

RIVER VALLEY HIGH SCHOOL JC 2 PRELIMINARY EXAMINATION

CANDIDATE NAME						
CLASS	2	3	J			
CENTRE NUMBER	S				INDEX NUMBER	

H1 CHEMISTRY

Paper 2 Structured Questions

8873/02

9 September 2024 2 hours

Candidates answer on the Question Paper.

Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number, class and name on all the work that you hand in. Write in dark blue or black pen. You may use an HB pencil for any diagrams or graphs. Do not use staples, paper clips, glue or correction fluid. DO **NOT** WRITE IN ANY BARCODES.

Section A

Answer **all** the questions.

Section B

Answer one question.

The use of an approved scientific calculator is expected, where appropriate. A Data Booklet is provided.

The number of marks is given in brackets [] at the end of each question or part question.

			For Ex	aminer's l	Jse			
Question Number	1	2	3	4	5	6	7	8
Marks	9	16	7	5	9	14	20	20
significant figures			units				Total	80

This document consists of 25 printed pages and 3 blank pages.



1 Ammonium sulfite can be prepared by the reaction of ammonia with sulfur dioxide in aqueous solution.

 $2NH_3 + SO_2 + H_2O \rightarrow (NH_4)_2SO_3$

Draw a 'dot-and-cross' diagram to show the bonding in ammonium sulfite. (a)

			[2]
(b)	State and explain the shape and b	bond angle in sulfite anion, SO_3^{2-} .	
	Shape:		
	Bond angle:		
	Explanation:		
			[3]
(c)	Explain how a dative bond is form	ied in NH4 ⁺ .	
			[1]
(d)	Explain, in terms of structure and has a higher boiling point.	bonding, if ammonium sulfite or ammonia	
			[3]
		[Tota	al: 9]
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- **2** Calcium chloride is used in temperate countries to prevent ice formation.
 - (a) Using an equation, define the lattice energy of calcium chloride, CaCl₂.
 - (b) Use the data from the *Data Booklet*, explain how the magnitude of lattice energy of calcium chloride might compare to that of magnesium chloride.

.....

-[2]
- (c) Like magnesium chloride, a solution of calcium chloride is of pH 6.5.With the aid of a suitable equation, explain this observation.

[2]

[1]



(d) A solution of calcium chloride can be formed from reacting solid calcium carbonate with hydrochloric acid.

 $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ $\Delta H_r = x \text{ kJ mol}^{-1}$

When 11.375 g of calcium carbonate is reacted with 250 cm³ of 2.00 mol dm⁻³ hydrochloric acid, the temperature of the resultant solution increased by 1.58 °C.

Assuming that 4.2 J of heat is required to raise the temperature of 1.0 cm³ of the solution by 1.0 °C, calculate the value of x.

[3]

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(e) The rate of reaction between CaCO₃(s) and HC*l*(aq) can be measured by monitoring the mass of the reaction mixture over time.

An experiment was carried out where 11.375 g of calcium carbonate is reacted with 250 cm³ of 2.00 mol dm⁻³ HC*l*(aq) using the following setup:



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(ii)	Show that the maximum mass loss is expected to be 5.00 g.

[1]

- (iii) Given that the reaction is 1^{st} order with respect to HC*l* and 0^{th} order with respect to CaCO₃, write the rate equation for the reaction.
 -[1]
- (iv) Hence, sketch the expected mass loss over time on the given axis.
 Indicate the 1st and 2nd half-lives with their corresponding mass loss on your graph.





Z ZDO NOT WRITE IN THIS MARGINZ (v) With the aid of a Boltzmann distribution curve, explain how the rate of this reaction would be affected by an increase in temperature. RV RV RV RV RV RV RV RV RV RV [2] RV RV (vi) Sketch on the same graph as (e)(iv), the expected mass loss over time RV for a reaction at a higher temperature. [1] RV RV [Total: 16] RV RV RV

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(e) 'Armchair' and 'zigzag' are the names of two types of CNT. They are named according to the structures of the nanotubes. Outline the armchair and zigzag shapes on the structures and name the structures.

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structures	
names	

[2]

[Total: 7]

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4 Study the reaction scheme below carefully.





(d) Give the skeletal structure of compound C.

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[1] [Total: 5]



5 Bakelite is the commercial name for the polymer obtained by the polymerisation of the monomers, phenol and methanal. Bakelite is one of the oldest synthetic polymers. Fig. 5.1 below shows the synthetic route of Bakelite.



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(a)	Defin	e the term <i>polymer</i> .	
			[1]
(b)	(i)	State the type of polymerisation that phenol and methanal undergone to form Bakelite.	
	(ii)	Predict whether Bakelite is a thermosetting or a thermoplastic polymer. Explain your answer using the structure of Bakelite in Fig. 5.1 and your knowledge of the structure and bonding in polymers.	[1]
	(iii)	Using the structure of Bakelite in Fig. 5.1, explain if Bakelite can be recycled.	[2]
(c)	Poly(disso	vinyl alcohol), PVA, is a water soluble polymer. Explain how PVA lves in water. Include a diagram in your answer.	[2]

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.....[3]

[Total: 9]

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[Turn over





6 The *dissolved oxygen concentration* (DOC) in rivers and lakes is important for aquatic life. To survive, small aquatic animals require DOC of at least 4.5 mg dm⁻³, while larger fishes require DOC of more than 9.5 mg dm⁻³.

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[1 g = 1000 mg]

Environmental chemists can determine the DOC in water using the procedure below:

Step 1: A sample of river water is shaken with excess aqueous Mn^{2+} and aqueous alkali. The dissolved oxygen oxidises the Mn^{2+} to Mn^{3+} , forming a pale brown precipitate of $Mn(OH)_3$.

$$O_2(aq) + 4Mn^{2+}(aq) + 8OH^{-}(aq) + 2H_2O(I) \rightarrow 4Mn(OH)_3(s)$$

Step 2: The $Mn(OH)_3$ precipitate is then reacted with an excess of aqueous potassium iodide, which is oxidised to iodine.

 $2Mn(OH)_3(s) + 2I^{-}(aq) \rightarrow I_2(aq) + 2Mn(OH)_2(s) + 2OH^{-}(aq)$

Step 3: The amount of iodine formed is determined by titration with aqueous sodium thiosulfate, $Na_2S_2O_3(aq)$.

$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^{-}(aq)$$

30.0 cm³ of a sample of river water was analysed using the above procedure. The titration requires 25.60 cm³ of 0.00150 mol dm⁻³ Na₂S₂O₃(aq).

(a) Calculate the expected amount of oxygen present in the 30.0 cm³ sample of river water.



(b) The presence of nitrite ions, NO_2^- , in the river water interferes with this method because NO_2^- ions can also react with iodide ions. During the reaction, NO_2^- is reduced to NO while iodide is oxidised to iodine.

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(i) Construct the half-equation for the reduction of NO_2^- to NO in an alkaline medium. Hence, give the overall equation for the reaction between NO_2^- and iodide ions.

(ii) State and explain how the presence NO₂⁻ in the water sample affects the calculated amount of oxygen in (a).

- (iii) In a separate analysis, it was discovered that 30.0 cm³ of a sample from the same river contains 5.70×10^{-6} mol of NO₂⁻ ions.

Calculate the actual amount of oxygen present in the 30.0 cm³ sample of river water.

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(iv)	Hence, calculate the DOC, in mg dm ⁻³ , in the river water.	
(v)	Comment on how well the river can support aquatic life	[1]
(*)		
		[1]
An ox	ide of manganese contains 72 0% by mass of manganese	ניו
	Determine the eveninical formula of this evide	
		[2]
(ii)	The oxide in (c)(i) is a mixture of two oxides. The oxidation state of	[~]
	manganese in one of the oxides is +3.	
	State the formulae and relative quantities of both oxides.	[2]
	Total	: 14]

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Section B

Answer one question from this section in the spaces provided.

7 Fig. 7.1 shows the first seven ionisation energies for nickel and two other main (a) group elements, A and B.





(iii) State the identity of element **B**.

......[1]

(b) A Monel alloy contains nickel and copper. A sample of the alloy was analysed and four different types of atoms were identified – **P**, **Q**, **R**, **S**. Table 7.1 shows the information about the four types of atoms found in the sample.

atom	relative mass	relative % abundance
Р	57.98	18.1
Q	59.02	44.9
R	62.91	25.5
S	64.88	11.5

Table 7.1

Calculate the relative atomic mass of nickel in this sample to four significant figures. Show your working.

(c) (i) Describe and explain how the volatilities of the halogens vary from fluorine to iodine.

[2]

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\'')	Describe and expl	ain the trend i	in therm	al stability of	f hydrogen	halides	
X ha	s the formula $NC/2^+$	and contains	¹⁴ N ³⁵ C	C_{I} and ${}^{37}C_{I}$			
X is	also unstable and br	eaks down in	to two fr	agments, Y	and Z .		
(i) Complete Table 7.2 to describe the characteristics of these particles \mathbf{r}							
Table 7.2							
(')	·	т	able 7.2	2			
(')		т	able 7.2 X	2 Y	Z]	
\' <i>1</i>	nucleon n	T umber	able 7.2 X 121	2 Y	Z 35	-	
\' <i>'</i>	nucleon n charge	T umber	able 7.2 X 121 +1	2 Y +1	Z 35		
(ii)	nucleon n charge X, Y and Z were fi	T umber red with equa	X 121 +1 I speed	2 Y +1 into an elec	Z 35 tric field.		
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(e) 13.9 g of bromine chloride was allowed to partially dissociate into bromine and chlorine in a 2.00 dm³ vessel. The degree of dissociation of bromine chloride was 0.460.

 $2BrCl(g) = Br_2(g) + Cl_2(g)$

- (i) Write an expression for the equilibrium constant, K_c , for the dissociation of BrC*l*.
 -[1]
- (ii) Hence, calculate the value of K_c of this reaction.

[2]

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(f) A mixture of gaseous reactants and products was allowed to reach equilibrium.

The effects on the equilibrium yield of the products caused by changes in the pressure and in the temperature of the gaseous mixture are shown in the graph.



Deduce whether the forward reaction is exothermic or endothermic.
 Explain your answer using references to the graph and to the position of equilibrium.

		[2]
(ii) Deduce whether in the total numb	r the forward reaction involves an increase or decrease ber of gaseous molecules.	
Explain your and of equilibrium.	swer using references to the graph and to the position	
		[2]
	[Total:	20]
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- Sodium fluoride reacts with concentrated sulfuric acid to form hydrogen fluoride which dissolves in water to form hydrofluoric acid, HF(aq). Hydrofluoric acid is a weak acid while sulfuric acid is a strong acid. With reference to hydrofluoric acid and sulfuric acid, define the terms (a) (i) strong and weak Arrhenius acids. _____ [2] (ii) Write an equation to show the reaction of hydrofluoric acid with water. [1] (iii) Hence, identify the two different conjugate acid-base pairs in the reaction occurring in (a)(ii). acid conjugate base base conjugate acid [2] Write the K_a expression for hydrofluoric acid, stating its unit. (iv)
 - Write the $K_{\rm a}$ expression for hydrofluoric acid, stating its unit.
 -[2]

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 $H_2O + H_2O = H_3O^+ + OH^ \Lambda H = -ve$. (i) Write the expression for the ionic product of water. [1] (ii) Explain if water will remain neutral, becomes acidic or alkaline at higher temperature. [2] Calculate the pH of 0.0500 mol dm⁻³ sulfuric acid at 298 K. (iii) [1] Using your answer in (b)(i) and (b)(iii), calculate the concentration of (iv) hydroxide ions in 0.0500 mol dm⁻³ sulfuric acid at 298 K. _____ [1]

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(c) Cinnamon is used as a condiment in various cuisines. The aroma of cinnamon is derived from its principal component, cinnamaldehyde.

The formula of structure of cinnamaldehyde is shown below.



(i) Draw and identify the cis-trans isomers of cinnamaldehyde.

RV [2] RV RV State what feature of the C=C double bond allows this molecule to (ii) RV show cis-trans isomerism. RV RV RV RV [1] RV RV (iii) Suggest a chemical test to confirm the presence of the alkene RV functional group in cinnamaldehyde. State the observation. RV RV RV Test: RV RV RV Observation: RV RV RV RV [2] RV RV RV RV

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(iv) Draw a well labelled electron-in-box diagram for a C atom present.

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[1]

(v) Hence, identify the types of bonds present in C=C using the concept of orbital overlap. Include a well labelled diagram in your answer.

[2] [Total: 20]

THE END



Additional answer space

If you use the following page to complete the answer to any question, the question number must be clearly shown.

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