: Shiny with high melting point and does not melt and insoluble in both solvents
- Solid M
  - Bonding in M: Ionic bonding
  - Reason: High melting point and does not melt and soluble in water but insoluble in organic solvent

- Solid N
  - Bonding in N: Van der Waal's forces between molecules and covalent bonding
  - Reason: Dissolved in the polar solvent but not the nonpolar solvent

Some candidates had difficulty giving the reasons for the type of bonding present. It is recommended that properties of metallic, ionic and covalent substances be discussed in the context of a laboratory activity.

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## Question 2

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### Part (a)

In Part (a) (i), candidates were asked to construct a results table to display the student's recorded volumes of hydrogen gas at specific time intervals at 50 °C. The table needed correctly labelled columns for time and volume, with all values accurately transferred. An example of the expected table is shown below.

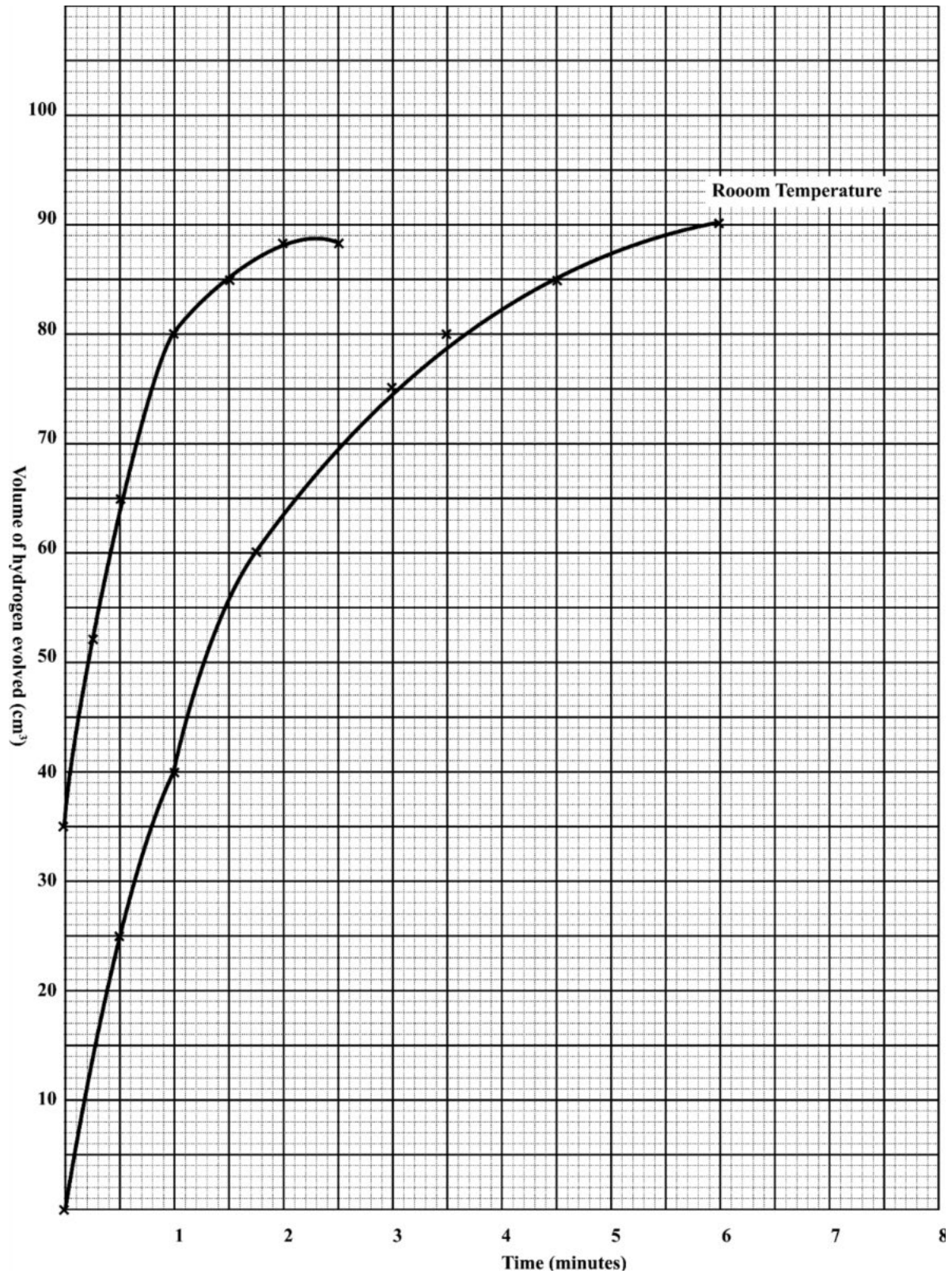
Time Intervals (minutes)	Volume of Hydrogen Evolved (cm <sup>3</sup> )
0.25	52.5
0.50	65.0
0.75	78.0
1.00	80.0
1.5	85.0
2.0	88.0
2.5	88.0

In Part (a) (ii), candidates were required to identify two pieces of apparatus essential for measuring gas volume during the reaction of magnesium with hydrochloric acid (for example, gas collection and reaction-setup equipment). Candidates who stated any two of the following pieces of apparatus were awarded full marks.

- Thermometer
- Graduated syringe
- Stopwatch or stop clock

### Part (b)

In Part (b) (i), candidates were required to plot a graph of volume of hydrogen against time at 50 °C, placing it alongside the room-temperature curve already provided. Candidates were expected to use a suitable scale, correctly plot each point and draw a smooth curve. An example of the expected graph is shown below.



In Part (b) (ii), candidates were asked to describe the shape of the hydrogen volume–time curve at 50 °C to show that they understood how the gas evolution rate changes at a higher temperature. Most candidates correctly stated that *the graph shows a rapid or sharp increase in the volume of hydrogen evolved as time progresses* and so they were awarded full marks.

### Part (c)

This part required candidates to state the total volume of hydrogen produced in the reaction at 50 °C. Based on the results provided, the correct value was  $88.0 \text{ cm}^3$ .

### Part (d)

Candidates were required to determine the time taken for  $60 \text{ cm}^3$  of hydrogen to be collected at room temperature (from the graph already provided) and at 50 °C (from the graph the candidate plotted). Some candidates experienced difficulty reading values accurately from the graph. The use of graphs for interpolation is recommended.

Accurate interpretation of both curves was required. The expected values were

- at room temperature, the time was 1.75 minutes
- at 50°C, the time was 0.45 minutes.

### Part (e)

In this part, candidates were required to compare the reaction rates at room temperature and at 50 °C, using the times calculated in Part (d). Many candidates correctly stated that based on the values in Part (d), *the reaction at 50 °C occurs faster than the reaction at room temperature*.

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## Question 3

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This question required candidates to design a simple qualitative experiment to distinguish magnesium sulfate from magnesium sulfite by outlining a hypothesis, aim, materials, procedure, variables and expected results that demonstrated the different reactions of the two compounds. Generally, candidates had difficulty writing the steps for an acceptable procedure. It must be noted that candidates are expected to be familiar with the procedures related to the syllabus objectives for the practical activities.

### Part (a)

Candidates were able to formulate a hypothesis predicting how magnesium sulfate and magnesium sulfite would behave under experimental conditions, allowing the two substances to be distinguished.

#### Hypothesis

*The powdered substances A and B are magnesium sulfite and magnesium sulfate, respectively.*

### Part (b)

This part required candidates to state the aim of the experiment, clearly identifying the purpose of determining which substance is magnesium sulfite and which is magnesium sulfate.

#### Aim

*To determine whether powdered substances A and B are a sulfite and a sulfate, respectively.*

### Part (c)

Candidates were required to list the apparatus and materials needed to carry out the investigation, including the basic laboratory equipment and reagents necessary to differentiate the two powdered samples.

#### Apparatus and Materials

- Test tubes, test-tube rack
- Barium chloride solution
- Dilute hydrochloric acid
- *or* barium nitrate solution and dilute nitric acid
- Distilled water

### Part (d)

Candidates were asked to describe a step-by-step experimental procedure that would allow the two substances to be identified, demonstrating correct scientific method and safe laboratory practice.

#### Experimental Procedure

*Distilled water is added to an amount of the powdered substance A to make a solution. To 1 cm<sup>3</sup> of the solution in a test tube, aqueous barium chloride is added followed by dilute hydrochloric acid. The above procedure is repeated with Substance B.*

### Part (e)

This part required candidates to identify the different variables involved in the investigation.

#### Variables

- Manipulated variable — Substance A and Substance B
- Responding variable — Solubility of the precipitates in acid
- Controlled variables — The same volume of added reagents

### Part (f)

Candidates were required to state the expected results that would allow magnesium sulfate to be distinguished from magnesium sulfite, based on their differing chemical behaviours.

#### Expected Results

- It is expected that the barium sulfite formed is soluble in acid and the barium sulfate formed is insoluble in acid.
- If the white precipitate forms with aqueous barium chloride or barium nitrate and this precipitate dissolves in dilute hydrochloric acid/nitric acid, the substance A is a sulfite.
- If the white precipitate does not dissolve in acid, substance B is a sulfate.