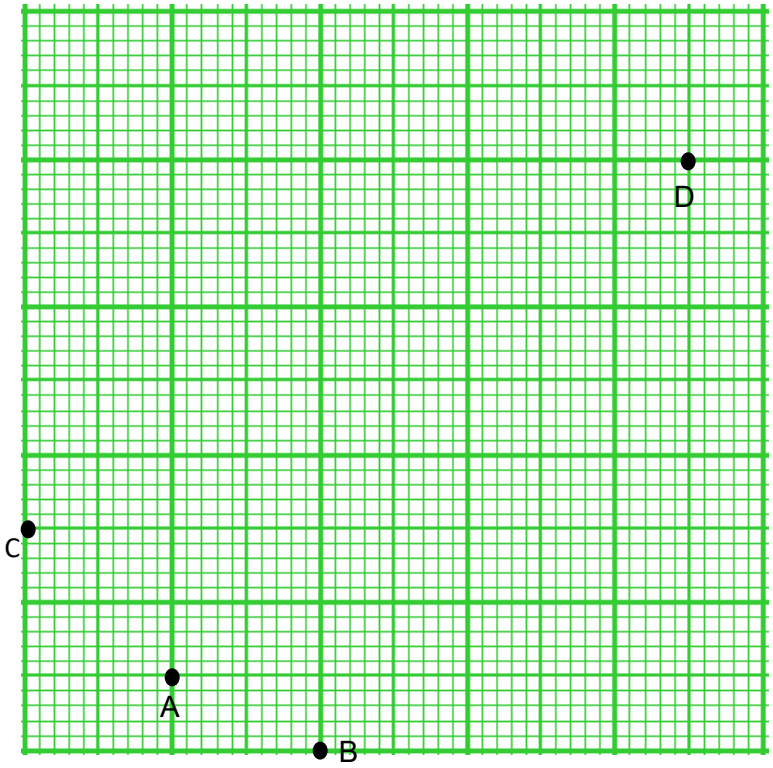
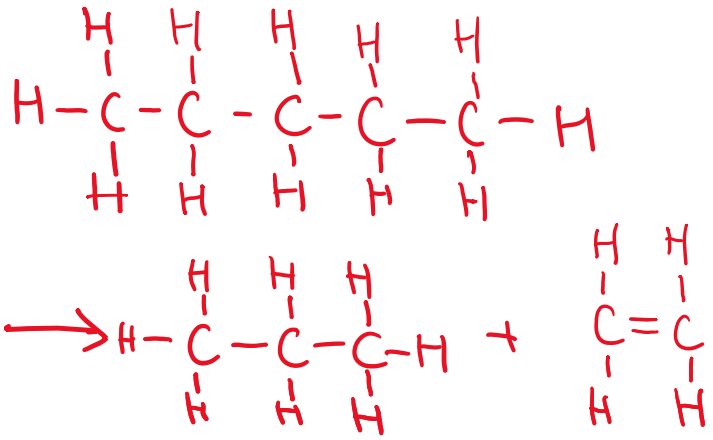
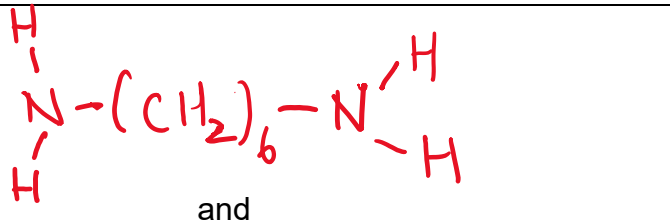
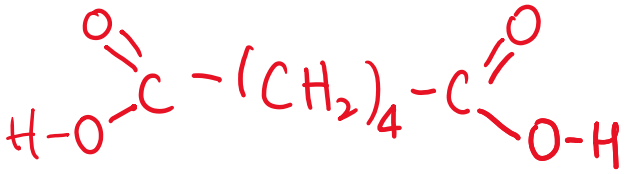
2024 4E Prelim Pure Chemistry 6092

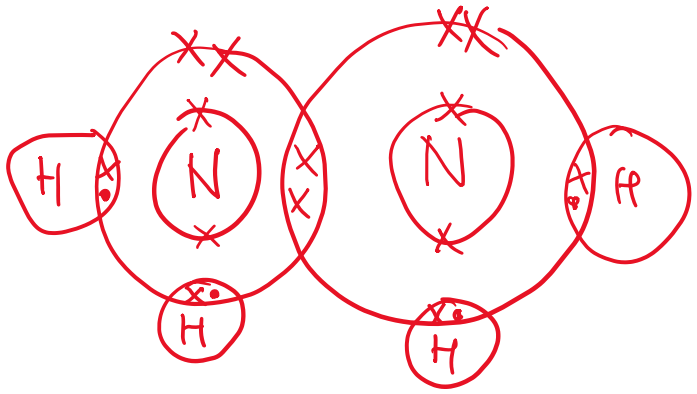
Section A Mark Scheme

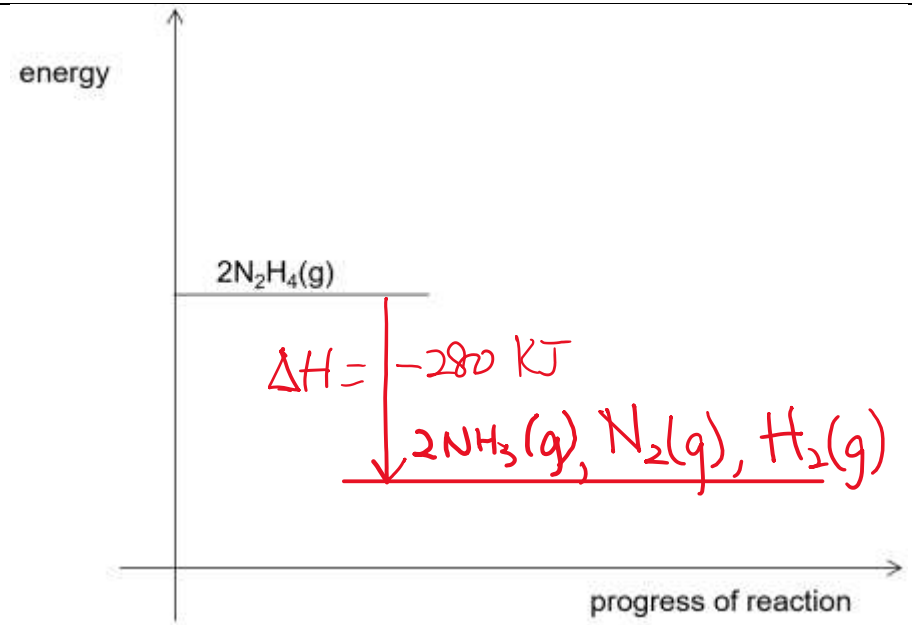
S/N	Mark Scheme	Common Mistakes
A1	(a) $FeSO_4$ (b) Al_2O_3 (c) Ag_2CO_3 (d) $(NH_4)_2SO_4$ (e) SiO_2 or Al_2O_3	
A2(a)	The metal electrodes have a giant metallic lattice structure. [1] It consists of 'sea of delocalised electrons' that are mobile to act as charged carriers. [1]	
A2(b)	Q, S, P, R	
A2(c)	X: 1.6 V Y: 0.8 V Accept values $\pm$ 0.2 V of answer.	
A2(d)	Oxidation	
A2(e)	Yes [stop marking if wrong] Metal P is more reactive than Metal R, it is able to reduce the oxide of metal R / displace R from the oxide of R. [1]	

A3(a)	D	
A3(b)	C [1] C is not soluble in solvent 2. [1]	
A3(c)	 1 m for each correct plot of A and D.	
A3(d)	Spray locating agent on the chromatogram.	
A4(a)	It is used as a feedstock for chemicals.	

A4(b)	 0.5 m for pentane and propane, 1 m for correct drawing of ethene	
A4(c)	Product 2. [0.5] [stop marking if wrong.] It has the same molecular formula [0.5] of C_6H_{14} [0.5] as hexane, but different structural formula. [0.5]	
A5(a)	Graph X [1] Ethanoic acid ionised partially in water to give a low concentration of hydrogen ions, hence the starting pH should be higher than HCl. [1] Or This is because ethanoic acid is a weak acid hence the starting pH should be higher than that of hydrochloric acid. [1]	
A5(b)	Both graphs show that both acids require the same volume (50 cm^3) of NaOH to neutralise.	

A5(c)	Phenolphthalein is a more suitable indicator. [1] The end-point falls within the colour change interval of phenolphthalein. [1]	
A6(a)	Amide linkage	
A6(b)	 and  1m each	
A6(c)	Mr of 1 repeat unit = 14x 2 +2 + 12 x 2 + 16 x 2 + 10 x (12 +2) = 226 [1] No. of repeat units in polymer C = 20800 / 226 = 92 [1]	

A7(a)		
A7(b)	$2N_2H_4(g) \rightarrow 2NH_3(g) + N_2(g) + H_2(g)$ Total energy absorbed for bond breaking = 2 x 160 + 8 x 390 = 3440 kJ [1] Total energy released for bond forming = 2 x 3 x 390 + 944 + 436 = 3720 kJ [1] Enthalpy change = 3440 – 3720 [1] = -280 kJ [shown]	

A7(c)	 1 m for correct named products lower than reactants 1 m for correct direction of arrow of enthalpy change -0.5 m for adding in activation profile	
A7(d)	Dinitrogen monoxide can cause global warming which leads to: Any of the following: • Melting of ice cap, hence flooding of low-lying lands • Droughts	
A8(a)	(i) Hydrogen gas that is produced escaped to the environment.	

	(ii) No. of moles of magneisum = 1.2/ 24 = 0.05 [0.5] No. of moles of nitric acid = 0.25 x 0.5 = 0.125 [0.5] Moles ratio of Mg : HNO_3 1 : 2 0.05 : 0.100 [1] 0.05 moles of Mg requires 0.100 moles of HNO_3, but 0.125 moles are given. Hence HNO_3 is in excess and Mg is the limiting reagent. [1]	
A8(b)	Either of the following: - Lower temperature - Larger lumps of Mg - Lower concentration of acid (make sure acid still in excess)	
A8(c)	I agree. [1] stop marking if wrong. Mg is more reactive than copper and can displace copper from copper(II) sulfate./ (mention of displacement reaction occuring) [1] Hence, less Mg to react with acid, hence less hydrogen gas will be produced, and less loss of mass will occur. [1]	
A9(a)	Presence of oxygen and water/ moisture	
A9(b)	To act as a barrier to prevent the iron metal from having contact with moisture and oxygen. (prevent rusting)	

<table>
<tr><td>A9(c)</td><td>When iron is in contact with copper, it acts as a sacrificial metal and corrodes in place of copper. [1]</td><td></td></tr>
<tr><td>A9(d)</td><td>Copper(II) carbonate</td><td></td></tr>
<tr><td>A9(f)</td><td>(i) Cathode: $Cu^{2+} + 2e \rightarrow Cu$
Anode: $Cu \rightarrow Cu^{2+} + 2e$</td><td></td></tr>
<tr><td></td><td>(ii) The concentration of the solution remains unchanged. [1]

For every one mole of Cu^{2+} discharged at the cathode, one mole of Cu^{2+} is formed at the anode. [1]

Or

The amount of Cu^{2+} ions formed at the anode is the same as the amount of Cu^{2+} ions that is discharged at the cathode.</td><td></td></tr>
<tr><td>A10(a)</td><td>(i) $2H^+ + 2e \rightarrow H_2$</td><td></td></tr>
<tr><td></td><td>(iii) Graphite is cheaper / more readily available.</td><td></td></tr>
<tr><td>A10 (b)(i)</td><td><table><tr><th>substances</th><th>oxidation state of chlorine</th></tr><tr><td>ClO^-</td><td>+1</td></tr><tr><td>ClO_3^-</td><td>+5</td></tr><tr><td>Cl^-</td><td>-1</td></tr></table>All 3 correct – 2m</td><td></td></tr>
</table>

	2 correct – 1m 1 correct - 0	
A10(b)(ii)	Oxidation state of Cl increases from 0 in Cl_2 to +1 in ClO^- / +5 in $ClOI_3^-$. Therefore, Cl_2 is oxidised. [1] Oxidation state of Cl decreases from 0 in Cl_2 to -1 in Cl^-. Therefore, Cl_2 is reduced. [1]	
A10(c)	Number of moles of NaCl in 1 tonne of brine = 1000000 x 0.25 / (23 + 35.5) = 4273.5 moles [0.5] Mole ratio: NaCl: H_2 is 2: 1 Number of moles of H_2 = 4273.5/2 = 2136.8 moles [0.5] Volume of H_2 = 2136.8x 24 = 51282 = 51300 dm^3 [3 s.f.] [1 for correct 3 s.f.]	
A10(d)	Membrane cell operates at a lower voltage of 3.3V as compared to diaphragm cell of 3.8V, hence cheaper to operate.	
A10(e)	Agree. Chloride ions are preferentially discharged to hydroxide ions due to higher concentration. [1] Hydrogen ions are preferentially discharged to sodium ions as hydrogen is lower than sodium in the reactivity series. [1] Hence, sodium ions and hydroxide ions remain behind.	

Section B Mark Scheme

S/N	Mark Scheme	Common Mistakes
B11(a)	$H_2O_2(aq) + 2H^+(aq) + 2\,I^-(aq) \rightarrow 2H_2O(l) + I_2(aq)$	
(b)	Reducing agent: iodide ions/ I^- [1] Stop marking if wrong Explanation: Iodide ions reduces oxygen in H_2O_2 to H_2O causing oxygen to gain electrons. [1]	
(c)	Colourless solution turns yellow/ yellow brown/ brown. [1]	
(d)(i)	Comparing experiment 1 and 4, increasing concentration of KI from 0.1 to 0.3 mol/dm^3, increases speed of reaction from 0.00017 to 0.00051 mol/dm^3 per second. 1m – trend 1m – quoting values Accept any other comparison of expt.	
(d)(ii)	Comparing experiment 1 and 3, increasing concentration of sulfuric acid from 0.1 to 0.2 mol/dm^3 has no effect of the speed of reaction as it remains constant at 0.00017 mol/dm^3 per second. 1m – trend 1m – quoting values Accept any other comparison of expt.	

<table>
<tr><td>(e)</td><td>• Increasing the temperature increases the kinetic energy of the particles, hence they move faster. [0.5]
• This will also increase the number of particles having energy equal to or greater than the activation energy. [0.5]
• Hence, the frequency of collision as well as frequency of effective collision will increase. [0.5]
• Thus, speed of reaction increases. [0.5]</td><td></td></tr>
<tr><td>B12 (a)(i)</td><td>$2Zn(NO_3)_2 \rightarrow 2ZnO + 4NO_2 + O_2$</td><td></td></tr>
<tr><td>(a)(ii)</td><td>White solid turns yellow when hot.</td><td></td></tr>
<tr><td>(a)(iii)</td><td>1) Add <u>excess zinc oxide</u> into dilute nitric acid and stir thoroughly. [0.5]
2) <u>Filter</u> the mixture to obtain zinc nitrate solution as the <u>filtrate</u>. [0.5]
3) Heat the filtrate until <u>saturated</u>. [0.5]
4) Leave it to <u>cool</u> for crystals to form. [0.5]
5) Filter out the crystals as residue.
6) <u>Wash</u> the residue with <u>cold distilled wat</u>er. [0.5]
7) Press <u>dry the residue</u> between sheets of filter paper. [0.5]

Must be correct method before steps 6 and 7 is awarded 1m.</td><td></td></tr>
<tr><td>(b)(i)</td><td>$Zn^{2+} + 2OH^- \rightarrow Zn(OH)_2$</td><td></td></tr>
<tr><td>(b)(ii)</td><td>White ppt is soluble in excess aqueous ammonia to form a colourless solution.</td><td></td></tr>
<tr><td>(b)(iii)</td><td><table><tr><td>test number</td><td>tests</td><td>observations</td></tr><tr><td>1</td><td>An equal portion of aqueous sodium</td><td>White ppt seen. [1]</td></tr></table></td><td></td></tr>
</table>

		carbonate is added to solution X.			
	2	Aqueous ammonia is added to solution X.	A white ppt is seen.		
	3	Aqueous sodium hydroxide and aluminium foil are added to solution X and the mixture is warmed.	• Effervescence seen. [0.5] • Colourless [0.5] and pungent gas evolved. [0.5] • Gas evolved turned damp red litmus blue. [0.5] • Gas evolved is ammonia. [0.5] Max 2 m		