O Level Combined Chemistry Structured

Speed of Reaction Test 2.0

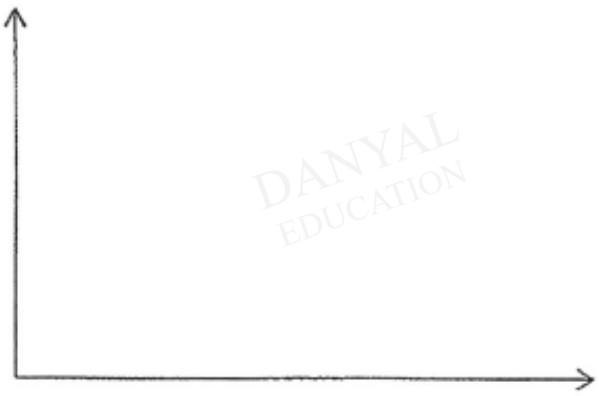
Q1

Four separate experiments were conducted using excess calcium carbonate and 100 cm^3 of 1.0 mol/dm^3 hydrochloric acid. The particle size of calcium carbonate and temperature are different for each experiment as shown in Table 7.1.

Table 7.1

experiment	particle size of calcium carbonate	temperature/ °C
I	lumps	30
II	powder	30
III	powder	40
IV	lumps	40

(a) Sketch and label, on the same axes, the graphs of two experiments to show the effect of temperature on the speed of reaction.



[2]

(b) State and explain, using the collision theory, which two experiments can be used to show the effect of particle size on the speed of reaction.

.....

.....

.....

.....[3]

(c) Describe, with the aid of a labelled diagram, an experiment to study the effect of concentration on the speed of reaction.

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.....

.....

.....[3]

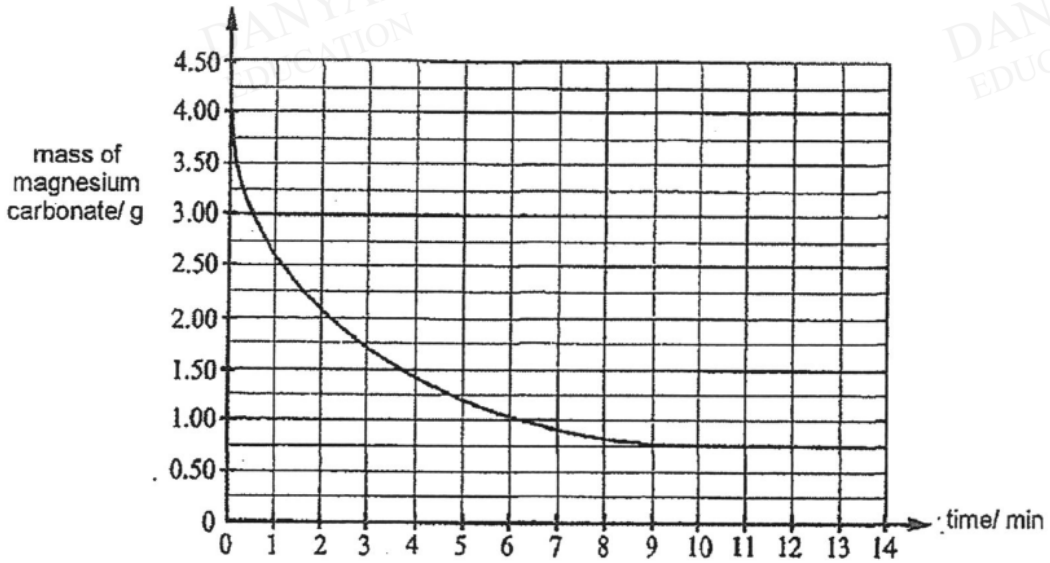
Q2

Dilute hydrochloric acid is added to magnesium carbonate in a conical flask.

The chemical equation for the reaction is given.

$$2HCl\,(aq) + MgCO_3\,(s) \rightarrow MgCl_2\,(aq) + CO_2\,(g) + H_2O\,(l)$$

The graph below shows how the mass of magnesium carbonate in the flask changes with time.



(a) Using the graph, identify the limiting reagent in the reaction. [1]

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(b) What can you tell from the graph about the speed of the reaction during its first 14 minutes? [1]

.....

.....

(c) (i) Calculate the number of moles of magnesium carbonate used in the reaction. [2]

moles of magnesium carbonate = ...mol

(ii) Calculate the volume of carbon dioxide produced. [2]

volume of carbon dioxide = ...dm^3

(d) Sketch on the given graph the curve you would expect if the reaction was repeated with all the conditions kept the same except that **larger pieces** of magnesium carbonate were used. [2]

Q3

Excess calcium carbonate is added to a fixed volume of dilute hydrochloric acid in a conical flask.

Fig. 5.1 shows how the loss in mass changes with time.

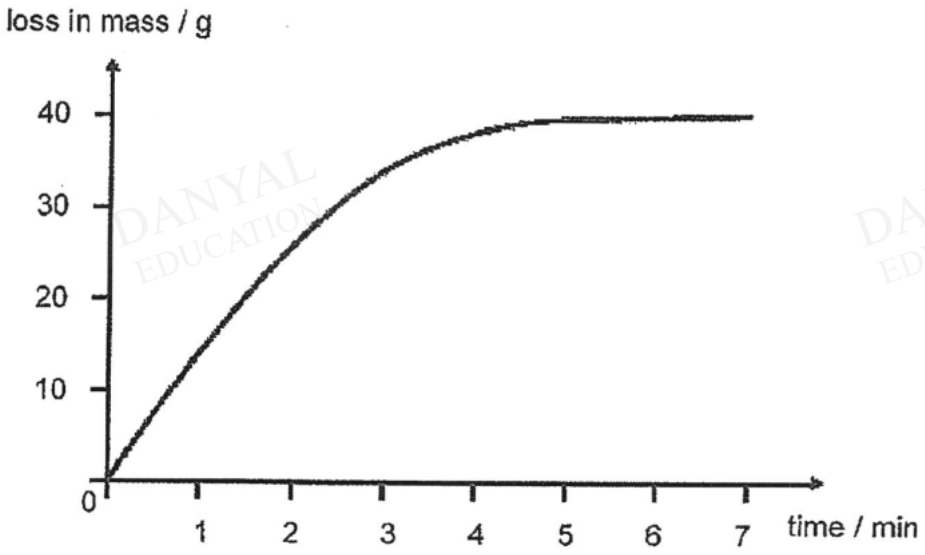


Fig. 5.1

The rate of reaction can be changed by changing the reaction conditions.

(a) Why does the loss in mass gradually increase as time increases?

..... [1]

(b) The experiment is repeated using warm dilute hydrochloric acid.

Using your knowledge of reacting particles, explain why the rate of reaction increases when the reaction mixture is heated to a higher temperature.

.....

.....

..... [2]

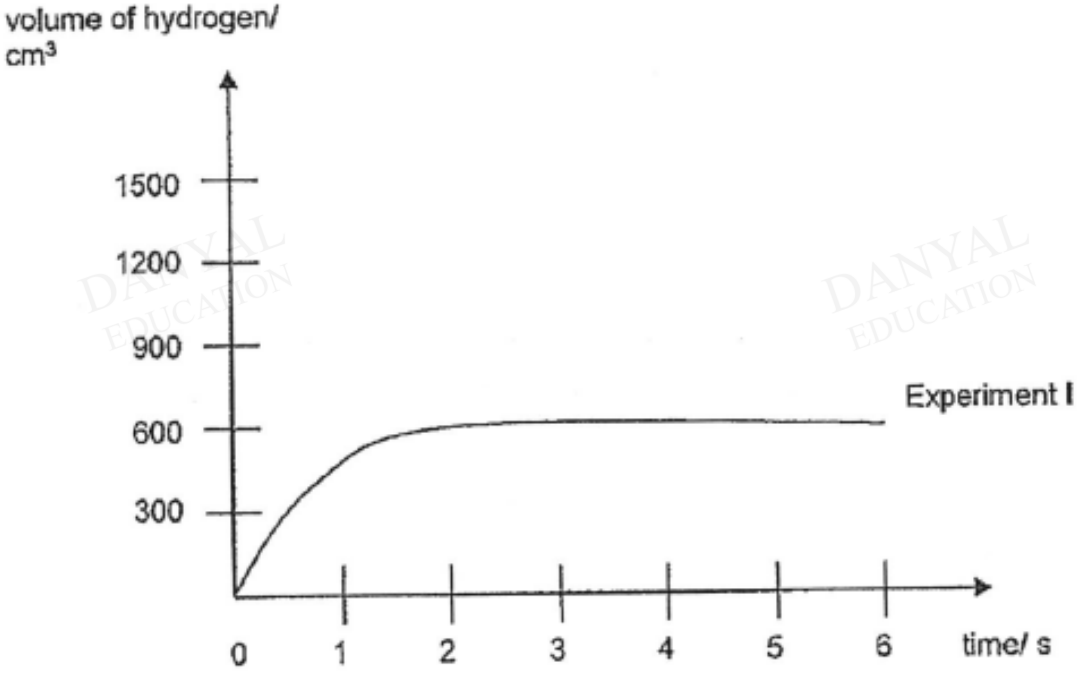
(c) On Fig. 5.1, sketch the graphs obtained when the experiment is repeated with

(i) more finely powdered calcium carbonate. Label this graph as **A**. [1]

(ii) dilute hydrochloric acid of half the original concentration.
Label this graph as **B**. [1]

Q4

In Experiment I, 6.00 g of magnesium powder is reacted with excess dilute hydrochloric acid at room temperature and pressure. The following shows how the total volume of hydrogen evolved changed with time.



(a) Write a balanced chemical equation for the reaction between magnesium and hydrochloric acid. [2]

(b) Two further reactions were carried out.

Conditions for Experiment II were the same as Experiment I, except that 15.0 g of magnesium was used.

Conditions for Experiment III were the same as Experiment I, except that the concentration of hydrochloric acid was doubled.

Sketch the graphs for Experiment II and Experiment III on the same axes above. Label your graphs clearly. [2]

(c) Explain, in terms of collisions between particles, the graph that you have drawn for Experiment III in part (b). [2]

Q5

Baking powder is a mixture containing sodium hydrogencarbonate and a compound which dissolves **slowly** in water to form an acid.

A student set-up three experiments to study the reaction between baking powder and liquid **X**.

experiment	mass of baking powder / g	liquid **X**	temperature of liquid **X** / °C	volume of gas produced after 5 min / dm^3
1	10	water	30	1.5
2	10	water	60	8.5
3	10	vinegar	30	10.1

(i) Suggest which gas is produced in all three experiments. [1]

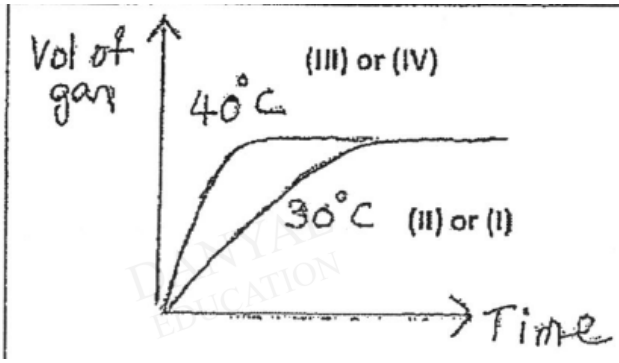
(ii) Suggest why the gas is produced more quickly in experiment **3** than in experiment **1**. [1]

(iii) If liquid **X** is dilute sulfuric acid, what changes will occur to the rate of reaction between the baking powder and liquid **X**, and also the volume of gas collected after **5** min? [2]

Answers

Speed of Reaction Test 2.0

Q1

(a)	 1m for correct labels for both axes (units not required) 1m for correct graphs of experiments R: amount of gas for y-axis	[1] [1]
(b)	Experiments I and II/ III and IV; Calcium carbonate lumps have smaller surface area to volume ratio than calcium carbonate powder OR vice versa; Decreases the frequency/ probability/ chance/ rate of effective collisions, thus decreases the speed of reaction OR vice versa; R: number of effective collisions	[1] [1] [1]
(c)	Labelled diagram for collection of gas using gas syringe or mass loss method; Collect the gas produced/ record the mass/ weight of the reaction mixture at regular intervals as excess calcium carbonate reacts with hydrochloric acid; Repeat the experiment with hydrochloric acid of a different concentration while keeping all other variables constant; A: amount of gas instead of volume of gas if gas syringe was drawn or mentioned in answer A: drawings with 2 beakers containing acid and metal/ insoluble metal carbonate, but need to describe how to determine the end of reaction Note: no penalty if amount instead of specific physical quantities of measurements used	[1] [1] [1]

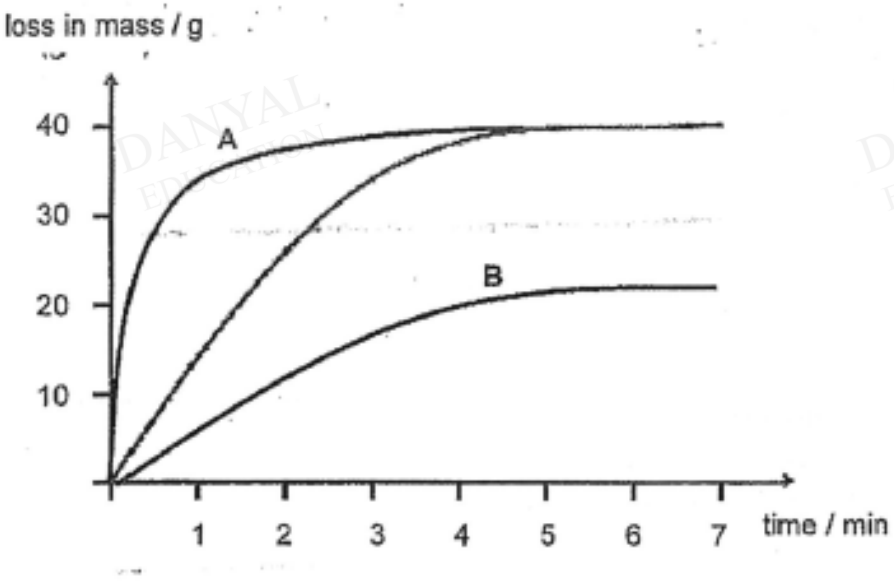
Q2

(a)	Hydrochloric Acid	[1]
(b)	The speed is fast at first then it slow down and stop at the 10th minute.	[1]
(c)(i)	Mass of magnesium carbonate used = 4 - 0.75 = 3.25g [1m] Mole of magnesium carbonate used = 3.25/ 84 = 0.0387 mol [1m]	[2]
(c)(ii)	Mole of carbon dioxide produced = 0.0387 mol [1m] Volume of carbon dioxide produced = 0.0387 x 24 = 0.929 dm^3 [1m]	
(d)	Less steep [1m] end off at 0.75 g after 10 minutes [1m]	[2]

Q3

(a)	It is due to the increase in the mass of carbon dioxide formed which escapes from the flask. [1]	[2]
(b)	At higher temperature, the molecules gain kinetic energy and move faster. [1] This will lead to more effective collisions between reacting particles, forming more products per unit time [1] and thus increasing the rate of reaction.	[2]

(c)



[1] for each correct graph drawn

Q4

(a) $Mg + 2HCl \rightarrow MgCl_2 + H_2$ [formula:1, balancing:1]

(b) Experiment **II** – gradient steeper than **I** and volume of gas ends at 1500 cm^3 [1]

Experiment **III** – gradient steeper than **I** and volume of gas ends at 600 cm^3 [1]

(c) There are more particles in a given volume of more concentrated hydrochloric acid [1] and therefore the frequency of effective collisions increases between the particles [1] leading to higher rate of reaction.

Q5

(i)	carbon dioxide	[1]
(ii)	Liquid X in experiment 3 is **an acid** while that in experiment 1 is water. Acid **reacts faster** with the sodium hydrogencarbonate to form carbon dioxide.	[1] [1]
(iii)	The rate of reaction would be faster than expt 3 and the volume of gas collected after 5 min would be more.	[1] [1]