ST ANDREW'S SECONDARY SCHOOL

NAME | TEACHING GROUP

DATE (DD / MM / YYYY)

Chemistry

2023 JUNE HOLIDAY REVISION PRACTICE

Metals, The Periodic Table, Electrochemistry & Rate of Reaction

Write your answers to each set of questions on writing papers.

JUNE HOLIDAYS 2023

MON	TUE	WED	THU	FRI	SAT	SUN
29 GCE O-LEVEL MT	30 GCE O-LEVEL MT 'B'	31 Metals (1)	1 Metals (2)	2 VESAK DAY	3	4
5 Metals (3)	6 Metals (4)	7 Periodic Table (1)	8 Periodic Table (2)	9 Periodic Table (3)	10	11
12 Periodic Table (4)	13 Electrochemistry (1)	14 Electrochemistry (2)	15 Electrochemistry (3)	16 Electrochemistry (4)	17	18
19 Rate of Rxn (1)	20 Rate of Rxn (2)	21 Rate of Rxn (3)	22 Rate of Rxn (4)	23	24	25
26 Semester 2 BEGINS						

4 topics each with **4** sets of questions:

each set consists of just 2 questions – 1 MCQ & 1 Structured.

only **0.25 h / 15 min / 900 s** needed each day to complete 1 set!

"An 🍎 **each** day keeps the 👨 away"

apple *doctor*

"A set 📄 **each** day keeps the 👻 away"

questions *nightmares*

METALS (1)

1 Which of the following metal oxides is most easily reduced by carbon?

A CuO **B** Fe_2O_3 **C** MgO **D** ZnO

2 The Statue of Liberty in New York City was constructed in Paris, France, in the 1880s and presented as a gift to the United States of America. Its structure consists of an iron frame wrapped around with a sheet of pure copper.

Due to a chemical process called patination, the copper reacted with oxygen and water in the air and became blue-green. The following chemical equations outline the steps in patination.

Step 1: $4Cu\ (s) + O_2\ (g) \rightarrow 2Cu_2O\ (s)$
Step 2: $2Cu_2O\ (s) + O_2\ (g) \rightarrow 4CuO\ (s)$
Step 3: $2CuO\ (s) + CO_2\ (g) + H_2O\ (l) \rightarrow Cu_2CO_3(OH)_2\ (s)$

The patina formed on the surface of the statue prevented copper from further oxidation.

(a) **(i)** Determine the oxidation state of copper in CuO, Cu_2O and $Cu_2CO_3(OH)_2$. [3]

(ii) Using the oxidation states determined in **(a)(i)**, state with reasoning, whether each of the steps in patination is a redox reaction. [3]

The iron frame eventually undergoes corrosion. However, unlike patination, corrosion of iron is considered to be destructive.

(b) **(i)** Suggest why the corrosion of iron is considered to be destructive. [1]

(ii) Is the iron frame in the Statue of Liberty expected to corrode at a faster or slower rate than usual? Provide an explanation to your answer. [2]

(iii) Even though the iron frame can be protected from corrosion by coating with paint, this method was never considered. Suggest a reason why. [1]

METALS (2)

3 Which of the following metals does **not** react with cold water, but reacts with steam to produce hydrogen gas?

A Calcium **B** Copper **C** Lead **D** Zinc

4 Aluminium is the most abundant metallic element found on Earth, making up about 8% of the Earth's crust. It is also the most widely used non-ferrous metal today.

Aluminium does not occur naturally in its metallic form. It was only in 1807 that aluminium was discovered by Sir Humphry Davy. An economically viable process to extract aluminium by electrolysis was developed later in 1886.

(a) Give one use of aluminium. [1]

(b) Suggest a reason why aluminium does not occur naturally in its metallic form. [1]

(c) How does the extraction method for aluminium relate to its position in the reactivity series? [1]

(d) Despite being the most abundant metal found on Earth, most of the aluminium used today is recycled. Suggest a reason why. [1]

(e) Give one benefit and one drawback from recycling aluminium. [2]

5 Brass is a copper alloy that contains zinc.

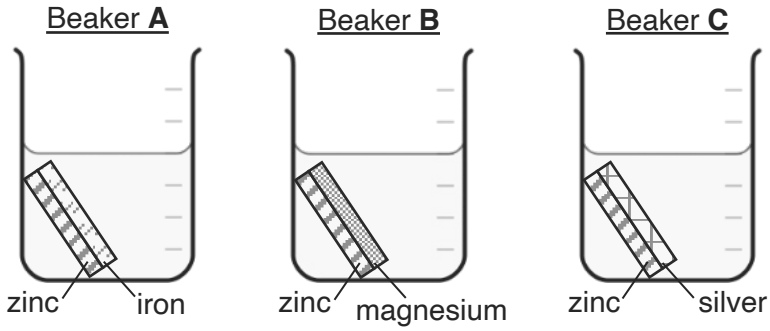
Which statements about brass are correct?

1 Brass conducts electricity because it contains mobile electrons.
2 Brass does not react with dilute hydrochloric acid.
3 Brass has a higher melting point than copper or zinc.
4 The density of brass is much higher than copper or zinc.

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

6 A student conducted an experiment to investigate the sacrificial protection between metals.

He immersed two different strips of metals in three beakers, **A**, **B** and **C**, containing equal volumes of dilute hydrochloric acid. The diagrams below show the metal strips in each beaker.



(a) Suggest, with reasoning, two observations the student would make in all three beakers. [4]

(b) In which beaker would the time required for the zinc metal stripe to completely dissolve be

(i) the shortest? [1]

(ii) the longest? [1]

(c) Discuss how you deduce at your answers in **(b)**. [2]

METALS (4)

7 Mercury is found to be more reactive than silver but less reactive than copper.

Which of the following statements about mercury is correct?

A Mercury can be obtained from its ore by roasting in air.
B Mercury displaces zinc from aqueous zinc nitrate solution.
C Mercury reacts with cold water to produce hydrogen gas.
D Mercury reacts with dilute hydrochloric acid to produce hydrogen gas.

8 You are provided with the following set of substances:

- Copper wire
- Copper(II) sulfate powder
- Distilled water
- Iron(II) chloride powder
- Iron wire

Using only the substances provided above, describe an experiment to determine the order of reactivity between copper and iron accurately. You may assume that all apparatus found in a school laboratory are available for your use.

Your answer should include:

- balanced chemical equations for all reactions that occurred,
- relevant observations made. [5]

PERIODIC TABLE (1)

9 Which statements about the Periodic Table are correct?

1 Elements become less metallic in character going down a group.
2 Elements change from being metallic to non-metallic in character moving across a period.
3 Elements in the same group undergo similar chemical reactions.
4 The group number represents the number of electron shells in an atom.

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

10 The electronic configuration of five elements, **A** – **E**, are listed in the table below.

Element	**A**	**B**	**C**	**D**	**E**
Electronic configuration	2,4	2,8,2	2,8,7	2,8,8,1	2,8,18,8

(a) Using the letters **A**, **B**, **C**, **D** and **E**, state which element is

(i) a Group II metal? [1]

(ii) a halogen? [1]

(iii) a noble gas? [1]

(iv) an alkali metal? [1]

(b) **(i)** Deduce the formula of the compound formed between elements **A** and **C**. [1]

(ii) Draw a 'dot-and-cross' diagram to show the bonding present in the compound in **(b)(i)**. Explain how this bonding is formed. [3]

PERIODIC TABLE (2)

11 Which statement explains why neon is chemically unreactive?

A It contains an equal number of electrons and neutrons.
B It does not gain or lose electrons.
C Its first electron shell is completely filled.
D Its valence electron shell is completely filled.

12 Chlorine is a halogen that is commonly used as a disinfectant and bleaching agent due to its powerful oxidising properties.

(a) Use ideas about electron transfer to explain why chlorine is a powerful oxidising agent. [2]

(b) A chemical reaction occurs when chlorine gas is bubbled into a solution of sodium iodide.

(i) Describe the observation made during this reaction. [1]

(ii) Construct a balanced chemical equation, with state symbols, for this reaction. [1]

(iii) Using ideas about oxidation state and electron transfer, explain how this reaction occurs. [2]

PERIODIC TABLE (3)

13 The chemical nature of oxides formed by the elements across a period changes from basic to acidic.

Which of the following statements best explains this?

A The metallic nature of the elements decreases going across a period.
B The non-metallic nature of the elements decreases going across a period.
C The reactivity of the elements decreases going across a period.
D The reactivity of the elements increases going across a period.

14 Some physical properties of a few Group I elements are provided in the table below.

Element	Melting point / °C	Boiling point / °C	Density / g cm^{-3}
Lithium	180	1330	0.53
Sodium	98	890	0.97
Potassium	64	760	0.86

(a) Give two physical properties, other than those provided in the table, of Group I elements. [2]

(b) Going down Group I, state the trend in:

(i) melting and boiling points. [1]

(ii) density. [1]

Rubidium is found below potassium in the Periodic Table.

(c) Predict which Group I element, rubidium or potassium, has:

(i) lower melting and boiling points? [1]

(ii) a higher chemical reactivity? [1]

(d) Use ideas about atomic structure to explain your answer in **(c)(ii)**. [2]

PERIODIC TABLE (4)

15 A newly discovered element has the following properties:

- Melting point = –200°C; Boiling point = –150°C.
- It is composed entirely of discrete atoms.
- It does not form any chemical bonds with other elements.

In which group of the Periodic Table would this element most likely be found?

A Group I
B Group IV
C Group VII
D Group 0

16 Manganese dioxide is a black solid. It reacts with hydrochloric acid to form aqueous manganese(II) chloride, which is pink in colour. Manganese dioxide is often added to increase the rate of oxygen gas produced in the decomposition of aqueous hydrogen peroxide, H_2O_2.

(a) From the information above, state two ways that show manganese as a transition element. [2]

(b) Provide an explanation to support each of your answer in **(a)**. [2]

(c) Copper(II) oxide is also a black solid. It reacts with hydrochloric acid to form aqueous copper(II) chloride, which is blue in colour.

A student hypothesized that based on the similarities in the observations made, the reaction between hydrochloric acid with manganese dioxide is similar to that with copper(II) oxide.

(i) Construct a balanced chemical equation for the reaction between copper(II) oxide with hydrochloric acid. [1]

(ii) With reference to the chemical equation in **(c)(i)**, decide with reasoning, whether you would agree or disagree with the student's hypothesis. [3]

ELECTROCHEMISTRY (1)

17 Which of the following factors does **not** affect the products obtained in electrolysis?

A Concentration of the aqueous electrolyte
B Position of the metals in the reactivity series
C Nature of the electrodes
D Source of the electric current

18 An aqueous solution of copper(II) sulfate is electrolysed using copper electrodes.

(a) Account for the changes observed at the anode and the cathode.
Include half-equations for the reactions that led to the changes observed at each electrode. [4]

(b) Give an industrial application of the electrolysis of copper(II) sulfate using copper electrodes. [1]

(c) Electrolysis is a costly chemical process as it consumes large amounts of electricity.
Despite this reason, the industrial application in **(b)** continues to be performed on a large scale.

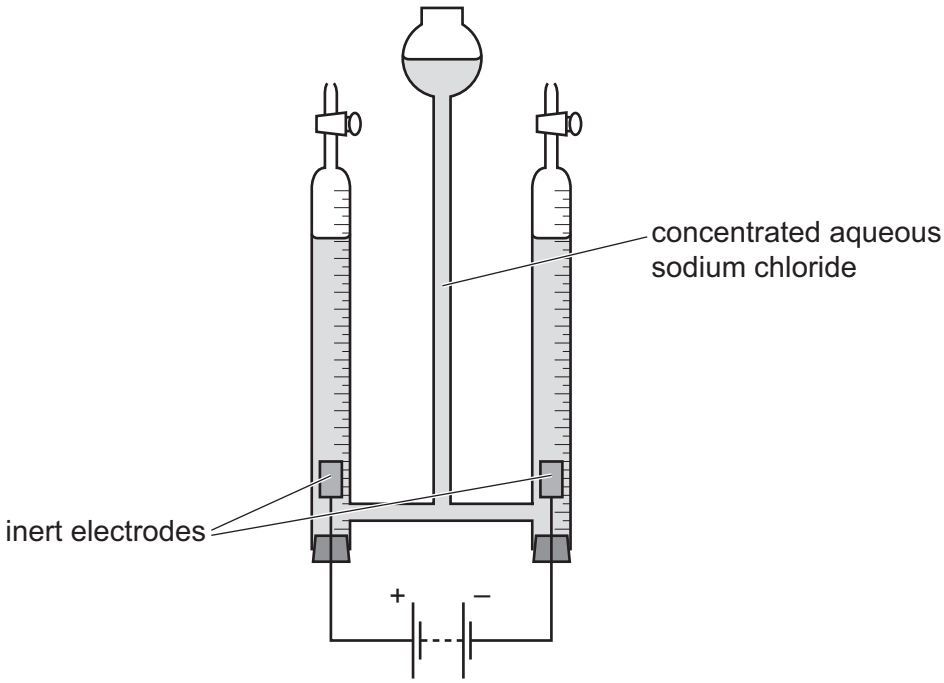
Suggest a reason why. [1]

ELECTROCHEMISTRY (2)

19 Which of the following conducts electricity and can be decomposed by it?

A Copper metal
B Graphite
C Potassium chloride dissolved in water
D Sugar dissolved in water

20 A student used the following apparatus to study the electrolysis of concentrated aqueous sodium chloride solution using inert electrodes.



(a) Suggest a suitable substance the student could use as the inert electrodes. [1]

(b) Account for the changes observed at the anode and the cathode.
Include half-equations for the reactions that led to the changes observed at each electrode. [4]

(c) Describe a simple chemical test the student could perform to confirm the answer in **(b)**. [2]

(d) How, if at all, does the pH of the solution changes during the electrolysis?
Explain your answer. [2]

ELECTROCHEMISTRY (3)

21 Concentrated $CuSO_4$ solution is electrolysed using copper electrodes.

Which ionic half-equation describes the reaction taking place at the cathode?

A $2H^+ (aq) + 2e^- \rightarrow H_2 (g)$
B $4OH^- (aq) \rightarrow O_2 (g) + 2H_2O(l) + 4e^-$
C $Cu (s) \rightarrow Cu^{2+} (aq) + 2e^-$
D $Cu^{2+} (aq) + 2e^- \rightarrow Cu (s)$

22 A sample of concentrated hydrobromic acid, HBr (aq), was electrolysed using inert electrodes.

(a) Determine the concentration of this HBr (aq), in mol/dm^3, if it was produced by bubbling 15 litres of hydrogen bromide gas into 100 cm^3 of distilled water. [2]

(b) Explain why this sample of concentrated HBr (aq) can conduct electricity. [1]

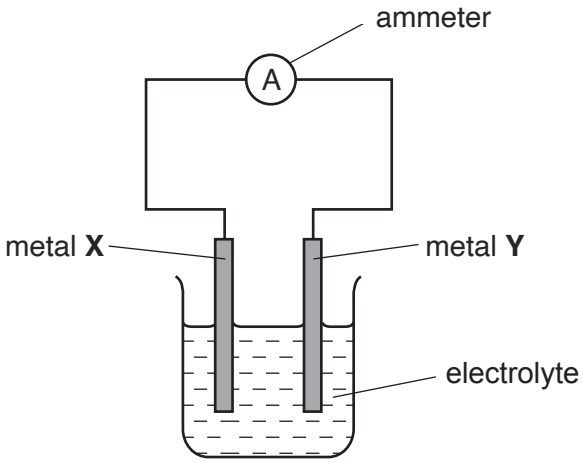
(c) Predict the product formed at the anode when concentrated HBr (aq) was electrolysed. [1]

(d) Magnesium should not be used as the electrodes. Explain why. [1]

(e) Describe the differences in the observations made, if any, when a sample of dilute HBr (aq) was electrolysed instead. Include appropriate half-equations to support your answer. [3]

ELECTROCHEMISTRY (4)

23 The diagram shows two strips of metals, **X** and **Y**, immersed in an electrolyte and connected by a conducting wire.

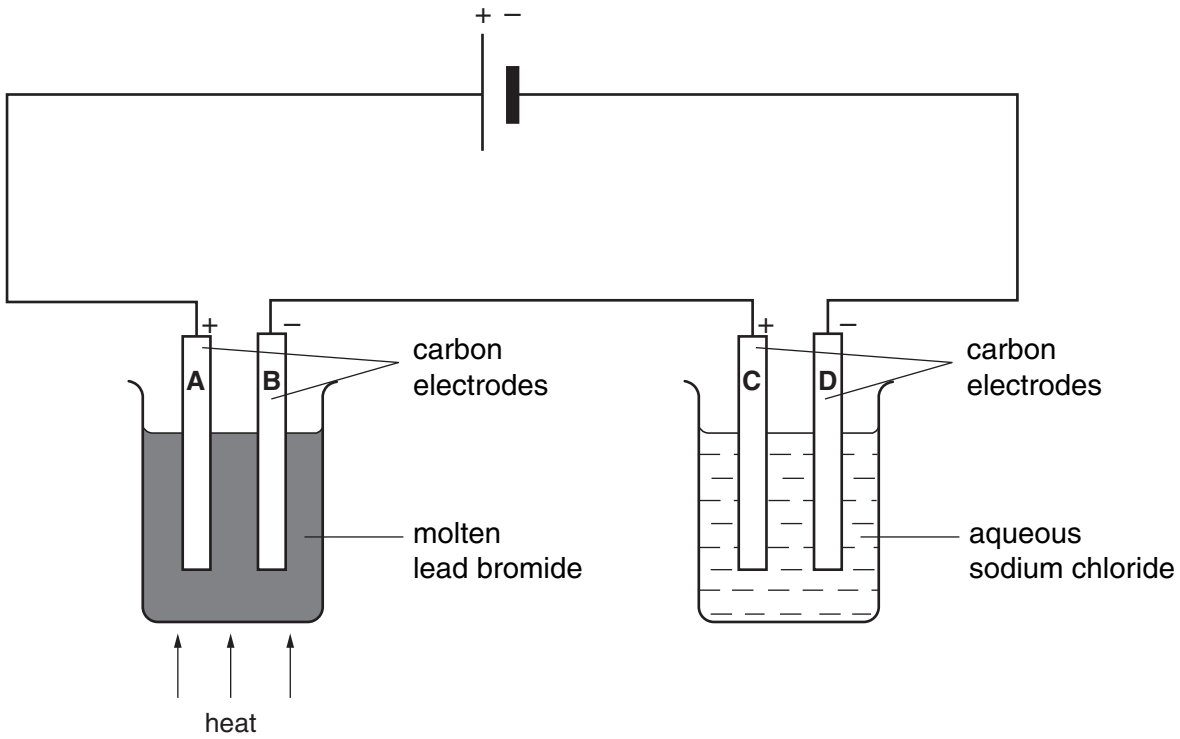


The ammeter recorded a reading.

Which metal could **X** and **Y** be?

	X	Y
A	Cu	Cu
B	Cu	Zn
C	K	Na
D	Zn	Zn

24 A student electrolysed lead bromide and aqueous sodium chloride in the apparatus shown below.



Each electrode is labelled with a letter.

(a) Explain why it was necessary for lead bromide to be molten. [1]

(b) **(i)** What was produced at electrode **A**? [1]

(ii) Describe the appearance of the product in **(b)(i)**. [1]

(c) **(i)** What was produced at electrode **B**? [1]

(ii) Where will the product in **(c)(i)** be collected? [1]

(d) It was found that 1 mol of product at electrode **A** is formed with 2 mol of product formed at electrode **B**, resulting in 1 mol of O_2 and 2 mol of H_2 produced.

Use this information to deduce the chemical formula of the lead bromide. [1]

RATE OF REACTION (1)

25 Which statement about a catalyst is correct?

A It does not take part in the chemical reaction.
B It is necessary to start a chemical reaction.
C It is recovered chemically unchanged at the end of the reaction.
D It provides an alternative pathway with lower activation energy, resulting in more products formed.

26 Explain the following observations.

(a) Magnesium ribbon burns more vigorously in pure oxygen than in air. [2]

(b) Zinc powder does not react with cold water. However, when the water is heated to its boiling point, zinc reacts with the water to produce hydrogen gas. [2]

(c) When two gases are reacted in a closed container, the rate of reaction is usually increased by decreasing the volume of the container. [2]

RATE OF REACTION (2)

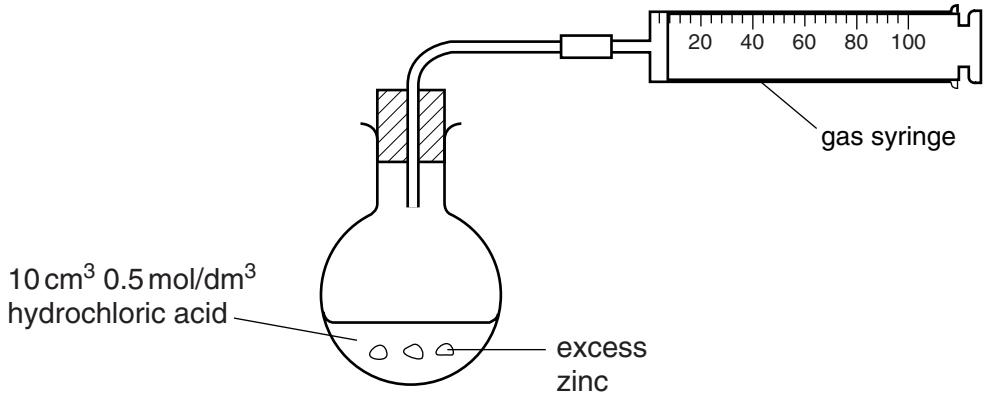
27 Magnesium reacts with an excess of dilute acid to produce hydrogen gas.

Which statements about this reaction are correct?

1 Changing the concentration of the dilute acid does not affect the yield for this reaction.
2 The faster the magnesium disappears, the faster the rate of reaction.
3 The higher the temperature, the faster the magnesium disappears.
4 The larger the particles of magnesium used, the faster the rate of reaction.

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

28 An excess of zinc was added to 10 cm^3 of 0.5 mol/dm^3 hydrochloric acid in an experiment using the apparatus below.



(a) **(i)** Calculate the maximum volume of hydrogen gas produced in the reaction. [2]

(ii) Suggest two reasons why the actual volume of hydrogen gas obtained in the gas syringe is lower than that in **(a)(i)**. [2]

(b) Sketch a graph with labelled axes to show how the volume of hydrogen changes during the reaction. Label this graph as **curve A**.

(c) The experiment was repeated using sulfuric acid of the same concentration.

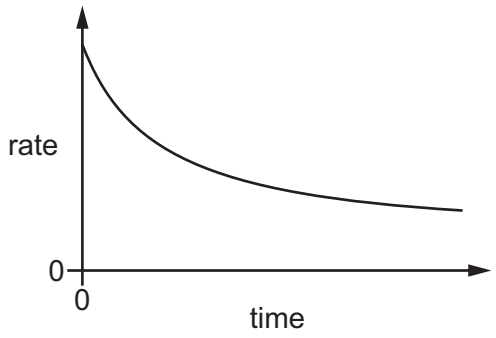
(i) Write a balanced chemical equation for the reaction between zinc and sulfuric acid.

Suggest how the rate of reaction and the total volume of hydrogen obtained would differ from the reaction between zinc and hydrochloric acid. Provide reasons to explain why. [4]

(ii) On the same axes in **(b)**, sketch a graph to show how the volume of hydrogen changes during this reaction. Label this graph as **curve B**. [1]

RATE OF REACTION (3)

29 The graph shows how the rate of reaction between two aqueous compounds, **X** and **Y**, changes with time.



The reaction between **X** and **Y** is slow and exothermic.

A student suggests that the rate of reaction decreases with time because:

1 the activation energy decreases
2 the speed of the particles of **X** and **Y** decreases
3 the concentration of both **X** and **Y** decreases

Which suggestions are correct?

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

30 A student studies the reaction of zinc with hydrochloric acid. He investigates the effects of changing the temperature and concentration of acid on the rate of reaction.

His results are shown below.

temperature in °C	concentration of hydrochloric acid in mol/dm^3	rate of reaction (in arbitrary units)
20	0.3	4.5
	0.6	9.1
	1.2	17.9
30	0.3	9.0
	0.6	18.1
	1.2	35.9
40	0.3	18.0
	0.6	36.1
	1.2	71.9

Use the information provided to discuss how the rate of reaction changes with

(a) temperature. [3]

(b) concentration. [3]

RATE OF REACTION (4)

31 Hydrogen reacts with iodine to form hydrogen iodide.

$$H_2\,(g) + I_2\,(g) \rightarrow 2HI\,(g)$$

Which statements explain why the reaction is faster when the pressure is increased, at constant temperature?

1 At higher pressure, more of the molecules have the required activation energy.
2 At higher pressure, the molecules are closer together.
3 At higher pressure, the molecules are moving faster.
4 At higher pressure, the molecules collide more frequently.

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

32 In two separate experiments, 20.0 g of magnesium carbonate is reacted with 500 cm^3 of 2.0 mol/dm^3 hydrochloric acid. The temperature employed is 20°C in the first experiment and 60°C in the second experiment. In each case, the total volume of carbon dioxide produced is measured at room temperature and pressure.

(a) Explain why the second reaction is faster. [2]

(b) As a 'rule of thumb', it is often said that for every 10°C rise in temperature, the reaction rate doubles.

How much faster would the second reaction be compared to the first reaction? Explain. [2]

(c) **(i)** Determine the limiting reagent for the reaction. [2]

(ii) Deduce the volume of carbon dioxide produced at room temperature and pressure. [2]