

CHRISTIAN SOCIAL SERVICES COMMISSION (CSSC)
NORTHERN ZONE JOINT EXAMINATIONS SYNDICATE (NZ-JES)



FORM FOUR PRE-NATIONALEXAMINATION2026

032/1

CHEMISTRY 1

MARKING SCHEME

1. Multiple Choice(1mark@)

i	ii	iii	iv	V	vi	vii	viii	ix	x
A	D	B	A	E	A	C	D	C	A

2. Matching items(1mark@)

LIST A	I	II	III	IV	V	VI
LIST B	D	J	E	G	I	K

QUESTION 3 — Laboratory Preparation of Hydrogen (9 Marks)

Part	Marks	Expected Answer / Marking Points	Examiner Notes
(a) Equation	1 mark	$\text{Zn(s)} + 2\text{HCl(aq)} \rightarrow \text{ZnCl}_2\text{(aq)} + \text{H}_2\text{(g)}$	Must be balanced.
(b) Dilute vs. Conc. HCl	2 marks	Concentrated HCl is volatile and releases HCl fumes that would contaminate the hydrogen gas collected. Dilute acid reacts at a controllable rate without excessive heat.	

Part	Marks	Expected Answer / Marking Points	Examiner Notes
(c) Testing H ₂	2 marks	Collect gas in a test tube; bring a burning splint to the mouth of the tube. A squeaky pop sound confirms the presence of hydrogen gas.	
(d) Collection over water	2 marks	Hydrogen is less dense than air and insoluble in water, so it displaces water upward efficiently. It does not react with water.	1 mk each valid reason (insoluble in water; less dense/does not react).
(e) No dilute HNO ₃	2 marks	Dilute nitric acid is an oxidising acid and reacts with zinc to produce nitrogen oxides (NO or NO ₂) rather than hydrogen gas.	Must mention oxidising nature or NO ₃ ⁻ oxidises H ₂ .

QUESTION 4 — Physical/Chemical Change & Separation Methods (9 Marks)

Part	Marks	Expected Answer / Marking Points	Examiner Notes
(a)(i) Type of change	1 mark	Physical change — the maize is ground into flour but no new substance is formed.	—
(a)(ii) Four reasons	4 marks	1. No new substance is produced. 2. The change is reversible (flour can be seen as maize constituent). 3. Mass is conserved (1 kg in → 1 kg out). 4. Only the physical size/state changes, not chemical composition.	Award 1 mark each (max 4 marks) for any four valid points.
(b)(i) Beaker A: spirit + water	1 mark	Fractional distillation (or simple distillation) — the two liquids are miscible with different boiling points.	—
(b)(ii) Beaker B: iodine	1 mark	Sublimation — iodine sublimes on heating and is re-collected, leaving sand behind.	—

Part	Marks	Expected Answer / Marking Points	Examiner Notes
+ sand			
(b)(iii) Beaker C: dyes	1 mark	Chromatography (paper chromatography) — dyes travel at different rates on paper.	—
(b)(iv) Beaker D: muddy water	1 mark	Filtration (or sedimentation then decantation then filtration) — to remove suspended solid particles.	—

QUESTION 5 — Organic Chemistry (9 Marks)

Part	Marks	Expected Answer / Marking Points	Examiner Notes
(a)(i) Homologous series	1 mark	A family of organic compounds that have the same functional group, same general formula, and show a gradual change in physical properties as the chain length increases, differing by a CH ₂ unit.	—
(a)(iii) Functional group	1 mark	An atom or group of atoms in an organic molecule that determines the chemical properties and reactions of that molecule (e.g., –OH, –COOH, –CHO).	—
(a)(iv) Esterification	1 mark	A reaction between a carboxylic acid and an alcohol (in the presence of a concentrated acid catalyst) to produce an ester and water.	-
(b)(i)	2 marks	Ethene burns completely with a luminous, slightly smoky flame to produce carbon dioxide, water vapor, and a large amount of heat energy. $\text{C}_2\text{H}_{4(g)} + 3\text{O}_{2(g)} \rightarrow 2\text{CO}_{2(g)} + 2\text{H}_2\text{O}_{(g)} + \text{Heat}$	Award mark for reasonable systematic attempt.
ii	2 marks	Ethene undergoes an addition reaction with halogens such as bromine or chlorine.	

Part	Marks	Expected Answer / Marking Points	Examiner Notes
		The double bond breaks, and the halogen atoms add across it to form a dihaloalkane. $\text{C}_2\text{H}_4 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_4\text{Br}_2$	
iii	2 marks	Ethene reacts with steam in the presence of an acid catalyst (such as phosphoric acid) to form ethanol . $\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_5\text{OH}$	

QUESTION 6 — Hard Water (9 Marks)

Part	Marks	Expected Answer / Marking Points	Examiner Notes
(a) 4 Chemicals to harden soft water	3marks	1. Calcium sulphate (CaSO_4) 2. Calcium hydrogencarbonate ($\text{Ca}(\text{HCO}_3)_2$) 3. Magnesium sulphate (MgSO_4) 4. Magnesium hydrogencarbonate ($\text{Mg}(\text{HCO}_3)_2$)	1mark each chemical; max 3 marks. Any three
(b)(i) Boiling removes temp. hardness	2marks	$\text{Ca}(\text{HCO}_3)_2(\text{aq}) \rightarrow \text{CaCO}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$. When boiled, soluble Ca^{2+} and HCO_3^- ions react to form insoluble CaCO_3 (limescale) precipitate which is removed.	
(b)(ii) Washing soda removes perm. hardness	2marks	$\text{Na}_2\text{CO}_3(\text{aq}) + \text{CaSO}_4(\text{aq}) \rightarrow \text{CaCO}_3(\text{s}) + \text{Na}_2\text{SO}_4(\text{aq})$. The CO_3^{2-} ions precipitate Ca^{2+} and Mg^{2+} ions as insoluble carbonates.	
(iii) addition of aqueous ammonium	2marks	$\text{Mg}(\text{HCO}_3)_2(\text{aq}) + 2\text{NH}_4\text{OH}(\text{aq}) \rightarrow \text{MgCO}_3(\text{s}) + (\text{NH}_4)_2\text{CO}_3(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$	

Part	Marks	Expected Answer / Marking Points	Examiner Notes

QUESTION 7— Mystery Substance & Conc. H₂ SO₄ Reactions (9Marks)

Part	Marks	Expected Answer / Marking Points	Examiner Notes
(a)(i) Formulae	2 Marks	A = CuCO ₃ . B = CO ₂ . C = CuO. D = CuSO ₄ (blue solution).	½ mk each formula; total 2 mks.
(a)(ii) Equation	1 mark	CuCO ₃ (s) → CuO(s) + CO ₂ (g)	1 mk correct reactant/products; 1 mk balanced.
(b)(i) Sugar (C ₁₂ H ₂₂ O ₁₁)	2 marks	The white sugar turns black (carbon is dehydrated out) and swells/puffs up. The reaction is: C ₁₂ H ₂₂ O ₁₁ → 12C + 11H ₂ O. Observation: black spongy mass of carbon produced, with steam.	—
(b)(ii) CuSO ₄ ·5H ₂ O	2marks	The blue hydrated crystals turn white as the water of crystallisation is removed by the concentrated H ₂ SO ₄ . Heat is also produced.	—
(b)(iii) Sulphur	2 marks	Concentrated H ₂ SO ₄ oxidises sulphur to form sulphur dioxide gas (SO ₂) — pungent smell observed. S + 2H ₂ SO ₄ (conc) → 3SO ₂ + 2H ₂ O	—

QUESTION 8— mole concept (9Marks)

First, find the molar masses of all participating substances using the standard atomic masses ($Ca = 40$, $C = 12$, $O = 16$, $H = 1$):

- $M(CaC_2) = 40 + 2(12) = 64 \text{ g/mol}$
- $M(H_2O) = 2(1) + 16 = 18 \text{ g/mol}$
- $M(Ca(OH)_2) = 40 + 2(16 + 1) = 74 \text{ g/mol}$
- $M(C_2H_2) = 2(12) + 2(1) = 26 \text{ g/mol}$

1MARK

1. Mass of water required for complete reaction

The mole ratio of CaC_2 to H_2O is 1 : 2.

- **Moles of H_2O required:** $2 \times 500,000 = 1,000,000$ moles
- **Molar Mass of H_2O :** $2(1) + 16 = 18 \text{ g/mol}$
- **Mass of H_2O :** $1,000,000 \text{ moles} \times 18 \text{ g/mol} = 18,000,000 \text{ g} = \mathbf{18 \text{ tonnes}}$

2MARKS

2. Mass of calcium hydroxide produced

The mole ratio of CaC_2 to $Ca(OH)_2$ is 1 : 1.

- **Moles of $Ca(OH)_2$ produced:** 500,000 moles
- **Molar Mass of $Ca(OH)_2$:** $40 + 2(16 + 1) = 74 \text{ g/mol}$
- **Mass of $Ca(OH)_2$:** $500,000 \text{ moles} \times 74 \text{ g/mol} = 37,000,000 \text{ g} = \mathbf{37 \text{ tonnes}}$

2MARKS

3. Volume of ethyne (C_2H_2) at STP if CaC_2 was 50% pure

If the starting material is only 50% pure, the actual mass of reacting CaC_2 scales down.

- **Mass of pure CaC_2 :** $50\% \times 32 \text{ tonnes} = 16 \text{ tonnes} = 16,000,000 \text{ g}$
- **Moles of pure CaC_2 :** $\frac{16,000,000 \text{ g}}{64 \text{ g/mol}} = 250,000 \text{ moles}$
- **Moles of C_2H_2 produced:** 250,000 moles (1 : 1 ratio)
- **Volume at STP** (using 22.4 L/mol): $250,000 \text{ moles} \times 22.4 \text{ L/mol} = 5,600,000 \text{ L}$ (or $5.6 \times 10^6 \text{ L}$)

2MARKS

4. Number of molecules of ethyne formed

(Note: Since your question mentions "formed in (b)" but part (b) asked for calcium hydroxide, calculations for both the 50% pure scenario and the original 100% pure scenario are provided below using Avogadro's number 6.02×10^{23}).

- **If referring to the 50% pure scenario:**

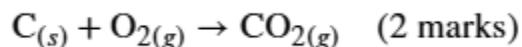
$$\text{Molecules} = 250,000 \text{ moles} \times 6.02 \times 10^{23} = 1.505 \times 10^{29} \text{ molecules}$$

2MARKS

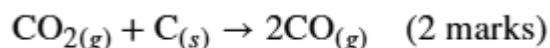
SECTION C (30 Marks)

9. (a) An ore is a naturally occurring rock or mineral from which a metal can be extracted profitably. (1 mark)

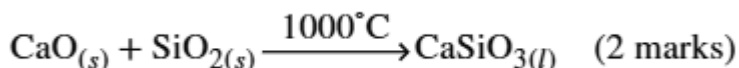
(b) (i) equation for the exothermic reaction that causes this high temperature



ii. Carbon monoxide is formed through the reaction of carbon with oxygen at high temperature to produce carbon dioxide. Carbon dioxide formed then reacts with more coke to form carbon monoxide.



iii. Formation of slag



(b) Steps in Metallurgy / Extraction of Metals

- **Concentration of ore / dressing:**
It involves crushing & washing to remove impurities using physical processes such as froth flotation or magnetic separation. (2marks)
- **Roasting / Calcination:**
(Conversion to oxide) through heating processes in excess air (**Roasting**) or in limited air (**Calcination**). (2marks)
- **Reduction:**
Removal of oxygen from a metal oxide by smelting or by electrolysis. (2marks)
- **Purification and refining:**
This is through electrolytic refining or distillation to remove trace impurities. (2marks)

QUESTION 10 — Fertilizers: Nitrogen & Application (9 Marks)

Part	Marks	Expected Answer / Marking Points	Examiner Notes
(a)(i) Fertilizer definition	1 mark	A fertilizer is any natural or synthetic substance added to soil to supply one or more plant nutrients essential for plant growth.	—

Part	Marks	Expected Answer / Marking Points	Examiner Notes
(a)(ii) 3 Effects of excess nitrogen	3 marks	1. Excessive leafy/vegetative growth at the expense of fruiting. 2. Lodging (plants become too tall and fall over). 3. Delayed maturity of crops. Also: promotes fungal disease; groundwater/water body pollution (eutrophication).	1mark each; max 3marks. Explanation needed
(b)(i) 4 Application methods	4marks	1. Broadcasting 2. Side-dressing 3. Band application 4. Foliar spraying 5. Drip application	1markeach; max 4marks. Explanation needed
(b)(ii) 4 Advantages of manure	4 marks	1. Improves soil structure and water retention. 2. Provides slow-release nutrients. 3. Increases soil microbial activity. 4. Environmentally sustainable/cheap.	1mark each; max 4marks for 4 advantages. Explanation needed
(b)(iii) % N in $(\text{NH}_4)_2\text{SO}_4$	3 marks	Molar mass of fertilizer = 132 g/mol; mass N = 28 g; $\%N = (28/132) \times 100 = 21.2\%$	3marks 1@=3marks

QUESTION 11 — Le Chatelier & Ammonia Equilibrium (15 Marks)

Part	Marks	Expected Answer / Marking Points	Examiner Notes
(a) Le Chatelier's Principle	2 marks	When a system at equilibrium is disturbed by a change in conditions (concentration, temperature, or pressure), the system adjusts the position of equilibrium to oppose the change and restore a new equilibrium. Application: haber process, contact process and product removal in synthesis	Stating the principle 1 mark and explanation of any of the applications 1 mark = 2 marks
(ii) Conditions	4 marks	Any four conditions: (1) The reaction should be reversible (2) Should take place in a closed system. (3) Rate of forward reaction should be equal with the rate of backward reaction (4) Concentration of species remains fairly constant	1 mark @ = 4 marks
(b)(i) Ammonia removed	3 marks	Equilibrium shifts to the RIGHT (forward direction) to replace the removed NH_3 , producing more ammonia.	3 marks with explanation
(b)(ii) Temperature increased	3 marks	The reaction is exothermic. Increasing temperature adds heat (energy), so equilibrium shifts LEFT (reverse direction) to absorb the excess heat, producing more N_2 and H_2 .	3 marks with explanation
(c) Moles H_2	1 mark	22.4 L at STP = 1 mole of H_2	1 mark
(c) Moles NH_3	1 mark	From equation: $3\text{H}_2 \rightarrow 2\text{NH}_3$; ratio = 2/3; moles NH_3 = $(2/3) \times 1 = 0.667 \text{ mol}$	1 mark
(c) Volume NH_3	1 mark	$V = 0.667 \times 22.4 = 14.93 \text{ L} \approx 14.9 \text{ L at STP}$	1 mark