

NAME \_\_\_\_\_ INDEX NUMBER \_\_\_\_\_

SCHOOL \_\_\_\_\_ DATE \_\_\_\_\_

## REACTION RATES AND REVERSIBLE REACTIONS

1. 1989 Q 4 P1

The graph shows the loss in total mass of a mixture of marble chips and dilute hydrochloric acid with time at 250C



On the same axis sketch the graph that would obtained if the experiment was repeated at 40<sup>0</sup>C (2 Marks)

2. 1989 P1 QUE 23

Explain why the volume of a gas increase when its temperature is increased at a constant pressure. (1 Mark)

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3. 1989 P1 QUE 32

In the experiment, 50cm<sup>3</sup> of 1M sodium hydroxide solution was neutralized by reading 5cm<sup>3</sup> portion of hydrochloric acid successively. After each addition the mixture was stirred and the highest temperature recorded. Below is a graph of temperature rise plotted against volume of acid added. Use the graph to answer the questions that follow.

(a) Name the processes that take place in  
S ..... (1 Mark)

R ..... (1 Mark)

(b) State one use of calcium chloride (CaCl<sub>2</sub>) (1 Mark)

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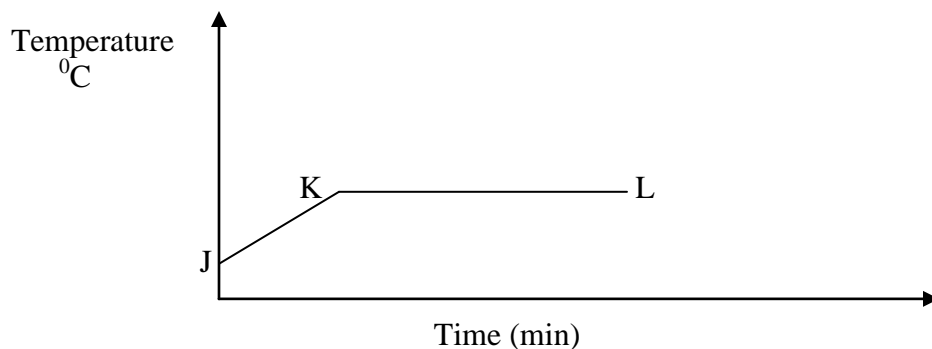
(c) Write the equations for the reactions taking place

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I .....

**4. 1990 P1 QUE 7**

The graph below shows part of a temperature – time curve obtained when solid naphthalene was heated.



Explain what happen to the naphthalene molecules along the curve (1 mark)

(a) JK

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(b) KL

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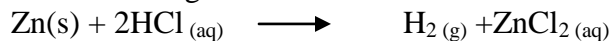
**5. 1992 P1 QUE 14**

In an experiment involving the reaction between magnesium and 1 m hydrochloric acid, the volume of hydrogen gas produced after time (seconds) was measured. The experiment was repeated using the same amount of magnesium reacting with 2M hydrochloric acid. Sketch the expected results for the two experiments and label them clearly (2 marks)

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**6. 1993 P1 Q 26**

(a) The table below give factors which affect the rate of the reaction:

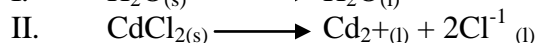
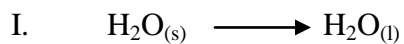


Complete the table to show how the factors given affect the rate reaction and give an explanation for each effect.

Factor	Effect on rate reaction	Explanation
Using Zinc powder instead of Zinc granules		
Hating the reactants		

7. **1994 P1A QUE 20**

The equations below represent two process that take place without any change in temperature.



(a) Explain why although heat is required for each of the process to take place, the temperature remains constant in both processes. (1mark)

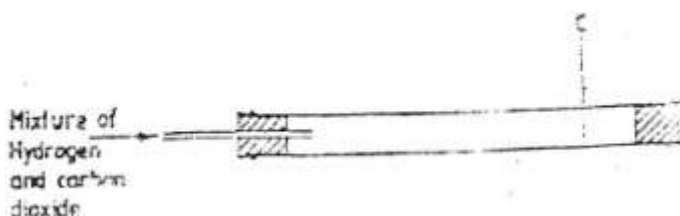
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(b) Which of the two processes has a higher enthalpy change (H)? Give a reason (2 marks)

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8. **1995 Q 19**

A mixture containing equal volumes of hydrogen and carbon dioxide was introduced one end of a tube as shown below.



Which gas would be detected at appoint C in first? Explain (2 marks)

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9. **1995 Q 20**

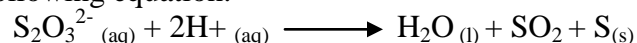
The table below gives three experiments on the reaction of excess sulphuric acid and 0.5g of zinc done under different conditions. In each the volume of gas was recorded at different time intervals.

Experiment	Form of Zinc	Sulphuric acid solution
I	Power	0.8m
II	Power	1.0m
III	Granules	0.8m

On the axis below draw and label the three curves that could be obtained from such results.

**10. 1996 Q 1 P2**

Sodium thiosulphate solution reacts with dilute hydrochloric acid according to the following equation.



In an experiment to study how the rate of reaction varies with concentration, 10cm<sup>3</sup> of 0.4M sodium thiosulphate was mixed with 10cm<sup>3</sup> of 2M hydrochloric acid in a flask. The flask was placed in a white paper marked with a cross X. The time taken for the cross X to become invisible when viewed from above was noted and recorded in the table below. The experiment was repeated three times as the temperature using the volumes in the table and the results recorded as shown in the table below.

Experiment	Volume of 0.4M thiosulphate (cm <sup>3</sup> )	Volume of water (cm <sup>3</sup> )	Volume of 2M HCl (cm <sup>3</sup> )	Time (Sec)
1	10	0	10	16
2	7.5	2.5	10	23
3	5.0	5.0	10	32
4	2.5	7.5	10	72

- a) i) On the grid below, plot a graph of the volume of thiosulphate (Vertical axis)

against time taken for the cross (X) to become invisible)

- ii) From the graph determine how long it would take for the cross to become invisible if the experiment was done. (3 marks)

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- i) Using  $6\text{cm}^3$  of the 0.4M thiosulphate (1 mark)

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- ii) Using  $6\text{cm}^3$  of 0.2M thiosulphate solution (1 mark)

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- b) i) Using values for experiment I. Calculate,  
i) Moles of thiosulphate used (1 mark)

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- ii) Moles of hydrochloric acid used (1mark)

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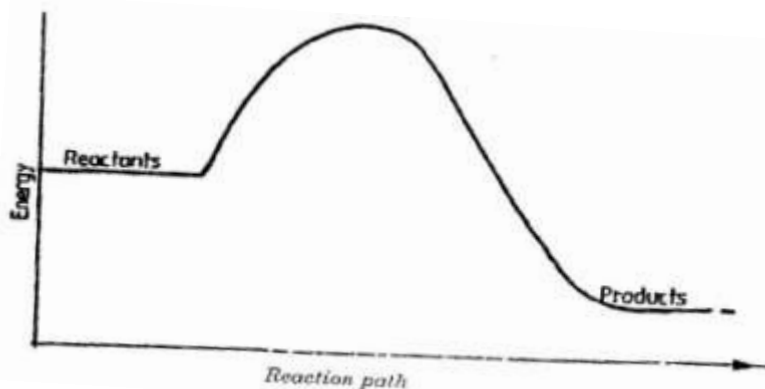
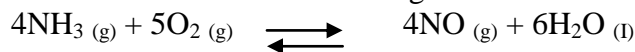
- ii) Explain which of the two reactants in experiment I controlled the rate of the reaction? Explain (1mark)

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- c) Give two precautions which should be taken in experiment I controlled the rate of the reaction? Explain (2 marks)

11. 1996 Q 2

Ammonia can be converted to nitrogen monoxide as shown in the equation below



- (a) Explain how an increase in temperature would affect the yield of nitrogen monoxide (2 marks)

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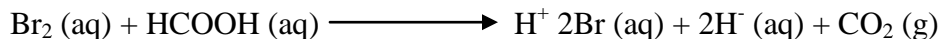
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- b) On the energy level diagram above sketch, the energy level diagram that would be obtained if the reaction is carried out in the presence of platinum catalyst. (1 mark)

12. 1997 Q 5 P2

The reaction between bromine and methanoic acid at 30<sup>o</sup> C proceeds according to the information given below



Concentration of Br <sub>2</sub> (aq) Moldm <sup>-3</sup>	Time minutes
10.0 x 10 <sup>-3</sup>	0
8.1 x 10 <sup>-3</sup>	1
6.6 x 10 <sup>-3</sup>	2
4.4 x 10 <sup>-3</sup>	4
3.0 x 10 <sup>-3</sup>	6
2.0 x 10 <sup>-3</sup>	8
1.3 x 10 <sup>-3</sup>	10

- (a) On the grid below, plot a graph of concentration of Bromine (Vertical axis against time)
- (b) From the graph determine:

(i) The concentration of bromine at the end of 3 minutes

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(ii) The rate of reaction at time 't' where  $t = 1 \frac{1}{2}$  minutes

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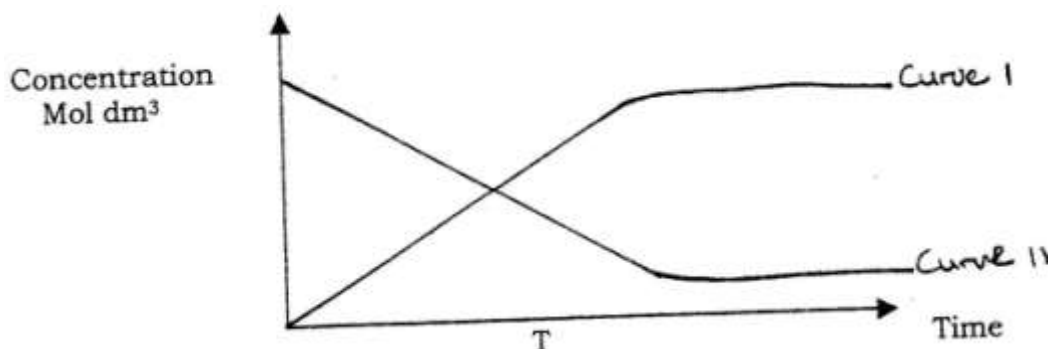
(c) Explain how the concentration of bromine affects the rate of reaction

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(d) On the same axis sketch the curve that would be obtained if the reaction was carried out at  $20^{\circ}\text{C}$  and label the curve as curve II. Give a reason for your answer.

13. 1999 Q 12

The curve below represents the changes in the concentration of substance E and F with time in the reaction;  $\text{E (g)} \rightleftharpoons \text{F(g)}$



(i) Which curve represents the changes in concentration of substance F? Give a reason

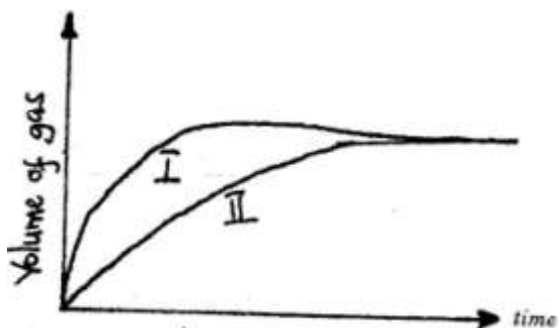
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(ii) Give a reason for shapes of curves after time 't' minutes

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**14. 2000 Q 19**

The curves below were obtained when two equal volumes of hydrogen peroxide of the same concentration were allowed to decompose separately. In one case, manganese (IV) oxide was added to the hydrogen peroxide



Which curve represents the decomposition of hydrogen peroxide with manganese (IV) oxide?  
 Explain

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**15. 2001 Q 1 P2**

In an experiment to study the rate for reaction between duralumin (an alloy of aluminium, magnesium and copper) and hydrochloric acid, 0.5g of the alloy were reacted with excess 4M hydrochloric acid. The data in the table below was recorded.

Use it to answer the questions that follow.

Time (minutes)	Total volume of gas (cm <sup>3</sup> )
1	0
2	220
3	410
4	540
5	620
6	640
7	640

a) i) On the grid provided, plot a graph of total volume of gas produced (vertical axis) again time.

ii) From the graph, determine the volume of gas produced at the end of 2 ½ minutes.



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b) Determine the rate of reaction between the 3<sup>rd</sup> and 4<sup>th</sup> minute.

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c) Give a reason why some solid remained at the end of the experiment

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d) Given that 2.5cm<sup>3</sup> of the total volume of the gas was from the reaction between magnesium and aqueous hydrochloric acid, calculate the percentage mass of aluminium present in 0.5g of the alloy. (Al = 27.0 and Molar gas volume = 24,000cm<sup>3</sup> at 298k)

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e) State two properties of duralumin that make it more suitable than aluminium in aeroplane construction.

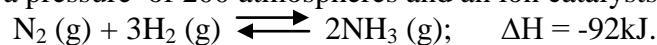
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State and explain how the rate of reaction between zinc granules and steam can be increased

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**17. 2003 Q 19a**

In the Haber process, the optimum yield of ammonia is obtained when a temperature of 450<sup>o</sup>C, a pressure of 200 atmospheres and an iron catalysts are used



a) How would the yield of ammonia be affected if the temperature was raised to 600<sup>o</sup>C? (2 marks)

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**18. 2003 Q 4 P2**

Excess marble chips (calcium carbonate) was put in a beaker containing 100cm<sup>3</sup> of dilute hydrochloric acid. The beaker was then placed on a balance and the total loss in mass recorded after every two minutes as shown in the table below.

Time(min)	0	2	4	6	8	10
Total loss in mass (g)	0	1.8	2.45	2.95	3.2	3.3

a) Why was there a loss in mass? (1mark)

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b) Calculate the average rate of loss in mass between:  
i) 0 and 2 minutes (1mark)

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ii) 6 and 8 minutes (1 mark)

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iii) Explain the difference in the average rates of reaction in (b) (i) and (ii) above (2marks)

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c) Write the equation for the reaction which takes place in the beaker

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d) State three ways in which the rate of the reaction above could be increased (3 marks)

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e) The solution in the beaker was evaporated to dryness what would happen if the open beaker and its contents were left in the laboratory overnight. (2 marks)

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f) Finally some water was added to the contents of the beaker. When aqueous sodium sulphate was added to the contents of the beaker, a white precipitate was formed. (1 mark)

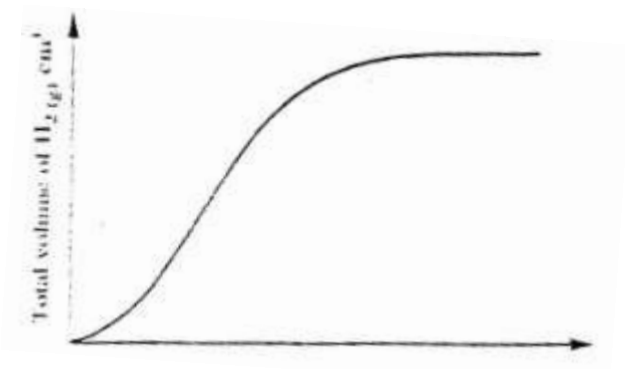
i) Identify the white precipitate

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ii) State one use of the substance identified in (f) (i) above (1 mark)

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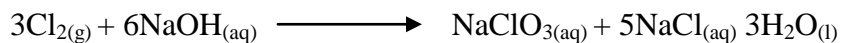
The reaction between a piece of magnesium ribbon with excess 2M hydrochloric acid was investigated at 25°C by measuring the volume of hydrogen gas produced as the reaction progressed. The sketch below represents the graph that was obtained.



- a) Name one piece of apparatus that may be used to measure the volume of hydrogen gas produced.

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- b) On the same diagram, sketch the curve that would be obtained if the experiment when excess chlorine gas was bubbled into hot concentrated sodium hydroxide, the following reaction occurred.

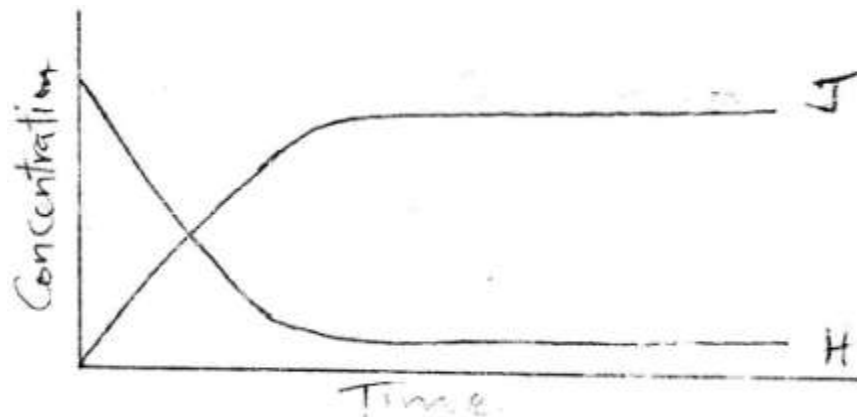


In which product did chlorine undergo oxidation? Explain (3 marks)

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20. 2005 Q 10

The sketch completely with substance H is converted into J. Study it and answer the question that follows.



Why do the two curves become horizontal after sometime?

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**21. 2005 Q 17**

(a) What condition is necessary for equilibrium to be established? (1 mark)

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(b) When calcium carbonate is heated, the equilibrium shown below is established



How would the position of equilibrium be affected if a small amount of dilute potassium hydroxide is added to the equilibrium mixture? Explain (2 marks)

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**22. 2005 Q 20**

Equal volumes of 1M monobasic acids L and M were each reacted with excess magnesium turnings. The table below shows the volumes of the gas produced after one minute.

Acid	Volume of gas (cm <sup>3</sup> )
L	40
M	100

Explain the differences in the volumes of the gas produced (2 marks)

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**23. 2006 Q 6b,c P2**

b) Explain how the rate of the reaction between lead and nitric acid would be affected if the temperature of the reaction mixture was raised. (2 marks)

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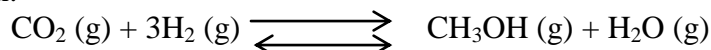
c) On the grid provided below, plot a graph of the volume of the gas produced (Vertical

axis) against volume of acid.

(3 marks)

**24. 2007 Q 4 P2**

(a) Methanol is manufactured from carbon (IV) oxide and hydrogen gas according to the equation:



The reaction is carried out in the presence of a chromium catalyst at 700K and 30kPa. Under these conditions, equilibrium is reached when 2% of the carbon (IV) oxide is converted to methanol

(i) How does the rate of the forward reaction compare with that of the reverse reaction when 2% of the carbon (IV) oxide is converted to methanol? (1 mark)

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(ii) Explain how each of the following would affect the yield of methanol:  
I Reduction (2 marks)

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II Using a more efficient catalyst (2 marks)

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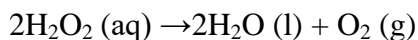
(iii) If the reaction is carried out at 500K and 30kPa, the percentage of carbon (IV) oxide converted to methanol is higher than 2%  
I. What is the sign of  $\Delta H$  for the reaction? Give a reason (2 marks)

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II Explain why in practice the reaction is carried out at 700K but NOT at 500K (1mark)

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(b) Hydrogen peroxide decomposes according to the following equation:



In an experiment, the rate of decomposition of hydrogen peroxide was found to be  $6.0 \times 10^{-8} \text{ mol dm}^{-3} \text{ s}^{-1}$ .

- (i) Calculate the number of moles per  $\text{dm}^3$  of hydrogen peroxide that had decomposed within the first 2 minutes (2 marks)

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- (ii) In another experiment, the rate of decomposition was found to be  $1.8 \times 10^{-7} \text{ mol dm}^{-3} \text{ s}^{-1}$ . The difference in two rates could have been caused by addition of a catalyst. State, giving reasons, one other factor that may have caused the difference in two rates of decomposition (2 marks)

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**25. 2008 Q 23**

In a closed system, aqueous iron (III) chloride reacts with sulphide gas as shown in the equation below.

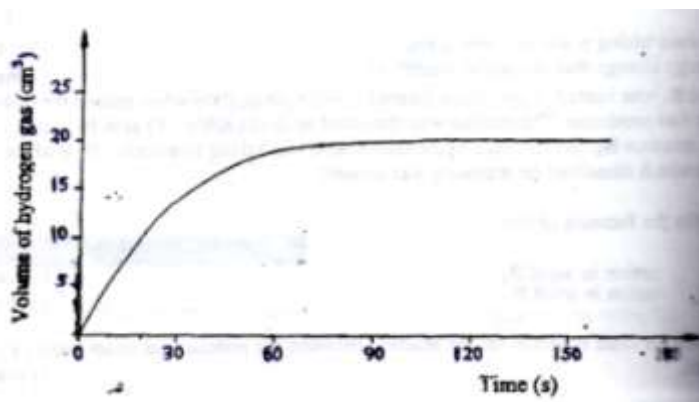


State and explain the observation that would be made if dilute hydrochloric acid is added to the system at equilibrium. (2 marks)

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**26. 2008 Q 29**

A certain mass of a metal E<sub>1</sub> reacted with excess dilute hydrochloric acid at 25°C. The volume of hydrogen gas liberated was measured after every 30 seconds. The results were presented as shown in the graph below.



a) Name one piece of apparatus that may have been used to measure the volume of gas liberated. (1mark)

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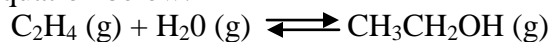
b) (i) On the same axis, sketch the curve that would be obtained if the experiment was repeated at 35°C. (1mark)

(ii) Explain the shape of your curve in b(i) above. (1mark)

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**27. 2011 Q 3**

a) Ethanol can be manufactured from ethane and steam as shown in the equation below:



Temperature and pressure will affect the position of equilibrium of the above reaction. Name the other factor that will affect the position of equilibrium of the above reaction.

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b) The data in the table was recorded when one mole of ethane was reacted with



excess steam. The amount of ethanol in the equilibrium mixture was recorded under different conditions of temperature and pressure. Use the data to answer the questions that follow.

Temperature ( $^{\circ}\text{C}$ )	Pressure (Atm)	Amount of ethanol at equilibrium (moles)
300	50	0.40
300	60	0.46
300	70	0.55
250	50	0.42
350	50	0.38

- i.) State whether the reaction between ethane and steam is exothermic or endothermic. Explain your answer. (3 marks)

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- ii) State and explain one advantage and one disadvantage of using extremely high pressure in this reaction. (2 marks)
- i. Advantage

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- ii. Disadvantage (2 marks)

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- c) In an experiment to determine the rate of reaction between calcium carbonate and dilute hydrochloric acid, 2g of calcium carbonate were reacted with excess 2M hydrochloric acid. The volume of carbon (IV) oxide evolved was recorded at regular intervals of one minute for six minutes. The results are as shown in the table below.

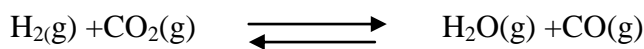
Time ( minutes)	1	2	3	4	5
Volume of Carbon (IV) oxide ( $\text{cm}^3$ )	170	296	405	465	480

- i) Plot a graph of time in minutes on the horizontal axis against volume of carbon (IV) oxide on the vertical axis. (3 marks)
- ii) Determine the rate of reaction at 4 minutes. (2 marks)

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**28. 2012 Q13 P1**

A dynamic equilibrium is established when hydrogen and carbon (IV) oxide react as shown below:



What is the effect of adding powdered iron catalyst on the position of the equilibrium? Give a reason. (2 marks)

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**29. 2012 Q4 P2**

The factors which affect the rate of reaction between lead carbonate and dilute nitric (V) acid were investigated by carrying out three experiments:

Experiment number	Lead carbonate	Concentration of nitric (V) acid
1	Lumps	4M
2	Powdered	4M
3	Lumps	2M

(a) Other than concentration, name the factor that was investigated in the experiments. (1 mark)

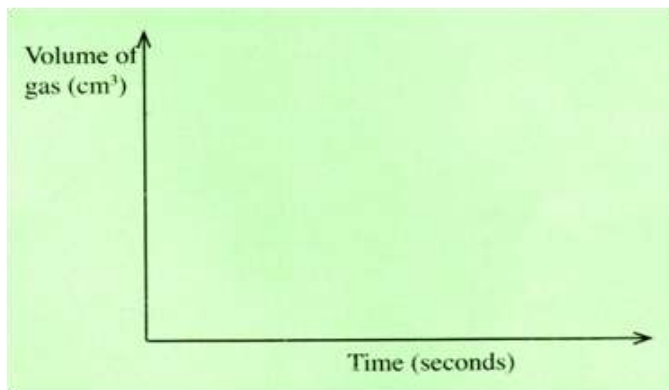
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(b) For each experiment, the same volume of acid (excess) and mass of lead carbonate were used and the volume of gas liberated measured with time.

(i) Draw a set up that can be used to investigate the rate of reaction for one of the experiments. (3 marks)

(ii) On the grid provided, sketch the curves obtained when the volume of gas produced was plotted against time for each of the experiments and label each as 1, 2, or 3.

(4 marks)



(iii) Write an equation for the reaction that took place.

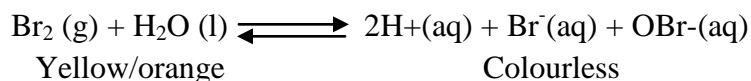
(1 mark)

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(c) If the experiments were carried out using dilute hydrochloric acid in place of dilute nitric (V) acid, the reaction would start, slow down and eventually stop. Explain these observations. (2 marks)

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(d) A solution of bromine gas in water is an example of a chemical reaction in a state of balance. The reaction involved is represented by the equation below.



State and explain the observations made when hydrochloric acid is added to the mixture (2 marks)

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