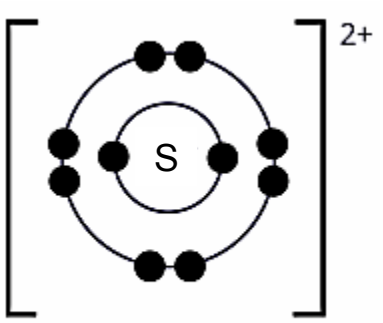
ANG MO KIO SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY FOUR EXPRESS
CHEMISTRY [6092]

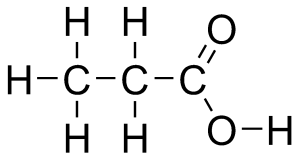
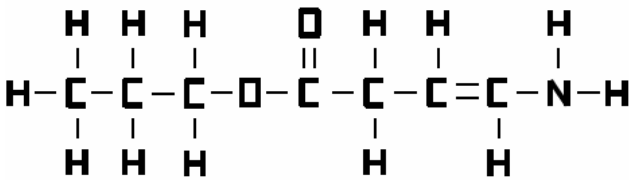
ANSWER SCHEME

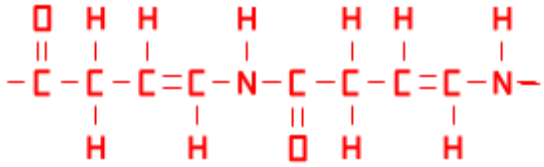
Paper 2
Section A: Compulsory Structured Questions [70 Marks]

1a	P and S	1	
1b	Q	1	
1c	P_3U_2	1	
1d		1	
	Total	**4**	
2a	Covalent bonding. <u>Bonding between non-metal elements phosphorus and oxygen</u> is covalent in nature.	1 1	
2b	P_4O_6	1	(R): P_2O_3 / O_6P_4
2c	Liquid X is not able to conduct electricity. X has a <u>simple molecular structure / is a simple molecule</u> and <u>does not have mobile ions or electrons</u> to act as charge carriers to conduct electricity.	1 1	
2d	pH of solution Y is <u>less than pH 7</u>. Substance X is <u>acidic oxide as it is a non-metal oxide</u> and <u>will dissolve in / react with water to form an acidic solution</u>.	1 1	
	Total	**7**	
3a	Bond breaking energy for 4 moles of C-F = 4 x 495 kJ/mol	2	

	= 1980 kJ Bond breaking energy for 2 moles of C-Cl = 2 x 339 kJ/mol = 678 kJ Bond breaking energy for 2 moles of C-H = 2 x 413 kJ/mol = 826 kJ Total bond breaking energy = 1980 + 678 + 826 = 3484 kJ (correct working = 1; correct ans = 1)		
3b	Bond forming energy for 4 moles of C-F = 4 x 495 kJ/mol = 1980 kJ Bond forming energy for 1 mole of C=C is 610 kJ Bond forming energy for 2 moles of H-Cl = 2 x 431 kJ/mol = 862 kJ Total bond forming energy = 1980 + 610 + 862 = 3452 kJ (correct working = 1; correct ans = 1)	2	
3c	Δ H of the reaction = 3484 kJ – 3452 kJ = + 32 kJ	1	Allow for ecf
3d	Fluorine is more reactive than chlorine. Therefore, the covalent bond formed between C – F is stronger than between C – Cl. Hence, it needs more energy to break the C – F bond compared to C – Cl bond.	1	
	Total	**6**	
4a	$2\ NaN_3 \rightarrow 2\ Na + 3\ N_2$	1	
4b	M_r of NaN_3 = 23 + 3(14) = 65 Number of moles of NaN_3 used = 120 ÷ 65 = 1.84615 mol [1m] Mole ratio of $NaN_3 : N_2$ = 2 : 3 = 1.84615 : 2.76923 Number of moles of N_2 produced = 2.76923 mol [1m] Volume of N_2 produced = 2.76923 × 24 dm^3 = 66.46154 = 66.5 dm^3 [1m]	3	
4ci	$10\ Na + 2\ KNO_3 \rightarrow 5\ Na_2O + K_2O + N_2$	1	
4cii	Sodium is a very reactive metal which reacts violently with water and oxygen in air.	1	
4d	Method: titration	1	

	Reagents formulae: KOH / K_2CO_3 and HNO_3	1	
	Total	**8**	
5a	$NaOH$ and $(NH_4)_2SO_4$	1	
5b	HNO_3 and Zn	1	
5c	$Cu(NO_3)_2$ and Na_2CO_3	1	
5d	$Cu(NO_3)_2$ and Zn	1	
5e	KI and $Ag(NO_3)_2$	1	
	Total	**5**	
6a	Potassium chloride is an ionic compound. In the solid state, the oppositely charged ions in potassium iodide are fixed in position and cannot move freely to act as charge carries to conduct electricity.	1 1	
6b	Add distilled water to solid potassium chloride to form an aqueous solution / heat potassium chloride until it melts to form a molten liquid.	1	
6c	$4\ OH^-\ (aq) \rightarrow 2\ H_2O\ (l) + O_2\ (g) + 4\ e^-$ Effervescence observed. A colourless and odourless gas is given off. OH^- ions are preferentially discharged in place of SO_4^{2-} ions. Each OH^- ion loses an electron to form water and oxygen gas. OH^- ions are oxidised.	1 1 1	
6d	$Cu^{2+}\ (aq) + 2\ e^- \rightarrow Cu\ (s)$ A brown solid is deposited on the electrode. Cu^{2+} ions are preferentially discharged in place of H^+ ions. Cu^{2+} ion gains two electrons to form Cu metal. Cu^{2+} ions are reduced.	1 1 1	
6e	Blue copper(II) sulfate solution turns colourless / pale blue.	1	
	Total	**10**	
7a	fractional distillation	1	
7b	C_8H_{18}	1	
7c	The greater the number of carbon atoms per molecule, the	1	

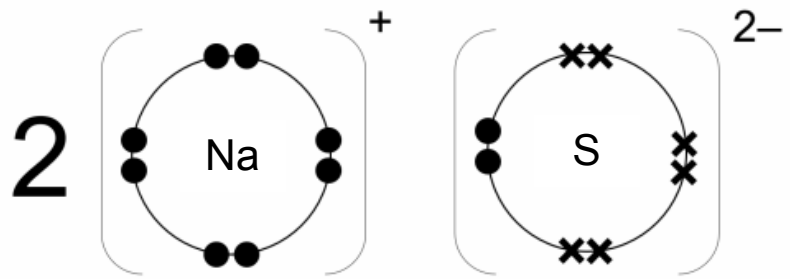
	higher the melting and boiling points of the alkanes. As the molecular mass / size increases with more carbon atoms per molecule, the intermolecular forces of attraction between the molecules increases. More energy is needed to overcome the stronger attractive forces.	1	
7di	Equation: $C_{16}H_{34} \rightarrow C_8H_{18} + 2\ C_3H_6 + C_2H_4$	1	
7dii	Name: propanoic acid Full structural formula: 	1 1	
7e	Percentage by mass of carbon in octane = {8(12) ÷ [8(12) + 18(1)]} × 100% = 84.2% Percentage by mass of carbon in hexadecane = {16(12) ÷ [16(12) + 34(1)]} × 100% = 84.95% = 85.0% Octane has a lower percentage by mass of carbon than hexadecane. Octane is more flammable than hexadecane as flammability of alkanes decreases with higher percentage of carbon by mass.	1 1 1	
	Total	**10**	
8a	water	1	
8b	Ester Sweet smelling	1 1	
8c		1	
8d	Red-brown aqueous bromine becomes decolourised / turns colourless.	1	

	Compound X is an unsaturated organic compound and will undergo addition reaction with bromine.	1	
8ei	 (correct amide linkage = 1; two repeating units = 1)	2	
8eii	Amide bond / linkage	1	
	Total	**9**	
9a	Cl_2 (g) + 2 NaBr (aq) $\rightarrow$ 2 NaCl (aq) + Br_2 (aq) (balanced equation = 1; state symbols = 1)	2	
9b	Experiment 2	1	
9c	In the first two minutes, the rate of change of absorbance is very fast as there is a high concentration of bromide ions being displaced. The rate of change of absorbance then slows down as the concentration of bromide ions being displaced decreases over time. After 3 minutes, the reaction has come to a stop as all the bromide ions are displaced from the solution.	1 1 1	
9d	Experiments 1 and 3	1	
9ei	The absorbance reading of experiment 5 is lower than 0.4. Chlorine is less reactive than fluorine and will not displace fluorine from sodium fluoride. The colour of aqueous chlorine and sodium fluoride is lighter than aqueous bromine.	1 1	
9eii	The absorbance reading of experiment 6 is higher than 0.4. Chlorine is more reactive than iodine and will displace iodine from sodium iodide to form aqueous iodine. Aqueous iodine is darker in colour than aqueous bromine.	1 1	
	Total	**11**	

Section B: Free Response Questions [10 Marks]

10a	The decomposition point of potassium chlorate(V) is below its	1	(R): Sublimation

	boiling point / potassium chlorate(V) decomposes at a temperature below its boiling point.		
10b	Liquid state	1	
10c	• Heat the mixture to 400 ºC to decompose $KClO_3$ to form KCl. • Weigh and reheat the mixture until the mass remains constant. • Add excess distilled water to the cooled mixture to dissolve KCl. • Filter the mixture to remove CuO as the residue. • Heat the filtrate of KCl to saturation. • Cool the filtrate to allow crystallisation of KCl. • Filter the filtrate to obtain KCl crystals as residue. • Wash with distilled water and dry between dry filter papers. (8 points = 3; 6-7 points = 2; 4-5 points= 1)	3	
10d	+ 5	1	
10e	The oxidation state of chlorine decreases from +5 in $KClO_3$ to −1 in KCl. Therefore, chlorine in $KClO_3$ is reduced. The oxidation state of oxygen increases from −2 in $KClO_3$ to 0 in O_2. Therefore, oxygen in $KClO_3$ is oxidised. Since there is oxidation and reduction occurring during the decomposition reaction, it is a redox reaction.	1 1	
10f	acid-base neutralisation / precipitation reaction (an appropriate equation based on the stated reaction; state symbols not required)	1 1	
	Total	**10**	
11a	Ionisation energy decreases down group 1. Down group 1, the number of electron shells increases. The increase in distance between the outer electron and the nucleus / protons resulted in weaker electrostatic attraction between them and less energy needed to remove an electron.	1 1 1	
11b	Ionisation energy increases across period 2. Across period 2, the number of protons increases but the number of electron shells is the same. The increase in proton number but with similar distance between protons and outer electrons resulted in stronger electrostatic attraction between them and more energy needed to remove an electron.	1 1 1	
11c	The ionisation energies of Li−6 and Li−7 are the same / similar.	1	

	Ionisation energy is dependent on the electrostatic attraction between protons and electrons, not the number of neutrons. Both isotopes have the same number of protons and electrons.	1	
11d	 (correct ratio of atoms and no. of electrons = 1; correct charges = 1)	2	
	Total	**10**	