CHEMISTRY FORM FOUR

MID-TERM 2 EXAM 2026
MARKING SCHEME &

SECTION A (40 MARKS)

Question 1: State the meaning of the term allotropy. ***(2 Marks)***

Allotropy is the existence of an element in two or more different physical forms (allotropes) in the same physical state. **(✔ 1 Mark)**

Explanation: The forms have different physical properties due to different structural/molecular arrangements, but exhibit identical chemical properties. **(✔ 1 Mark)**

Question 2: Differentiate between strong acids and weak acids. ***(2 Marks)***

• **Strong Acids:** Acids that undergo complete ionization/dissociation in aqueous solution to yield a high concentration of hydrogen ions (H^+). Examples include HCl, HNO_3, H_2SO_4. **(✔ 1 Mark)**

• **Weak Acids:** Acids that undergo only partial/incomplete ionization/dissociation in aqueous solution to yield a low concentration of hydrogen ions (H^+). Examples include CH_3COOH, H_2CO_3. **(✔ 1 Mark)**

Question 3: Name two uses of ammonia in industries. ***(2 Marks)***

Any two valid uses for 1 Mark each:

1. Manufacture of nitrogenous fertilizers such as Ammonium Nitrate, Ammonium Sulphate, and Urea. **(✔ 1 Mark)**

2. Manufacture of Nitric (V) Acid via the Ostwald process. **(✔ 1 Mark)**

3. Used as an industrial refrigerant in large-scale industrial cold storage facilities. (Alternative valid response)

Question 4: Calculate the number of moles in 11.2 dm^3 of carbon dioxide gas at s.t.p. ***(3 Marks)***

Formula: Number of moles = Volume of gas at s.t.p. / Molar gas volume at s.t.p.

Standard Molar Gas Volume at s.t.p. = 22.4 dm^3/mol (✔ 1 Mark)

Substitution: Moles = 11.2 dm^3 / 22.4 $dm^3\ mol^{-1}$ **(✔ 1 Mark)**

Final Answer: 0.5 Moles (✔ 1 Mark with correct units)

Question 5: A hydrocarbon contains 85.7% carbon and 14.3% hydrogen. Determine its empirical formula. (C=12, H=1) ***(3 Marks)***

Element breakdown:
Moles of C = 85.7 / 12 = 7.142 moles
Moles of H = 14.3 / 1 = 14.300 moles **(✔ 1 Mark)**

Determine Mole Ratio (Divide by smallest value 7.142):
Ratio for C = 7.142 / 7.142 = 1
Ratio for H = 14.300 / 7.142 = 2 **(✔ 1 Mark)**

Empirical Formula = CH_2 (✔ 1 Mark for final correct structure)

Question 6: State Charles' Law. ***(2 Marks)***

Charles' Law states that the **volume of a fixed mass of gas is directly proportional to its absolute temperature (Kelvin) provided the pressure remains constant.**
Award parameters: Mention of fixed mass and constant pressure (✔ 1 Mark); direct proportion of volume to absolute temperature (✔ 1 Mark).

Question 7: Give one observation made when dilute hydrochloric acid is added to zinc granules. ***(2 Marks)***

Primary Observation: Effervescence / rapid bubbling / fizzing occurs as a colorless gas is produced. **(✔ 1 Mark)**
Secondary Observation: The zinc granules gradually dissolve / decrease in size / disappear, OR the test tube becomes warm. **(✔ 1 Mark)**

Question 8: Calculate the concentration of a solution containing 5.85 g of sodium chloride dissolved in 500 cm^3 of solution. (Na=23, Cl=35.5) ***(3 Marks)***

1. Molar Mass (RFM) of NaCl = 23 + 35.5 = 58.5 g/mol **(✔ 1 Mark)**
2. Moles of NaCl = 5.85 g / 58.5 g/mol = 0.1 moles
3. Concentration scaling to 1000 cm^3: Molarity = (0.1 moles × 1000) / 500 **(✔ 1 Mark)**

Final Concentration = 0.2 M or 0.2 mol/dm^3 (✔ 1 Mark for absolute accuracy with units)

Question 9: Name the process used to separate crude oil into useful fractions. ***(2 Marks)***

Fractional Distillation (✔ 2 Marks for complete exact terminology).
Note: Award 1 mark if candidate only states 'Distillation' without the specific prefix 'Fractional'.

Question 10: State two factors that affect the rate of reaction. ***(2 Marks)***

Any two correct answers (1 Mark each):

• Concentration of reactants (or pressure for gases) (✔ 1 Mark)

• Temperature of the reaction environment (✔ 1 Mark)

• Surface area / particle size of solid reactants (✔ 1 Mark)

• Presence of a catalyst (✔ 1 Mark)

Question 11: Electrolysis system analysis:

a) Name gas produced at the cathode during electrolysis of acidified water. (1 Mark)

b) State one use of electrolysis in industries. (1 Mark) ***(2 Marks)***

a) Cathode Gas: Hydrogen gas (H_2) (✔ 1 Mark)

b) Industrial Use (Accept any one for 1 Mark):

- Electroplating of metals to prevent rust or improve aesthetics (✔ 1 Mark)
- Extraction of reactive metals like Aluminium and Sodium (✔ 1 Mark)
- Refining/purification of copper metal (✔ 1 Mark)

SECTION B (60 MARKS)

Question 12: Thermochemical Analysis of Ethanol:

a) Define molar heat of combustion. (2 Marks)

b) 2.5 g of ethanol was burnt and raised the temperature of 200 g of water from 20°C to 55°C. Calculate:

i) Heat energy released. (3 Marks)

ii) Molar heat of combustion of ethanol. (4 Marks) ***(9 Marks)***

a) Definition: The heat energy released/enthalpy change when one mole of a substance is burned completely in excess oxygen under standard conditions. **(✔ 2 Marks; 1 for 'one mole', 1 for 'completely burned')**

b) i) Heat energy released ($Q = mc\Delta T$):

$\Delta T = 55°C - 20°C = 35°C$ **(✔ 1 Mark)**

$Q = 200g \times 4.2\ J/g°C \times 35°C = 29,400\ J$ or $29.4\ kJ$ **(✔ 1 Mark for formula substitution, ✔ 1 Mark for final calculation)**

b) ii) Molar Heat of Combustion calculation:

Moles of Ethanol (C_2H_5OH, Molar Mass = 46g/mol) = 2.5g / 46g/mol = 0.05435 moles **(✔ 1 Mark)**

Enthalpy for 1 mole = 29.4 kJ / 0.05435 moles = 540.94 kJ/mol **(✔ 1 Mark for scaling**

logic, ✔ 1 Mark for value)

Final Enthalpy Display: ΔH = -540.94 kJ/mol (✔ 1 Mark for explicit negative sign showing exothermic property)

Question 13: Nitrogen gas configurations:

a) Write balanced equation for preparation from ammonium nitrite. (2 Marks)

b) State two physical properties of nitrogen. (2 Marks)

c) Explain use in food packaging. (2 Marks) ***(6 Marks)***

a) Chemical Equation:

$NH_4NO_2(s) \xrightarrow{\Delta} N_2(g) + 2H_2O(l)$ or $NH_4NO_2(aq) \xrightarrow{\Delta} N_2(g) + 2H_2O(g)$

Marking: 1 mark for correct formulas, 1 mark for correct balance status.

b) Physical Properties (Any two for 1 Mark each):

- Colorless and odorless gas.
- Sparingly soluble in water.
- Slightly less dense than air.

c) Food Packaging application: Nitrogen is a chemically inert/unreactive gas due to a strong N≡N triple bond. It replaces oxygen inside food packs to prevent oxidation of fats/oils, thereby stopping food spoilage and preserving freshness. **(✔ 1 Mark for inert property, ✔ 1 Mark for preventing oxidation).**

Question 14: Standard Solutions and Volumetric Calculations:

a) Describe laboratory standard solution preparation of sodium carbonate. (5 Marks)

b) Volumetric problem titration of 25cm³ Na_2CO_3 with 20cm³ of 0.1M HCl. Calculate concentration. (5 Marks) ***(10 Marks)***

a) Step-by-Step Laboratory Instructions (1 Mark for each clear procedural standard):

1. Weigh out the precise mass of anhydrous sodium carbonate solid using an analytical balance. (✔ 1 Mark)
2. Transfer the salt into a clean beaker and dissolve it thoroughly with about 100 cm³ of distilled water. (✔ 1 Mark)
3. Pour this solution quantitatively into a clean 250 cm³ volumetric flask using a glass funnel. (✔ 1 Mark)
4. Rinse the beaker and rod multiple times with distilled water, transferring all rinse contents into the flask. (✔ 1 Mark)
5. Top up with distilled water until the bottom of the meniscus rests exactly on the 250 cm³ mark at eye level. Stopper and invert to mix uniformly. (✔ 1 Mark)

b) Titration Calculations:

1. Moles of HCl = (0.1 M × 20 cm^3) / 1000 = 0.002 moles **(✔1 Mark)**
2. From Equation, mole ratio of Na_2CO_3 : HCl is 1 : 2
3. Moles of Na_2CO_3 reacting = 0.002 / 2 = 0.001 moles **(✔1 Mark for ratio step, ✔1 Mark for value)**
4. Concentration of Na_2CO_3 = (0.001 moles × 1000) / 25 cm^3 **(✔1 Mark for volume scaling step)**
5. **Final Answer = 0.04 M or 0.04 mol/dm^3 (✔1 Mark for absolute numerical correctness with units)**

Question 15: Corrosion mechanisms and rust prevention setup:

a) Explain: i) Salt water acceleration (2 Marks); ii) Aluminium protective layer (2 Marks)

b) State three rust prevention techniques. (3 Marks)

c) Draw/label setup parameters to investigate rusting. (3 Marks) ***(10 Marks)***

a) i) Salt water rusting: Salty water contains dissolved ions (Na^+, Cl^-) which increase the electrical conductivity of water, accelerating the underlying electrochemical corrosion processes. **(✔2 Marks)**

a) ii) Aluminium corrosion trait: Aluminium forms a highly stable, uniform, and non-porous Aluminium Oxide (Al_2O_3) coating on its surface when exposed to air. This impermeable layer adheres firmly to the metal, protecting the deeper metal layers from further exposure to oxygen and moisture. **(✔2 Marks)**

b) Three Prevention Methods (1 Mark each):

- Painting the surface to block air and water entry. (✔1 Mark)
- Oiling/Greasing moving structural parts. (✔1 Mark)
- Galvanizing iron components with a protective zinc layer. (✔1 Mark)

c) Experimental Investigation Setup Guidelines (3 Marks Total):

The marking key requires visual or layout logic verifying the presence of 3 clear environments:

- Test environment 1: Iron nail exposed to air and normal water (Rust forms). (✔1 Mark)
- Test environment 2: Iron nail in boiled water wrapped under an oil layer to isolate oxygen (No rust). (✔1 Mark)
- Test environment 3: Iron nail sealed with anhydrous calcium chloride to absorb moisture (No rust). (✔1 Mark)

Question 16: Organic chemistry structures and advanced analysis:

a) Homologous series (1 Mark)

b) But-2-ene drawing (2 Marks)

c) Two uses of ethanoic acid (2 Marks)
d) Molecular formula computation from 92.3% C, 7.7% H, and Molar Mass 78 g/mol. (5 Marks) ***(10 Marks)***

a) Homologous Series: Alkanes (✔ 1 Mark)

b) Structural Formula of But-2-ene:
$CH_3—CH=CH—CH_3$ (Full expanded lines linking all Hydrogens structurally to their respective Carbons must be shown clearly by the student). **(✔ 2 Marks)**

c) Uses of Ethanoic Acid (Any two for 1 Mark each):
- Component of vinegar used for food flavoring and preservation.
- Used as a chemical industrial solvent.
- Used in the manufacture of dyes, pharmaceuticals, and artificial polymers.

d) Advanced Molecular Formula Determination:
1. Moles C = 92.3 / 12 = 7.69 | Moles H = 7.7 / 1 = 7.70 **(✔ 1 Mark)**
2. Simplest ratio: C = 1, H = 1 ⇒ Empirical Formula = CH **(✔ 1 Mark)**
3. Empirical Formula Mass (CH) = 12 + 1 = 13 g/mol
4. Scale factor n = 78 / 13 = 6 **(✔ 1 Mark)**
5. **Molecular Formula = $(CH) \times 6 = C_6H_6$ (✔ 2 Marks for complete exact format)**