



RIVER VALLEY HIGH SCHOOL

JC 2 PRELIMINARY EXAMINATION

CANDIDATE
NAME

CLASS

1	9	J		
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CENTRE
NUMBER

S				
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INDEX
NUMBER

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H1 CHEMISTRY

8873/01

Paper 1 Multiple Choice

24 September 2020

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class, centre number and index number on the Answer Sheet in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **12** printed pages.

1 Which statements are correct?

- 1 One mole of a compound is the amount that contains the same number of atoms as there are atoms in 12.000 g of carbon-12.
- 2 The relative isotopic mass of lithium-7 is the ratio of the average mass of all isotopes of lithium relative to $\frac{1}{12}$ the mass of one atom of carbon-12.
- 3 The relative atomic mass of oxygen is the ratio of the average mass of one atom of oxygen relative to $\frac{1}{12}$ the mass of one atom of carbon-12.
- 4 The relative molecular mass of water is the ratio of the average mass of one molecule of water relative to $\frac{1}{12}$ the mass of one molecule of carbon-12.

A 1 and 2 only **B** 2 and 3 only **C** 3 and 4 only **D** 3 only

2 The ionic hydrides of Group 1 and Group 2 metals react with water.



In an experiment, 1.00 g of a sample of an ionic hydride is dissolved in water. The resultant solution requires 23.75 cm³ of 2.00 mol dm⁻³ HCl(aq) for complete neutralisation.

What is the formula of the hydride?

A LiH **B** NaH **C** MgH₂ **D** CaH₂

3 Two identical solutions containing Br⁻ were titrated separately with acidified K₂Cr₂O₇(aq) and acidified KMnO₄(aq) of the same concentration.

Which of the following correctly describes the volume of acidified K₂Cr₂O₇(aq) and that of acidified KMnO₄(aq) needed to react stoichiometrically with the Br⁻ present?

- A** The volume of acidified K₂Cr₂O₇(aq) needed is 0.45 times that of acidified KMnO₄(aq) needed.
- B** The volume of acidified K₂Cr₂O₇(aq) needed is 0.55 times that of acidified KMnO₄(aq) needed.
- C** The volume of acidified K₂Cr₂O₇(aq) needed is 0.83 times that of acidified KMnO₄(aq) needed.
- D** The volume of acidified K₂Cr₂O₇(aq) needed is 1.20 times that of acidified KMnO₄(aq) needed.

- 4 What are the numbers of electrons and neutrons in the carbonate ion, $^{13}\text{C}^{16}\text{O}_3^{2-}$?

	electrons	neutrons
A	30	30
B	30	31
C	32	30
D	32	31

- 5 Paramagnetism refers to the magnetic state of an atom with one or more unpaired electrons. The greater the number of unpaired electrons in an atom, the greater the paramagnetism.

Which atom has the greatest paramagnetism?

- A** aluminium **B** scandium **C** chromium **D** manganese

- 6 Propane gas is a popular choice of fuel for barbecues and portable stoves because its low boiling point makes it vapourise as soon as it is released from its pressurised container.

Which statement best explains why propane liquefies under pressure?

- A** Increasing the pressure decreases the size of the propane molecules.
B Increasing the pressure decreases the distance between the molecules.
C Increasing the pressure decreases the kinetic energy of the propane molecules.
D Increasing the pressure causes the temperature of the gas to decrease below its boiling point.

7 Which of the following statements best explains why the boiling point of $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ is higher than that of $(\text{CH}_3)_3\text{N}$?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ molecule is polar while $(\text{CH}_3)_3\text{N}$ molecule is non-polar.
- B There are more electrons in $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ molecule than $(\text{CH}_3)_3\text{N}$ molecule.
- C The surface area of $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ molecule is larger than that of $(\text{CH}_3)_3\text{N}$ molecule.
- D There are hydrogen bonds between $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ molecules but not between $(\text{CH}_3)_3\text{N}$ molecules.

8 Which of the following statements about graphite are correct?

- 1 Each carbon atom has one delocalised electron.
- 2 The arrangement around each carbon atom is trigonal planar.
- 3 Weak instantaneous dipole-induced dipole interactions exist between layers of carbon atoms.

A 1, 2 and 3 B 1 and 2 only C 1 only D 2 only

9 *Use of the Data Booklet is relevant to this question.*

A student carried out an experiment to determine the enthalpy change of combustion of ethanol. It was found that the combustion of 1.00 g of ethanol raises the temperature of 100 g of water by 43°C .

Given that the enthalpy change of combustion of ethanol is -1370 kJ mol^{-1} , what is the efficiency of the heat transfer process?

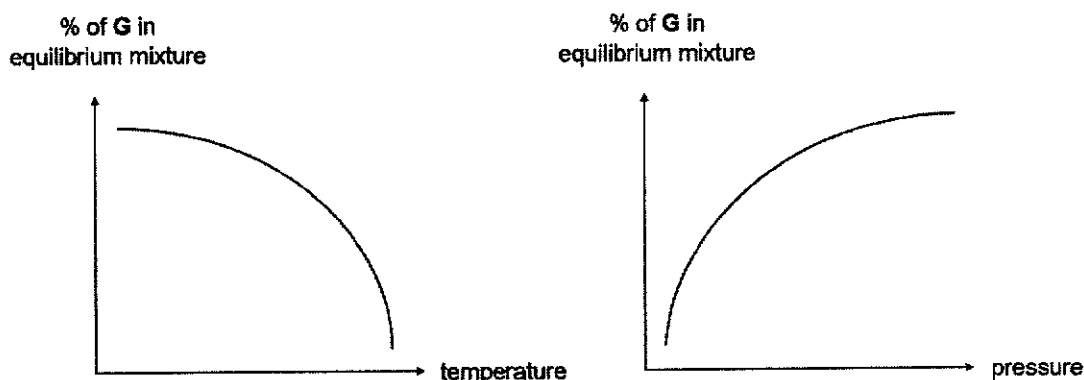
A 46% B 60% C 81% D 97%

10 The bond dissociation energy of H^-Cl is 431 kJ mol^{-1} .

In which of the following processes is 431 kJ of energy released?

- A $\text{H}(\text{g}) + \text{Cl}(\text{g}) \rightarrow \text{HCl}(\text{g})$
- B $\text{HCl}(\text{g}) \rightarrow \text{H}(\text{g}) + \text{Cl}(\text{g})$
- C $\text{HCl}(\text{g}) \rightarrow \frac{1}{2}\text{H}_2(\text{g}) + \frac{1}{2}\text{Cl}_2(\text{g})$
- D $\frac{1}{2}\text{H}_2(\text{g}) + \frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{HCl}(\text{g})$

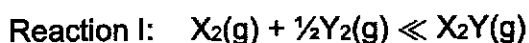
- 11 Compound **G** is formed during a reaction involving only gaseous particles. The graphs below show how the percentage of compound **G** at equilibrium varies with temperature and pressure.



Which of the following equations represents the formation of compound **G**?

- | | | |
|----------|--|-----------------------|
| A | $E(g) + 3F(g) \rightleftharpoons 2G(g)$ | ΔH : negative |
| B | $2E(g) \rightleftharpoons F(g) + 2G(g)$ | ΔH : positive |
| C | $4D(g) + 3E(g) \rightleftharpoons 2F(g) + 6G(g)$ | ΔH : negative |
| D | $E(g) + F(g) \rightleftharpoons 2G(g)$ | ΔH : positive |

- 12 Two equilibria are shown below.

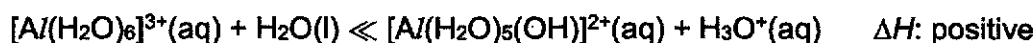


The numerical value of K_c for reaction I is 2.

Under the same conditions, what is the numerical value of K_c for reaction II?

- | | | | | | | | |
|----------|---------------|----------|----------------------|----------|---------------|----------|----|
| A | $\frac{1}{2}$ | B | $\frac{1}{\sqrt{2}}$ | C | $\frac{1}{4}$ | D | -2 |
|----------|---------------|----------|----------------------|----------|---------------|----------|----|

- 13 Hydrated aluminium ion hydrolyses as shown below.



Which of the following statements about the equilibrium are true?

- 1 $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ is more stable in acidic conditions.
- 2 Addition of $\text{OH}^-(\text{aq})$ favours the formation of $[\text{Al}(\text{H}_2\text{O})_5(\text{OH})]^{2+}$.
- 3 Increasing the concentration of $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ increases the value of K_c .

A 1 and 2 only B 1 and 3 only C 2 only D 3 only

- 14 35.0 cm^3 of $0.001 \text{ mol dm}^{-3}$ dilute nitric acid is added to 35.0 cm^3 of $0.001 \text{ mol dm}^{-3}$ dilute sulfuric acid.

What is the resultant pH of the mixture?

A 1.5 B 2.5 C 2.8 D 3.0

- 15 Three unknown solutions **P**, **Q** and **R** contain a strong monoprotic acid, a weak monoprotic acid and a strong monoprotic base, but not necessarily in the same order. The concentration and pH of each solution are shown below.

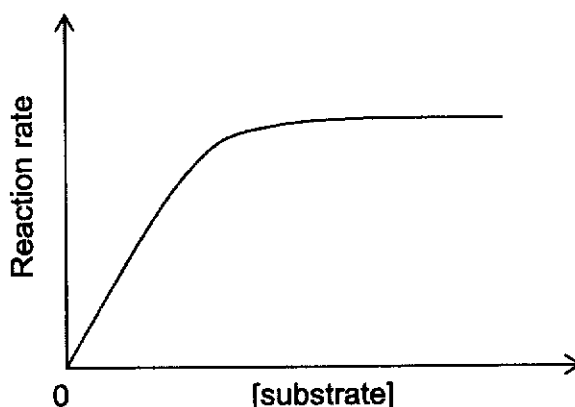
P	Q	R
$1.000 \text{ mol dm}^{-3}$ pH = 2.4	$0.010 \text{ mol dm}^{-3}$ pH = 12.0	$0.001 \text{ mol dm}^{-3}$ pH = 3.0

Which of the following statements are true?

- 1 **P** contains the weak acid.
- 2 **Q** contains the strong base.
- 3 Mixing equal volumes of **Q** and **R** gives rise to a solution of pH 7.

A 2 only B 1 and 2 only C 2 and 3 only D 1, 2 and 3

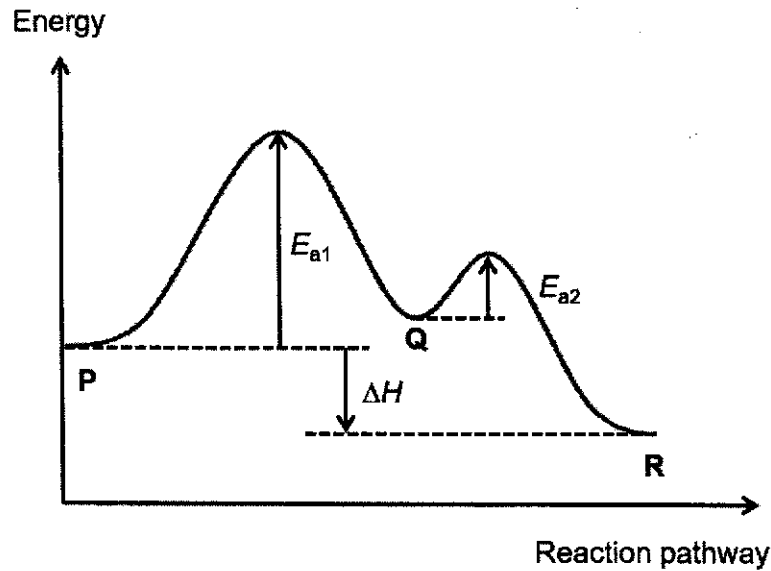
- 16 Which statement about buffer solutions is correct?
- A The pH of a buffer solution changes slightly when a small amount of acid or base is added.
 - B The pH of a buffer solution remains unchanged when a small amount of acid or base is added.
 - C The pH of a buffer solution changes slightly when a large amount of acid or base is added.
 - D The pH of a buffer solution remains unchanged when a large amount of acid or base is added.
- 17 In an enzyme-catalysed reaction, the rate is affected by the concentration of substrate as shown in the graph below.



Which of the following conclusions can be drawn?

- 1 When [substrate] is low, the reaction is 1st order with respect to the substrate.
 - 2 When [substrate] is high, the reaction is 0 order with respect to the substrate.
 - 3 When [substrate] is high, all the active sites on the enzymes are occupied.
- A 1, 2 and 3 B 1 and 2 only C 2 and 3 only D 3 only

- 18 The energy profile diagram of a reaction, $P \rightarrow R$, is shown below.



Which of the following statements are true?

- 1 **Q** is an intermediate for the reaction.
- 2 The addition of a catalyst has no effect on ΔH .
- 3 Increasing the temperature decreases both the values of E_{a1} and E_{a2} .

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 1 only

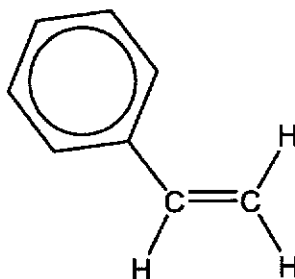
- 19 **X** and **Y**, with half-lives of 5 min and 10 min respectively, are two isotopes of a radioactive element. An experiment begins with 4 times as many atoms of **X** as of **Y**.

Given that radioactive decay is a first-order reaction, how long will it take for the number of atoms of **X** left to become equal to the number of atoms of **Y** left?

- A** 10 min **B** 15 min
C 20 min **D** 25 min

- 20 For elements in the third period of the Periodic Table, which property decreases consistently from sodium to chlorine?
- A melting point
B atomic radius
C electronegativity
D electrical conductivity
- 21 J, K and L are elements in the same period of the Periodic Table. The oxide of J is amphoteric, the oxide of K is basic and the oxide of L is acidic.
Which of the following trends for these elements are correct?
- 1 proton number: $K < J < L$
2 atomic radius: $L < J < K$
3 melting point: $J < L < K$
- A 1 only B 2 only C 1 and 2 only D 1, 2 and 3
- 22 Which of the following correctly describes the trend for elements in Group 17?
- A boiling point of HX decreases from HF to HI
B bond length of X-X bond increases from F-F to I-I
C bond energy of X-X bond decreases from F-F to I-I
D bond energy of H-X bond increases from H-F to H-I
- 23 What is the total number of hydrocarbons formed, including stereoisomers, when 2-chlorobutane is heated under reflux with ethanolic NaOH?
- A 1 B 2 C 3 D 4

- 27 Polystyrene is a polymer that is made up of repeated units of styrene.



styrene

Which statements are correct?

- 1 Styrene decolourises bromine dissolved in CCl_4 .
- 2 The conversion of styrene monomers to polystyrene involves addition reaction.
- 3 All atoms lie on the same plane for styrene as well as polystyrene.

A 1 and 2 only **B** 2 and 3 only **C** 1 and 3 only **D** 1, 2 and 3

- 28 A section of nylon-6,6 is shown below.



Which monomers could form this polymer?

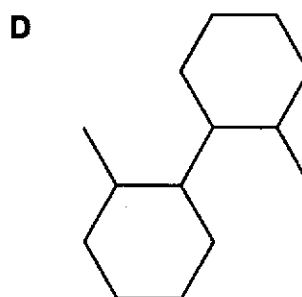
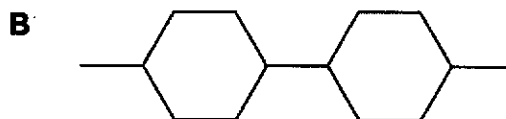
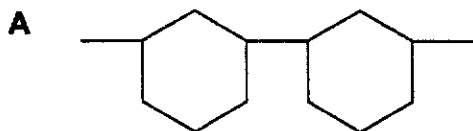
- | | | | |
|----------|---|-----|---|
| A | $\text{NH}_2(\text{CH}_2)_6\text{NH}_2$ | and | $\text{CH}_3(\text{CH}_2)_3\text{CO}_2\text{H}$ |
| B | $\text{NH}_2(\text{CH}_2)_6\text{NHCO}_2\text{H}$ | and | $\text{CH}_3(\text{CH}_2)_3\text{CO}_2\text{H}$ |
| C | $\text{NH}_2(\text{CH}_2)_6\text{NH}_2$ | and | $\text{HO}_2\text{C(CH}_2\text{)}_4\text{CO}_2\text{H}$ |
| D | $\text{CH}_3(\text{CH}_2)_5\text{NH}_2$ | and | $\text{HO}_2\text{C(CH}_2\text{)}_4\text{CONH}_2$ |

- 29 Cyclohexene can form an addition polymer.

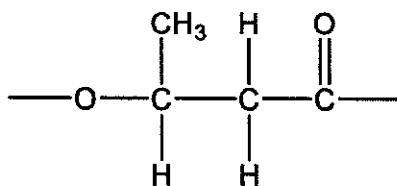


cyclohexene

Which of the following shows a section of the polymer?



- 30 The polymer having the repeat unit shown occurs in bacteria as cell storage material.



Which of the following deductions can be made about this substance?

- 1 It is a polyester.
- 2 It can be readily made from $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$.
- 3 Hydrogen bonding is formed between two polymer chains.

- A** 1, 2 and 3 **B** 1 and 3 only **C** 2 and 3 only **D** 1 only



RIVER VALLEY HIGH SCHOOL

JC 2 PRELIMINARY EXAMINATION

CANDIDATE
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H1 CHEMISTRY

8873/02

Paper 2 Structured Questions

16 September 2020

Additional Materials: Data Booklet

2 hours

READ THESE INSTRUCTIONS FIRST.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Write your name, class and index number in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** the questions.

Section B

Answer **one** question.

If additional space is required, you should use the page at the end of this booklet (page 28). The question number must be clearly shown.

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 Examiner's Use	
Paper 1	30
Paper 2	
1	15
2	9
3	11
4	6
5	12
6	7
7 or 8	20
5-1	
units	
Paper 2 total	80
Total	110

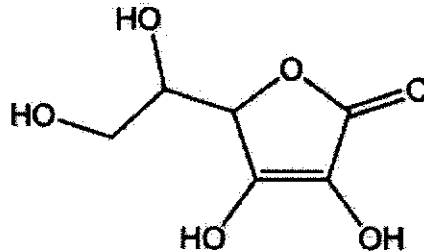
This paper consists of **26** printed pages and **2** blank pages.

Section A

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

- 1 Ascorbic acid, commonly known as Vitamin C, is an important water-soluble vitamin and biological antioxidant. Vitamin C is needed by the body to support growth and repair of bones, muscles, blood vessels as well as aid in the absorption of iron.

Vitamin C has the following structure:



Vitamin C is commercially sold in the form of 500 mg tablets. For adults, the recommended daily intake for Vitamin C is 65 to 90 milligrams (mg), and the maximum limit is 2 g a day. Although too much dietary Vitamin C is unlikely to be harmful, an overdose might cause symptoms like diarrhoea, nausea and abdominal cramps.

- (a) On the structure above, circle and name three different functional groups present in Vitamin C. [3]
- (b) Calculate the maximum number of 500 mg Vitamin C tablets that an adult can consume in a week. [1]

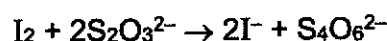
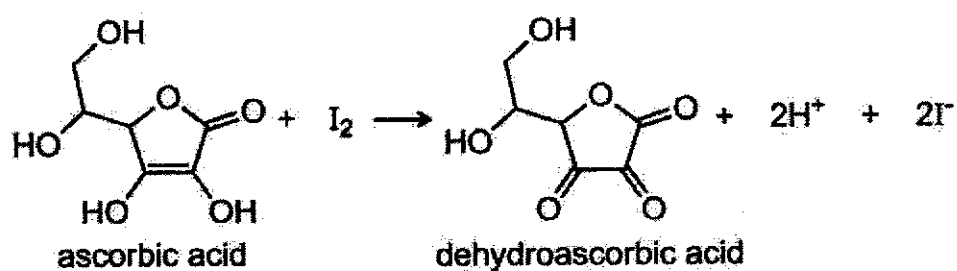
- (c) Draw a diagram to suggest why vitamin C is soluble in water. [2]

To determine the concentration of ascorbic acid in a Vitamin C tablet, an iodometric titration is carried out.

Firstly, one 500 mg Vitamin C tablet is dissolved in sulfuric acid and diluted with deionised water up to the 250 cm³ mark in a volumetric flask. 25.0 cm³ of this ascorbic acid solution is pipetted into a conical flask containing 3.00 × 10⁻⁴ mol of iodine solution (excess). The unreacted iodine in the resulting solution is immediately titrated with a standard sodium thiosulfate solution, Na₂S₂O₃, until the brown colour of iodine lightens to a pale yellow.

Starch indicator is added at this point to form an intense blue-black complex with the iodine still present in the conical flask. The titration with Na₂S₂O₃ is continued until the blue-black colour disappears, leaving a colourless solution.

The reaction equations are as follows:



It was found that 12.50 cm³ of 0.00500 mol dm⁻³ Na₂S₂O₃ is required to observe the disappearance of the blue-black colour.

- (d) (i) Calculate the amount of I₂ that reacted with Na₂S₂O₃.

[1]

- (ii) Calculate the amount of I₂ that reacted with 25 cm³ of ascorbic acid solution.

[1]

(iii) Calculate the amount of ascorbic acid in the 250 cm³ standard solution.

[1]

(iv) Determine the mass percentage of ascorbic acid in a 500 mg Vitamin C tablet.

[2]

(e) Describe a simple chemical test that can be used to distinguish between ascorbic acid and dehydroascorbic acid. Write the observation for each compound.

.....
.....
.....

[2]

(f) Use the table of characteristic values for infra-red absorption in the *Data Booklet* to answer this question.

Identify an infra-red absorption range that will be shown by

(i) both ascorbic acid and dehydroascorbic acid

.....

[1]

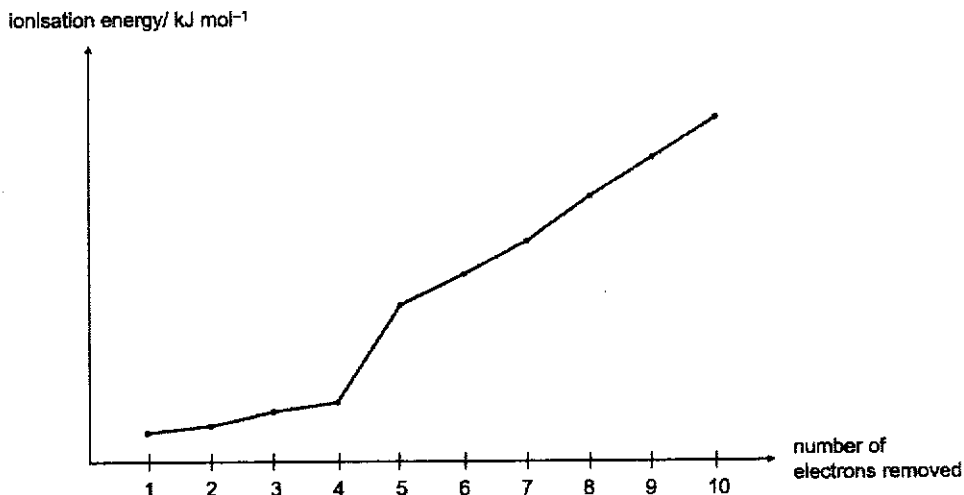
(ii) dehydroascorbic acid but not by ascorbic acid

.....

[1]

[Total: 15]

- 2 (a) The graph below shows the successive ionisation energies of an element in Period 3.



- (i) Explain the general trend in successive ionisation energies.

.....
.....
.....

[1]

- (ii) Identify the element and explain your answer.

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[2]

- (b) The table below shows the properties of two successive Period 3 elements, X and Y.

element	X	Y
melting point/ °C	660	1414
electrical conductivity	very good	low

- (i) Suggest the nature of the oxide of element X.

..... [1]

- (ii) Using the **actual** chemical symbol for element X, write a balanced equation, with state symbols, for the reaction between the oxide of element X and NaOH(aq).

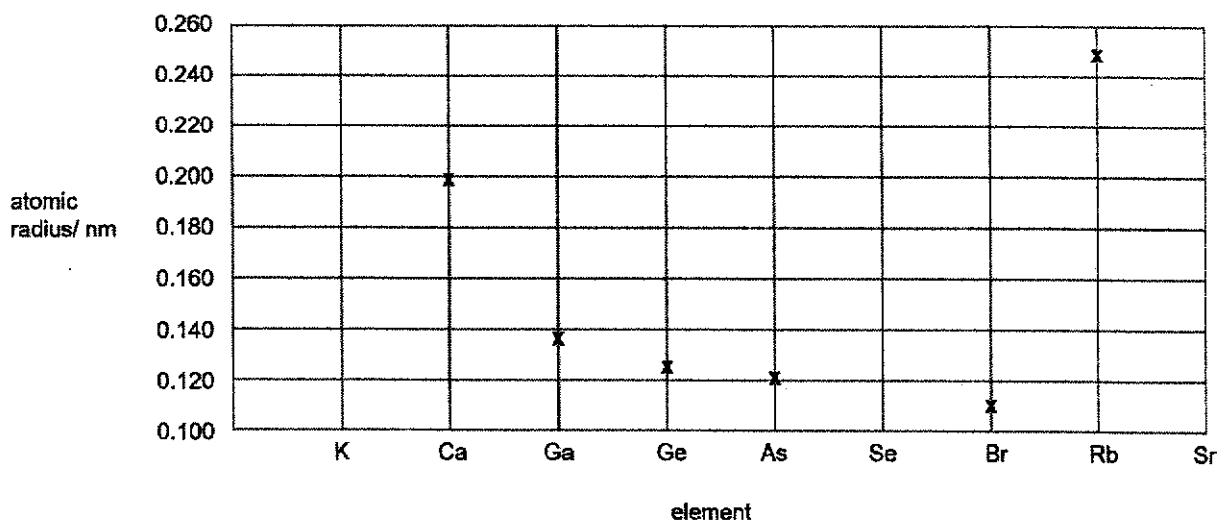
..... [1]

- (iii) State the pH of the reaction mixture obtained when the oxide of element Y is added to water.

..... [1]

- (c) (i) The graph below can be used to plot the atomic radii of the elements potassium to strontium (excluding the d-block elements and krypton). Six of these elements have already been plotted.

Use your knowledge of the variation in atomic radius of the elements of Period 3 (Na to Cl) to estimate and plot on the graph, the atomic radii of the other three elements: K, Se and Sr. [1]



(ii) Justify your predictions in (c)(i), by explaining how the atomic radii of:

- K compare with that of Rb, and
- Se compare with that of As.

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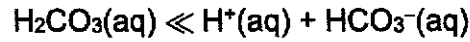
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.....

[2]

[Total: 9]

3 Carbonic acid, H_2CO_3 is a weak acid.



(a) Explain the term *weak acid*.

..... [1]

(b) Write an expression for the acid dissociation constant, K_a , of carbonic acid, and state its units.

..... [2]
.....

In the human biological system, the blood is responsible for the transport of materials as well as distribution of heat throughout the body. Due to the many biochemical processes taking place in blood, a buffer system consisting of H_2CO_3 and HCO_3^- is present to maintain pH level at 7.40.

(c) Describe and explain, with the aid of relevant equations, how the presence of H_2CO_3/HCO_3^- in blood helps to maintain pH levels.

..... [2]
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Another commonly used laboratory buffer solution, especially in experiments involving nucleic acids, is called Tris/Borate/EDTA (TBE). Boric acid, also known as boron(III) hydroxide, is a major component of TBE buffer.

Boric acid is acidic because it can react with water to form tetrahydroxyborate, B(OH)_4^- .

- (d) Write a balanced chemical equation for the reaction of boric acid with water.

..... [1]

- (e) Draw the dot-and-cross diagram of B(OH)_4^- .

[1]

- (f) State the shape and angle around the boron atom.

..... [2]

- (g) Explain why B(OH)_3 can react with OH^- to form B(OH)_4^- .

.....

 [2]

[Total: 11]

- 4 (a) Define the term *lattice energy*.

.....

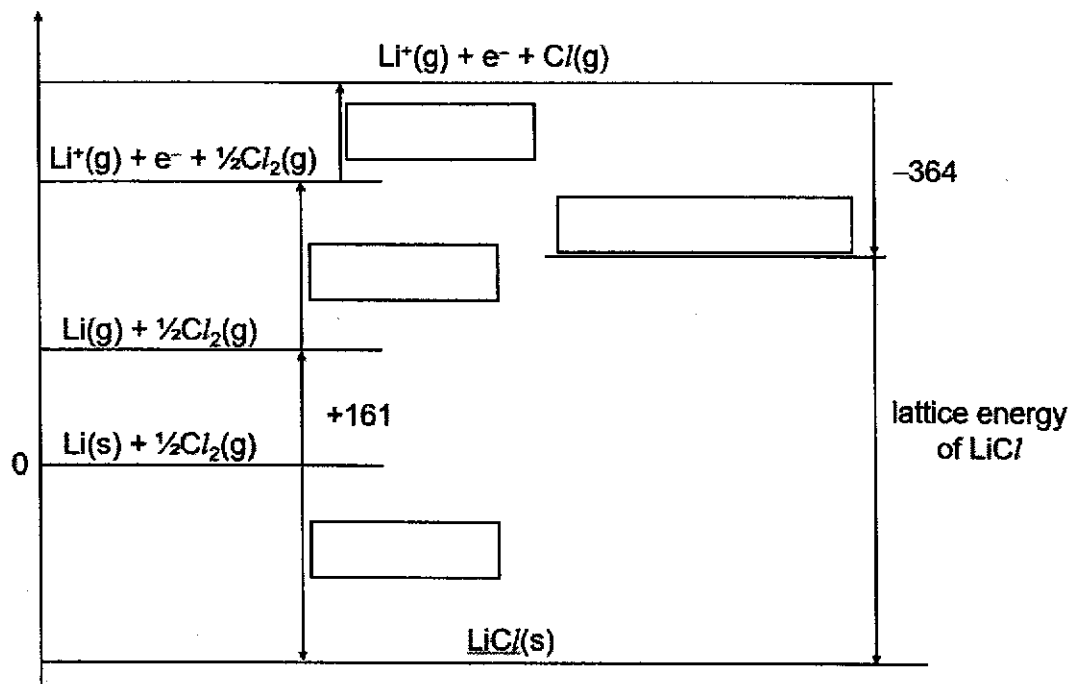
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[1]

- (b) (i) The lattice energy of lithium chloride can be calculated using the Born-Haber cycle below.

Given that the standard enthalpy change of formation of lithium chloride is -409 kJ mol^{-1} , use relevant information from the *Data Booklet* to fill in the blanks in the Born-Haber cycle.

Energy/ kJ mol^{-1} 

[2]

- (ii) Hence, calculate the lattice energy of lithium chloride.

[1]

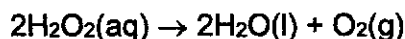
(c) Explain how the magnitude of lattice energy of magnesium oxide compares with that of lithium chloride.

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[2]

[Total: 6]

- 5 A solution of hydrogen peroxide was catalytically decomposed using solid manganese(IV) oxide, MnO_2 .



The rate of reaction can be followed by measuring the volume of oxygen collected at regular time intervals. The following results were obtained:

Time, t / min	0	2	4	6	8	10	12	14
Volume of $\text{O}_2(\text{g})$ collected, V_t / cm^3	0	1.26	2.38	3.30	4.00	4.56	5.00	5.20

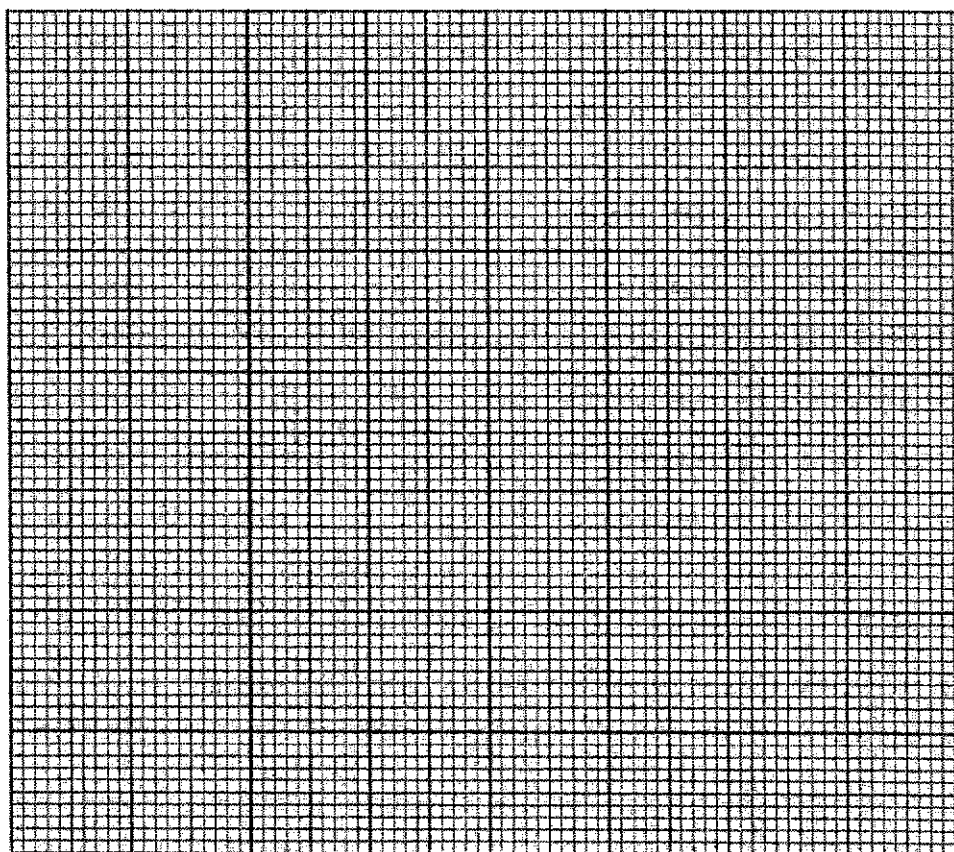
Upon complete decomposition of the hydrogen peroxide solution, the volume of oxygen collected, V_n , was 6.20 cm^3 .

- (a) Explain the significance of $V_n - V_t$.

.....

[1]

- (b) By means of a suitable graph, deduce the order of reaction with respect to H_2O_2 .



[3]

(c) Calculate the value of the rate constant.

[1]

(d) State the **type** of catalyst involved in the decomposition of H_2O_2 . Describe how this type of catalyst speeds up the reaction.

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[4]

(e) Outline another method, other than measuring the volume of oxygen collected, that can be used to monitor the rate of this reaction.

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[3]

[Total: 12]

[Turn over

- 6 (a) Poly(ethene) is a thermoplastic.
Explain the term *thermoplastic*.

.....

[1]

- (b) By adjusting the polymerisation process, two different types of poly(ethene) can be produced – low density poly(ethene) (LDPE) and high density poly(ethene) (HDPE).
Describe the structure and bonding in LDPE and HDPE, and explain how they affect their physical properties.

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[4]

- (c) Suggest a use for each polymer in view of its physical properties.

.....

[1]

- (d) In contrast to thermoplastics, thermosets are known to have low recyclability. Explain why this is so.

.....

.....

[1]

[Total: 7]

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Section B

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

- 7 (a) Describe and explain the reducing power of Group 1 elements down the group.

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.....

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.....

[2]

- (b) Table 7.1 gives the melting points, in °C, of the oxides and chlorides of three elements in Period 3.

Table 7.1

	magnesium	silicon	phosphorus
oxide	2800	1700	24
chloride	714	-70	-92

Explain, in terms of structure and bonding, the differences in melting point between:

- (i) MgO and SiO₂,

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[2]

- (ii) SiCl₄ and PCl₃.

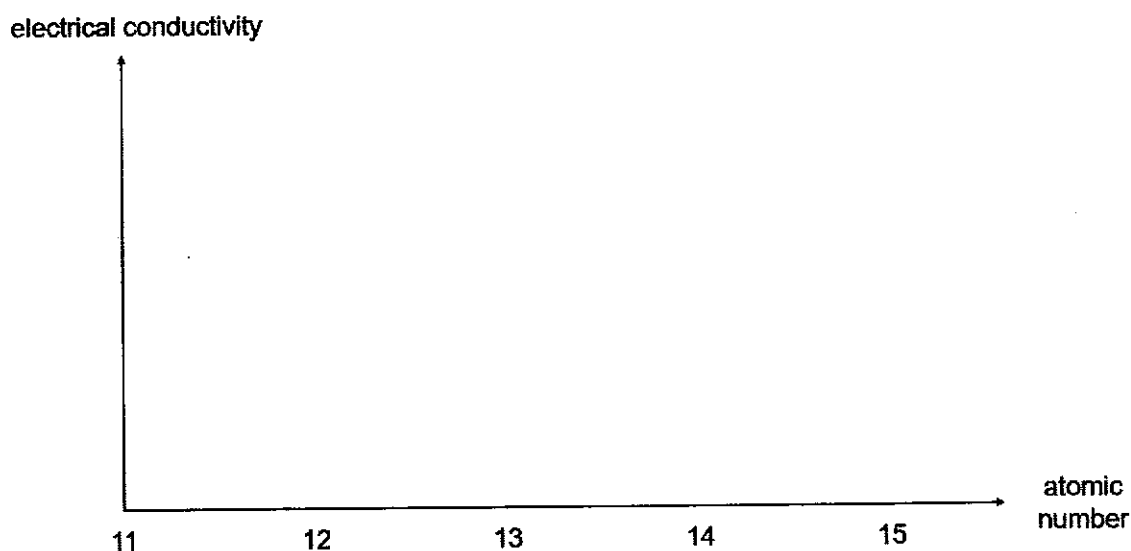
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[1]

- (c) (i) In the axes below, sketch a graph to show the variation in electrical conductivities of Period 3 elements from sodium to phosphorus.



[1]

- (ii) Explain, with reference to structure and bonding:
- the variation in electrical conductivity from sodium to aluminium, and
 - the electrical conductivity of phosphorus.

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.....

[2]

- (d) A solution of $\text{UO}_2^{2+}(\text{aq})$ is yellow. An excess of silver powder is added to the yellow solution in the presence of acid, and the $\text{UO}_2^{2+}(\text{aq})$ is reduced to $\text{U}^{x+}(\text{aq})$.

The $\text{U}^{x+}(\text{aq})$ formed can be oxidised back to $\text{UO}_2^{2+}(\text{aq})$ by acidified $\text{MnO}_4^{-}(\text{aq})$. It is found that 20.0 cm^3 of $0.100 \text{ mol dm}^{-3} \text{ U}^{x+}(\text{aq})$ reacted with 16.00 cm^3 of $0.050 \text{ mol dm}^{-3} \text{ MnO}_4^{-}(\text{aq})$. The half-equation for the reduction of $\text{MnO}_4^{-}(\text{aq})$ is given below:



- (i) State the oxidation state of uranium in $\text{UO}_2^{2+}(\text{aq})$.

..... [1]

- (ii) Write the electronic configuration of $\text{Mn}^{2+}(\text{aq})$.

..... [1]

- (iii) Calculate the amount of $\text{U}^{x+}(\text{aq})$ that reacted with 1 mol of $\text{MnO}_4^{-}(\text{aq})$ in the reaction.

Hence, determine the value of x.

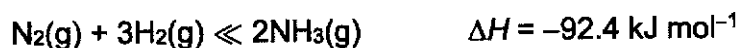
[3]

- (iv) $\text{UO}_2^{2+}(\text{aq})$ can also be reduced by zinc to form $\text{U}^{3+}(\text{aq})$.

Construct a balanced equation for the reaction between zinc and $\text{UO}_2^{2+}(\text{aq})$ in acidic medium.

..... [1]

- (e) The Haber process is the industrial preparation of ammonia involving nitrogen and hydrogen reacting in a reversible process.



- (i) Write an expression for the equilibrium constant, K_c , for Haber process and state its units.

..... [1]

- (ii) At the start of the reaction, 1.20 mol dm^{-3} of $\text{N}_2(\text{g})$ and 4.00 mol dm^{-3} of $\text{H}_2(\text{g})$ were introduced into an evacuated tank. When equilibrium was reached at 500°C , it was found that 20% of the $\text{N}_2(\text{g})$ had reacted to form $\text{NH}_3(\text{g})$.

Fill in the table below.

	$\text{N}_2(\text{g})$	+	$3\text{H}_2(\text{g})$	\rightleftharpoons	$2\text{NH}_3(\text{g})$
Initial [] / mol dm^{-3}	1.20		4.00		0
Change in [] / mol dm^{-3}					
Equilibrium [] / mol dm^{-3}					

[2]

- (iii) Hence, calculate the K_c for Haber process at 500°C .

[1]

- (iv) The numerical value of K_c for Haber process at 400°C is 0.0150. Explain the difference between this value and the one determined in (e)(iii).

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[1]

20

- (v) State and explain the effect of adding finely divided iron to the reaction mixture on K_c .

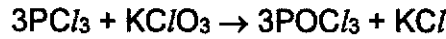
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.....

[1]

[Total: 20]

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8 (a) PCl_3 undergoes oxidation with $KClO_3$ to form $POCl_3$.



(i) Draw the dot-and-cross diagrams for PCl_3 and $POCl_3$, given that phosphorus is the central atom in both molecules.

[2]

(ii) The $Cl-P-Cl$ bond angle in PCl_3 is 100° while that in $POCl_3$ is 103° .

Using the Valence Shell Electron Pair Repulsion theory, explain the difference in the bond angles.

.....
.....
.....
.....

[2]

(iii) Explain, using structure and bonding, whether the melting point of $KClO_3$ is higher or lower than that of $POCl_3$.

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.....
.....

[2]

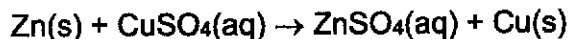
(iv) The molecule of POCl_3 contains both σ (sigma) and π (pi) bonds. Draw labelled diagrams to show how orbitals in POCl_3 overlap to form

- a σ (sigma) bond,

- a π (pi) bond.

[2]

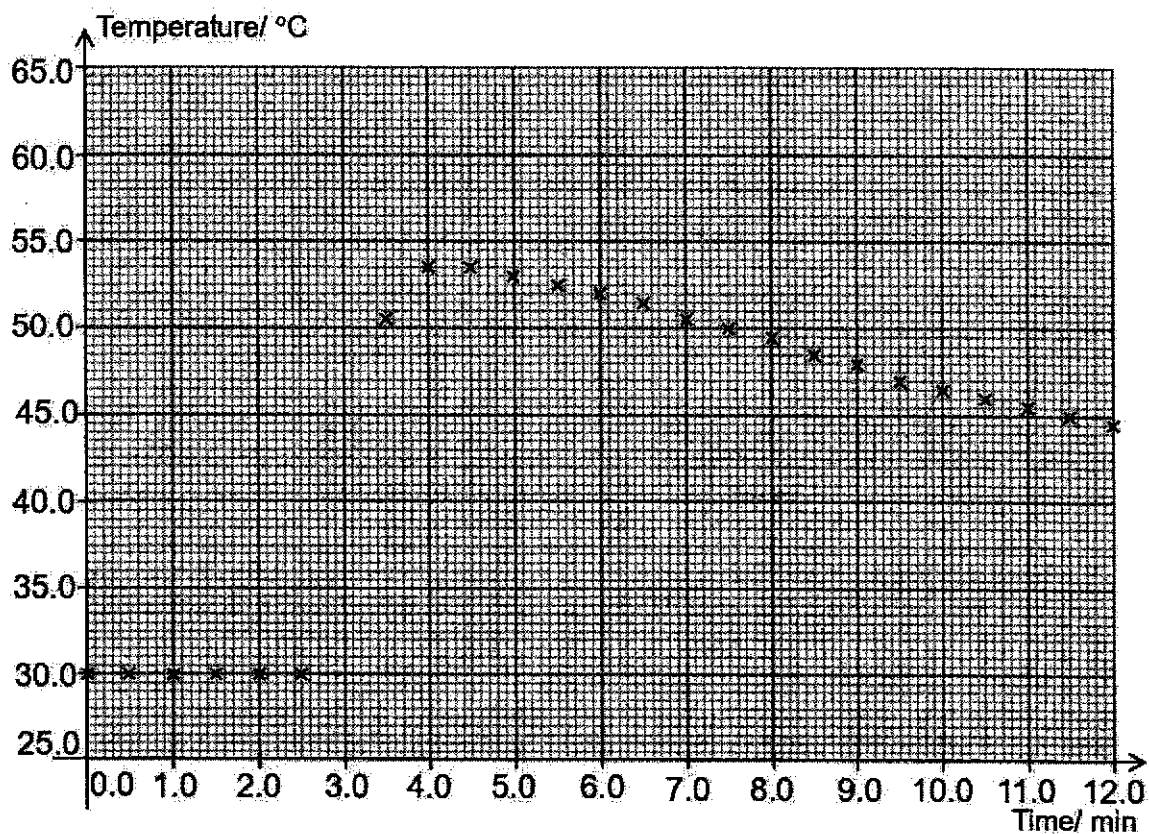
(b) The reaction between Zn(s) and $\text{CuSO}_4(\text{aq})$ is an exothermic reaction.



A student conducted a thermochemical experiment using the following procedure:

1. Add 25.0 cm^3 of 1.00 mol dm^{-3} $\text{CuSO}_4(\text{aq})$ in a polystyrene cup.
2. Stir gently with a thermometer and record the temperature of $\text{CuSO}_4(\text{aq})$ every 0.5 min for 2.5 min.
3. At exactly 3.0 min, add a fixed mass of Zn(s) into the polystyrene cup.
4. Stir the mixture thoroughly and continue recording the temperature of the mixture every 0.5 min from 3.5 min to 12.0 min.

The student plotted his data points on a grid but did not complete the graph.



(i) Complete the graph for the student.

By extrapolation of the graph, estimate the maximum temperature of the mixture at 3.0 min.

..... [2]

(ii) Determine the highest temperature rise produced by this reaction.

[1]

- (iii) Using your answer in (b)(ii), calculate the heat evolved for this reaction.

You may assume that 4.2 J of heat is required to raise the temperature of 1.0 cm³ of the solution by 1.0 °C.

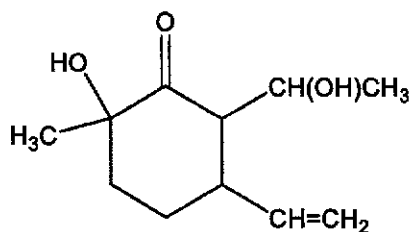
[1]

- (iv) Hence, determine the enthalpy change of reaction between Zn(s) and CuSO₄(aq) given that the mass of Zn(s) used was 1.050 g.

[2]

26

(c) Compound X has the following structure.



Draw the structures of the products formed when compound X is separately reacted with:

(i) hot acidified $K_2Cr_2O_7(aq)$

[1]

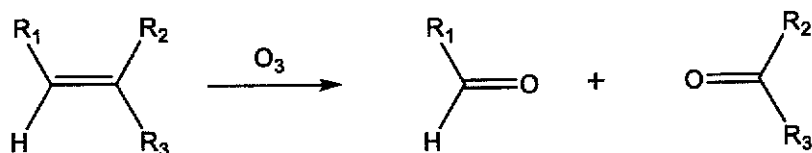
(ii) Br_2 dissolved in CCl_4

[1]

(iii) $LiAlH_4$ in dry ether

[1]

- (d) Ozonolysis is a reaction where the unsaturated bonds of alkenes are cleaved with ozone, forming carbonyl compounds.

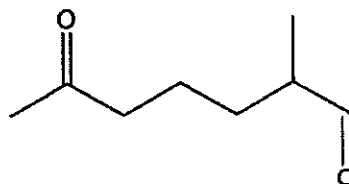


- (i) Suggest the structures of the products formed from the ozonolysis of 3-methylpent-2-ene.

Give the IUPAC names of the products.

[2]

- (ii) Suggest the structure of an alkene (C_8H_{14}) that undergoes ozonolysis to form the following compound.



[1]

[Total: 20]

A large rectangular area containing 28 horizontal dotted lines, intended for student responses.

Qn	Ans	Qn	Ans	Qn	Ans
1	D	11	A	21	C
2	D	12	C	22	B
3	C	13	A	23	C
4	D	14	C	24	B
5	C	15	B	25	D
6	B	16	A	26	B
7	D	17	A	27	A
8	A	18	B	28	C
9	B	19	C	29	D
10	A	20	B	30	D

Section A

1 (a)

[Redacted]

[3]

(b)

[Redacted]

[1]

(c)

[Redacted]

[2]

(d) (i)

[Redacted]

[1]

(ii)

[Redacted]

[1]

(iii)

[Redacted]

[1]

(iv)

[Redacted]

[2]

(e)

[Redacted]

[2]

[1]

[2]

3 (a)

(b)

(c)

[2]

[1]

(d)

(e)

[1]

[2]

[2]

(f)

(g)

[Total: 11]

[Turn over

[1]

[1]

[Total: 15]

[1]

[2]

[1]

[1]

[1]

(f) (i)

(ii)

2 (a) (i)

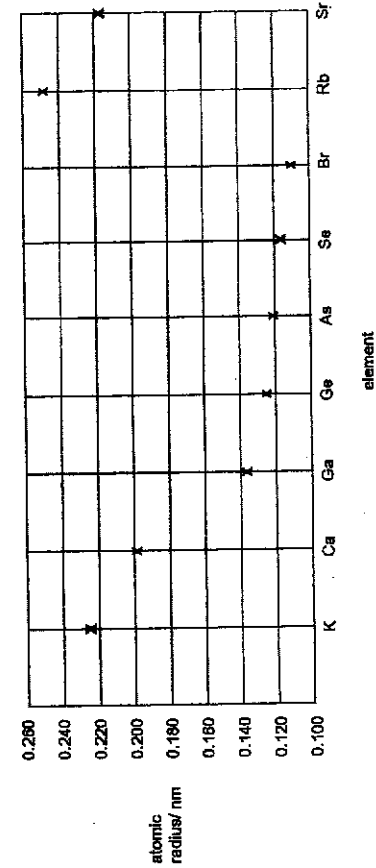
(ii)

(b) (i)

(ii)

(iii)

(c) (i)



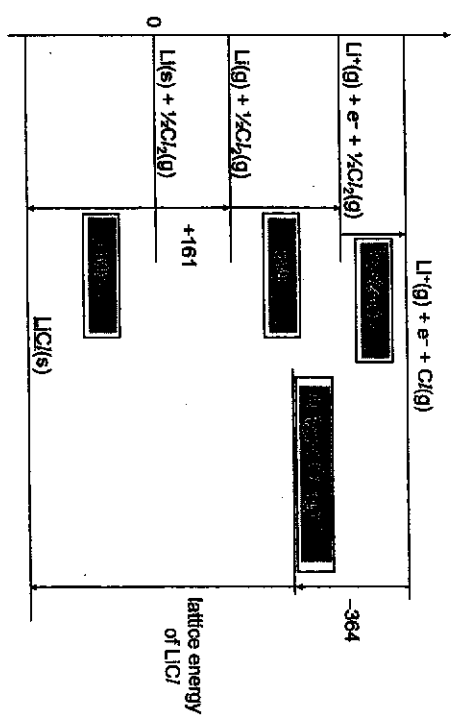
(ii)

[2]

[Total: 9]

4 (a) [1]

(b) (i) Energy/ kJ mol⁻¹

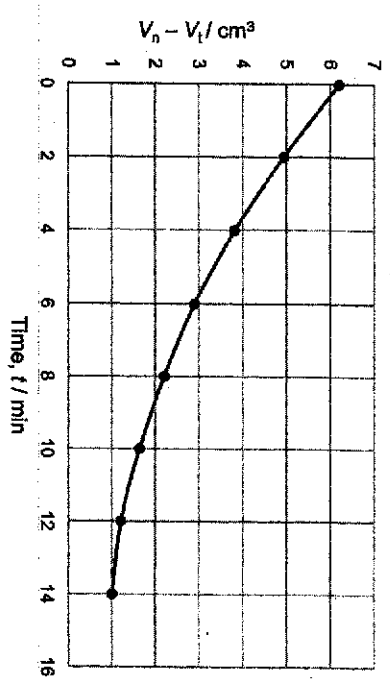


(ii) [2]

(c) [2]

[Total: 6]

5 (a) [1]



(b) [3]

(c) [1]

(d) [1]

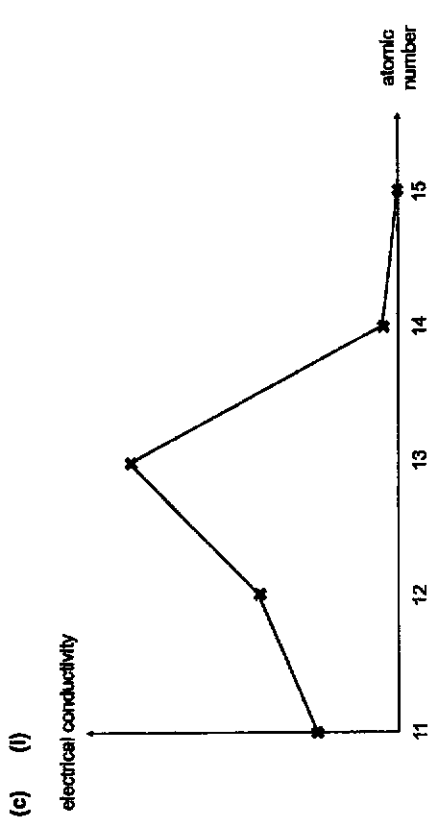
(e) [4]

[3]

[Total: 12]

Section B

- 7 (a) [2]
- (b) (i) [2]
- (ii) [1]



- (d) (i) [1]
- (ii) [2]

- 6 (a) [1]
 - (b) [4]
 - (c) [1]
 - (d) [1]
- [Total: 7]

[Turn over

(ii)

[REDACTED]

[1]

(iii)

[REDACTED]

[1]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

(iv)

[REDACTED]

[3]

(e) (i)

[REDACTED]

[1]

(ii)

[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

[2]

(iii)

[REDACTED]

[1]

(iv)

[REDACTED]

[1]

(v)

[REDACTED]

[1]

[Total: 20]

8 (a) (i)

[REDACTED]

(ii)

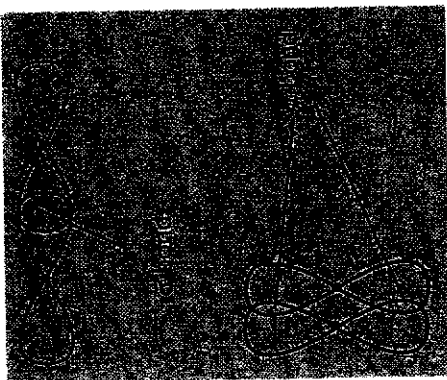
[REDACTED]

[2]

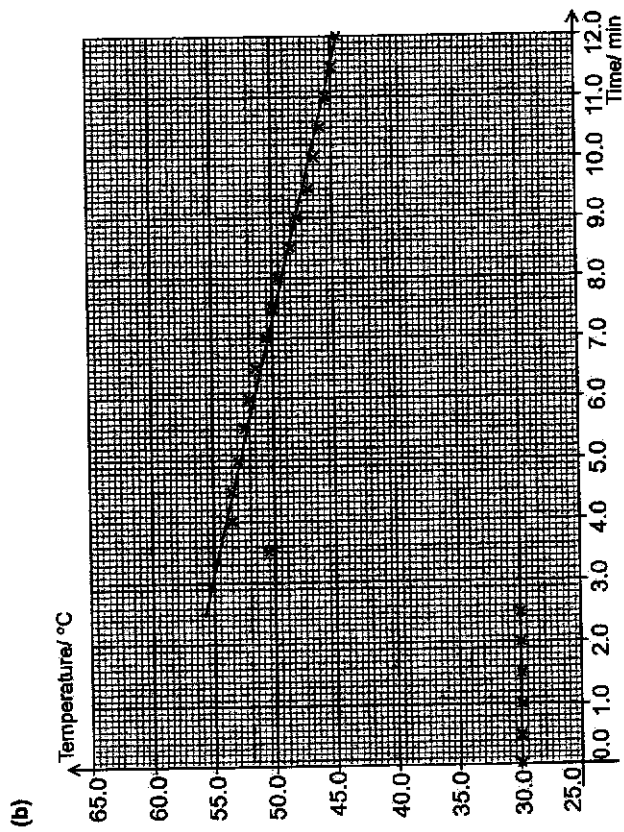
(iii)

[REDACTED]

[2]



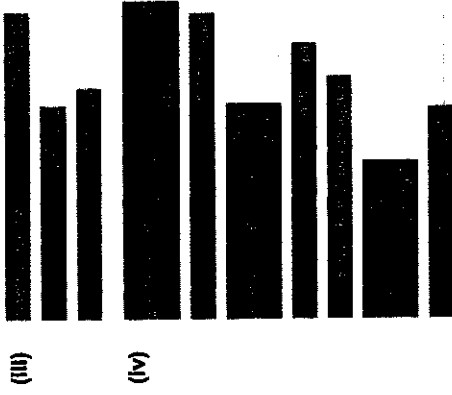
[2]



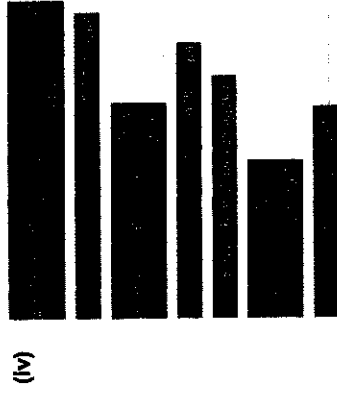
[2]



[1]



[1]



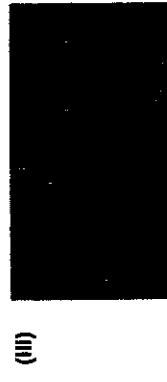
[2]



[1]



[1]



[1]



[2]

12



(ii)



[1]

[Total : 20]

