



CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION

CHEMISTRY

Paper 02 – General Proficiency

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in TWO sections. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. Where appropriate, ALL WORKING MUST BE SHOWN in this booklet.
5. You may use a silent, non-programmable calculator to answer questions.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s) you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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NOTHING HAS BEEN OMITTED.

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SECTION A

Answer ALL questions.

DO NOT spend more than 30 minutes on Question 1.

1. (a) Michael and Jennifer were assigned a group project to investigate the effect of surface area on the rate of reaction between zinc metal (Zn) and dilute sulfuric acid (H_2SO_4). They obtained six different grades of granulated zinc. The grades represent the average size of the radius (in microns, μm) of the granules. Six experiments were carried out using the different grades of zinc granules which were reacted with an excess of 0.5 mol dm^{-3} dilute sulfuric acid at $25^\circ C$. The same mass, 0.55 g of zinc granules was used in all experiments and the time taken to collect 100 cm^3 of hydrogen gas was noted as shown in Table 1 on page 6.

Figure 1 shows the stopwatch readings of the time taken to collect 100 cm^3 of hydrogen gas for Experiments 1–6.

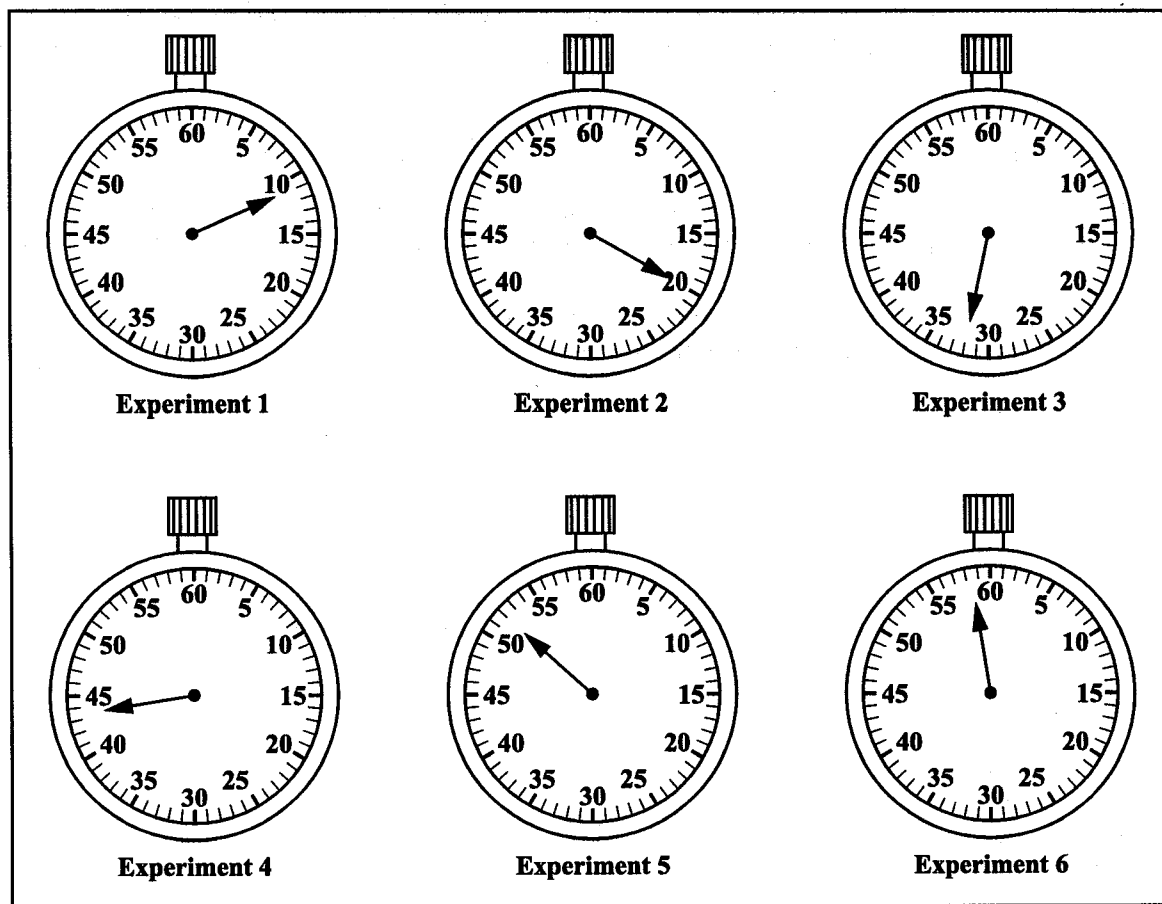


Figure 1. Time taken to collect 100 cm^3 of hydrogen gas

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TABLE 1. DATA OBTAINED FOR EXPERIMENTS 1–6

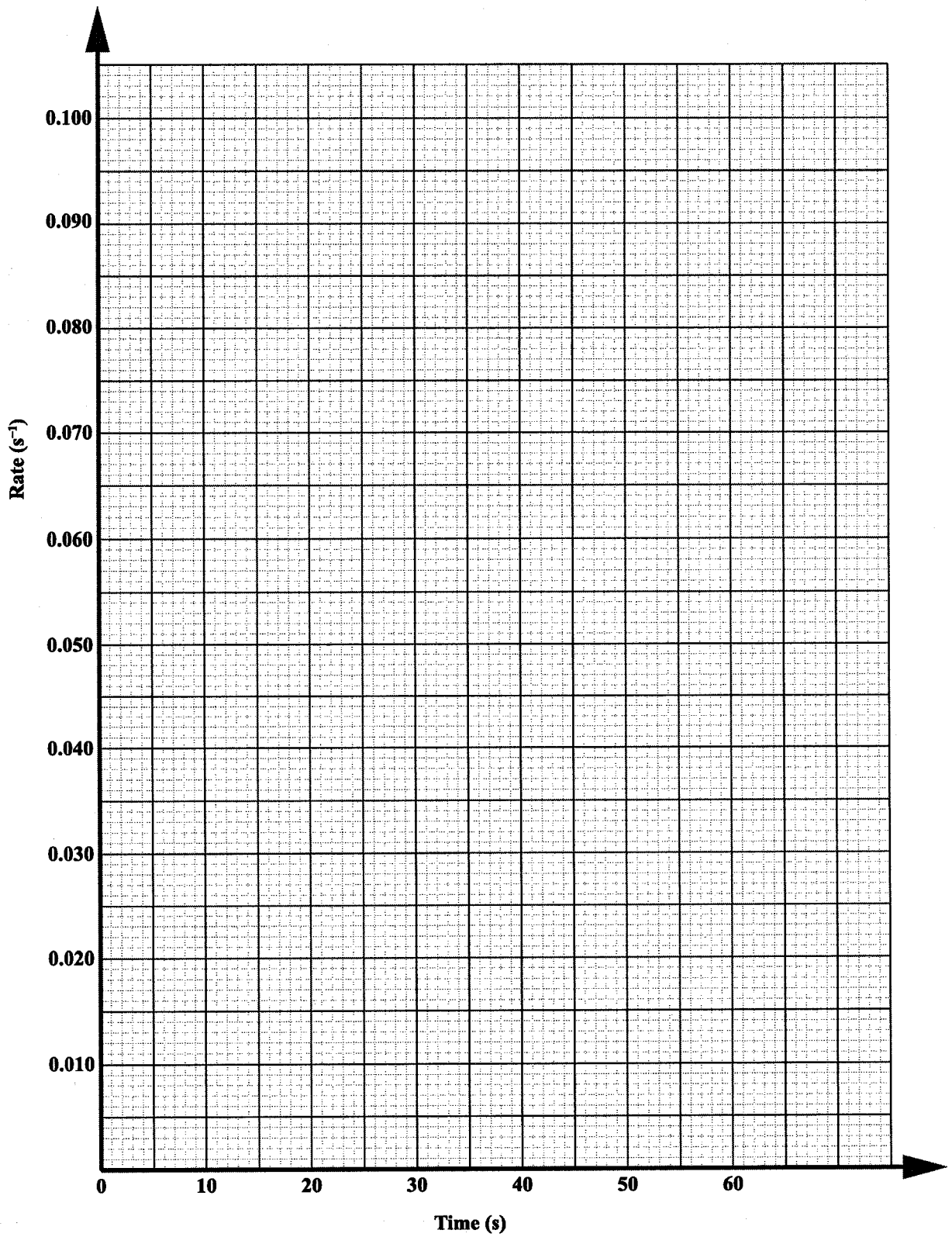
Experiment	Zinc Grade (μm)	Time (s)	Rate (s^{-1})
1	0.8	11.0	0.091
2	1.9		
3	3.0		
4	4.1		
5	5.2		
6	6.3		

- (i) From the stopwatches displayed in Figure 1 on page 5, record the times for the hydrogen gas to be collected in Column 3 in Table 1. The time taken for Experiment 1 has already been recorded for you. **(3 marks)**
- (ii) Using the formula $\text{Rate} = \frac{1}{\text{Time}}$, calculate the rate of reaction for each experiment and record these values to 3 decimal places in Column 4 of Table 1. The rate of reaction for Experiment 1 has already been calculated for you. **(3 marks)**
- (iii) Using the grid provided on page 7, plot a graph of rate versus time for Experiments 1–6. Draw the best curve through the points. **(5 marks)**

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(b) (i) Based on the graph plotted on page 7, deduce how the rate of the reaction varied with time.

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

(2 marks)

(ii) Explain how the trend in the rate of reaction stated in (b) (i) relates to the surface area of the zinc granules.

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

(2 marks)

(iii) List THREE factors, other than surface area, that affect the rate of a reaction.

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

(3 marks)

(c) State ONE safety precaution that Michael and Jennifer may have taken during the experiments.

.....
.....

(1 mark)

(d) Suggest ONE way in which Michael and Jennifer may have controlled the temperature during the experiments.

.....
.....

(1 mark)

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- (e) (i) Write a balanced chemical equation, including state symbols, for the reaction between zinc metal and sulfuric acid.

.....
.....

(2 marks)

- (ii) Calculate the total volume of hydrogen gas that would be produced at RTP from 0.55 g of zinc granules.

[RAM: Zn = 65.4; 1 mole of a gas occupies 24 000 cm³ at RTP]

(3 marks)

Total 25 marks

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2. Table 2 lists the chemical symbols of elements in Period 3 of the Periodic Table and their respective atomic numbers.

TABLE 2. ELEMENTS IN PERIOD 3

Chemical Symbols	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic Number	11	12	13	14	15	16	17	18

- (a) Explain why these elements are all placed in Period 3 of the Periodic Table.

.....

.....

.....

.....

.....

.....

(2 marks)

- (b) Which element in Table 2 forms an oxide which readily dissolves in water to give a solution with a pH greater than 7? Write a balanced equation to support your answer.

Element

.....

Equation

.....

.....

(3 marks)

- (c) The element sulfur, S, can exist as different allotropes. Define the term 'allotrope'.

.....

.....

(1 mark)

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(d) Draw a diagram to show the arrangement of electrons in sulfur.

(2 marks)

(e) (i) State the type of bond that forms when sulfur reacts with chlorine.

(1 mark)

(ii) Explain why the type of bond stated in (e) (i) is formed.

(3 marks)

(f) Write the formula of a compound which is formed when sulfur reacts with chlorine.

(1 mark)

(g) Draw a dot and cross diagram to show the bonding in the compound stated in (f).

(2 marks)

Total 15 marks

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3. (a) Polymerization is an important industrial process used in the manufacturing of many useful materials.

(i) Define the term 'polymer'.

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.....
.....

(1 mark)

(ii) Distinguish between 'addition polymerization' and 'condensation polymerization'.

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(2 marks)

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(b) Figure 2 illustrates the formation of a polymer.

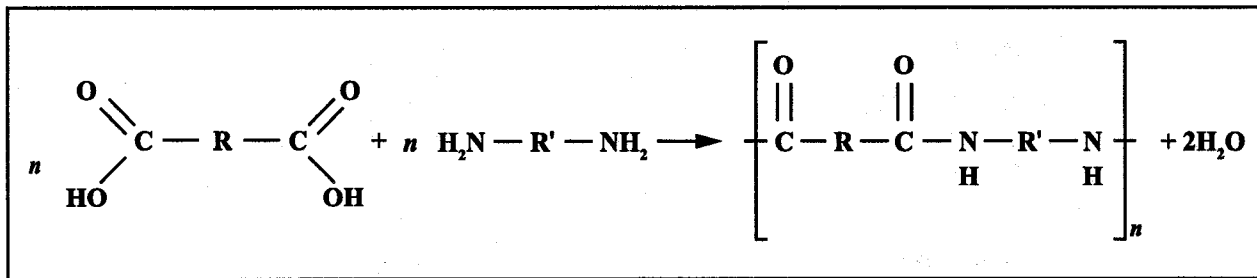


Figure 2. Formation of a polymer

(i) State the type of polymerization represented in Figure 2.

.....
(1 mark)

(ii) Give an explanation for your choice in (b) (i).

.....
.....
(1 mark)

(c) Identify ONE use of EACH of the following types of polymers.

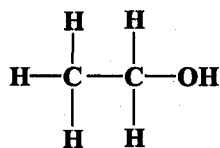
(i) Polyester
(1 mark)

(ii) Polyalkene
(1 mark)

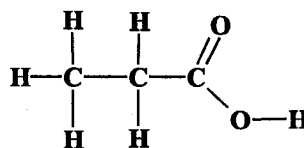
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(d) Figure 3 shows the fully displayed structural formulae for Compounds A and B.



Compound A



Compound B

Figure 3. Structural formulae

(i) State the homologous series to which Compounds A and B belong.

Compound A (1 mark)

Compound B (1 mark)

(ii) State the name of Compound A.

..... (1 mark)

(iii) Compounds A and B react to form Compound C. Sketch the FULLY DISPLAYED structural formula for Compound C.

Structure of Compound C

(2 marks)



(iv) Identify the homologous series of Compound C.

.....
(1 mark)

(v) State TWO other types of reactions that Compound A can undergo.

.....
.....
(2 marks)

Total 15 marks

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SECTION B

Answer ALL questions.

4. (a) You are provided with two identical samples of white powdery substances labelled D and E. One sample is finely ground sodium chloride and the other sample is finely ground diamond.

(i) Describe ONE simple test, including the observations, which could be used to distinguish between D and E.

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

(2 marks)

(ii) Sketch a unit cell of sodium chloride.

(3 marks)

(iii) State the type of bonding that occurs in sodium chloride.

.....
.....

(1 mark)

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- (b) Figure 4 shows a part of the Periodic Table with some known elements and an unknown element, X.

1	2								
				13	14	15	16	17	18
Li							O		
Na	Mg						S	Cl	
	Ca								
	X								

Figure 4. Part of the Periodic Table

Mg, Ca and the unknown element X react with water.

- (i) Discuss the relative reactivity of Mg, Ca and X with water.

.....

.....

.....

.....

(2 marks)

- (ii) Write a balanced chemical equation for the reaction between water and the unknown element (X).

.....

.....

.....

(2 marks)



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(c) Element X reacts with oxygen to form a stable compound.

(i) Suggest a formula for this compound.

.....
.....

(1 mark)

(ii) State whether an aqueous solution of this compound would be acidic or basic and give ONE reason for your answer.

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

(3 marks)

(iii) State ONE test to determine if an aqueous solution of this compound is acidic or basic.

.....
.....

(1 mark)

Total 15 marks

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5. (a) Methane is the first member of the alkane homologous series.

(i) List THREE general characteristics of a homologous series.

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

(3 marks)

(ii) Write the molecular formulae of the second and third members of the alkane homologous series.

.....
.....

(2 marks)

(iii) Derive the general formula of the alkane homologous series.

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(2 marks)

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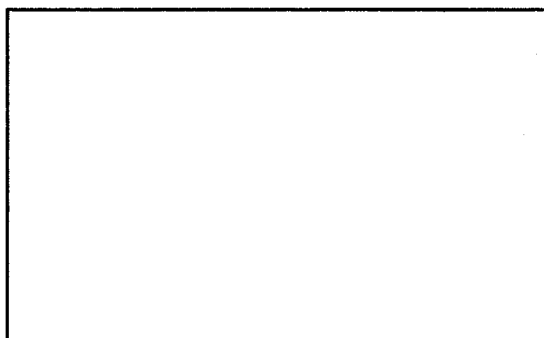
(b) 1-Butene belongs to the alkene homologous series and exhibits structural isomerism.

(i) Define the term 'structural isomerism'.

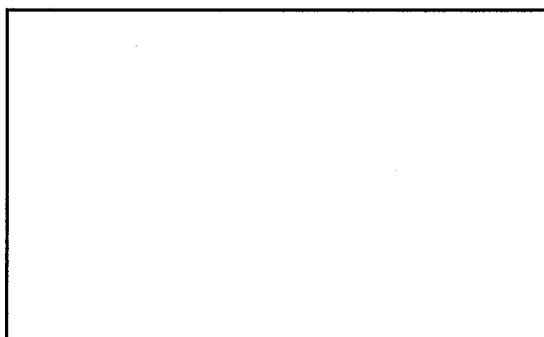
.....
.....
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(1 mark)

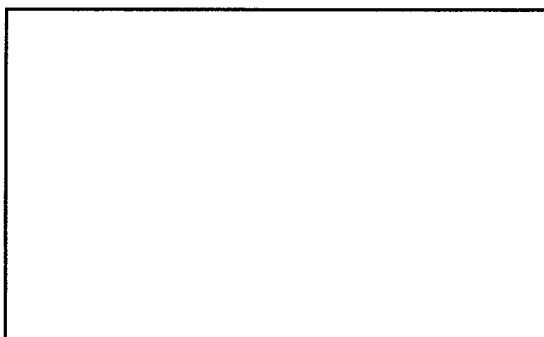
(ii) Draw a FULLY DISPLAYED structural formula of 1-Butene and its two isomers.



1-Butene



Isomer 1



Isomer 2

(3 marks)

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(c) 1-Butene, like all alkenes, are described as unsaturated compounds and undergo hydrogenation reactions to become saturated.

(i) Define the term 'unsaturated'.

.....
.....
(1 mark)

(ii) State what is meant by a hydrogenation reaction.

.....
.....
(1 mark)

(iii) Draw the FULLY DISPLAYED structural formula for the hydrogenation product of 1-Butene.

(2 marks)

Total 15 marks

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6. (a) Metal alloys are often used in place of metals because of their enhanced properties.

(i) Define the term 'alloy'.

.....
.....

(1 mark)

(ii) Name ONE alloy of aluminium **and** state its use based on one of its enhanced properties.

Alloy

Enhanced property

.....

Use of alloy

.....

(3 marks)

(b) A student conducted an experiment to investigate the reactivity each of the following metals; copper, iron, zinc and lead; by using solutions of their sulfate salts.

The data presented in Table 3 shows whether a visible chemical reaction took place when each metal was added to the four sulfate solutions.

Key: ✓ Visible chemical reaction took place
× No visible chemical reaction

TABLE 3. CHEMICAL REACTION OF METALS IN SULFATE SOLUTIONS

Sulfate Solution	Cu	Fe	Zn	Pb
CuSO ₄	×	✓	✓	✓
FeSO ₄	×	×	✓	×
ZnSO ₄	×	×	×	×
PbSO ₄	×	✓	✓	×

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- (i) State which of the TWO metals is more reactive: Fe or Zn. Give a reason for your answer.

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

(2 marks)

- (ii) Using the data in Table 3 on page 22, deduce the order of reactivity of the four metals Cu, Fe, Zn and Pb, from the **most** reactive to the **least** reactive metal.

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

(2 marks)

- (iii) The student recorded the following observations from the reaction between the iron and copper sulfate solution:

Observations: Reddish-brown solid coating formed on the iron strip.
Blue colour of the solution changed to dirty green.

Account for the observations made from the reaction between the iron and copper sulfate solution.

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.....
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(2 marks)

- (iv) Write the ionic equation, including state symbols, for the reaction between the iron and copper sulfate solution.

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

(2 marks)

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(c) Some metal compounds are health and environmental hazards.

(i) Identify which of the metals used in the experiment in (b) is MOST hazardous to the environment.

.....
.....

(1 mark)

(ii) State TWO harmful effects of continuous exposure to the metal identified in (c) (i) on human beings.

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

(2 marks)

Total 15 marks

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END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.

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