

NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAMINATIONS
 Higher 1

CANDIDATE
NAME

SUBJECT
CLASS

REGISTRATION
NUMBER

CHEMISTRY

8872/02

Paper 2 Structured Questions

Wednesday 24 August 2016
2 hours

Candidates answer Section A on the Question Paper.

Additional Materials: Answer Paper, Data Booklet

READ THESE INSTRUCTIONS FIRST Write your subject class, registration number and name on all the work you hand in. Write in dark blue or black pen. You may use a soft pencil for any diagrams, graphs or rough working. Do not use paper clips, highlighters, glue or correction fluid/tape. Section A Answers all questions. Section B Answers two questions on separate answer paper. At the end of the examination, fasten all your work securely together. The number of marks is given in brackets [] at the end of each question or part question.	For Examiner's Use	
	A1	/10
	A2	/10
	A3	/11
	A4	/9
	B5	/20
	B6	/20
	B7	/20
	Total	/80

This document consists of **14** printed pages.

Section A

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

- 1 "Lethal Dose", LD, is a means of measuring toxicity. LD₅₀ is the amount of a material which causes the death of 50% of a group of test animals. Its value is expressed as the mass of a chemical administered per kg body mass of a test animal.

"Lethal Concentration", LC, is another means of measuring toxicity. The value of LC₅₀ is the concentration of a chemical in air that kills 50% of the test animals during the observation period.

The table below shows the values for the LD₅₀ and LC₅₀ along with the toxicity ratings.

Toxicity Rating	Commonly used term	LD ₅₀ : Oral (mg kg ⁻¹)	LC ₅₀ : Inhalation (ppm)
1	Extremely Toxic	1 or less	10 or less
2	Highly Toxic	1 – 50	10 – 100
3	Moderately Toxic	50 – 500	100 – 1000
4	Slightly Toxic	500 – 5000	1000 – 10,000
5	Practically Non-toxic	5000 – 15,000	10,000 – 100,000
6	Relatively Harmless	15,000 or more	100,000 >

- (a) 1 mol of an organic toxic compound with a volume of 157.7 cm³ was used for testing. The density of the compound was given as 1.23 g cm⁻³.

- (i) Determine the M_r of the compound. [1]

Mass of 1 mole = Molar Mass

Molar mass = 157.7 × 1.23

= 193.97g

Hence, M_r = 194

1 mark

- (ii) The composition of the organic compound was found to be 49.5% C, 5.15% H, 16.5% O and 28.85% N by mass.

Determine the empirical formula and hence the molecular formula of the compound. [2]

	C	H	O	N
--	---	---	---	---

% by mass	49.5	5.15	16.5	28.85
A _r	12.0	1.0	16.0	14.0
	4.125	5.15	1.031	2.06
÷ by smallest number	4	5	1	2

Empirical formula = C₄H₅N₂O

1 mark for table

$$n(4 \times 12.0 + 5.0 + 16.0 + 14.0 \times 2) = 193.97$$

$$n = 1.9997$$

$$n \approx 2$$

Molecular formula = C₄H₁₀N₄O₂

1 mark for formula

- (iii) 9.90×10^{-4} mol of the compound was found to cause death in 50% of a 1 kg test animal.

Calculate the LD₅₀ of the compound and state its toxicity rating.

[2]

$$\begin{aligned} \text{Mass of compound} &= 9.90 \times 10^{-4} \times 194 \\ &= 0.19206 \text{ g} \end{aligned}$$

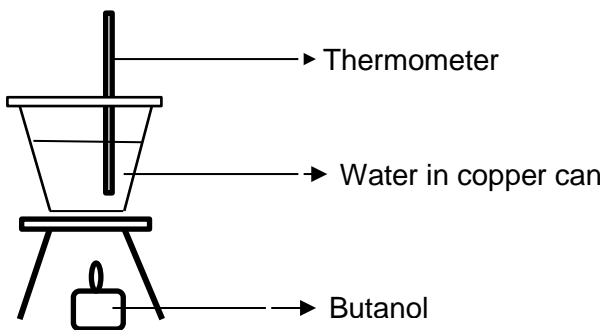
$$\begin{aligned} \text{Hence, LD}_{50} &= \frac{0.19206 \times 10^3}{1 \text{ kg}} \\ &= 192.06 \text{ mg/kg} \\ &\approx \mathbf{192 \text{ mg/kg}} \end{aligned}$$

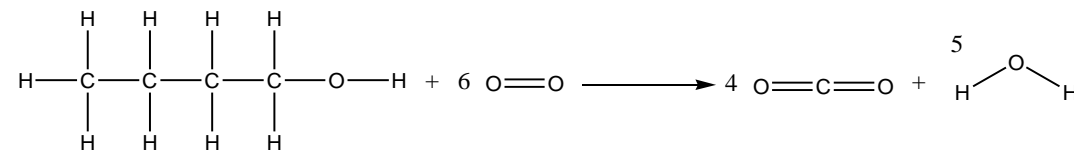
1 mark

The compound is **moderately toxic/3**

1 mark

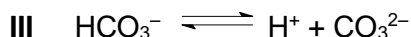
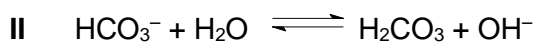
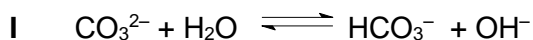
	<p>(b) Phosphine, PH_3, is gas that is widely used in the semi-conductor industry as a dopant and as a precursor for the deposition of compound semiconductors.</p> <p>For safety reasons, the permissible limits of phosphine must not exceed $\frac{1}{10}$ of its LC_{50} value.</p> <p>When expressing the concentration of a small quantity of gas, parts per million (ppm) can be used. Ppm is usually used for volume of gases and is expressed as shown in the equation below:</p> $\text{Concentration of gas (in ppm)} = \frac{\text{volume of gas}}{\text{volume of air}} \times 10^6$
	<p>(i) Given that the LC_{50} for phosphine is 55 mg m^{-3} at room temperature, convert the LC_{50} to ppm and determine its toxicity rating. [3]</p>
	<p>Volume of $\text{PH}_3 = \frac{55 \times 10^{-3}}{34.0} \times 24 \text{ dm}^3$ $= 1.6176 \times 10^{-3} \times 24 \text{ dm}^3$ $= \mathbf{0.03882 \text{ dm}^3}$ 1 mark</p> <p>$\text{LC}_{50} = \frac{0.03882 \times 10^{-3}}{1} \times 10^6$ $= 38.82$ $\approx \mathbf{38.8 \text{ ppm}}$ 1 mark</p> <p>The toxicity rating is highly toxic/2 1 mark</p>
	<p>(ii) A semiconductor factory releases 36 g of phosphine in a day.</p> <p>Using your value in (i), determine the minimum volume of the factory that will allow the volume of phosphine to be within permissible limits at room temperature. [2]</p>
	<p>Allowed amount of PH_3 in ppm $= 38.82 \div 10$ $= \mathbf{3.882 \text{ ppm}}$ 1 mark</p> <p>Given amount of PH_3 produced a day is 36g</p> <p>$3.882 = \frac{\text{vol of } \text{PH}_3}{\text{vol of factory}} \times 10^6$ $3.882 = \frac{\frac{36}{34} \times 24}{\text{vol of factory}} \times 10^6$ Minimum volume of factory $= \mathbf{6.546 \times 10^6 \text{ dm}^3}$ 1 mark</p>
	<p>[Total:10]</p>

2	(a)	<p>Butanol was burnt in a spirit burner under a beaker of water as shown in the diagram.</p> <div></div> <p>The experimental results obtained are shown below.</p> <table><tr><td>mass of water</td><td>= 200 g</td></tr><tr><td>original temperature of water</td><td>= 29.4 °C</td></tr><tr><td>final temperature of water</td><td>= 36.9 °C</td></tr><tr><td>original mass of burner + butanol</td><td>= 50.64 g</td></tr><tr><td>final mass of burner + butanol</td><td>= 50.44 g</td></tr></table>	mass of water	= 200 g	original temperature of water	= 29.4 °C	final temperature of water	= 36.9 °C	original mass of burner + butanol	= 50.64 g	final mass of burner + butanol	= 50.44 g
mass of water	= 200 g											
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	(i)	<p>Calculate the enthalpy change of combustion, ΔH_c, for butanol. Ignore the heat capacity of the copper can and use the figure of $4.18 \text{ J g}^{-1} \text{ K}^{-1}$ for the specific heat capacity of water. [3]</p>										
		<p>$q = mc\Delta T$ $= 200 (4.18) (36.9 - 29.4)$ $= \mathbf{6270 \text{ J}}$ 1 mark for correct answer</p> <p>Amount of butanol combusted $= \frac{50.64 - 50.44}{12.0 \times 4 + 1.0 \times 10 + 16.0}$ $= \mathbf{2.703 \times 10^{-3} \text{ mol}}$ 1 mark</p> <p>$\Delta H_c \text{ for butanol} = \frac{6270}{2.703 \times 10^{-3}}$ $= \mathbf{2319 \text{ kJ mol}^{-1}}$ 1 mark</p>										
	(ii)	<p>Explain why the value of the ΔH_c obtained in (i) differs from the true value of $-2676 \text{ kJ mol}^{-1}$ and suggest an improvement to the set-up. [2]</p>										
		<p><u>Heat is lost</u> through radiation to the surroundings. 1 mark</p> <p>Use an air vent to prevent wind from blowing. 1 mark</p>										
	(iii)	<p>Write the equation that represents the combustion of butanol. [1]</p>										
		<p>$\text{C}_4\text{H}_9\text{OH} + 6\text{O}_2 \longrightarrow 4\text{CO}_2 + 5\text{H}_2\text{O}$</p>										

		(iv)	Using bond energy data from the <i>Data Booklet</i> , calculate another value for the enthalpy change of combustion for butanol. Show your workings clearly. [2]										
			<div style="text-align: center;"></div> <p style="color: red; margin-top: 20px;">Bonds broken: 4 C-C , 9 C-H , 1 C-O , 1 O-H, 6 O=O Bonds formed: 8 C=O, 10 O-H bonds 1 mark</p> <p style="color: red; margin-top: 20px;">$\Delta H_c \text{ butanol} = 4 \times 350 + 9 \times 410 + 360 + 460 + 496 - (8 \times 740 + 10 \times 496)$ $= \underline{\underline{- 4474 \text{ kJ mol}^{-1}}}$ 1 mark</p>										
		(b)	<p>The table below shows the solubility of some alcohols.</p> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"><tr><th style="width: 30%;">Alcohol</th><th style="width: 15%;">Butanol</th><th style="width: 15%;">Pentanol</th><th style="width: 15%;">Hexanol</th><th style="width: 15%;">Heptanol</th></tr><tr><td>Solubility/ g per 100 g of water</td><td>0.11</td><td>0.030</td><td>0.0058</td><td>0.0008</td></tr></table> <p>Explain why the solubility of alcohols decreases as the number of carbons increases. [2]</p> <p style="color: red;">As the number of carbons increases from butanol to heptanol, the electron cloud sizes of the molecules increase and the ease of polarisability increases, leading to increasingly stronger temporary dipole – induced dipole between the molecules with more carbons. The energy released from the hydrogen bonds between the alcohols and water molecules is not enough to overcome the increasingly stronger temporary dipole–induced dipole between the alcohol molecules and hydrogen bonds between the water molecules.</p> <p style="color: red; margin-top: 20px;"><i>Every point is ½ mark.</i></p>	Alcohol	Butanol	Pentanol	Hexanol	Heptanol	Solubility/ g per 100 g of water	0.11	0.030	0.0058	0.0008
Alcohol	Butanol	Pentanol	Hexanol	Heptanol									
Solubility/ g per 100 g of water	0.11	0.030	0.0058	0.0008									
			[Total:10]										

- 3 Sodium carbonate, Na_2CO_3 , is the water-soluble sodium salt of carbonic acid, H_2CO_3 . Sodium carbonate is a food additive used as an acidity regulator, anticaking agent, raising agent and stabiliser. It is one of the components of *kansui*, a solution of alkaline salts used to give ramen noodles their characteristic flavour and texture.

A number of equilibria exist within a solution of *Kansui*.



- (a) (i) Write the K_c expression for equilibrium I and state its units. [1]

$$K_c = \frac{[\text{HCO}_3^-][\text{OH}^-]}{[\text{CO}_3^{2-}]} \quad \text{units: mol dm}^{-3} \quad 1 \text{ mark}$$

- (ii) K_c for equilibrium I has a numerical value of 2.5×10^{-6} . Calculate the concentration of $\text{OH}^-(\text{aq})$ ions in this equilibrium when the concentration of CO_3^{2-} is 0.45 mol dm^{-3} . [2]

$$2.5 \times 10^{-6} = \frac{[x][x]}{[0.45]} \quad 1 \text{ mark} ; [\text{OH}^-] = 0.00107 \text{ mol dm}^{-3} \quad 1 \text{ mark}$$

- (iii) Use the value calculated in (ii) to calculate the pH of *Kansui*. [1]

$$\text{pOH} = -\lg[\text{OH}^-]$$

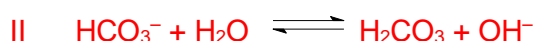
$$\text{pH} = 14 - \text{pOH} = 11.0 \quad 1 \text{ mark}$$

- (iv) Hence, suggest and explain whether sodium carbonate is a strong base or weak base given that the initial concentration of sodium carbonate is $0.100 \text{ mol dm}^{-3}$.

Sodium carbonate is a weak base. 1 mark

It is because sodium carbonate does not undergoes complete dissociation as the given initial concentration of $0.100 \text{ mol dm}^{-3}$ will give a pH of more than 11.0
1 mark [2]

- (b) If the container containing *Kansui* in equilibrium is heated, the pH will increase. Use the information above to deduce whether equilibrium II is exothermic or endothermic, explaining your answer.



pH increases = $[\text{OH}^-]$ increases when heated; equilibrium shifts right upon heating.
1 mark

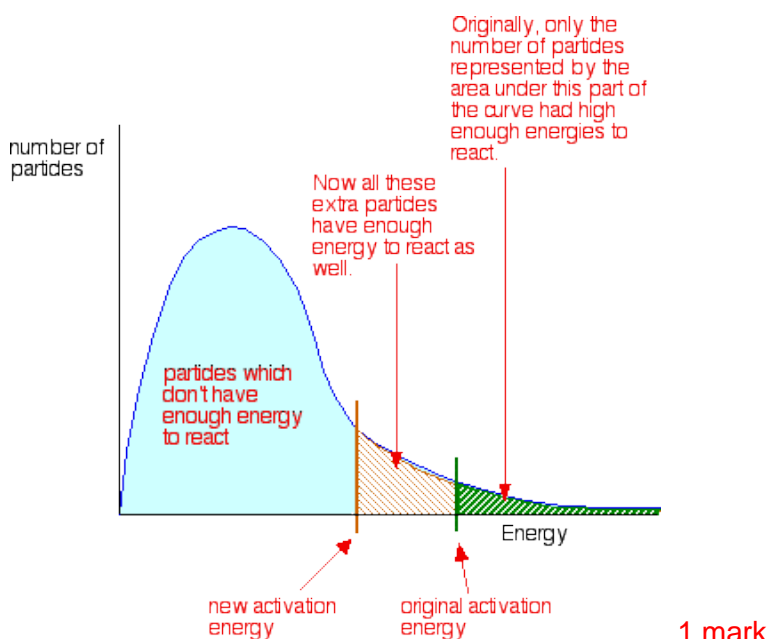
According to Le Chatelier's principle, when temperature increases, the system will counteract the changes by shifting to the direction which will absorb heat (endothermic).
1 mark

[2]

- (c) In order to increase the rate of reaction, a catalyst can be added.
Explain in detail how a catalyst works. Draw an energy distribution diagram to illustrate your answer.

A catalyst is used to lower the activation energy of the reaction by providing an alternative pathway.
1 mark

By lower the activation energy, the proportion of particles that possess the minimum energy (E_a) will increase and it will increase the effective collision which results in the increase in reaction rate. 1 mark

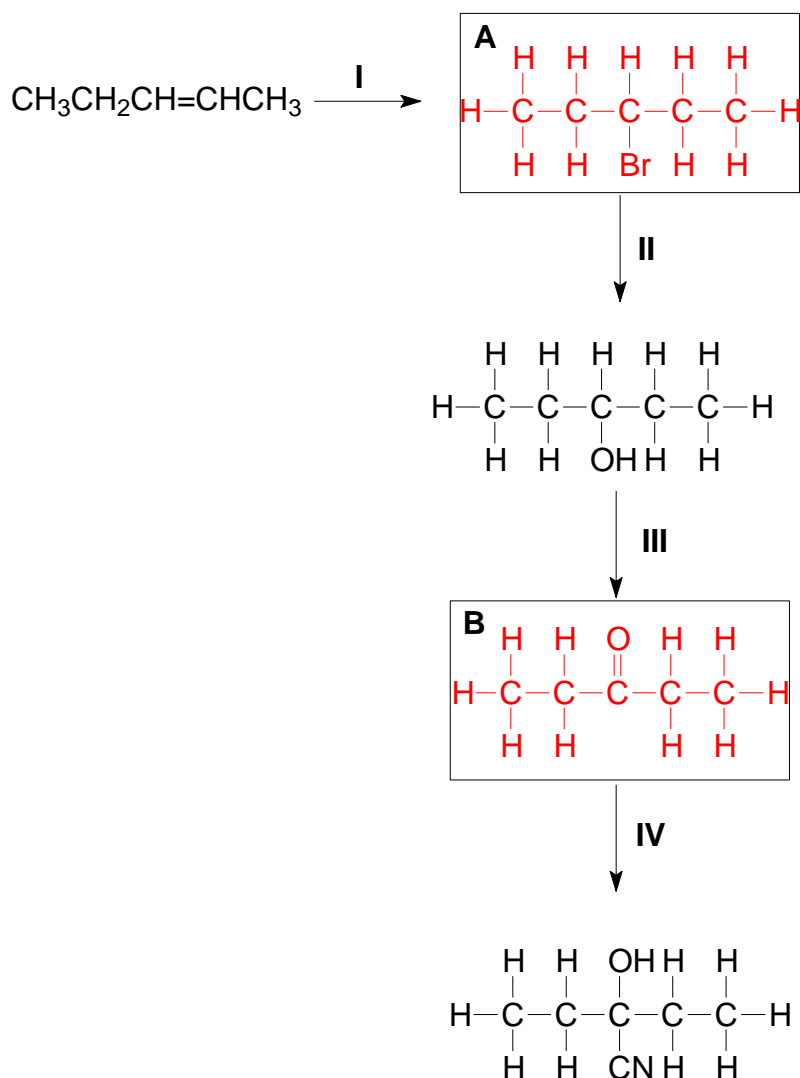


1 mark

[3]

[Total:11]

- 4 A sequence of reactions starting from but-2-ene, is shown below.



(a) In the appropriate boxes, draw the structures of compounds **A** and **B**. [2]

(b) For the reactions in the scheme shown above, state

- the type of reaction in reaction I,

Addition (electrophilic addition)

- the reagents and conditions for reaction II,

NaOH(aq), heat

- the reagent and conditions for reaction IV,

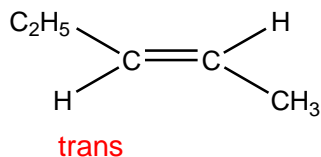
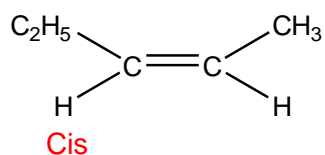
NaCN/KCN and HCl/H₂SO₄ with trace amount of NaCN/KCN/NaOH

[3]

(c) Pent-2-ene has geometrical isomers.

Draw the structural formulae of **each** of the two isomers so as to identify this isomerism and label each structure.

[2]

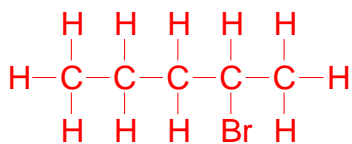


1 mark each

(d) Reaction I produced an isomer of **A**.

Draw the structural formula of the isomer and state the type of isomerism exhibited.

[2]



1 mark

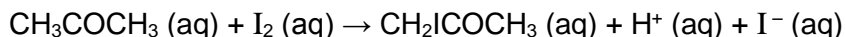
Structural isomer 1 mark

[Total:9]

Section B

Answer **two** questions of the three questions in this section on separate paper.

- 7(a)** Propanone reacts with iodine in an aqueous solution of sulfuric acid as shown below.



The rate of this reaction was investigated by withdrawing samples from the reaction mixture, 'quenching' by adding the sample to a large volume of ice-cold water, then measuring the amount of iodine in the sample by a reaction which turned the solution colourless.

- (i)** Why is it necessary to *quench* the sample before measuring the amount of iodine?

It is to slow down the reaction by a great extent such that the concentration of I_2 can be correctly determined at specified time.

Four separate experiments were carried out to determine the initial rates of reaction and the results obtained are given in the table below.

Expt	Volume of CH_3COCH_3 / cm^3	Volume of 1 mol dm^{-3} H_2SO_4 / cm^3	Volume of 0.01 mol dm^{-3} I_2 / cm^3	Volume of H_2O / cm^3	Time taken for colourless solution to form /s
1	20	10	10	150	8
2	10	10	10	160	16
3	20	5	10	155	16
4	20	5	5	160	8

- (ii)** Why is it necessary to vary the volume of water in each experiment? [1]

This is to keep the total volume constant such that the volume of reactants used is proportional to the concentration of the reactants.

- (iii)** What is the relationship between the time taken for the solution to turn colourless and the rate of reaction? [1]

$$\text{Rate of reaction} \propto \frac{\text{volume of iodine used}}{\text{time taken for colourless solution to form}}$$

- (iv)** Deduce the orders of reaction with respect to propanone, sulfuric acid and iodine. Hence, write the overall rate equation for this reaction. [3]

Expt	Relative Rate
1	2
2	1
3	1

4	1
---	---

1 mark

- (b) A student was given two containers without labels and told that they contained pure samples of two of the following three compounds.

- Propanone, CH_3COCH_3
- 2-iodopropanone, $\text{CH}_3\text{ICOCH}_3$
- Propene, $\text{CH}_2=\text{CHCH}_3$

- (i) Describe **one** test that could show that the samples contained propanone and 2-iodopropanone and not propene. [2]

Test: 2, 4-dinitrophenylhydrazine 1 mark

Observation: orange crystal for propanone and 2-iodopropanone 1 mark

- (ii) Describe **one** test that could distinguish between propanone and 2-iodopropanone. [2]

Test: NaOH(aq) , heat, cooled and HNO_3 followed by AgNO_3 1 mark

Observation: Yellow ppt for 2-iodopropanone 1 mark

- (iii) Describe **three** tests that could identify propene. [6]

Test 1: Cold concentrated KMnO_4

Observation: brown ppt form

Test 2: $\text{Br}_2(\text{aq})$

Observation: yellow solution decolourises

Test 3: Br_2 in CCl_4

Observation: Reddish brown solution decolourises

Test 4: Hot concentrated acidic KMnO_4

Observation: Purple solution decolouries

2 marks each (any 3)

In each case, you should say what reagents and conditions you would use and what observations you would make.

- (c) Suggest how propanone could be prepared from propene in not more than **three** steps. [4]

Step 1: HBr(g) or NaBr and Concentrated H_2SO_4

Step 2: NaOH(aq) , heat

Step 3: Hot, H_2SO_4 , $\text{K}_2\text{Cr}_2\text{O}_7/\text{KMnO}_4$

[Total:20]

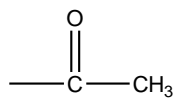
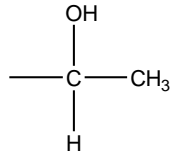
- 8 (a) Compound **P** has molecular formula, C_4H_6O . Reaction of **P** with hot acidified potassium manganate(VII) produces compound **Q**, $C_3H_4O_3$, and effervescence is observed. The gas gives a white precipitate when passed through $Ca(OH)_2(aq)$.

One mol of **Q** requires one mol of $KOH(aq)$ for complete neutralisation. Both **P** and **Q** give a yellow precipitate when warmed with alkaline aqueous iodine.

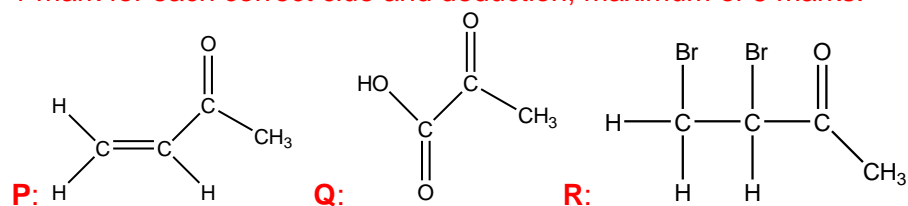
P decolourises bromine in CCl_4 to form compound **R**, $C_4H_6OBr_2$. Both **P** and **R** give a orange precipitate with 2,4-dinitrophenylhydrazine.

Deduce a possible structure for each of the compounds **P** to **R** and explain the chemistry of the reactions described.

[8]

Clues	Deduction
molecular formula, C_4H_6O	P contains either alcohol or carbonyl group
hot acidified potassium manganate(VII) produces compound Q , $C_3H_4O_3$,	Decrease in 1 C and 2 H; presence of $C=C$ which undergoes oxidative cleavage.
Effervescence is observed and gas gives a white precipitate when passed through $Ca(OH)_2(aq)$	Effervescence means the presence of $C=CH_2$ which undergoes oxidative cleavage to give CO_2
One mol of Q requires one mol of $KOH(aq)$ for complete neutralisation	Q contains one $COOH$ group
P and Q give orange precipitate with 2,4-dinitrophenylhydrazine	Has either  or 
P decolourises bromine in CCl_4 to form compound R	P contains $C=C$ and undergoes electrophilic addition to form R .
Both P and R give a orange precipitate with 2,4-dinitrophenylhydrazine	Both contain $C=O$

1 mark for each correct clue and deduction, maximum of 5 marks.



1 mark for each structure

- (b) Hydrochloric acid can be formed from the reaction between hydrogen gas and chlorine gas.



- (i) A mixture at equilibrium was found to contain 0.1 mol of H_2 , 0.1 mol of Cl_2 and 0.2 mol of HCl in a 2 dm^3 vessel.

Determine the K_c for the reaction.

[2]

$$\begin{aligned}
 K_c &= \frac{[HCl]^2}{[H_2][Cl_2]} \\
 &= \frac{\left[\frac{0.2}{2}\right]^2}{\left[\frac{0.1}{2}\right]\left[\frac{0.1}{2}\right]} && \text{1 mark for subbing in correct value} \\
 &= 4 && \text{1 mark for correct answer}
 \end{aligned}$$

- (ii) State and explain how the equilibrium position is affected if the pressure of the equilibrium mixture from (i) is increased. [2]

The equilibrium position **remains unaffected** 1 mark

as there are **equal number** of gaseous reactants and products. 1 mark

- (iii) Suggest and explain how the yield of HCl can be increased without adding or removing any reagents. [2]

By **decreasing the temperature**, 1 mark

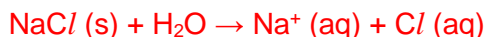
the **equilibrium position will shift to the right** so as to partially make up for the loss of heat. Thus, the yield of HCl increases. 1 mark

- (c) Elements **S**, **T** and **U** are in Period 3.

Chlorides of **S** and **T** dissolve in water to form an acidic solution ($\text{pH} \approx 3$) and a neutral solution ($\text{pH} = 7$) respectively. The oxide of element **U** is insoluble in water, while its chloride forms a strongly acidic solution ($\text{pH} \approx 2$).

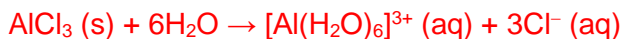
- (i) Identity elements **S** and **T**, and explain the above observations as fully as you can with the aid of equations. [4]

T is Na. 1 mark



Na^+ is unable to hydrolyse water due to its low charge over size ratio. 1 mark

S is Al. 1 mark



Al hydrolyses in water to form a form acidic solution. 1 mark

- (ii) Identify element **U** and explain why the chloride of **U** forms a strongly acidic solution with the aid of an equation. [2]

U is Si.

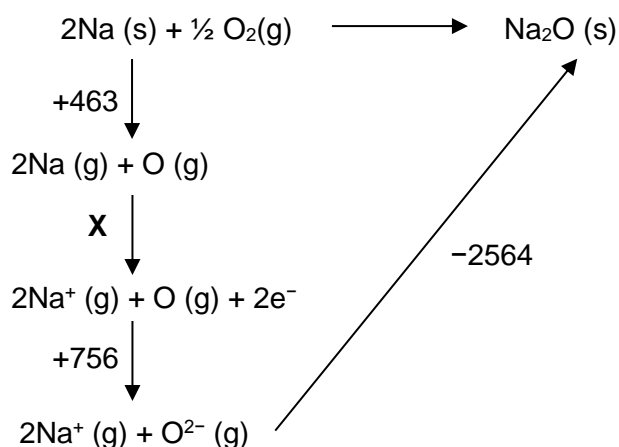
1 mark



Si hydrolyses in water to form a strongly acidic solution. 1 mark

[Total:20]

- 9 (a) The energy cycle to form sodium oxide from reacting sodium and oxygen is shown below:



- (i) Define the term *enthalpy change of formation*. [1]

The enthalpy change which occurs when 1 mole of a compound is formed from its elements in their standard states.

- (ii) With the aid of the *Data Booklet*, determine the value for the enthalpy change of X. [1]

$$\begin{aligned}
 \text{Enthalpy change of X} &= +494 \times 2 \\
 &= +988 \text{ kJ mol}^{-1}
 \end{aligned}$$

- (iii) Hence, calculate the value of enthalpy change of formation of Na_2O . [2]

$$\begin{aligned}
 \Delta H_f &= +463 + 988 + 756 - 2564 && \text{1 mark for forming equation correctly} \\
 &= -357 \text{ kJ mol}^{-1} && \text{1 mark for correct answer}
 \end{aligned}$$

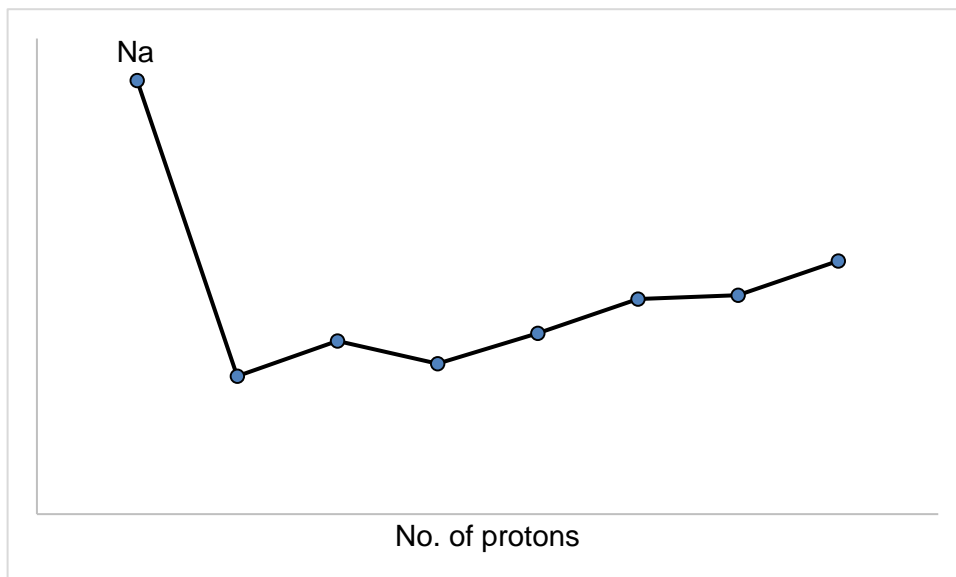
- (iv) Suggest, with reasons, how the magnitude of the lattice energy of Na_2O might compare to that of Na_2S . [2]

The product of the charges in Na_2O and Na_2S is the same. $\frac{1}{2}$ mark

However, the interionic distance in Na_2O is shorter than that of Na_2S . $\frac{1}{2}$ mark

Given $|\text{L.E.}| \propto \frac{q_+ q_-}{r_+ + r_-}$, hence magnitude of the lattice energy in Na_2O is greater than Na_2S . 1 mark

- (b) The graph below shows the variation of a property of Period 3 elements with Na being labelled.



Suggest and explain which property is exhibited in the graph above.

[2]

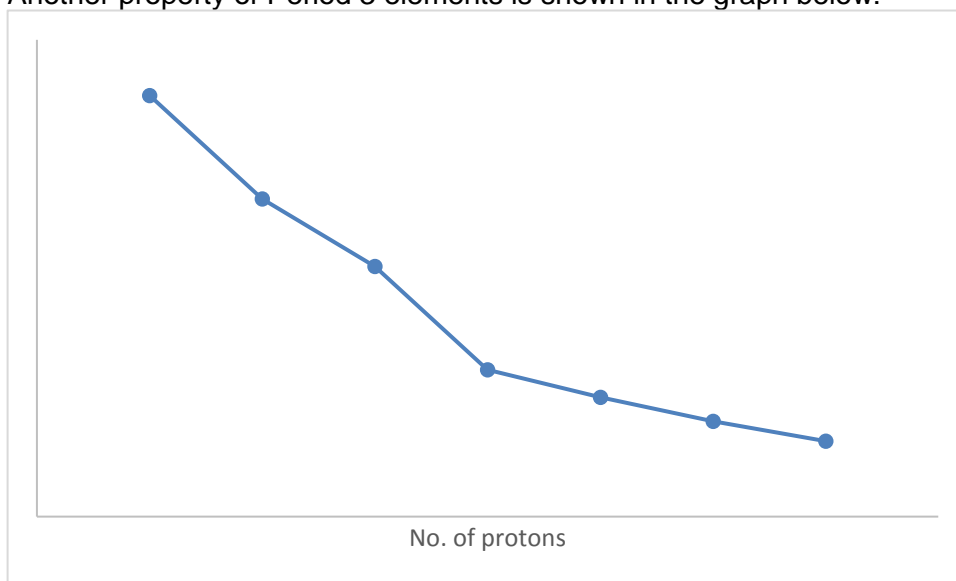
The 2nd ionisation energy.

1 mark

From the position of Na, the **most loosely held** electron removed is from an inner quantum shell as seen from the **jump in the ionisation energy of the next proton number.**

1 mark

- (c) Another property of Period 3 elements is shown in the graph below:



Suggest and explain which property is exhibited in the graph above.

[2]

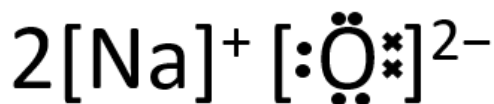
Atomic radius.

1 mark

As the proton number increases, the nuclear charge increases. The number of inner shell electrons remain the same. $\frac{1}{2}$ mark

Hence, nuclear attraction for the outer most electron increases across the period and atomic radius decreases across the group. $\frac{1}{2}$ mark

- (d) (i) Draw the 'dot-and-cross' diagram of Na_2O and SO_2 . [2]



- (ii) State the bond angle in SO_2 and explain how this angle arises. [2]

Bond angle: $<120^\circ$ 1 mark

There is 1 lone pair and 2 bond pairs. The lone pair – bond pair repulsion is greater than bond pair – bond pair repulsion. Hence, bond angle is lesser than 120° . 1 mark

- (iii) Suggest, in terms of structure and bonding, why the melting point of Na_2O is higher than that of SO_2 . [2]

Na_2O has a giant ionic lattice while SO_2 is simple covalent. 1 mark

More energy is needed to over the stronger ionic bonds in Na_2O $\frac{1}{2}$ mark

then the **weaker intermolecular forces of attraction** between the SO_2 molecules. Hence, Na_2O has a much higher melting point than SO_2 . $\frac{1}{2}$ mark

- (e) 1 mol dm^{-3} of $\text{NaOH}(\text{aq})$ and 1 mol dm^{-3} butanoic acid is mixed in a 1:2 ratio, forming a *buffer solution*.

- (i) Explain what is meant by the term *buffer solution* and how does mixing $\text{NaOH}(\text{aq})$ with butanoic acid form a *buffer solution*. [2]

A buffer solution is one which tends to **resist changes in pH** on dilution or on addition of small quantities of an acid or alkali. 1 mark

The resulting solution contains a weak acid, butanoic acid, and its conjugate base, sodium butanoate. 1 mark

- (ii) With the aid of two equations, explain how the solution of butanoic acid and NaOH(aq) resist changes in pH of the solution.

[2]

When H⁺ is added:



When OH⁻ is added:



[Total:20]