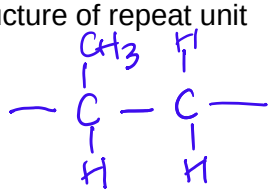
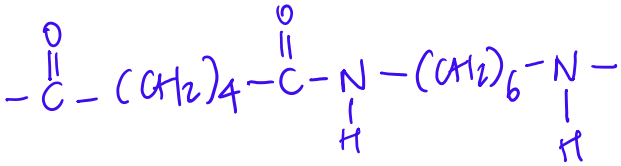
2024 Sec 4 Preliminary Examination Mark Scheme

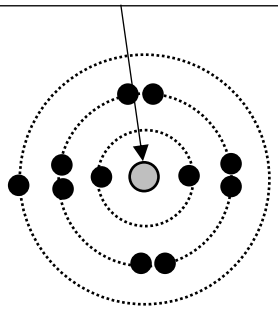
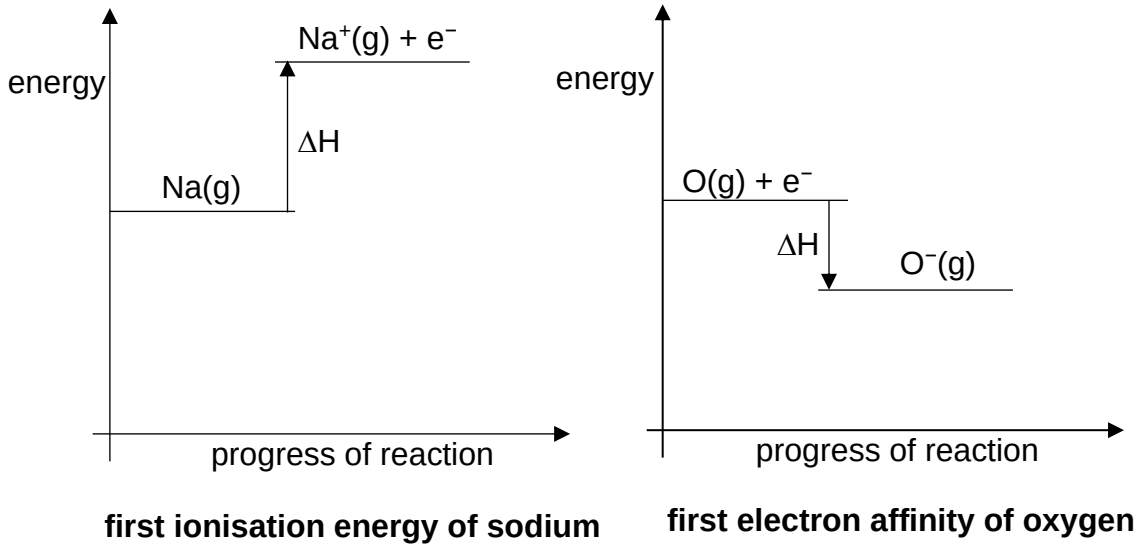
Paper 1

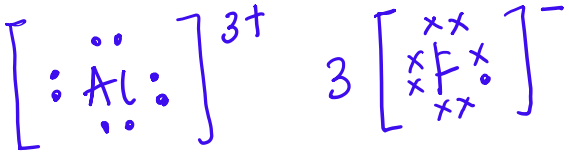
1	2	3	4	5	6	7	8	9	10
B	A	D	A	B	A	D	B	C	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	A	C	C	D	D	D	D	C	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	C	B	B	B	C	C	D	A	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	A	C	D	B	B	B	D	B	A

Paper 2 Section A

Qn	Answers	Mark	Guidance
1a	**D**	1	R: multiple answers
1b	**B**	1	
1c	**J**	1	
1d	**I**	1	
1e	**H**	1	
2	Polymer **A** Structure of repeat unit  ; Type of reaction : <u>addition</u> ; Polymer **B** Structure of repeat unit  ; Type of reaction : <u>condensation</u> ;	4	R: structure of polymer

Qn	Answers	Mark	Guidance
3a	At lower temperatures, less/slower reaction between nitrogen and oxygen ;	1	OWTTE
3b	More oxygen + less incomplete combustion / more complete combustion ;	1	
3ci	$2CO + 2NO \rightarrow 2CO_2 + N_2$	1	
3cii	catalysts provide an alternative reaction pathway with lower activation energy ; greater proportion of molecules with energy greater than or equal to activation energy ; greater frequency of effective collisions ;	3	 A: number & particles
4ai	filter out excess solid / CuO / to obtain filtrate ; heat filtrate to saturation + leave to cool (for crystals to form) ; filter out crystals + wash crystals with little cold distilled water + dry between pieces of filter paper ;	3	
4aii	Copper is unreactive / does not react with dilute acids	1	
4bi	$NaOH(aq)$ / $Na_2CO_3(aq)$; $H_2SO_4(aq)$;	2	
4bii	solid Na_2O is soluble in water + not possible to separate excess reagent from Na_2SO_4 (by filtration) ;	1	OWTTE
5ai	Hydrogen / H_2 ; Place a <u>lighted splint</u> at the mouth of test-tube + gas extinguishes a lighted splint with a '<u>pop</u>' sound ;	2	
5aii	Mass of solid increases ; Iron gains oxygen to form iron oxide ;		 OWTTE
5aiii	(order of change in mass) Pb, Mg, Fe ; Pb does not react with steam + no change in mass ; 1 mole of Mg gains 16 g while 1 mole of Fe gains 21.3 g ;	3	 OWTTE R: no mention of numbers

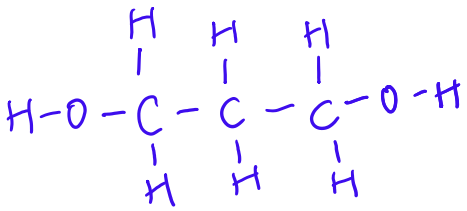
Qn	Answers	Mark	Guidance
5b	Iron is more reactive than copper ; Iron loses electrons / oxidises more readily + provides <u>sacrificial protection</u> to copper ;	2	ORA
6ai	**Sodium** nucleus contains <u>11 protons + 12 neutrons</u> 	1	A: crosses to represent electrons
6aii	The electron removed for ΔH_2 is from a shell which is closer to the nucleus ;	1	R: Na attained noble gas electronic configuration
6b	Reactivity increases + melting point decreases down Group 1 ;	1	
6c	Energy is absorbed to overcome repulsion between like charges / negatively-charged ions and electrons ;	1	
6d	 **first ionisation energy of sodium** **first electron affinity of oxygen** correct diagram for first ionisation energy of sodium – 1 m correct diagram for first electron affinity of oxygen – 1 m labels – 1 m (I: E_a)		

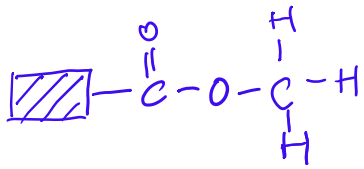
Qn	Answers	Mark	Guidance
7a	Mobile electrons in graphite acts as charge carriers + mobile ions in dilute aqueous sodium chloride act as charge carriers ; Graphite electrodes remain chemically unchanged + water (in dilute aqueous sodium chloride) decomposes (to form hydrogen and oxygen gas) ;	2	A: H^+ and OH^- ions selectively discharged A: chemically changed
7bi	(gas collected in test-tube Y) oxygen / O_2 + (gas collected in test-tube Z) hydrogen / H_2 ;	1	
7bii	(anode / positive electrode) $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$; (cathode / negative electrode) $2H^+(aq) + 2e^- \rightarrow H_2(g)$; Number of moles of electrons lost at anode is the same as the number of moles of electrons gained at the cathode + 2 moles of H_2 is produced with 1 mole of O_2 ; same amount of gas occupies the same volume at the same temperature and pressure (and so, volume ratio is the same as mole ratio) ;	4	OWTTE A: balanced overall equation A: for every 4 moles of electrons transferred
7ci	(gas collected in test-tube W) chlorine / Cl_2 + (gas collected in test-tube X) hydrogen / H_2 ;	1	
7cii	1:1	1	
7d	(colour in beaker 1) violet / purple + (colour in beaker 2) green ; In beaker 1, H^+ and Cl^- ions are selectively discharged (at the cathode and anode respectively) + leaving behind alkaline NaOH solution ; In beaker 2, H^+ and OH^- ions are selectively discharged (at the cathode and anode respectively) + leaving behind a (more concentrated) solution of neutral NaCl ;	3	A: blue A: comparison of concentration of H^+ and OH^- ions
8ai	 • Correct arrangement of electrons for Al^{3+} & '3+' charge • Correct arrangement of electrons for F^- & '-' charge • Charges balanced	2	

Qn	Answers	Mark	Guidance
	All 3 correct – 2 m 1 – 2 correct – 1 m		
8aii	(any 3) • Compounds formed between metals and non-metals are usually ionic (so, they have high melting points and conduct electricity when molten) ; • Aluminium chloride has a simple molecular structure • Less energy is needed to overcome weak intermolecular forces of attraction (resulting in low melting points) • Exists as (electrically neutral) molecules when molten / no mobile charge carriers when molten (resulting in poor electrical conductivity) OR • Compounds formed between metals and non-metals are usually ionic (so, they have high melting points and conduct electricity when molten) ; • Aluminium chloride should have a giant ionic structure ; • More energy is needed to overcome strong electrostatic forces of attraction between (oppositely-charged) ions (resulting in high melting points but melting point of aluminium chloride is low) • Ionic compounds conduct electricity when molten due to mobile ions (but aluminium chloride is a poor electrical conductor when molten) *Minus 1 mark if student states that aluminium chloride is an ionic compound or has a giant ionic structure*	3	
8bi	Beryllium oxide is amphoteric + magnesium oxide is basic	1	A: reacts with acids & alkalis + reacts with acids
8bii	(any 2) • High melting/boiling point • Semi-conductor / non-conductor of electricity • Insoluble in water / organic solvents • Brittle / Hard	1	R: High density
9ai	Sulfur is oxidised as oxidation state of sulfur increases from +2 in $S_2O_3^{2-}$ to +2.5 in $S_4O_6^{2-}$; Iodine is reduced as oxidation state of iodine decreases from 0 in I_2 to -1 in I^- ;	2	

Qn	Answers	Mark	Guidance
9aii	No. of moles of $S_2O_3^{2-}$ = 24.70 × 10^{-3} × 0.100 = 2.47 × 10^{-3} mol/dm^3 ; No. of moles of HC*l*O = no. of moles of I_2 = 2.47 × 10^{-3} ÷ 2 = 1.24 × 10^{-3} mol ;	2	Allow ECF
9b	(Yes) % C*l* in NaC*l*O = $\frac{35.5}{74.5}$ ×100 = 47.7 % % C*l* in Ca(C*l*O)$_2$ = $\frac{71}{143}$ ×100 = 49.7 % Cl_2 contains 100% chlorine 2 correct calculations + statement – 2m Any one correct calculation – 1m	2	
9ci	(any one) • Different precisions/significant figures • Different volumes of water used	1	
9cii	Mass of chlorine = 2.86 × 177 × 10^{-3} = 0.50622 g ; Solubility = 0.50622 ÷ 71 ÷ 100 × 10^{-3} = 0.0713 mol/dm^3 ;	2	Allow ECF
9ciii	(any one) • higher solubility of chlorine + less harmful chlorine (gas) released (OWTTE) • lower water evaporation + less harmful chlorine (gas) released (OWTTE) • reduces energy consumption/less energy needed + less crude oil / fossil fuels used • less CO_2 produced from burning fuels to heat the pool + which causes global warming		
9di	NH_3(aq) + 2HOC*l*(aq) → NHCl_2(aq) + 2H_2O(l) ;	1	State symbols not required
9dii	(any one) • pH > 5.5 / 6 or pH between 5.5 / 6 to 8 ; □ • low concentration of Cl_2/HOC*l*/NH_3 ;	1	A: ensure swimmers shower before entering the pool R: High pH

Paper 2 Section B

Qn	Answers	Mark	Guidance
10a	Both acids ionise <u>in water / aqueous solution</u> to <u>form H^+ ions</u> / are <u>dibasic</u> acids ;	1	
10b	<u>Difference:</u> pH of malonic acid is higher than that of sulfuric acid / ORA malonic acid reacts slower with sodium carbonate *Both differences – 1m* <u>explanation:</u> malonic acid is a weak acid which ionises partially in water + sulfuric acid is a strong acid which ionises completely in water ; malonic acid has a lower concentration of H^+ ions compared to sulfuric acid (at any point in time) ; <u>similarity:</u> both acids produce the same volume of CO_2 gas ; <u>explanation:</u> same amount of H^+ ions that react with sodium carbonate ;	5	
10ci	Oxidation ;	1	
10cii		1	
10ciii	alcohol	1	A: diol
10civ	No + different molecular formula + $C_3H_4O_4$ (malonic acid) vs $C_3H_4O_2$ (compound B) ;	1	A: compare no. of O atoms
11ai	Yes + same molecular formula of C_6H_{12} + different structural formula ;	1	A: structure A: same no. of C and H atoms
11aii	Similarity: Both undergo complete combustion to give CO_2 and H_2O ; $C_6H_{12} + 9O_2 \rightarrow 6CO_2 + 6H_2O$;	5	

Qn	Answers	Mark	Guidance
	Difference: Hexene undergoes addition reaction with aqueous bromine + cyclohexane does not react ; Observations: hexene decolourises orange/red-brown aqueous bromine + no observable change for cyclohexane ; $C_6H_{12} + Br_2 \rightarrow C_6H_{12}Br_2$;		A: aqueous Br_2 remains orange / red-brown R: compare sooty flame R: orange-brown
11bi	Ester	1	
11bii		1	
11biii	Plants used to make vegetable oil for biofuel can be regrown / / replanted / replaced (renewable) OR Crude oil is finite / a limited resource ; CO_2 is absorbed during photosynthesis which offsets the CO_2 produced when biofuel is burnt (environmentally sustainable) ; OWTTE	2	R: equal / net is zero