SOLUTION TO 5070/21/O/N/19

QUICK ACCESS GRID

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SECTION A: Q1		
	ANSWER	**NOTES**
a	P	P is present in group V of the periodic table and has 5 outer shell electrons. It forms a stable ion by gaining 3 electrons and completing an octet in its outer shell. $P + 3e^{-} \rightarrow P^{3-}$
b	Fe	Haematite – Fe_2O_3 – is an Iron ore.
c	Fe	Fe forms Fe^{3+} ion which gives a red-brown ppt. of $Fe(OH)_3$ with aqueous Ammonia (as well as with aqueous NaOH).
d	Mg	Mg is in the same group as Ca (group II), hence has similar chemical properties.
e	C	C in the form of Graphite can have lubricating properties.

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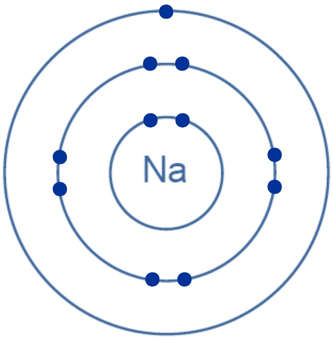
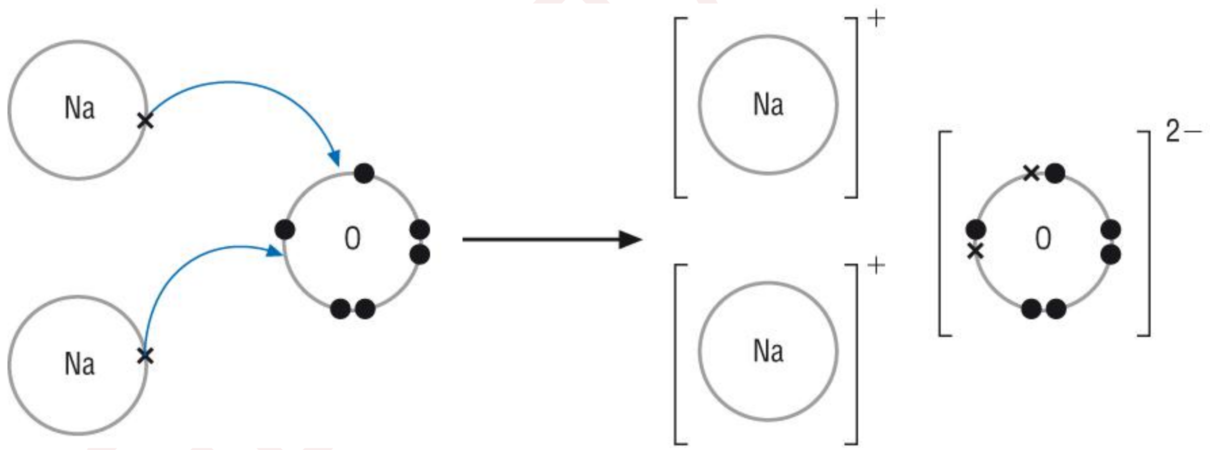
SECTION A: Q2

	ANSWER	NOTES
a	• low melting point / low boiling point • low density • soft	Group I metals are soft metals with low densities and low melting and boiling points. They are soft enough to be cut easily with a knife.
b		
c	V (H_2) = 300 cm^3 = 0.300 dm^3 n (H_2) = $\frac{0.300}{24}$ = 0.0125 **mole ratio** 2 mol of Na : 1 mol of H_2 n (Na) = 0.0125 × 2 = 0.0250 mass of Na = 0.0250 × 23 = **0.575 g**	Volume occupied by 1 mole of gas at room temperature and pressure = 24 dm^3 n = $\frac{V}{24}$ mass = n × Molar mass

SECTION A: Q2		
	ANSWER	**NOTES**
d	Sodium atom loses an electron to form Sodium ion, Na^+. Oxygen atom gains two electrons from two Sodium atoms to form Oxide ion, O^{2-}. Sodium ions and Oxide ions come close due to electrostatic attraction forming ionic bonds. One formula unit of Sodium oxide consists of 2 Sodium ions and 1 oxide ion.	
		
e (i)	high melting point / high boiling point / does not conduct electricity when solid / does conduct electricity when molten / does conduct electricity when in aqueous solution	Sodium chloride is an ionic compound. Ionic compounds generally have high melting and boiling points. They do not conduct electricity in the solid state as the ions are not free to move. They can conduct electricity in molten state / aqueous solution as ions are free to move.

SECTION A: Q2
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	ANSWER	NOTES
e (ii)	**product at anode:** Chlorine (gas) **product at cathode:** Hydrogen (gas)	Sodium is above Hydrogen on the reactivity series of metals. H^+ ions are therefore discharged at the cathode in preference to Na^+ ions. Since concentrated aqueous Sodium chloride is being used, chloride ions are discharged at the anode in preference to hydroxide ions.
(iii)	**Test:** add nitric acid followed by aqueous silver nitrate **Result:** white precipitate formed indicating presence of Chloride ions	Chloride ions react with Silver ions to form a white precipitate of Silver chloride.

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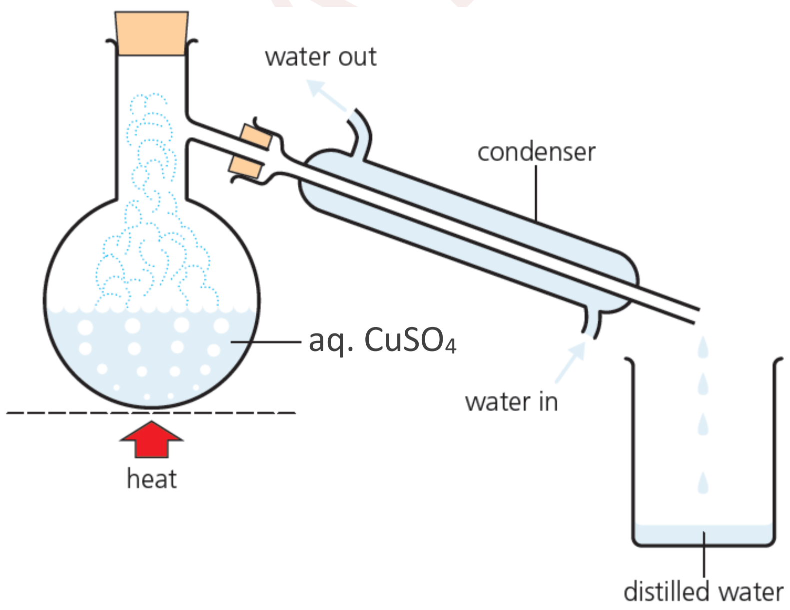
<table>
<tr><th colspan="3">SECTION A: Q3</th></tr>
<tr><th></th><th>ANSWER</th><th>NOTES</th></tr>
<tr><td>a</td><td>The boiling point of water is different from the boiling point of aqueous Copper(II) sulfate, hence distillation can be used for separation.

The solution is heated in a distillation flask connected to a water condensor. Water from the solution starts evaporating.

The vapours cool upon passing through the condensor. Liquid water (pure) is collected in a receiving flask.

Copper(II) sulfate remains behind as the residue in the distillation flask.</td><td>The boiling point of aqueous Copper(II) sulfate is greater than the boiling point of water.</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>b</td><td>Filtration</td><td>Excess CuO is insoluble in the reaction mixture, hence can be removed by filtration.</td></tr>
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SECTION A: Q3

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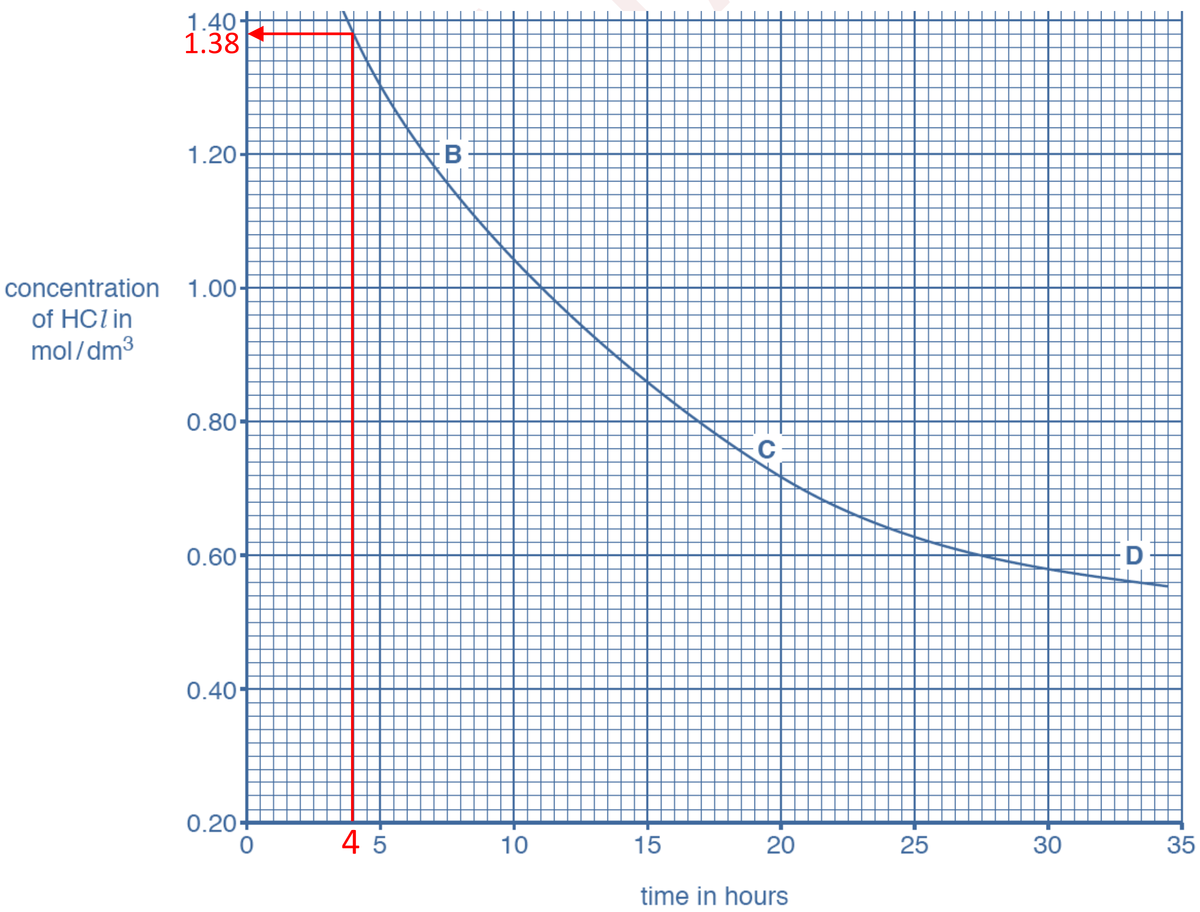
	ANSWER	NOTES
c	(see table below)	

	Cu	**Cs**	**Cl**
mass/100 g	21.09	43.82	35.09
A_r	64	133	35.5
n	$\frac{21.09}{64}$ = 0.33	$\frac{43.82}{133}$ = 0.33	$\frac{35.09}{35.5}$ = 0.99
Mole ratio	$\frac{0.33}{0.33}$ = 1	$\frac{0.33}{0.33}$ = 1	$\frac{0.99}{0.33}$ = 3
Empirical formula	**$CuCsCl_3$**		

SECTION A: Q4

	ANSWER	NOTES
a	Experimental technique: titration The concentration of HCl in the samples withdrawn from the reaction mixture every hour can be determined by titrating the samples against aq. NaOH of known concentration and a suitable indicator like phenolphthalein. A known volume of sample needs to be titrated against aq. NaOH till it turns pink (from colourless). The titre value can be used to calculate the concentration of HCl in the sample.	
b (i)	1.38 mol / dm^3	
		

SECTION A: Q4
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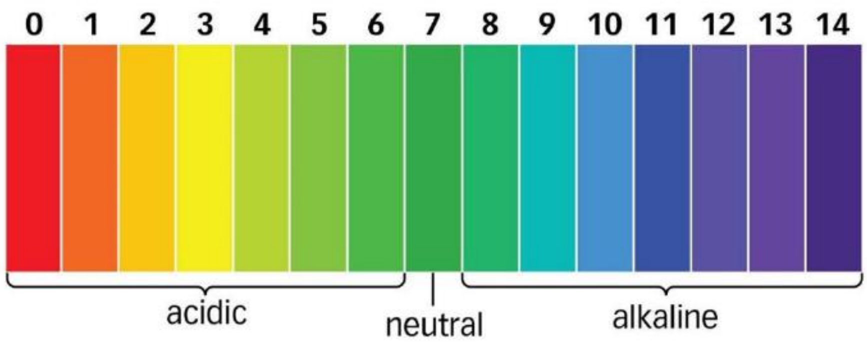
	ANSWER	NOTES
b (ii)	The rate of reaction is fastest at point A on the graph. The gradient of the curve is greatest at A indicating fastest reaction.	Gradient of graph at a given point = rate of reaction at that point
c	The rate of a reaction decreases when the temperature is decreased. At a lower temperature, the reacting particles lose energy, start moving slower and collide less often. The collision rate decreases. The proportion of reacting particles that collide with an energy ≤ activation energy also decreases.	Collision rate = number of collisions between reacting particles per unit time
d	Universal indicator paper turns red.	Hydrochloric acid is a strong acid (low pH), hence turns Universal indicator red.



	ANSWER	NOTES
e	lead chloride / silver chloride	

SECTION A: Q4
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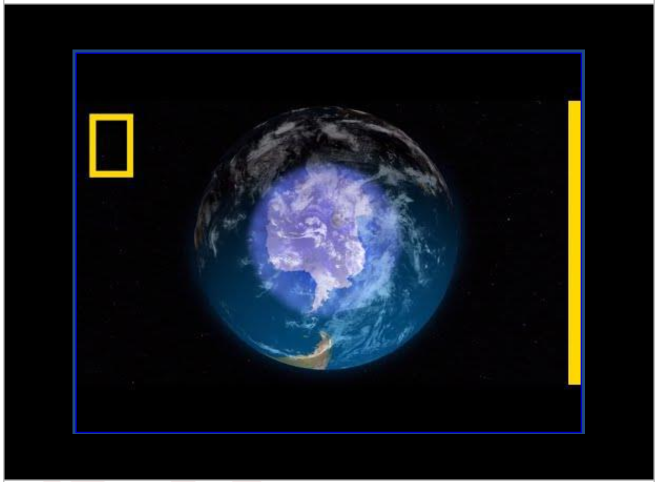
	ANSWER	NOTES
f	**Effect:** CFCs destroy ozone / deplete ozone layer **Explanation:** More (harmful) UV radiation will get to the Earth's surface. Incidences of skin cancer / eye cataracts increase.	

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SECTION A: Q5		
	ANSWER	**NOTES**
a (i)	boiling point of bromine: 59°C density of liquid chlorine: 2 g / cm^3	**Acceptable range of values:** boiling point of bromine: values from –10 to 150°C density of liquid chlorine: values from 1 to 3
(ii)	black / grey-black / purple-grey / purple-black	The colour darkens down the table. Astatine is therefore most likely to be black (darker than Iodine).
b	Chlorine disinfects the water by killing the bacteria. It makes the water potable.	
c (i)	$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$	$Cl_2 + 2KI \rightarrow 2KCl + I_2$ Ionic equation: $Cl_2 + 2K^+ + 2I^- \rightarrow 2K^+ + 2Cl^- + I_2$ Net ionic equation after eliminating the spectator ions ($2K^+$): $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$
(ii)	Chlorine is more reactive than Iodine, hence no reaction occurs.	A more reactive halogen can displace a less reactive halogen from its halide solution. Iodine is less reactive than Chlorine, hence no displacement reaction occurs.

SECTION A: Q5
(continued from previous page)

	ANSWER	NOTES
d	Relative molecular mass of $NiCl_2$ = 59 + 35.5 × 2 = 130 Mass of water in 238 g of hydrated Nickel(II) chloride = 238 – 130 = 108 g n (H_2O) = $\frac{108}{18}$ = 6 **mole ratio** 1 mol of $NiCl_2$: x mol of H_2O x = 6	Molar mass of water = 18 g

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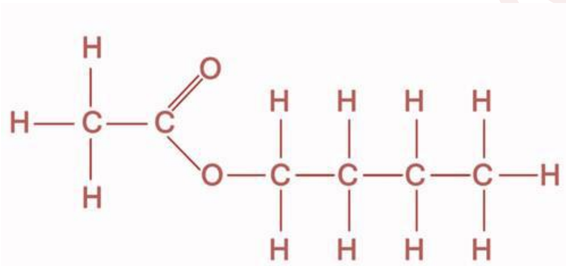
SECTION B: Q6		
	ANSWER	**NOTES**
a	Weak indicates an acid that does not dissociate completely / partial ionisation in water / little dissociation.	
b	**arrangement:** In a solid, the particles are held together closely, often in the form of a lattice. **movement:** The particles can only vibrate about their fixed positions.	Lattice = ordered / regular arrangement
c	gas 130°C > 118°C which is the boiling point of ethanol	
d	V (CH_3COOH) = 224 cm^3 = 0.224 dm^3 n (CH_3COOH) = 0.224 × 0.250 = 0.056 Molar mass of Sodium carbonate = 106 g n (Na_2CO_3) = $\frac{3.18}{106}$ = 0.03 **mole ratio** 1 Na_2CO_3 : 2 CH_3COOH 0.03 Na_2CO_3 : 0.06 CH_3COOH 0.056 < 0.06 Na_2CO_3 is therefore in excess.	1 dm^3 = 1000 cm^3 Molar mass of Sodium carbonate = 23 × 2 + 12 + 3 × 16 = 106 g

SECTION A: Q6
(continued from previous page)

	ANSWER	NOTES
e	$Ca + 2CH_3COOH \rightarrow (CH_3COO)_2Ca + H_2$	
f (i)	Butyl ethanoate	An ester has a two-part name. First part of the name is derived from the alcohol. Alcohol → Alkyl Butanol → Butyl Second part of the name is derived from the acid. carboxylic → carboxylate Ethanoic → ethanoate
(ii)	$CH_3COOC_4H_9$ 	

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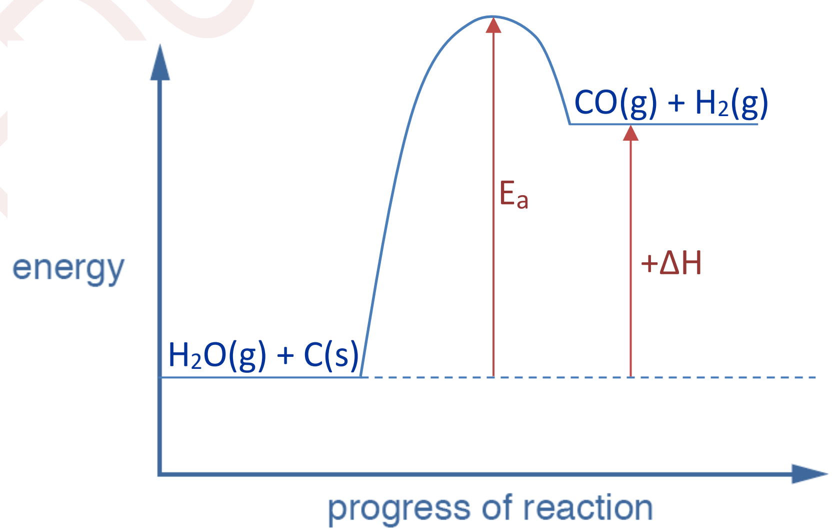
SECTION B: Q7

	ANSWER	NOTES
a (i)	The equilibrium shifts to the right as the forward reaction is exothermic.	Decrease in temperature favours the exothermic reaction. Increase in temperature favours the endothermic reaction.
(ii)	There are equal number of moles of gas on each side of equation.	Increase in pressure favours the side with fewer moles of gas while decrease in pressure favours the side with greater number of gas moles. If the number of gas moles on each side of the equation for the reaction are equal, change in pressure has no effect on the equilibrium position.
b (i)	↓	the enthalpy change for the reaction = +ΔH the activation energy of the reaction = E_a



SECTION B: Q7
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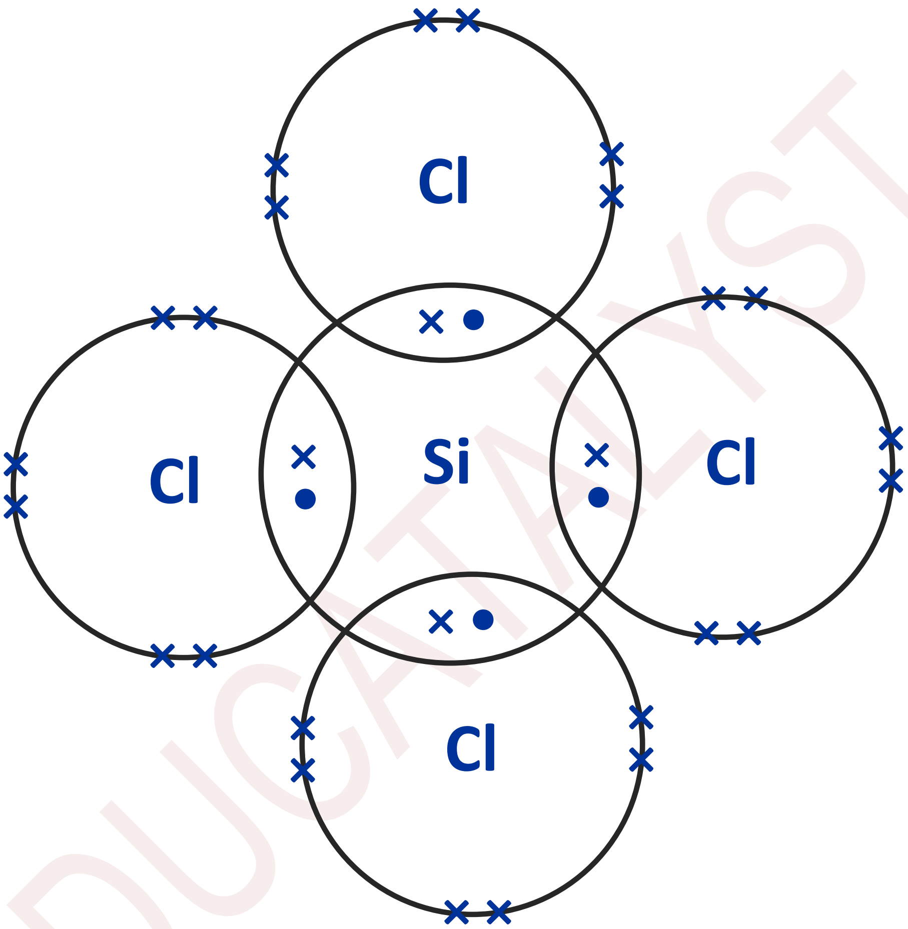
	ANSWER	NOTES
b (ii)	**2**$Fe(OH)_3$ + **3**H_2S → Fe_2S_3 + **6**H_2O	
c (i)	Sulfur present in fossil fuels burns to form sulfur dioxide, an acidic gas. Sulfur dioxide reacts with rainwater / water in atmosphere to form sulphurous acid.	
(ii)	Acid rain corrodes buildings made of carbonate rocks like marble. Acid rain reacts with mortar and can damage metallic structures	Acids can react with carbonates to form the corresponding salts and water and carbon dioxide gas Acids react with metallic structures to form the corresponding salts and hydrogen gas.

SECTION B: Q8		
	ANSWER	**NOTES**
a	number of electrons: 14 number of neutrons: 16 number of protons: 14	$^{30}_{14}Si$ 30 → Nucleon number 14 → Proton number In an atom, number of protons = number of electrons Number of neutrons = nucleon number – proton number
b	$3Si + 2N_2 \rightarrow Si_3N_4$	
c (i)	1. Both have giant covalent lattice structures. 2. Both structures are tetrahedral.	
(ii)	The atoms in Silicon dioxide are held together by an extensive network of strong covalent bonds. A large amount of energy is required to break many of these bonds in order to melt the solid, hence high melting point.	
d	$SiO_2C_4H_{12}$	Simply count the number of atoms of each type to deduce the molecular formula.

SECTION B: Q8 (continued from previous page)		
	ANSWER	**NOTES**
e	↓	
		

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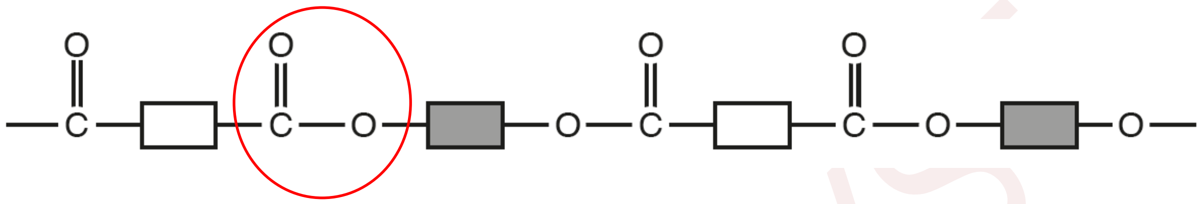
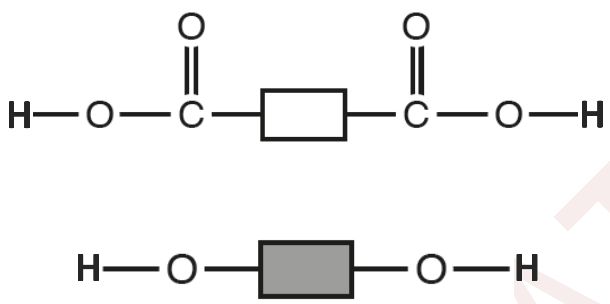
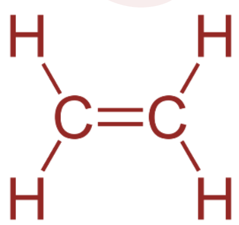
SECTION B: Q9

	ANSWER	NOTES
a	A condensation reaction is one in which two molecules combine and a small molecule, usually water, is eliminated.	
b (i)	↓ 	
(ii)		
(ii)	Terylene is used for manufacture of clothing / synthetic fabrics.	
c	Threonine has three different functional groups. Amide links can form between NH_2 and COOH. Ester link can form between OH and COOH.	
d (i)		

SECTION B: Q9

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	ANSWER	NOTES
d (ii)	Non-biodegradable cannot be broken down by organisms. **OR** It cannot be broken by down biological means. **OR** It cannot be decomposed by bacteria / cannot be decayed by fungi.	
(iii)	Non-biodegradable plastics get stuck in gullets of birds / get stuck in gills of fish / blocks drains / litter / burning causes toxic gases to be emitted / burning causes greenhouse gas emissions	

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