Section A

Answer **all** the questions in this section in the spaces provided.

1 Aqueous hydrogen peroxide, H_2O_2, slowly forms water and oxygen at room temperature and pressure, r.t.p. This rate of reaction is increased by the addition of a small amount of solid manganese(IV) oxide.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

(a) **(i)** Define the term, *rate of reaction*. [1]

The rate of a reaction is defined as the **change of amount or concentration** of a reactant or product **per unit time**.

key word: change of concentration & per unit time

(ii) State the role of manganese(IV) oxide and explain the reason. [2]

It is a heterogeneous catalyst as it is a catalyst which is in different phase as the reactant, aq H_2O_2.

note: different phase ≠ different state (example: organic vs aqueous)

(iii) State the test for oxygen gas. [1]

The test is to relight a glowing splint.

rekindle = relight = reignite

glowing splint ≠ burning splint

(iv) State the effect on the mass of oxygen gas produced if the mass of manganese(IV) oxide is increased. [1]

No effect

A catalyst only speeds up the rate of reaction of the oxygen produced but it does not increase the mass of oxygen gas produced.

(b) A student investigates the rate of formation of oxygen gas when manganese(IV) oxide is added to aqueous hydrogen peroxide.
The volume of oxygen gas formed is measured at regular time intervals at r.t.p.
The results are plotted onto the graph in Fig. 1.1.

(i) State how the graph in Fig. 1.1 shows the rate of reaction at time t_2, is lower than at time t_1. [1]

The gradient is gentler OR lower OR less steep at t_2 compared to t_1.

(ii) Explain, using collision theory, why the rate of reaction at time t_2 is lower than at time t_1. [2]

- When **concentration** of the H_2O_2 **decreases**, the number of molecules **per unit volume** having **energy ≥ E_a** decreases.

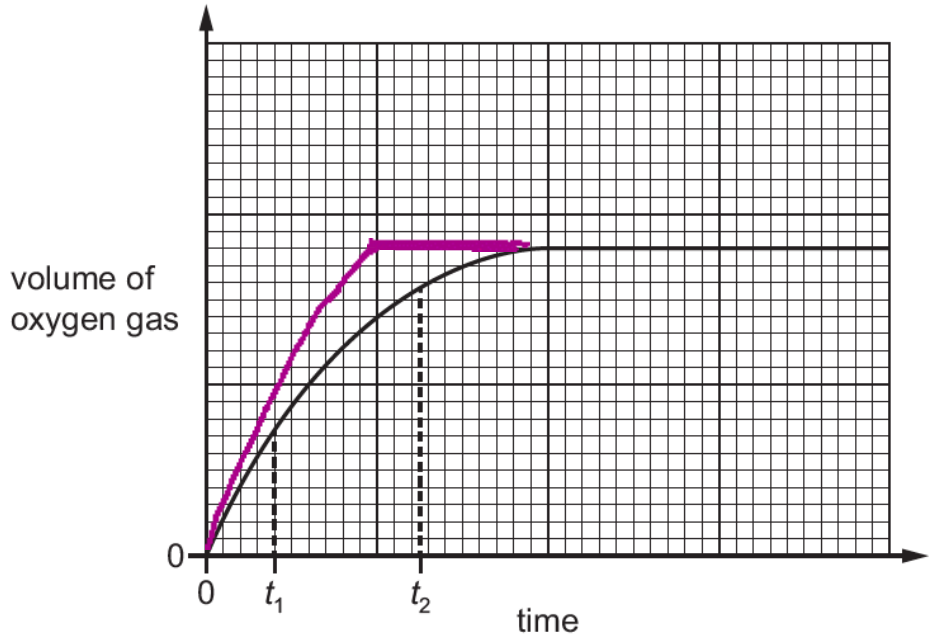
There will be greater surface area on the catalyst for the adsorption of the reactant molecules.

- This leads to an **decrease** in the **frequency of effective collisions** between reactant particles.

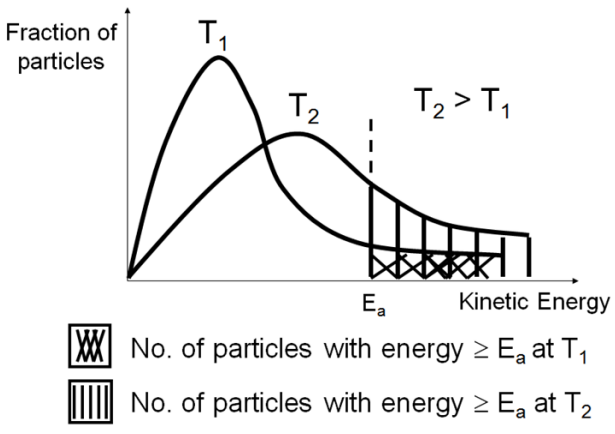
(iii) On Fig. 1.1, sketch the graph obtained when the experiment is repeated using aqueous hydrogen peroxide at a higher temperature. All other conditions remain the same. [1]

steeper curve which does not cross original curve and levels off before the original curve and finishes at same volume

initial gradient should be steeper to show that rate is faster at higher temperature.
maximum volume of oxygen gas produced should be the same but the time taken to reach the maximum volume should be shorter.

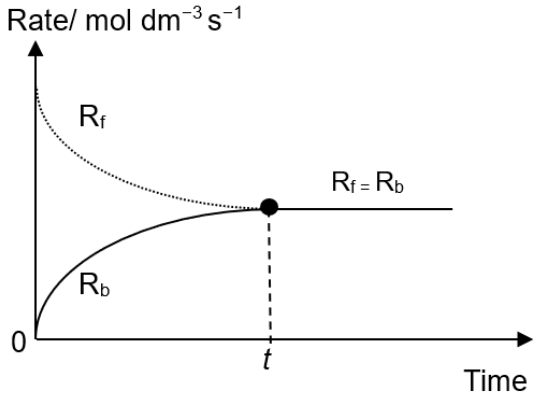


(c) The experiment is repeated at an increased temperature. All other conditions stay the same.
Draw labelled Boltzmann distribution curve(s) to explain why the rate of reaction increases at a higher temperature. [3]

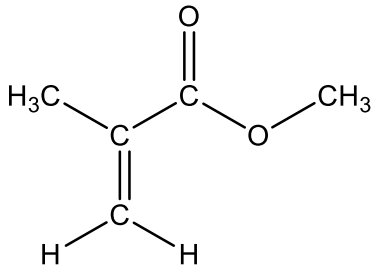


		• When temperature increases, there is an **increase** in the number of particles with kinetic energy ε E_a (larger shaded area under the curve at T_2 than T_1). • This leads to an **increase** in the **frequency of effective collisions** between reactant particles. Hence the rate of reaction increases**.**		
	(d)	Manganese(IV) oxide is added to 20 cm^3 of aqueous hydrogen peroxide. The total volume of oxygen gas produced is 72 cm^3 at r.t.p. $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$		
		(i)	Calculate the number of moles of hydrogen peroxide that reacted.	[1]
			Amt of O_2 = 72 / 24000 = 0.003 Amt of H_2O_2 = 0.003 x 2 = **<u>0.00600</u>** mol Some students wrongly assume that H_2O_2 is a gas. r.t.p. 1 mol of **gas** occupies 24,000 cm^3	
		(ii)	Calculate the concentration of aqueous hydrogen peroxide in g/ dm^3.	[1]
			$[H_2O_2]$ = 0.006 x 1000 / 20 = 0.3 mol/ dm^3 $[H_2O_2]$ = 34 x 0.3 = **<u>10.2</u>** g/ dm^3	
				[Total: 14]

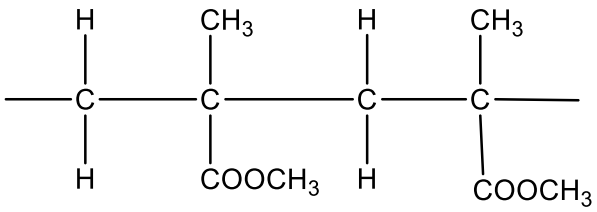
2	Methane reacts with steam to produce hydrogen gas. equation 2.1 $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$ ΔH = + 200 kJ mol^{-1} The reaction takes place at 1000 °C and 100 kPa pressure.			
	(a)	The reaction is reversible and reaches dynamic equilibrium in a closed system.		
		(i)	State two features of a dynamic equilibrium.	[2]
			The rate of forward reaction is equal to the rate of the backward reaction. The concentrations of reactants and products remain constant over time. There is no net change in the concentration of reactants and products over time even though the forward and backward reaction is still ongoing.	
		(ii)	Sketch a labelled graph to show how the **rates** of the forward and reverse reactions change from the start of the reaction to the time the reaction reaches equilibrium.	[2]

			 the graphs meet at *t* when the reaction reaches dynamic equilibrium • R_f decreases with time since [A] and [B] decreases • R_b increases with time since [C] and [D] increases
	(b)	State and explain, the effect on the amount of hydrogen when:	
		(i)	the pressure is increased [2]
			When the pressure is increased, POE will shift to the LHS as there are **fewer gaseous molecules** on the LHS. Amount of hydrogen **decreases**. Students are to explain why POE shift to the LHS. Key word: gaseous
		(ii)	the temperature is increased [2]
			When the temperature is increased, POE shifts to the RHS to absorb the excess heat and favour the forward endothermic reaction. Amount of hydrogen increases. Students are to explain why favour endothermic reaction.
	(c)	**(i)**	Write the expression for the equilibrium constant, K_c, for equation 2.1. [1]
			$K_c = \frac{[CO][H_2]^3}{[CH_4][H_2O]}$
		(ii)	State the effect of decreasing temperature on the equilibrium constant, K_c. [1]
			K_c value will **decrease**. When temperature decreases, POE will shift left and K_c will decrease.
			[Total: 10]

3	Perspex, a transparent thermoplastic, is commonly utilised in sheet form as a lightweight, shatter-resistant substitute for glass. It also finds application as a casting resin, inks, and coatings. Moreover, Perspex, poly(methyl 2-methylpropenoate), is formed by polymerising methyl 2-methylpropenoate, a single monomer.



methyl 2-methylpropenoate

	(a)	**(i)**	Identify **all** the functional groups in methyl 2-methylpropenoate. [1]
			ester and alkene note: ketone is NOT present Students should avoid drawing the functional group C=C but rather name the functional group as alkene.
		(ii)	State the functional group that reacts with bromine in CCl_4 and the expected observation. [1]
			Alkene. Reddish brown bromine decolourises.
	(b)	**(i)**	Describe the term *polymer*. [1]
			A polymer is a **macromolecule** built up from **monomers**, with **average molar mass of at least 1000** or **at least 100 repeat units**.
		(ii)	State the type of polymerisation the monomer undergoes to form Perspex. Draw the structural formula for Perspex, showing two monomer units. [2]
			addition polymerisation 
		(iii)	Describe two characteristics of thermoplastics in terms of their structure and bonding. [2]
			• These are the polymers in which the monomer units are linked to one another to form **long linear chains with no cross-links**. • These linear chains are **closely packed** in space. The close packing results in **high densities**. e.g. high density polyethene, nylon and polyesters are linear polymers. • They have **weak instantaneous dipole-induced dipole interactions or permanent dipole- permanent dipole interactions between the various chains, easily broken by heating**.
		(iv)	State two different physical properties of thermoplastics and thermosets. [2]

Properties	Thermoplastics (linear polymers)	Thermosets/ Thermosetting plastic (cross-linked polymers)
Softening behaviour (response to heat)	Will be softened upon heating due to breaking of weak intermolecular forces between chains. Can be reshaped and reused	Will degrade upon heating due to strong cross–links between chains. Cannot be reshaped or reused
Rigidity	Flexible and soft Weak intermolecular forces between chains can be broken easily allowing molecular movements.	Very rigid, harder and stiffer Strong cross links between chains restrict movement of chains.
Tensile Strength	Low	High

(v) Although Perspex is a thermoplastic, it has only a limited degree of flexibility as its polymer chains do not slide over each other effectively. When it is stressed too far, it tends to crack in a brittle manner. State two reasons to explain this. [2]

Perspex is brittle as the **bulky side groups will hinder the movement** of the polymer chains. Also, the C=O and C-O groups are polar, there will be **permanent dipole-permanent dipole interactions between the side groups** of neighbouring polymer chains, restricting movement.

(vi) State and explain whether Perspex is biodegradable. [2]

Perspex is an addition polymer/ polyalkene and it is **non-biodegradable** as it has **non-polar saturated C-C bonds**.

[Total: 13]

4 (a) Nano tape, also called gecko tape, is a synthetic adhesive tape. This nanomaterial consists of arrays of carbon nanotubes transferred onto a backing material of flexible polymer tape. The structure of nano tape closely mimics that of gecko feet. It works on a variety of surfaces, including glass and sandpaper.

(i) Define the term *nanomaterial*. [1]

A material with **at least one dimension** on the nanoscale (1-100 nm)

(ii) Suggest the structure and interactions of nano tape that closely mimics that of gecko feet. [2]

Nanotape has **nano-structures (synthetic setae) that possess high surface area to volume ratio.**
The adhesion is due to weak **instantaneous dipole- induced dipole interactions** which allows tape to be reused many times as it can be easily peeled off.

	(b)	In March 2017, residents in a small town northwest of Edmonton were surprised by bright pink water flowing from their taps. Upon investigation, it was found that the town's water treatment plant was conducting a filter wash using potassium manganate(VII), $KMnO_4$, which can turn water pink when used in large quantities. $KMnO_4$ is used to remove Mn^{2+} present in water. $KMnO_4$ will oxidise Mn^{2+} to form **only solid** MnO_2 under treatment conditions which can easily be filtered from the water.	
		(i)	Suggest the appearance of solid MnO_2. [1]
			Black solid
		(ii)	With reference to the *Data Booklet*, write down the oxidation and reduction half equations during the treatment of the water. [2]
			[O]: $Mn^{2+} + 2H_2O$ □ $MnO_2 + 4H^+ + 2e^-$ [R]: $MnO_4^- + 4H^+ + 3e^-$ □ $MnO_2 + 2H_2O$ Key phrase: $KMnO_4$ will oxidise Mn^{2+} to form **only solid** MnO_2 Students should use □ and NOT ⇌
		(iii)	Hence, give the overall equation that shows the removal of Mn^{2+} during the treatment of water. [1]
			$3Mn^{2+} + 2H_2O + 2MnO_4^-$ □ $5MnO_2 + 4H^+$ [O]: $Mn^{2+} + 2H_2O$ □ $MnO_2 + 4H^+ + 2e^-$ (x3 throughout) [R]: $MnO_4^- + 4H^+ + 3e^-$ □ $MnO_2 + 2H_2O$ (x2 throughout) Combine [O] and [R] equation above to get the overall equation Concept: electron gain = electron lost
		(iv)	During the treatment of water, the concentration of $KMnO_4$ used is 1 mg dm^{-3}. Calculate the maximum mass of MnO_2 that can be precipitated per cubic metre of water. [3]
			Concentration of $KMnO_4 = \frac{1\times10^{-3}}{158} = 6.329 \times 10^{-6}$ mol dm^{-3} Maximum amount of solid MnO_2 that forms in 1 $dm^3 = \frac{5}{2} \times (6.329 \times 10^{-6})$ $= 1.582 \times 10^{-5}$ mol Mass of MnO_2 formed in 1 $dm^3 = (1.582 \times 10^{-5})(54.9 + 2(16.0))$ $= 1.375 \times 10^{-3}$ g per cubic metre of water = 1 m^3 1 m^3 = 1000 dm^3 Mass of MnO_2 formed per cubic metre of water = $1.375 \times 10^{-3} \times 1000$ = **1.38 g**
			[Total: 10]

5	Respiration within the human body generates carbon dioxide and water as byproducts, which can be combined to produce hydrogen ions. However, the blood contains a

hydrogen carbonate buffer system that helps maintain pH balance by converting carbonic acid into hydrogen carbonate ions and hydrogen ions. The pH of blood is 7.4.

$$H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$$

(a) **(i)** Define an *acidic buffer* solution. [2]

A buffer solution is a solution containing a **large reservoir of weak acid and its conjugate base salt** which resists pH change and **does not show significant changes in pH when small amount of strong acid or strong base are added to it.**

(ii) Identify the acid-conjugate base components in the blood buffer and write an expression for K_c for the blood buffer. [2]

$H_2CO_3(aq)$ and $HCO_3^-(aq)$

$$K_C = \frac{[H^+][HCO_3^-]}{[H_2CO_3]}$$

(iii) Describe what happens when a small amount of strong alkali is added to the buffer solution. Write an equation to explain your answer. [2]

When a small amount of alkali is added, it will be removed by H_2CO_3.
$[OH^-]$ does not change significantly and thus pH of the buffer solution remains almost unchanged.

$OH^- + H_2CO_3 \square HCO_3^- + H_2O$

Full arrow □

(b) Haemoglobin also forms oxyhaemoglobin when it reacts with oxygen. This process requires iron, and individuals deficient in iron, known as anaemic, often experience fatigue and lethargy. Vitamin C facilitates the absorption of iron from the diet, aiding in its incorporation into haemoglobin.

The bone marrow produces around 10,000 million new blood cells daily, with red blood cells having a lifespan of approximately 120 days. Healthy individuals should have about 15 grams of haemoglobin per 100 cm^3 of blood and a red blood cell count of 5 million per cm^3. Iron constitutes approximately 4% of the mass of the haemoglobin molecule.

To combat anaemia, individuals often supplement their diet with iron tablets, typically containing iron(II) sulfate. Each tablet typically contains 200 mg of iron. These iron ions can undergo reactions with potassium manganate(VII) ions, MnO_4^-, for various purposes

$$5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$$

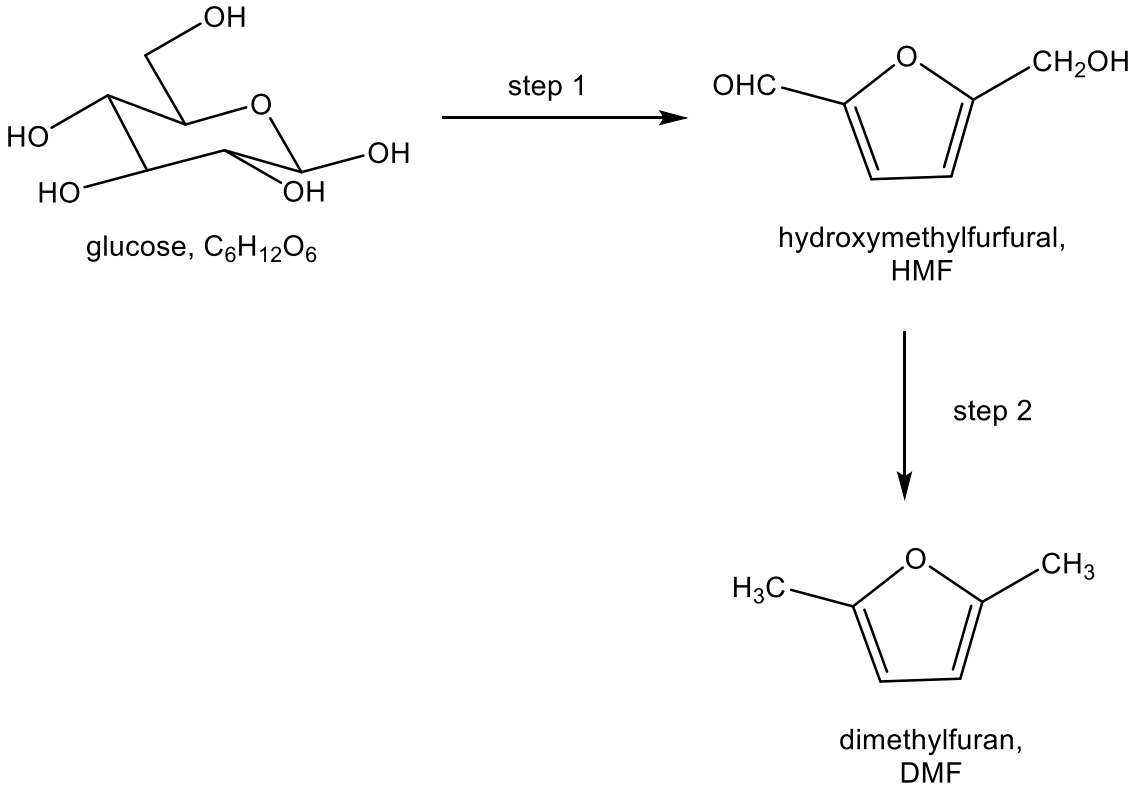
(i) For 100 cm^3 of a healthy individual's blood, calculate
1. the mass of iron that should be present ~~in~~
2. ~~the mass~~ the number of red blood cells that would be present

			Mass of iron present in 100 cm^3 of healthy person's blood = 4/100 x 15 g = 0.600 g [1]
			In 1 cm^3 of blood, there are 5 million red blood cells Thus, in 100 cm^3 of blood, there will be 5 x 100 = 500 million red blood cells.[1]
		(ii)	Calculate the amount of iron, in mol, that needs to be available each day within the bone marrow for the production of new red blood cells. [2]
			Amt of Fe in 100 cm^3 blood = 0.6 / 55.8 = 0.010753 0.010753 mol of Fe can produce 500 million red blood cells in 100 cm^3 blood Given that daily production of red blood cells is 10 000 million, Amount of Fe required daily = 0.0108 /500 x 10 000 = **0.215 mol**
		(iii)	Suggest why a person does **not** need to consume the complete amount of iron each day that was calculated in part **b(iii)**. [1]
			This is because red blood cells that contain iron have a lifespan of 120 days. Students should make reference to the data information given in the question.
	(c)	Calculate the number of iron tablets ~~have been~~ dissolved in a solution that will react with 35.80 cm^3 of 0.020 mol dm^{-3} potassium manganate(VII) solution in a titration. [2]	
		Amt of $KMnO_4$ = $\frac{35.80}{1000} \times 0.020$ = 7.16 x 10^{-4} mol Since 5 Fe^{2+} ≡ MnO_4^- Amt of Fe^{2+} in titration = 7.16 x 10^{-4} x 5 = 3.58 x 10^{-3} mol Amount of Fe in 1 tablet = $\frac{0.200g}{55.8}$ = 3.58 x 10^{-3} mol of Fe Thus, no. of Fe tablets dissolved = $\frac{3.58 \times 10^{-3}}{3.58 \times 10^{-3}}$ = 1	
		[Total: 13]	

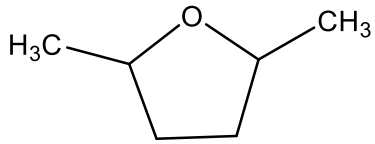
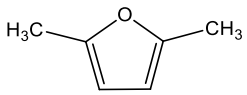
Section B

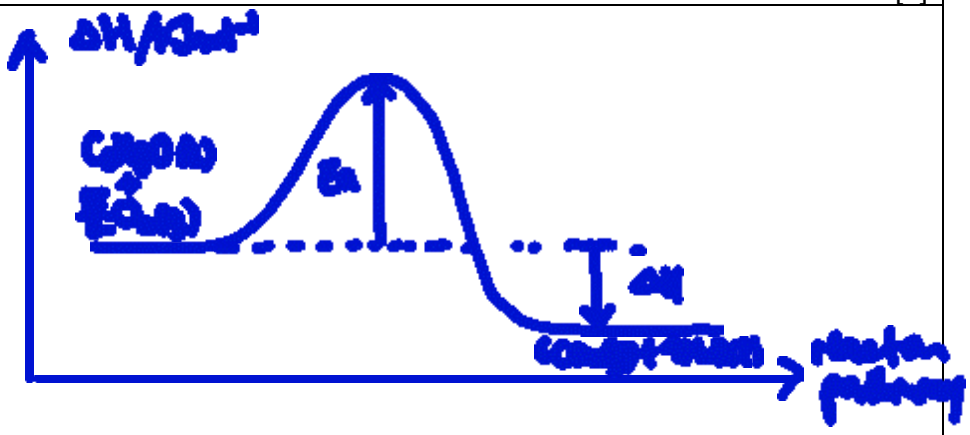
Answer **one** question from this section in the spaces provided.

6	Dimethylfuran, DMF, is a colourless volatile liquid with boiling point 92 °C, which is comparable to that of heptane (98 °C), a component of gasoline. It has a role as a human urinary metabolite, an antifungal agent, a bacterial metabolite, a fumigant and a fuel. It is obtained from glucose in a two-step reaction.



	(a)	**(i)**	Suggest the molecular formula of the compounds HMF and DMF.	[1]
			HMF: $C_6H_6O_3$	
		(ii)	Suggest the types of reaction for step 1 and 2.	[2]
			step 1: elimination step 2: reduction	
		(iii)	State and explain whether DMF is polar.	[2]
			DMF is polar. It has a net dipole moment as it has two C-O polar bonds which do not cancel out each other's dipole moment. By stating that there is difference in electronegativity between C and O is not enough to explain why DMF is polar. Students have to recognise that the polar bonds present in the molecule results in dipole moments not able to be cancelled because of the bent shape around O.	
		(iv)	Suggest a chemical test to identify between the compounds HMF and DMF. State the observations for both compounds.	[2]
			Test: $K_2Cr_2O_7$ (aq), H_2SO_4 (aq), heat OR $KMnO_4$ (aq), H_2SO_4 (aq), heat	

			Observation for HMF: $K_2Cr_2O_7$ (aq) turns from orange ($Cr_2O_7^{2-}$) to green (Cr^{3+}). OR $KMnO_4$ solution turns from purple (MnO_4^-) to pale pink (Mn^{2+}) OR the purple solution (MnO_4^-) is decolourised. Observation for DMF: $K_2Cr_2O_7$ (aq) remains orange OR $KMnO_4$ solution remains purple (MnO_4^-). NOTE: $KMnO_4$ is accepted as H1 students do not learn that alkenes can be oxidised by $KMnO_4$. Cannot accept Br_2 liquid as the chemical test because both HMF and DMF have alkene functional groups. Students are to state the colour change (before and after).
		(v)	Draw the product formed when DMF reacts with hydrogen gas and state the type of reaction formed. [2]
			 reduction
	(b)	**(i)**	Define the term *standard enthalpy change of combustion of DMF.* [1]
			Standard enthalpy change of combustion of DMF is the energy evolved when one mole of substance is burnt completely in excess oxygen at 298 K and 1 bar.
		(ii)	Write a balanced equation for the complete combustion of DMF. Use bond energy data from the *Data Booklet* to calculate its enthalpy change of combustion. [3]
			 $(l) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 4H_2O(l)$ ΔH_c $= 3BE(C–C) + 8BE(C–H) + 2BE(C=C) + 2BE(C–O) + \frac{15}{2}BE(O=O) – 12BE(C=O) – 8BE(O–H)$ $= 3(350) + 8(410) + 2(610) + 2(360) + \frac{15}{2}(496) – 12(805) – 8(460)$ $=$ **$-3350\ kJ\ mol^{-1}$** identification of correct bond energy values from Data Booklet ΔH = BE (reactants) – BE (products)
		(iii)	*Use of the Data Booklet is relevant to this question*. A sample of DMF was burned under laboratory conditions in an apparatus that only 80% of the heat evolved is transferred to heating a container of water. The burning of 1.00g of DMF raised the temperature of 200 g of water by 32 K.

			Calculate the experimental enthalpy change of combustion, and comment on the difference between this value and that calculated in **(b)(i)** using bond energies. [4]
			Heat absorbed by water = 200 × 4.18 × 32 = 26752 J Heat released by burning 1.00 g of DMF = 26752 J × $\frac{100}{80}$ = 33440 J Amount of DMF = 1.00 ÷ [6(12.0) + 8(1.0) + 16.0] = 0.0142 mol ΔH_c(DMF) = -33440 ÷ 0.01042 = -3210 kJ mol^{-1} (correct to 3 s.f.) The answer in **(b) (i)** did not account for ΔH_{vap} of DMF as it was liquid DMF that combusted. OR Data Booklet bond energies are average values. Heat absorbed by the water is only 80% of the heat released by burning the 1.00 g of DMF.
		(iv)	Draw an energy profile diagram showing the complete combustion of DMF. [3]
			 show correct axis – enthalpy for y-axis & reaction pathway/ progress for x-axis show both E_a and ΔH show reactants and products in the correct ratio with state symbols
			[Total: 20]

$6CO_2(g) + 4H_2O(l)$

7	**(a)**	The oxygen family, also called the chalcogens, consists of the elements found in Group 16 of the Periodic Table and is considered among the main group elements. It consists of the elements oxygen, sulfur, selenium, tellurium and polonium.

		(i)	State and explain the trend in the first ionisation energy of the Group 16 elements down the group. [2]
			The first ionisation energy of the Group 16 elements decreases down the group. Nuclear charge increases (due to increase in number of protons). Shielding effect increases (due to the increase in number of inner shell electrons). Effective nuclear charge remains approximately constant. In addition, the number of electron shells also increases and valence electrons are further away from the nucleus. nuclear charge attraction experienced by the valence electron decreases. Less energy is required to remove the valence electron. trend explanation in terms of weaker attraction due to valence electron being furthe from nucleus / at a higher energy level LO 4(b)ii
		(ii)	Compare the first ionisation energy of $_{34}$Se to that of $_{35}$Br and explain your answer. [2]
			The first ionisation energy of Se is lower than of Br. Se has smaller nuclear charge (due to one less proton) than Br but relatively constant shielding effect (due to additional electrons added to the same valence shell and provides negligible shielding effect) and effective nuclear charge is smaller in Se. Valence electrons in Se experience a weaker nuclear attraction and therefore less energy is required to remove the first electron from Se as compared to Br. √ I.E. of Se is lower than Br √ Se smaller nuclear charge √ relatively constant shielding effect √ Se smaller effective nuclear charge √ Se experience weaker nuclear attraction √ less energy remove first electron from Se LO 4(b)i
		(iii)	Describe the structure of a ^{128}Te atom, in terms of number and type of sub–atomic particles and give the valence electronic configuration for a tellurium(II) ion, Te^{2+}. [3]
			no. of protons = 52 = no. of electrons no. of neutrons = 128 – 52 = 76 Recognise that Te is in Period 5 and Group 16 electronic configuration of Te: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^4$ electronic configuration of Te^{2+}: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^2$ valence electronic configuration of Te^{2+}: $5s^2\ 5p^2$ 2m LO 1d , 1m LO 4a

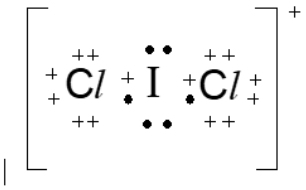
		(iv)	State the formula of the oxide of tellurium in its highest oxidation state. [1]
			TeO_3 1m LO 4e(i)
		(v)	State one physical property that you would expect this oxide of tellurium to possess. Explain, in terms of the structure and bonding present, why it possesses this property. [2]
			TeO_3 has a simple molecular structure with weak instantaneous dipole-induced dipole interactions between molecules. Hence TeO_3 has low boiling point / melting point. OR TeO_3 has a simple molecular structure with strong covalent bonds between Te and O atoms and there are no mobile or delocalised electrons. Hence TeO_3 has does not conduct electricity in all states. Students should recognise that Te is in the same group as S (both in Group 16). SO_3 is a simple molecular structure and thus TeO_3 should similarly be a simple molecular structure. 2m LO 4h
		(vi)	Write an equation to illustrate the behaviour of this oxide of tellurium in water and predict pH of the solution formed. [2]
			Hydrolysis **$TeO_3 + H_2O \longrightarrow H_2TeO_4$** **Accept pH 1 OR 2** 2m LO 4e(iii)

(b) When SO_3 is distilled into ICl_3 at 10 °C, a single ionic product is formed.

$$ICl_3 + SO_3 \longrightarrow (ICl_2^+)(SO_3Cl^-)$$

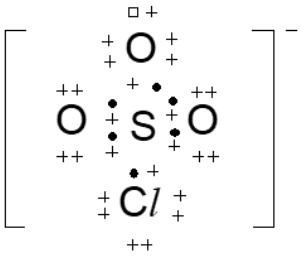
(i) Draw dot–and–cross diagrams to illustrate the bonding in **each** of the ions and predict their shapes. [4]

ICl_2^+



shape: bent

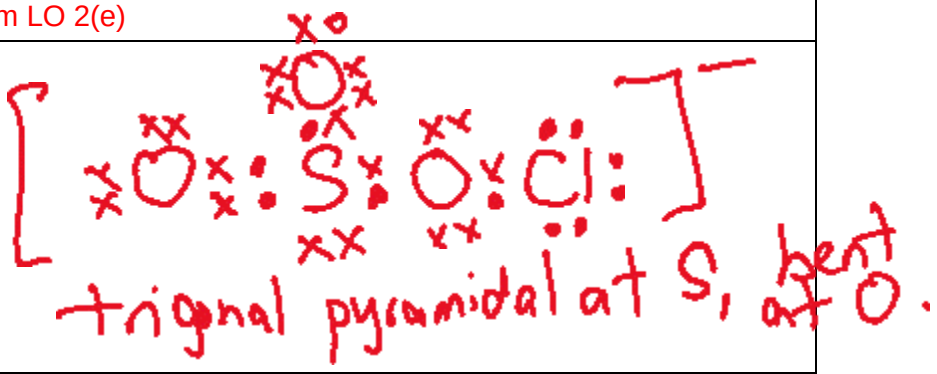
SO_3Cl^-



shape: tetrahedral

2m LO 2b(i); 2m LO 2(e)

Accepted alternative answer



(ii) The boiling point of ICl_3 is 97.4°C and the boiling point of $(ICl_2^+)(SO_3Cl^-)$ is found to be higher. Explain using structure and bonding, the difference in boiling points of $(ICl_2^+)(SO_3Cl^-)$ and ICl_3. [3]

ICl_3 has a (√) simple molecular structure with strong covalent bonds between I and Cl atoms and weak (√) permanent dipole-permanent dipole (pd-pd) between molecules.

$(ICl_2^+)(SO_3Cl^-)$ has (√) giant ionic lattice structure and strong (√) electrostatic force of attraction between oppositely charged ions, ICl_2^+ and SO_3Cl^-.

Since ionic bonds between ICl_2^+ and SO_3Cl^- are (√) stronger than pd-pd between ICl_3 molecules , (√) more energy is needed to overcome, hence resulting in a higher boiling point.
[3] LO 2(o)

(iii) SO_3 dissolves in water to form sulfuric acid, $H_2SO_4(aq)$ which is a dibasic Bronsted-Lowry strong acid.
Explain the term *dibasic Bronsted-Lowry strong acid*. [1]

H_2SO_4 is a proton donor which ionises completely in water, releasing $2H^+$ ions in water.

AOA [1] LO 3b

			[Total: 20]