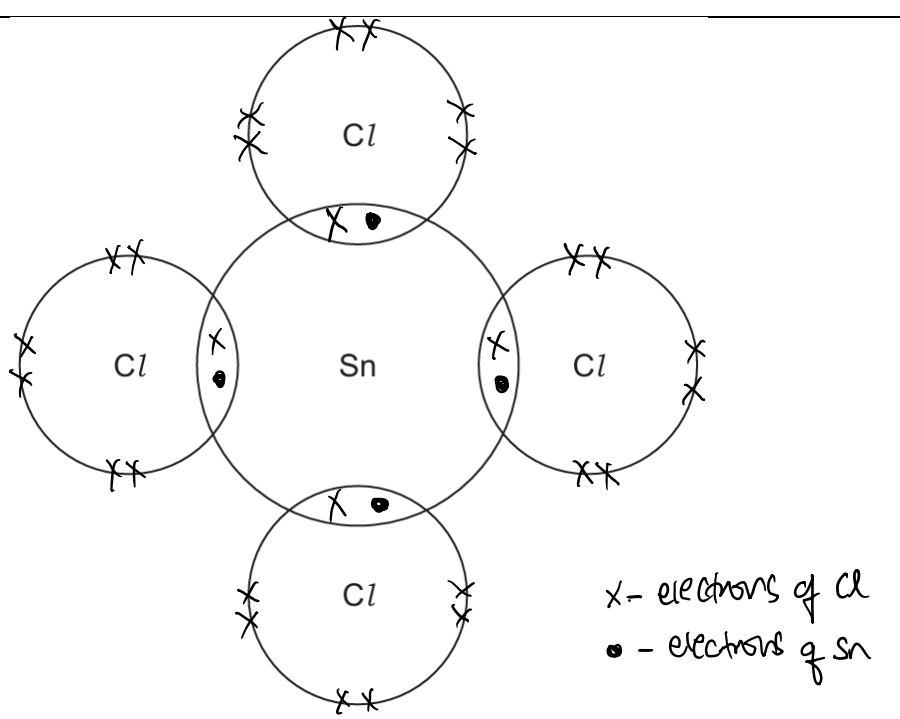
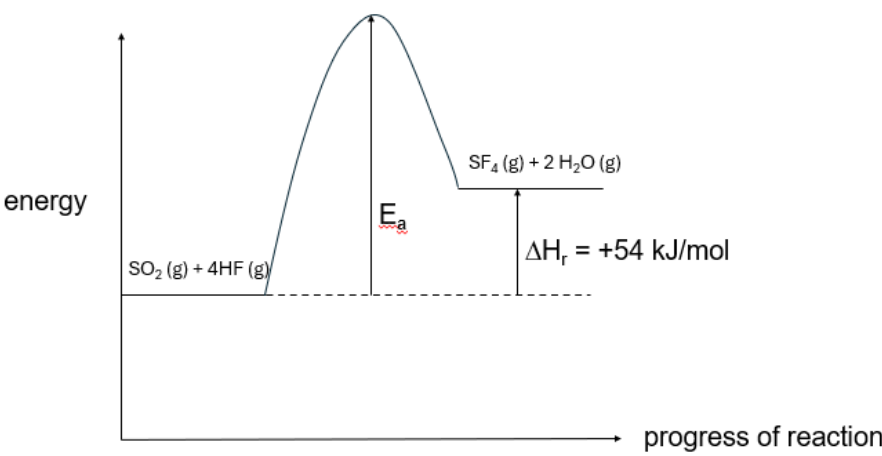


PLMGSS Answers to Sec 4 Pure Chemistry Prelim P2 2026

SECTION A		
Qn	Answer	Marks
1	Potassium hydroxide Barium nitrate and sulfuric acid Hydrochloric acid and excess magnesium oxide Carbonic acid Calcium oxide	[1] [1] [1] [1] [1]
2(a)(i)	It means tin(IV) oxide can react with both acids and bases.	[1]
2(a)(ii)	$\text{SnO}_2 (\text{s}) + 2\text{NaOH} (\text{aq}) \rightarrow \text{Na}_2\text{SnO}_3 (\text{aq}) + \text{H}_2\text{O} (\text{l})$	[1] – eq [1] – state
2(a)(iii)	Percentage by mass of tin = $119 / 151 \times 100 = 78.8\%$	[1]
2(b)	 x - electrons of Cl • - electrons of Sn	[1] – sharing of 1 pair of electron for each Cl [1] – correct number of valence electrons
2(c)	SnO_2 has a giant ionic crystal lattice structure with strong electrostatic forces of attraction between oppositely charged ions, while SnCl_4 has a simple covalent structure with weak intermolecular forces of attraction between molecules. More energy is needed to overcome the strong electrostatic forces of attraction in SnO_2, resulting in a lower melting point for SnCl_4. (vice versa)	M1 – SnO_2 M2 – SnCl_4 M3 - energy

3(a)	As atomic radius decreases, the first ionisation energy increases. This is because the electrostatic forces of attraction between the positively charged nucleus and outermost electrons becomes stronger as atomic radius decreases. Hence, more energy is needed to overcome these attractive forces to remove the outermost electron from the neutral atom in gaseous state.	M1 – relationship M2 – FOA M3 – energy
3(b)	Element Z is likely to be chlorine. Chlorine is more reactive than bromine, hence it displaced bromine from potassium bromide. Bromine vaporised and appeared as the brown gas.	M1 - chlorine M2 – reactivity and displacement
3(c)	Element W and X have giant metallic structure with strong electrostatic forces of attraction between positive metal ions and sea of delocalised electrons. Both are able to conduct electricity as the delocalised electrons act as mobile charge carriers.	M1 – structure and bonding M2 – property to bonding
3(d)	Y, as it is a non-metal since it does not conduct electricity and is found near the middle of the Periodic Table between element X and Z. Hence, it would form network of strong covalent bonds to achieve the stable noble gas configuration.	[1] – non-metal and middle of Periodic Table
4(a)	 energy SO₂ (g) + 4HF (g) SF₄ (g) + 2 H₂O (g) E_a $\Delta H_r = +54 \text{ kJ/mol}$ progress of reaction	M1 – reactants and products M2 – Ea M3 – enthalpy change

4(b)(i)	$-54 \text{ kJ/mol} = (4 \times 330) + 4(460) - (2 \times \text{S=O}) - (4 \times 570)$ $2 \times \text{S=O} = 54 + 1320 + 1840 - 2280$ $\text{S=O bond energy} = 467 \text{ kJ/mol}$	M1 – correct number of bonds M2 – correct signs for bond breaking/forming M3 – 467 kJ/mol
4(b)(ii)	Yes I agree, as the reactants are all in gaseous state. Hence, as pressure increases, the number of particles per unit volume will increase. This results in a higher frequency of effective collisions and an increase in rate of reaction.	M1 – state M2 – increase conc and freq of eff collisions
5(a)	Blue Cu^{2+} ions that are positively charged will be attracted to the negative electrode as current flows. Yellow CrO_4^{2-} ions that are negative charged will be attracted to the positive electrode as current flows.	M1 – colour of ions M2 – charge of ions
5(b)	The electrolyte solution contains Ag^+ ions. Silver is less reactive than copper, hence Ag^+ ions will be selectively discharged instead of Cu^{2+} ions.	M1 – ions present M2 – compare reactivity
5(c)	$4\text{OH}^- (\text{aq}) \rightarrow 2\text{H}_2\text{O} (\text{l}) + \text{O}_2 (\text{g}) + 4\text{e}^-$ Hydroxide ions are lower in the electrochemical series, hence will be selectively discharged. Water and oxygen will be produced, oxygen relights the glowing splint.	M1 – equation M2 – position of OH^- ions
5(d)	Cu^{2+} ions has a lower mass of 64 as compared to CrO_4^{2-} ions ($M_r = 116$). Hence, Cu^{2+} ions will diffuse away from the electrode faster than CrO_4^{2-} ions. (vice versa)	M1 – masses M2 – diffuse faster

6(a)	A: C ₃ H ₆ C: C ₂ H ₅ COOH D: (C ₂ H ₅ COO) ₂ Zn E: H ₂ F: CO ₂	M1 – A M2 – C M3 – D M4 – E and F
6(b)	Bubble the gas into limewater. The gas that forms white ppt in limewater is CO ₂ . OR Place a lighted splint beside the test tube of gas. The gas that extinguishes the lighted splint with a “pop” sound is H ₂ .	[1]
6(c)	White ppt, soluble in excess sodium hydroxide, giving a colourless solution.	[1]
6(d)	Propanoic acid is a weak acid which will dissociate partially to give much fewer hydrogen ions. Hence, the reaction releases less energy/is less exothermic, having the smallest temperature change. Sulfuric acid and hydrochloric acids are strong acids which dissociate completely in water. Sulfuric acid is a dibasic acid which will give two times the hydrogen ions as compared to hydrochloric acid which is a monobasic acid. Hence, the reaction with sulfuric acid releases more energy/is more exothermic, having the largest temperature change.	M1 – strength of C ₂ H ₅ COOH vs HCl and H ₂ SO ₄ M2 – basicity of H ₂ SO ₄ vs HCl M3 – more H ⁺ ions, more energy released (vice versa)
6(e)	Number of moles of zinc carbonate = $2 / (65+12+(16 \times 3))$ = 0.016 Number of moles of acid = $25.0/1000 \times 0.1$ = 0.0025 ZnCO ₃ + 2HCl → ZnCl ₂ + CO ₂ + H ₂ O 0.032 mol of acid needed ZnCO ₃ + H ₂ SO ₄ → ZnSO ₄ + CO ₂ + H ₂ O 0.016 mol of acid needed Acids are the limiting reagent in both reactions, not zinc carbonate. Since the mole ratios between acids and carbon dioxide gas are not the same , the volume of gas produced will not be the same.	M1 – moles M2 – LR M3 – different mole ratio, different volume

7(a)	To pump the unreacted nitrogen and hydrogen back into the reactor.	[1]
7(b)	Ammonia yield decreases from 38.5% to 14.1% as temperature increases from 350 °C to 550 °C.	[1] – relationship, no need data
7(c)	Order: Cobalt < Iron < Ruthenium Explanation: Ruthenium has the lowest activation energy. - Therefore, there are more particles with energy higher than or equal to activation energy. Frequency of effective collisions increases, leading to higher rate of reaction.	M1 – order M2 – lowest Ea M3 – key words
7(d)	When pressure is increased from 100 → 300 atm, the yield of ammonia increases by 30.1 – 14.5 = 15.6%. Every 1 atm change results in 0.078% increase in yield. When temperature is decreased from 550°C → 350°C, the yield of ammonia increases by 38.5 – 14.1 = 24.4%. Every 1 degree Celsius change results in 0.122% increase in yield. No I do not agree, as decreasing temperature produces a larger increase in equilibrium yield of ammonia. (vice versa)	M1 – difference in yield M2 - % increase with every 1 atm/°C M3 –decrease temperature leads to larger increase in yield.
7(e)	The oxidation state of nitrogen decreases from 0 in N₂ to –3 in NH₃ , hence N ₂ is reduced. The oxidation state of hydrogen increases from 0 in H₂ to +1 in NH₃ , hence H ₂ is oxidized. Since oxidation and reduction took place at the same time , formation of ammonia via Haber process is a redox reaction.	M1 – OS of nitrogen M2 – OS of hydrogen M3 - definition
7(f)	Haber process contributes to greenhouse gas emissions, leading to global warming.	[1]

8(a)	Same general formula; Each member differs from the next by a -CH ₂ group; Similar chemical properties; Gradual change in physical properties			[1] – give any 1
8(b)		Method 1 Use glucose as the starting material	Method 2 Use ethene as the starting material	Any 1 correct – 1m 2/3 correct – 2m 4 correct – 3m
	advantage	less energy needed to run the low temperature/ uses raw materials that are renewable	a lot of energy needed to run the high temperature/ uses raw materials that are non-renewable	
	disadvantage	slow process/ lower yield/	fast process/ higher yield/	
8(c)(i)	$\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + 2 \text{CH}_3\text{COOH} \rightarrow \text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOCH}_3 + 2 \text{H}_2\text{O}$ Concentrated sulfuric acid			[1] [1]
8(c)(ii)				M1 – ester linkage M2 - 2 repeat unit

SECTION B		
Qn	Answer	Marks
9(a)	Order: Magnesium > zinc > nickel > copper > silver Explanation: - The larger the voltage between metal electrodes, the greater the difference in metal reactivity. Magnesium is the most reactive as the voltage is the highest, followed by zinc. - Voltages between copper and nickel, and silver and nickel are negative, showing that these metals are less reactive than nickel. Silver is the least reactive as the voltage is most negative / lowest.	M1 – order M2 – either state relationship / Mg most reactive cos highest volt M3 – either state negative volt means less reactive / Ag least reactive cos lowest volt
9(b)(i)	Voltage = $2.38 + 0.33$ = 2.71V	[1]
9(b)(ii)	Experiment 1: $2\text{HNO}_3 + \text{Ni} \rightarrow \text{Ni}(\text{NO}_3)_2 + \text{H}_2$ Nickel reacts with acid to produce hydrogen gas. Experiment 2: $\text{Mg} + \text{Ni}(\text{NO}_3)_2 \rightarrow \text{Mg}(\text{NO}_3)_2 + \text{Ni}$ Magnesium is more reactive than nickel, hence magnesium can displace nickel from its solution.	[1] – equation [1] - explanation [1] – equation [1] - explanation
9(b)(iii)	Between 0.00 and -0.76V Nickel is above hydrogen in reactivity series and is less reactive than zinc, hence the value is negative and value is smaller than 0.76/ the potential is less negative.	[1] [1]

10(a)	+5	[1]
10(b)	Oxides with lower oxidation states, +1 and +2 are neutral while oxides with higher oxidation states, +3 to +5 are acidic. OR As the oxidation number of nitrogen in the oxides increases, their character changes from neutral to acidic.	[1]
10(c)	Cool the mixture of nitric oxide, nitrogen dioxide and nitrous oxide to below -152.0°C till all liquefy. Pass the liquid mixture into fractional distillation column where it is heated gradually. Nitric oxide, which has the lowest boiling point will rise to the top of the column and distil first, followed by nitrous oxide, then nitrogen dioxide.	[1] [1] [1]
10(d)(i)	Dinitrogen trioxide reaction is slower since it is a weak acid, turning Universal Indicator orange. Hence it will ionize/dissociate partially to give a low concentration of hydrogen ions. With less hydrogen ions per unit volume, the frequency of effective collisions will be lower, leading to slower reaction.	M1 – N_2O_3 weak acid, partial dissociation, lower conc of H^+ ions M2 – key words
10(d)(ii)	10 cm^3 (as $\text{Ca}(\text{OH})_2$ dissociates to give 2 times the OH^- ions)	[1]
10(d)(iii)	No precipitate is observed for nitrogen dioxide but a white precipitate is seen when carbon dioxide reacts with aqueous calcium hydroxide.	[1]
10(e)	Oxides of nitrogen will dissolve in rain to form acid rain, which will corrode buildings or bridges made of metals or carbonates. OR (affect aquatic plants and animals)	[1]