

Mark Scheme

Paper 1

1	2	3	4	5	6	7	8	9	10
C	C	C	B	B	D	D	B	D	B
11	12	13	14	15	16	17	18	19	20
A	C	B	C	B	D	D	D	A	A
21	22	23	24	25	26	27	28	29	30
C	B	B	A	A	B	B	D	C	C
31	32	33	34	35	36	37	38	39	40
D	D	A	C	C	A	C	A	B	C

Tally: A – 8 B – 11 C – 12 D – 9

Paper 2

Section A [70 m]

A1	(a) <u>calcium hydroxide</u> (b) <u>magnesium</u> (c) <u>sulfur dioxide</u> and <u>nitrogen dioxide</u> (d) <u>nitrogen</u> and <u>hydrogen</u>	[2] [2]												
A2	(a)(i) <u>ethanoic acid</u> , CH ₃ COOH; <u>propanol</u> , C ₃ H ₇ OH (ii) At higher temperatures, the reacting particles <u>move faster</u> leading to a <u>higher frequency of effective collisions</u> between the particles, resulting in a <u>higher rate of diffusion</u> . (b)(i) The esters have the <u>same general formula</u> , HCO ₂ C _n H _{2n+1} / The esters have the <u>same functional group</u> , HCO ₂ . (ii) <u>Methyl methanoate</u> It has the <u>lowest relative molecular mass</u> of <u>60</u> .	[2] [1] [1] [1] [1] [1]												
A3	(a)(i) <table border="1"><thead><tr><th>symbol</th><th>number of protons</th><th>number of neutrons</th><th>number of electrons</th></tr></thead><tbody><tr><td>⁷⁹₃₅Br</td><td>35</td><td><u>44</u></td><td>35</td></tr><tr><td>⁸¹₃₅Br⁻</td><td>35</td><td>46</td><td><u>36</u></td></tr></tbody></table> (ii) <u>Isotopes</u> have <u>the same number of protons</u> (i.e. 35 protons) but <u>different number of neutrons</u> (i.e. 44 and 46 neutrons). (iii) <u>Cl₂(g) + 2Br⁻(aq) → 2Cl⁻(aq) + Br₂(l)</u> (iv) Astatine, being <u>less reactive</u> than bromine, is <u>unable to displace</u> bromine from its salt. (b)(i) The <u>colourless</u> solution turns <u>dark-brown</u> . (ii) The iodine in potassium iodide undergoes <u>oxidation</u> , as the oxidation state of iodine increases from <u>-1 in I⁻</u> to <u>0 in I₂</u> . <u>The oxygen in ozone undergoes reduction</u> , as the oxidation state of oxygen decreases from <u>0 in O₃</u> to <u>-2 in H₂O</u> . (c)(i) 'Dot-and-cross' diagram [covalent; H ₃ C — S — CH ₃] (ii) Dimethyl sulfide is a <u>simple covalent</u> molecule. A <u>small</u> amount of heat energy is required to overcome the <u>weak intermolecular forces</u> of attraction between molecules .	symbol	number of protons	number of neutrons	number of electrons	⁷⁹ ₃₅ Br	35	<u>44</u>	35	⁸¹ ₃₅ Br ⁻	35	46	<u>36</u>	[1] [1] [1] [1] [1] [1] [1] [1] [2] [1]
symbol	number of protons	number of neutrons	number of electrons											
⁷⁹ ₃₅ Br	35	<u>44</u>	35											
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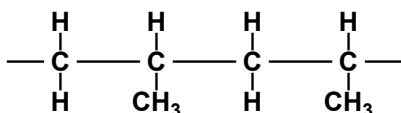
A4	(a) <u>silver</u>; $\text{Ag(s)} \rightarrow \text{Ag}^+(\text{aq}) + \text{e}^-$ <u>molten</u>; $2\text{Cl}^-(\text{l}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^-$ (b)(i) $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$ (ii) As chlorine is <u>slightly soluble</u> in water, the volume collected is lesser. (iii) The resulting solution becomes <u>increasingly alkaline</u>. With the <u>removal of H^+ and Cl^- ions</u>, the <u>remaining Na^+ and OH^-</u> combine to form the strong alkali, NaOH. (iv) similarity At the cathode, H^+ ions are discharged to form <u>hydrogen gas</u>. difference At the anode, OH^- ions are discharged to form <u>oxygen gas</u> for dilute aqueous sodium chloride, while Cl^- ions are discharged to form <u>chlorine gas</u> for concentrated aqueous sodium chloride.	[1] [1] [1] [1] [1] [1] [1]
A5	(a)(i) energy absorbed for bond-breaking = $610 + 4(414) + 2(463) = 3192 \text{ kJ/mol}$ energy released for bond-forming = $346 + 5(414) + 358 + 463 = 3237 \text{ kJ/mol}$ enthalpy change of reaction = $3192 + (-3237) = -45 \text{ kJ/mol}$ (ii) <u>More</u> energy is <u>released</u> in bond forming (i.e. C-C, C-H, C-O and O-H) than <u>absorbed</u> in bond breaking (i.e. C=C, C-H and O-H). (iii) on diagram: - the products of the reaction - the activation energy for the reaction - the enthalpy change of reaction, ΔH (b)(i) $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$ (ii) The fermentation of glucose can be carried out using <u>yeast</u> as catalyst. The mixture is kept at a temperature of about <u>37 °C</u>, producing a dilute solution of ethanol, with concentration <u>12-14%</u>. The process is carried out under <u>anaerobic</u> conditions. Ethanol is purified using <u>fractional distillation</u>. (c) test 1 : To 5 cm^3 of sample, add 1 g of <u>solid sodium carbonate</u>. observation : With ethanol, there is <u>no visible reaction</u>. With ethanoic acid, <u>effervescence</u> is observed. test 2 : To 5 cm^3 of sample, add an equal volume of <u>acidified potassium manganate(VII)</u>. observation : With ethanol, the <u>purple</u> solution turns <u>colourless</u>. With ethanoic acid, <u>no visible reaction</u>.	[1] [1] [1] [2] [1] [1] [1] [1] [2] [1] [1] [1]

A6

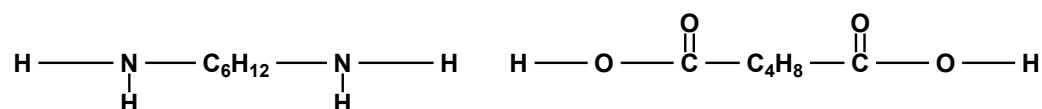
(a) Choose any one:

- The addition polymer contains the C-C chain while the condensation polymer contains the amide or ester linkages.
- The formation of addition polymers does not involve any loss of small molecules (i.e. 1 product formed). While the formation of condensation polymers involves the loss of small molecules like water (i.e. 2 products formed)
- The formation of addition polymers involves the C=C functional group, while the formation of condensation polymers involves monomers with functional groups like -NH_2 , -COOH and -OH .

(b)



(c)(i)



(ii) M_r of $C_{12}H_{22}N_2O_2$ = 226
range = 54 to 88

A7

(a) The pie charts show that there is 35% of iron in the whole Earth, while there is only 6% in the Earth's crust. This implies that 29% of the iron is in the inner core of the Earth.

(b)(i)

	Si	O
percentage	46.7	53.3
A _r	28	16
no. of moles	1.6679	3.3333
÷ 1.6679	1	2

empirical formula = SiO_2 ; name = silicon dioxide

(ii) Potassium oxide is an ionic compound.

A large amount of heat energy is required to overcome the strong electrostatic forces of attraction between oppositely-charged ions.

Silicon dioxide is a giant covalent molecule.

An even larger amount of heat energy is required to overcome the stronger covalent bonds between **atoms**.

For potassium oxide, the ions are held rigidly in fixed positions in the solid state. The absence of mobile charged ions prevents the electric current from being carried.

For silicon dioxide, all valence electrons are used for bonding. The absence of mobile charged **electrons** prevents the electric current from being carried.

(c) Ca²⁺, Al³⁺ and Si₂O₆⁸⁻

(d) M_r of phenacite = 110

mass of silicon in phenacite = $28/110 \times 1000 \text{ g} = \underline{255 \text{ g}}$ (to 3 s.f.)

mass of beryllium in phenacite = $2(9)/110 \times 1000 \text{ g} = \underline{164 \text{ g}}$ (to 3 s.f.)

From the above calculations, 1 kg of phenacite contains a larger mass of silicon than beryllium.

$$\text{no. of mol. of silicon} = 254.545 \text{ g} / 28 = \underline{9.09 \text{ mol (to 3 s.f.)}}$$
$$\text{no. of mol. of beryllium} = 163.636 \text{ g} / 9 = \underline{18.2 \text{ mol}} \text{ (to 3 s.f.)}$$

From the above calculations, 1 kg of phenacite contains a larger number of moles of beryllium atoms than silicon atoms.

[1]

[1]

[2]

[1]

[1]

[1]

[2]

[1]

[1]

[1]

[1]

[1]

[1]

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[1]

A8	(a) A catalyst provides an <u>alternative pathway</u> with a <u>lower activation energy</u> for the reaction to proceed, leading to a <u>higher frequency of effective collisions</u> between the particles, resulting in a <u>higher rate</u> of reaction.	[1] [1]
	(b) Comparing experiments 5, 7, 8 and 9, with the same starting temperature of 19 °C, Group 1 and 2 metal compounds are less effective as the time taken for reaction to finish is longer (i.e. NaNO ₃ takes <u>45s</u> , while Mg(NO ₃) ₂ takes <u>46 s</u>), as compared to the transition metal compounds which take a shorter time (i.e. Fe(NO ₃) ₃ takes <u>15s</u> and Co(NO ₃) ₂ takes <u>26s</u> .	[1] [1] [1]
	(c)(i) <u>Fe²⁺ and Fe³⁺</u>	
	(ii) <u>Iron(III) ion</u> is the more effective catalyst. Comparing experiments 6 and 7, iron(III) ion took a <u>shorter</u> time (i.e. <u>15s</u> in experiment 7) to complete the reaction, as compared to that of iron(II) ion (i.e. <u>22s</u> in experiment 6), despite the slight change in temperature.	[1] [1] [2]
	(iii) Transition metals form <u>coloured compounds</u> when hydrated. (d)(i) <u>Yes</u> . Comparing experiments 1 and 5, both NaCl/ and NaNO ₃ took <u>45s</u> to complete the reaction, regardless of the anion. Also, comparing experiments 2 and 6, both FeCl ₂ and Fe(NO ₃) ₂ took <u>22s</u> to complete the reaction, regardless of the anion. (ii) <u>15s</u>	[1] [1]

Section B [10 m]

B9	(a)(i) From the test with aqueous NaOH, the white precipitate formed is <u>soluble</u> in excess, implying that both Al ³⁺ ions and Zn ²⁺ ions are present. If Ca ²⁺ ion is present, then some white precipitate formed is <u>insoluble</u> in excess. From the test with aqueous NH ₄ OH, some white precipitate formed is <u>soluble</u> in excess, confirming that Zn ²⁺ ions are present, while some white precipitate formed is <u>insoluble</u> in excess, confirming that Al ³⁺ ions are present.	[1] [1] [1]
	(ii) <u>No</u> , the ammonia gas produced could be due to the presence of <u>aqueous ammonia</u> . To test for nitrate ions, the scientist should use <u>warm aqueous sodium hydroxide</u> and <u>aluminium foil</u> .	[1] [1] [1]
	(b) test : To a 2 cm ³ sample of river water, add an equal volume of <u>dilute acid</u> , followed by <u>aqueous silver nitrate</u> . result : <u>white precipitate</u> formed	[1] [1] [1]
	(c) 1. Add excess zinc carbonate [base] powder to warm <u>dilute hydrochloric acid</u> [acid]. 2. <u>Filter</u> the mixture to remove the excess zinc chloride. 3. <u>Heat</u> the filtrate till it is saturated.	[1] [1] [1]
	4. Allow the solution to <u>cool</u> and crystals of zinc chloride will form. <u>Filter</u> off the crystals. 5. <u>Wash</u> the crystals with distilled water. <u>Dry</u> the pieces of crystals between two pieces of filter paper.	[1] [1]

B10	(a)(i) $W > Z > Y > X$ (ii) <u>Effervescence</u> is observed. Metal Z, being a <u>reactive</u> metal (i.e. above H in the reactivity series), reacts with acid to displace <u>hydrogen gas</u>. (iii) <u>Approach:</u> The student measured and compared the <u>volume of hydrogen gas</u> collected for a <u>metal</u> of fixed mass (i.e. 0.5 g each of metals W, X, Y, Z and M) to react completely with <u>dilute hydrochloric acid</u> of a fixed concentration (i.e. 1 mol/dm³) and volume (30 cm³) over a 2-minute duration. <u>Procedure:</u> - Using a 50 cm³ measuring cylinder, measure 30 cm³ of HC/ and place it in a 250 cm³ conical flask. - Transfer the dilute hydrochloric acid into the conical flask, connect a gas syringe - Using an electronic mass balance, measure 0.5 g of metal W and add it to the conical flask. Stopper the conical flask and connect a gas syringe to the conical flask using a delivery tube. Start the stopwatch immediately. - Stop the stopwatch when it reaches 2 minutes. Record the volume of gas produced in a table of suitable format. <u>Conclusion:</u> Metal W will have the highest volume of hydrogen gas collected, followed by metals Z, Y, M (i.e. 4th most reactive) and X (b)(i) There is <u>no visible reaction</u> for experiments 1 and 3. Calcium and lead, being <u>more reactive</u> than hydrogen, <u>cannot be displaced</u> from their oxide by hydrogen. In experiment 2, the <u>red</u> copper oxide turns <u>red-brown</u>. Copper, being <u>less reactive</u> than hydrogen, <u>can be displaced</u> from its oxide by hydrogen. (ii) The tube containing <u>copper oxide</u>. Copper, being the <u>least reactive metal</u>, forms the <u>least stable metal oxide</u>, hence the oxide is <u>more readily reduced</u> by hydrogen.	[1] [1] [1] [1] [1] [1] [1] [1] [1]
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