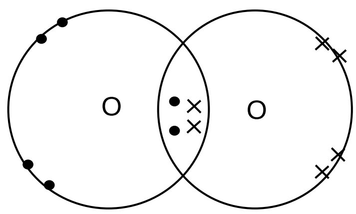
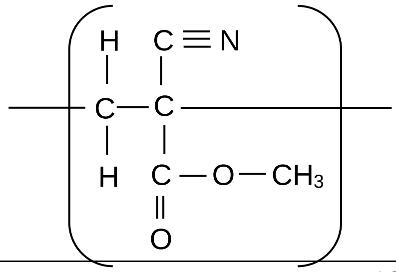
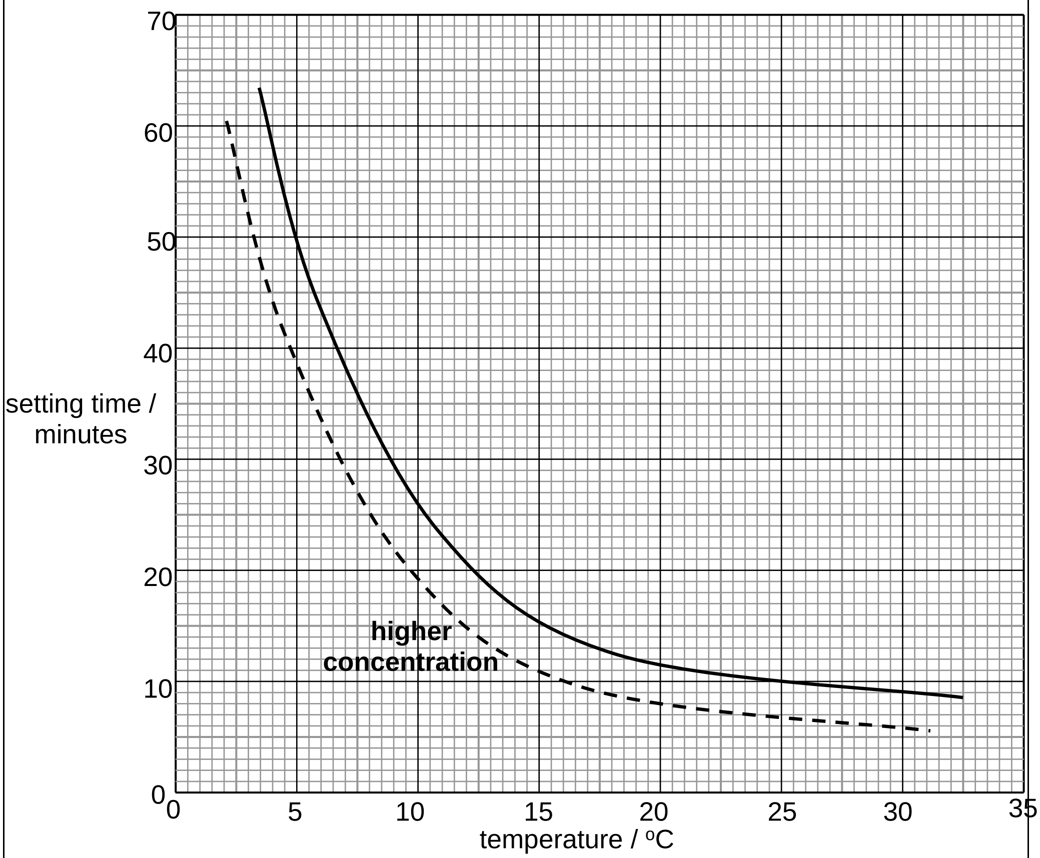
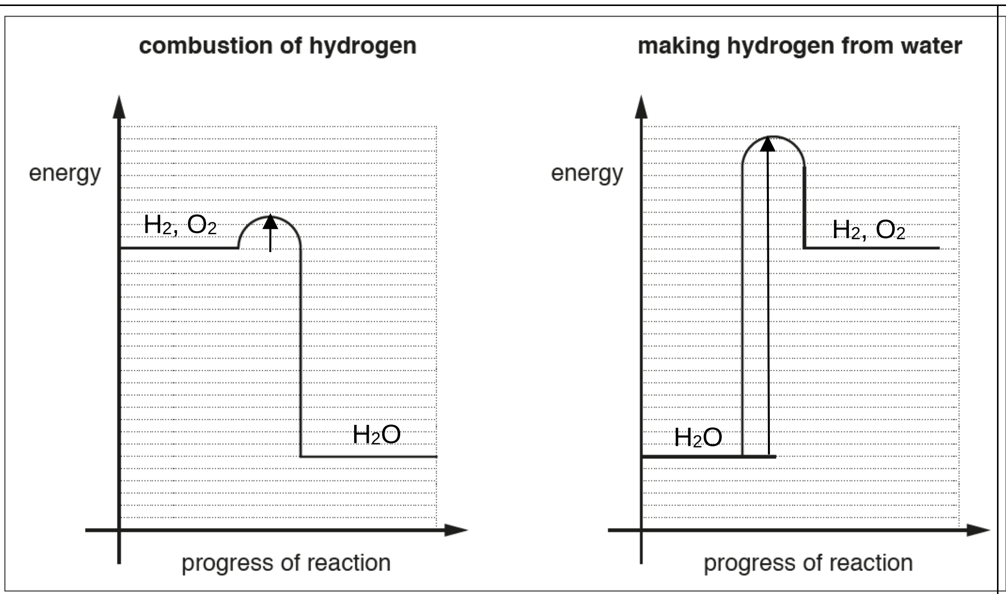
SEC 4E CHEMISTRY 6092

PRELIM 2023 PAPER 2 MARK SCHEME

SECTION A (50 marks)				
A1	**(a)**	**(i)**	O / S / Se	**1**
		(ii)	Cl	**1**
		(iii)	He	**1**
		(iv)	N	**1**
		(v)	C	**1**
	(b)	**(i)**	<table><tr><td></td><td>Xe</td><td>O</td><td>F</td></tr><tr><td>moles (1)</td><td>0.549/131 = 0.00419</td><td>0.134/16 = 0.008375</td><td>0.317/19 = 0.0167</td></tr><tr><td>simplest ratio</td><td>1</td><td>2</td><td>4</td></tr></table> XeO_2F_4 (1)	**2**
		(ii)	Relative molecular mass M_r / relative formula mass / molar mass	**1**
	(c)		 ALLOW same symbol for both atoms correct shared electron pairs (1) rest of molecule correct (1)	**2**
	(d)		any one from: <u>physical property</u> oxide of aluminium has a high melting/boiling point but oxide of sulfur has a low melting/boiling point oxide of aluminium conducts electricity when melted but oxide of sulfur does not conduct in any state oxide of aluminium is insoluble in water but oxide of sulfur is soluble in water any one from: <u>chemical property</u> oxide of aluminium is amphoteric but oxide of sulfur is acidic ALLOW oxide of amphoteric but oxide of sulfur is not oxide of aluminium can react with acids and alkalis but oxide of sulfur can only react with alkalis ALLOW oxide of aluminium is ionic but oxide of sulfur is covalent	**2**
			Total	**12**
A2	**(a)**	**(i)**	Ar of Fe (56) is smaller than Ar of Zn (65) (1) Hence there are more moles in 1.5 g of Fe than Zn(1)	**2**
		(ii)	metal that gives a steeper slope / larger gradient / more gas produced per unit time / shorter reaction time for a fixed volume of gas (1)	**1**
		(iii)	Any three from: For iron, green precipitate formed (1), insoluble in excess (1) For zinc, white precipitate formed (1), soluble in excess (1) / giving colourless solution	**3**
	(b)	**(i)**	$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$ balanced eqn (1) state symbols (1)	**2**
		(ii)	The concentration decreases	**1**
		(iii)	There is no change in the concentration	**1**
			Total	**10**

A3	**(a)**	**(i)**	addition polymerisation (NOT: additional polymerisation)	**1**
		(ii)		**1**
		(iii)	Percentage by mass of carbon $= \frac{12 \times 5}{111} \times 100\%$ (1) $= 54.1\%$ (1)	**2**
	(b)	**(i)**	25±1 ^oC	**1**
		(ii)	As the temperature increases, the <u>number of monomer particles having activation energy increases</u> (1) As the particles have <u>more energy</u>, (ACCEPT: move faster) (1) Hence the number of <u>effective collisions</u> (per unit time) <u>increases</u> (1)	**3**
		(iii)		**1**
			Total	**9**

A4	**(a)**	**(i)**	What are the positions of the four metals in the reactivity series? □	**1**
		(ii)	D	**1**
		(iii)	Ionic equation of this form: $X + Y^{2+} \rightarrow X^{2+} + Y$ e.g. $Sn + Cu^{2+} \rightarrow Sn^{2+} + Cu$	**1**
		(iv)	any of following for (1) copper in copper(II) sulfate tin in tin(II) sulfate iron in iron(II) sulfate zinc in zinc sulfate metal in its own sulfate solution metals in their own sulfate solutions metals do not displace themselves from solution / metals do not react with their own sulfate (1) *Accept any reasonable explanation.* *No credit for answers with example given but without explanation*	**2**
	(b)	**(i)**	either of following: the reaction is (extremely) exothermic the reaction temperature is high enough to melt iron reaction temperature is above melting point of iron the melting point of iron is below 2500 °C	**1**
		(ii)	moles of Fe_2O_3 = 1000 / 160 = 6.25 (1) moles of Fe produced = 12.5 (mole ratio is 1:2) mass of Fe produced = 12.5 × 56 = 700 g (1) OR 112/160 ×1000 (1) = 700 g (1)	**2**
		(iii)	Aluminium loses electrons / transfers its electrons to iron	**1**
			Total	**9**

A5	**(a)**	**(i)** **(ii)**		**3**
		(iii)	Reasons for great fuel: (any two) Combustion of hydrogen is (highly) exothermic / gives out (lots of) energy Combustion of hydrogen has a <u>small</u> activation energy Combustion of hydrogen forms <u>only</u> water (so pollution free) - ALLOW Reasons for sustainability: (any two) Making hydrogen is endothermic/takes in energy Making hydrogen has a <u>large</u> activation energy Energy given out when hydrogen burns is the same as the energy taken in when it forms. Electrolysis requires energy Fossil fuels are used to supply energy for electrolysis High activation energy for making hydrogen means <u>more</u> fossil fuel needed	**4**
	(b)		moles of C_2H_5OH = 0.005 (1) energy released = (moles of C_2H_5OH × 1350) (1) = 6.75 kJ (1)	**3**
			Total	**10**

SECTION B (30 marks)				
B6	**(a)**		$2H^+ + 2e^- \rightarrow H_2$	**1**
	(b)		The sodium hydroxide formed during electrolysis reacts with chlorine to form sodium hypochlorite <u>or</u> There is unwanted side reaction between sodium hydroxide and chlorine *Accept difficult to carry out continuous separation of chlorine and sodium hydroxide.*	**1**
	(c)		Mass of sodium hydroxide in 1000 dm^3 of output solution = 12 × 1000 = 12 000 g (1) $\frac{12000}{V} = 50$ g/dm$^3 \Rightarrow V = \frac{12000}{50} = 240$ dm^3 (1) Volume of water that needed to be evaporated = 1000 – 240 = 760 dm^3 (1)	**3**
	(d)		The chloride ions cannot pass through the membrane ALLOW: The chloride ions or anions cannot enter the cathode compartment	**1**
	(e)		To remove SO_4^{2-}, add barium chloride / calcium chloride (**NOT**: lead chloride) To remove Mg^{2+}, add sodium carbonate / sodium hydroxide Remove precipitates by filtration (ALLOW: sedimentation)	**1** **1** **1**
	(f)		For every mole Cl_2 produced, 2 moles of NaOH are produced. Mass of Cl_2 = 1 × 71 = 71 g Mass of NaOH = 2 × 40 = 80 g (1) mass ratio = $\frac{80\text{ g}}{71\text{g}}$ = 1.13 (1) <u>or</u> For every 1 g of Cl_2 produced, moles of Cl_2 = $\frac{1}{71}$ = 0.01408 (1) expected moles of NaOH = $2 \times \frac{1}{71}$ = 0.02817 (mole ratio is 1:2) expected mass of NaOH = 40 × $\frac{2}{71}$ = 1.13 g mass ratio = $\frac{1.13\text{ g}}{1\text{g}}$ = 1.13 (1)	**2**
	(g)		$2Cl^- + 2H_2O \rightarrow H_2 + Cl_2 + 2OH^-$	**1**
			Total	**12**
B7	**(a)**		Due to the attraction between oppositely-charged ions / positive and negative ions ALLOW: electrostatic forces of attraction between ions	**1**
	(b)		attraction between (a lattice of) positive ions / cations (1) and delocalised / 'sea' of electrons (1)	**2**
	(c)		<u>giant covalent</u> consists of only atoms / no ions (1) no mobile / moving / free-moving / delocalised electrons (1) <u>giant ionic</u> when solid, ions cannot move (1) when liquid, ions can move (1) <u>giant metallic</u> (both solid and liquid) metals have mobile / moving / free-moving / delocalised electrons (1)	**5**
			Total	**8**

B8 (E)	**(a)**	**(i)**	Both have different number of oxygen atoms / different molecular formula	**1**
		(ii)	**EITHER** test: Universal indicator (1) / add a metal carbonate e.g. sodium carbonate (1) cyclobutanol: goes green / does not change colour / no visible change (1) butanoic acid: goes red / orange or yellow (1) / bubbling of gas (1) **OR** test: heat with named alcohol (1) cyclobutanol: no reaction butanoic acid: gives sweet smelling compound (1) **OR** test: heat with named carboxylic acid (1) cyclobutanol: gives sweet smelling compound butanoic acid: no reaction (1) *Allow adding of potassium manganate(VII).* *cyclobutanol: purple to colourless* *butanoic acid: no visible change*	**2**
	(b)		No. of moles of linoleic acid in 100g = $\frac{100}{280} = 0.3571$ (1) 1 mole of linoleic acid reacts with 2 moles of iodine No. of moles of iodine reacted = $0.3571 \times 2 = 0.7142$ (1) Mass of iodine reacted = $0.7142 \times 254 = 181$ (iodine value) (1)	**3**
	(c)	**(i)**	$C_{18}H_{36}O_2$ iodine value = 0	**2**
		(ii)	linoleic acid: (rapidly) turns aqueous bromine from red-brown to colourless (1) stearic acid: aqueous bromine remains red-brown / no visible change (1)	**2**
			Total	**10**
B8 (O)	**(a)**		energy absorbed in bond breaking / total endothermic change: 436 + 158 = +594 kJ (1) energy released in bond forming / total exothermic change: 2 × 562 = –1124 kJ (1) enthalpy change for reaction = –530 kJ (exo) (1) not necessary to calculate –530, just show that exo change > than endo ALLOW: ECF	**3**
	(b)		HI is a strong acid **AND** HF is a weak acid HI is stronger than HF scores 0	**1**
	(c)	**(i)**	with hydriodic acid – solution turns brown with hydrofluoric acid – no change seen	**1** **1**
		(ii)	with hydriodic acid – yellow precipitate (ppt) seen with hydrochloric acid – white precipitate (ppt) seen	**1** **1**
	(d)		oxidised (1), oxidation state of Li increases from 0 to +1 (1)	**2**
			Total	**10**