CHIJ SECONDARY

Sec 4 Preliminary Examination 20**25**

Chemistry 6092 **Mark Scheme**

Updated on 14/09/2025

Total Score = (P1/40×30%) + (P2/80×50%) + (P3/40×20%)

Paper 1 (40 marks)

No	*Answer*	*No*	*Answer*	***No***	*Answer*	*No*	*Answer*
1	A	11	C	21	C	31	B
2	B	12	A	22	C	32	C
3	B	13	B	23	B	33	C
4	D	14	D	24	A	34	B
5	C	15	B	25	D	35	B
6	D	16	D	26	D	36	B
7	D	17	C	27	D	37	A
8	A	18	A	28	C	38	B
9	C	19	C	29	A	39	B
10	D	20	C	30	C	40	A

Abbreviations:

ORA: or reverse argument

AW: alternate wording

ECF: error carried forward (for calculations only)

Paper 2
Section A (70 marks)

Question			Answers	Marks	Total	Comment
1	(a)		Zn	1	5	
	(b)		Br	1		
	(c)		Li	1		
	(d)		Ar	1		
	(e)		Ag	1		ZnO is white when hot and yellow when cold, so it only forms 1 coloured compound.
2	(a)		The black dye is <u>impure</u>. (no mark) There is <u>more than one component/spot</u> on the chromatogram.	1	6	
	(b)		<u>Boil/freeze</u> the black dye / Determine the <u>boiling point/freezing point</u> of the black dye. If the black dye boils/freezes at a <u>fixed temperature, it is pure</u>. or If the black dye boils/freezes <u>over a range of temperatures, it is not pure</u>.	1 1		Reject methods relating to melting.
	(c)		Dye B is <u>insoluble in the solvent/ethanol</u>.	1		
	(d)		Dye <u>A</u> Distance of A from start line = <u>2.5</u> cm Distance of solvent front from start line = <u>5.5</u> cm (values must be correct) Rf value = <u>2.5 / 5.5</u> = 0.45 OR 0.45 = distance moved by solute ÷ (7 – 1.5) distance moved by solute = 0.45 × 5.5 = 2.475 Position on chromatogram = 2.475 + 1.5 = 3.975 ≈ 4cm	1 1		
3	(a)		nitrogen = 78% oxygen = 21%	1	7	% sign is not required
	(b)		32 / 24 = 1.33 g/dm^3	1		
	(c)	(i)	The total percentage composition of nitrogen and oxygen on Mars is much lower at 2.8% as compared to 99% on Earth / The percentage composition of nitrogen and oxygen on Mars is much lower at 2.6% and 0.3% compared to 78% and 21% on Earth. At <u>high temperatures</u> (in engines of vehicles or in factories or during lightning activity), <u>nitrogen and oxygen</u> in the air can <u>react</u> together to form nitrogen monoxide, <u>forming more nitrogen oxides</u> on Earth.	1 1		

Question			Answers	Marks	Total	Comment
		(ii)	In step 1, NO increased the rate of breakdown of ozone by providing alternative reaction pathway of lower activation energy; In step 2, the regeneration of NO showed that it remained chemically unchanged at the end of the reaction.	1 1		
	(d)		Mars has a high composition of carbon dioxide which traps heat/causes global warming.	1		
4	(a)	(i)	**Y** (Anode): $2Cl^- \rightarrow Cl_2 + 2e^-$ **Z** (Cathode): $2H^+ + 2e^- \rightarrow H_2$	1 1		
		(ii)	Universal Indicator turns from green to purple/violet. Since Cl^- and H^+ ions are discharged, K^+ and OH^- ions (or KOH) are left behind / the relative concentration of OH^- ions increases, forming a strong alkali.	1 1		
	(b)		**Similarity**: A red-brown deposit/coating forms at electrode X (cathode) / electrode X (cathode) increases in size. **Reasoning** (Similarity): In both cases, copper is less reactive than hydrogen, so copper(II) ions from the solution are preferentially discharged/reduced over hydrogen ions, and are reduced to form copper metal. **Difference**: When copper electrodes are used, electrode **W** decreases in size. When graphite electrodes are used, effervescence is observed at **W** / the electrodes do not change in size. **Reasoning** (Difference): • When copper electrodes are used, copper anode **W** oxidises to form Cu^{2+}. • When graphite electrodes are used, the OH^- ions are preferentially discharged over SO_4^{2-} ions to form oxygen gas, Or **Difference**: When copper electrodes are used, the blue solution does not decolourise. When graphite electrodes are used, the blue solution decolourises. **Reasoning** (Difference) :	1 1 1 1 1	8	Similarity 1M Difference 1M Reasoning 1M (for similarity) 1M (for difference)

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Marks</th><th>Total</th><th>Comment</th></tr>
<tr><td></td><td></td><td></td><td>• When copper electrodes are used, the <u>concentration of Cu^{2+} ions in the solution remains unchanged</u>.
• When graphite electrodes are used, the <u>concentration of Cu^{2+} ions decreases</u>.</td><td>1</td><td></td><td></td></tr>
<tr><td>5</td><td>(a)</td><td></td><td><table><tr><td>element</td><td>Fe</td><td>O</td></tr><tr><td>mass / g</td><td>4.2</td><td>1.8</td></tr><tr><td>Ar</td><td>56</td><td>16</td></tr><tr><td>no. of moles</td><td>0.075</td><td>0.1125</td></tr><tr><td>mole ratio</td><td>1</td><td>1.5</td></tr></table>[1] for each correct no. of moles calculated

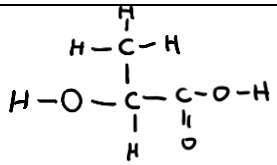
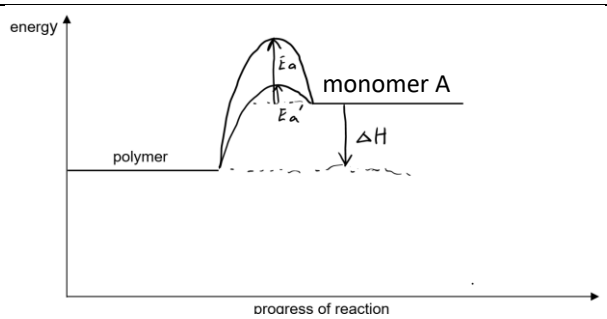
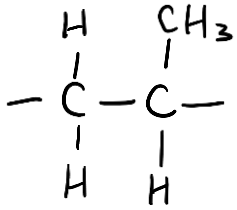
empirical formula is Fe_2O_3</td><td>2

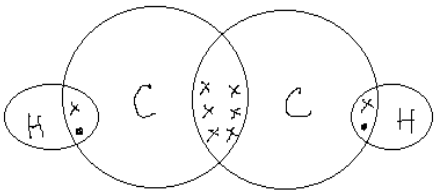
1</td><td rowspan="4">8</td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>magnesium oxide – no visible change / solid remains white
copper(II) oxide – <u>black</u> solid turns <u>red</u>-<u>brown</u></td><td>1

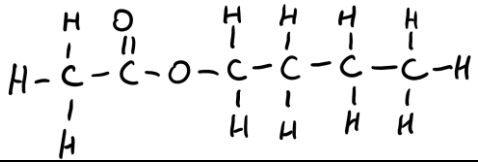
1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Copper(II) oxide
<u>Copper</u> is the <u>least reactive</u> compared to magnesium and lead.
<u>Copper(II) oxide</u> is the <u>least stable</u> metal oxide and will undergo reduction at the fastest rate.</td><td>1
1

1</td><td></td></tr>
<tr><td>6</td><td>(a)</td><td></td><td>• Compounds have the same general formula of $C_nH_{2n+1}NH_2$
• Compounds have the same functional group $-NH_2$
(may consider)
• Successive members differ from one another by a $-CH_2-$ unit</td><td>1

1</td><td rowspan="4">7</td><td>Reject: Gradual increase in physical properties like boiling point down the series.</td></tr>
<tr><td></td><td>(b)</td><td></td><td>Every 2 points is 1 mark:
• Particles in methylamine are very <u>far apart in a disorderly manner</u>
• while those in propylamine are <u>closely packed in a disorderly arrangement</u>
• Particles in methylamine are moving <u>rapidly and randomly in all directions</u>
• while those in propylamine are <u>sliding past one another</u>.</td><td>2</td><td>Must show comparison of arrangement and movement.</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>$(CH_3NH_3)_2SO_4$</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Blue precipitate forms.
Soluble in excess methylamine to form a dark blue solution.</td><td>1
1</td><td></td></tr>
</table>

Question			Answers	Marks	Total	Comment
7	(a)		It is a long-chain molecule / macromolecule with many ester linkages	1	9	Both ideas for 1M
	(b)		Water is added to the polymer, with acid as a catalyst Which causes the polymer to break down into its monomers.	1 1		
	(c)			1		
	(d)		 [1] correct shape [1] correctly labelled activation energies [1] correctly labelled enthalpy change	3		
	(e)	(i)		1		
		(ii)	Non-biodegrable plastics leads to increase in built-up waste in landfills when disposed by burying, causing land pollution; or When burnt, plastics can release toxic gases into the atmosphere, causing air pollution. or When thrown into water bodies, plastics can cause marine organisms to mistake them as food and choke on them, causing death.	1		

			Answers	Marks	Total	Comment
8	**(a)**	**(i)**	The higher the <u>concentration</u>, the faster the <u>rate of reaction</u>. (ORA) [1] The more <u>reacting particles per unit volume</u>, the higher <u>frequency of effective collisions</u>. [1]	2	**12**	Question was generally well done. A number of students mentioned activation energy, which was not relevant for concentration.
		(ii)	When the <u>concentration of C_2H_4 doubles</u> from 0.10mol/dm^3 in Experiment 1 to 0.20mol/dm^3 in Experiment 3 / 2 to 4, the <u>rate of reaction doubles</u> from 0.10 moldm^{-3}s^{-1} to 0.20 moldm^{-3}s^{-1}. [1] When the <u>concentration of Br_2 doubles</u> from 0.10mol/dm^3 in <u>Experiment 2 to</u> 0.20mol/dm^3 in <u>Experiment 3</u>, the <u>rate of reaction doubles</u> (from 0.10 moldm^{-3}s^{-1} to 0.20 moldm^{-3}s^{-1}). [1] Hence the reaction is <u>first order</u> with respect to <u>C_2H_4</u> and <u>first order</u> with respect to <u>Br_2.</u> [1]	3		Students must either cite the experiments or concentrations/ rates they are making reference to clearly. Answers that calculated the constant k to show that it was consistently 5 across at least 2 experiments were awarded max. 2 marks (1 mark per experiment). Answers where the value of constant k was incorrectly calculated were not given credit. A few students cited data without any explanation, so no credit was given. Very few students linked their explanation back to the order of reaction for each reactant.
		(iii)	Concentration of C_2H_4 doubles and concentration of Br_2 triples from experiment 4. Rate = 0.2 × 2 × 3 = 1.2 Time = 1000/1.2 ≈ <u>833 s</u>	1		Question was not well done.
		(iv)	Rate = k $[C_2H_2][Br_2]^2$	1		Question was not well done. Answers that used ( ) instead of [ ] were not given credit.
	(b)	**(i)**	 [1] correct bonding between C atoms [1] correct bonding between C and H atoms	2		There were some students who did not check that the C and H atoms had the correct number of valence electrons and had full valence shells, resulting in incorrect answers.
		(ii)	The aqueous bromine would change from <u>reddish-brown</u> (**R: brown**) to <u>colourless</u>.	1		Brown is rejected as the colour is used to describe aq. iodine.
		(iii)	Any value between 0.1 and 1.0 [1] The rate of reaction would be <u>faster</u> because <u>chlorine is more reactive than bromine</u>. [1]	2		Some students correctly stated that chlorine was more reactive than bromine but gave a slower rate; no credit was

			Answers	Marks	Total	Comment
						given for such answers due to contradiction.
9	**(a)**	**(i)**	Heat/warm butanol and ethanoic acid in the presence of concentrated sulfuric acid. [1] The ester can be obtained using a separating funnel (**A: fractional distillation**) [1]	2		Question was not well done.
		(ii)		1		
	(b)	**(i)**	$2CH_3COOH + CaCO_3 \rightarrow (CH_3COO)_2Ca + H_2O + CO_2$	1		Several equations were not balanced, or with incorrect products.
		(ii)	Effervescence is more vigorous (owtte) in the reaction with hydrochloric acid than in the reaction with ethanoic acid. [1] Hydrochloric acid undergoes complete ionisation while ethanoic acid undergoes only partial ionisation [1] hence hydrochloric acid has a higher concentration of hydrogen ions than ethanoic acid, resulting in a faster rate of reaction. [1]	3	**8**	Many students did not predict an observation but simply stated that the reaction would be faster or more vigorous. Some students incorrectly said that the yield of products would be greater for HCl than CH_3COOH. Answers that did not mention "concentration" (e.g. more ions) were not accepted. A few students used the term "deionised" which is incorrect.
		(iii)	Universal indicator: ethanoic acid will turn orange/yellow (**R: lighter red**) while hydrochloric acid will turn red.	1		Question was not well done. Many students knew to use universal indicator but did not provide the expected results for each acid.

Section B (10 marks)

			Answers	Marks	Total	Comment
10	**(a)**		Relationship between amount of energy to overcome forces/break bonds and melting point is correctly stated [1] Every 2 points is 1 mark: 1. Ethane has a <u>simple molecular structure</u> 2. held together by <u>weak intermolecular forces</u> of attraction that require very little energy to overcome, resulting in a low melting point. 3. Teflon has a <u>macromolecular structure</u>. 4. Because Teflon has a <u>larger molecule size</u> than ethane, it has <u>stronger intermolecular forces</u> that require more energy to overcome. Hence its melting point is higher than ethane. 5. Diamond has a <u>giant covalent structure</u> 6. where all the <u>atoms</u> are held together by <u>strong covalent bonds</u> that require a lot of energy to break, resulting in a very high melting point.	4	**10**	Question was generally well done except for the explanation for Teflon. Some students incorrectly thought that Teflon had a giant covalent structure like diamond or a simple molecular structure like ethane. Few mentioned the reason for the higher melting point of Teflon compared to ethane.
	(b)		% mass = 2(19)÷[2(19)+12]x100% = 76%	1		
	(c)		M_r of CF_2 = 12 + 2(19) = 50 [1] no. of C atoms = no. of CF_2 units = 89 000 ÷ 50 = 1780 [1] OR M_r of C_2F_4 = 2(12) + 4(19) = 100 no. of C atoms = (89 000 ÷ 100) × 2 = 1780 [1] OR total mass of C atoms = 24% × 89 000 = 21 360 [1] no. of C atoms = 21 360 ÷ 12 = 1780 [1]	2		Question was generally well done.
	(d)	**(i)**	$C_2H_6 + 2F_2 \rightarrow C_2H_4F_2 + 2HF$	1		Question was poorly done. Most students thought that the product of substitution was H_2. Many also wrote 2 mol of fluorine as 2F in an attempt to balance the equation.

			Answers	Marks	Total	Comment
		(ii)	No (no mark) Ethane undergoes a <u>substitution reaction</u> with fluorine [1] to <u>form a saturated product</u> / a product <u>without any C=C bonds</u> which <u>cannot undergo addition polymerisation</u>. [1]	2		Very few answers identified that the reaction was substitution, which would result in a saturated product. A few incorrectly identified the reaction as addition. Many students misread the question and thought that it was asking whether ethane (instead of the "resulting product") could undergo polymerisation to form Teflon. Such answers were not given credit. Answers that mentioned that the resulting product still had H atoms, making it impossible to form Teflon were given max. 1 mark credit.
11	**(a)**		Li: 1, Na: 2, K: 3 [1] F: 2, Cl: 3, Br: 4 [1]	2	**10**	The number of electron shells for Group 17 was often incorrect.
	(b)		Going down the group, the <u>number of electron shells increases</u> from <u>F to Br</u> from <u>2 to 4</u>. [1] Hence the <u>atomic radius increases</u> from <u>F to Br</u> / <u>down Group 17</u> from 71pm to 115pm. [1]	2		The instruction was given to "use the data to explain this trend", which many students ignored.
	(c)		When a lithium atom forms a lithium ion, the <u>radius decreases</u> because the <u>number of electron (**R: valence**) shells decreases</u> from <u>2 to 1</u>. [1] This is due to the <u>lithium atom losing its valence electron</u> to achieve a <u>stable electronic configuration</u>. [1]	2		While many students correctly stated that the Li atom loses an electron, the reason was often not provided. It was also common to see students stating that the number of valence shells decreased / lost a valence shell, which is incorrect.
	(d)		Relationship between amount of energy to overcome forces/break bonds and melting point is correctly stated [1] Every 2 points is 1 mark: 1. Fluorine has a <u>simple molecular structure</u> 2. held together by <u>weak intermolecular forces</u> of attraction that require very little	4		Question was generally well done, but a few students kept referring to the structure and bonding of lithium as metallic structure and bonding, which was not specific enough. Several answers also omitted the explanation for the difference in densities.

			Answers	Marks	Total	Comment
			energy to overcome, resulting in a low melting point. 3. Lithium has a positive ionic lattice surrounded by a 'sea' of delocalised electrons 4. held together by strong electrostatic forces of attraction that require a lot of energy to overcome, resulting in a relatively high melting point. Lithium has a higher density than fluorine because lithium exists as a solid while fluorine exists as a gas at room temperature. [1]			