

Name: _____ () Class: _____ Date _____

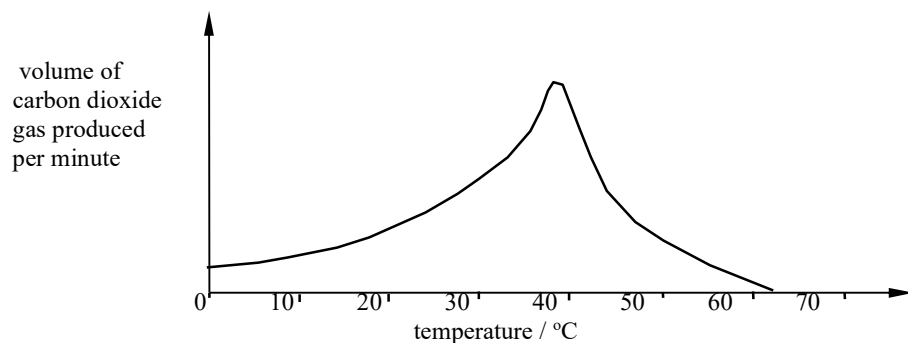
1 Zinc reacts with hydrochloric acid.

Which solution would give the fastest initial rate of reaction?

- A 80 g of HCl in 1000 cm³ of water
- B 40 g of HCl in 1000 cm³ of water
- C 20 g of HCl in 100 cm³ of water
- D 8 g of HCl in 50 cm³ of water

☐

2 Glucose is converted into ethanol and carbon dioxide by fermentation. The rate of reaction can be measured by the volume of carbon dioxide gas produced per minute. The graph shows how the volume of carbon dioxide produced per minute changes with temperature.



From the graph, which statement is correct?

- A The reaction is slowest at 0°C.
- B The reaction is fastest at about 60°C.
- C The rate of reaction always increases when the temperature increases.
- D The rate of reaction is greatest at about 40°C.

☐

3 Which section of the Periodic Table is most likely to contain an element suitable for use as a catalyst in an industrial process?

- | | |
|---------------------|---------------------------|
| A the alkali metals | B the halogens |
| C the noble gases | D the transition elements |

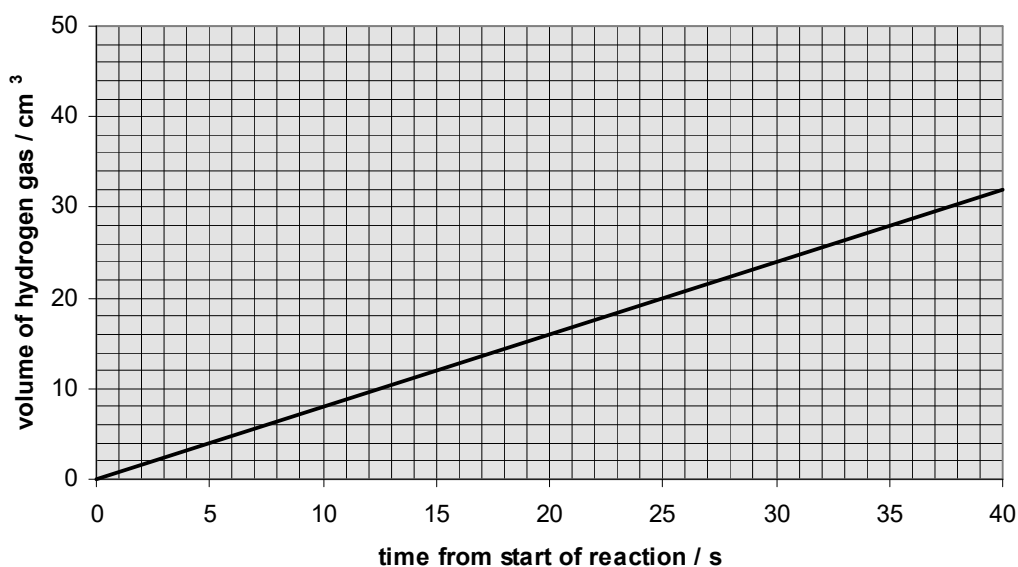
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- 4 In terms of particle theory, why do smaller pieces of solid react more quickly with liquid reactant than an equal mass of larger pieces of solid?

A There are stronger forces between the solid and the colliding particles .
B The solid has a larger surface area for particles of the liquid to collide with.
C The particles of the liquid collide with each other more frequently.
D The particles of liquid do not have to break so many bonds in the solid.

☐

- 5 Magnesium ribbon was reacted with hydrochloric acid. The volume of hydrogen gas produced was measured for the first 40 seconds.



What was the average rate of reaction in terms of volume of gas produced per second?

A 0.8 cm³/s B 5.0 cm³/s C 8 cm³/s D 80 cm³/s

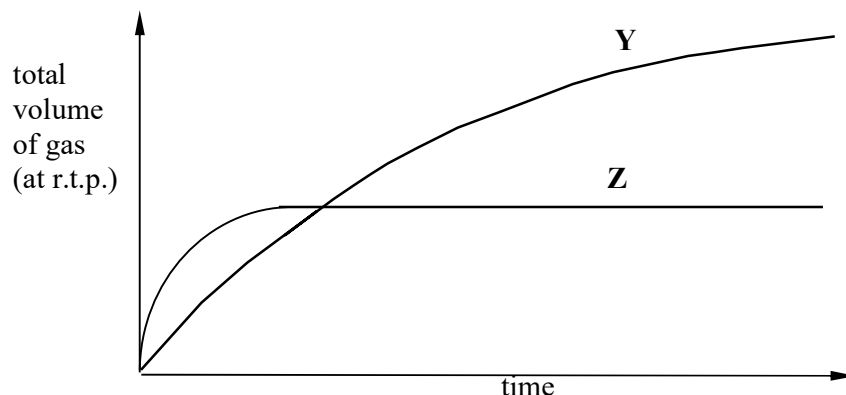
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- 6 Copper(II) oxide powder catalyses the decomposition of hydrogen peroxide. In a laboratory experiment, copper(II) oxide was mixed with aqueous hydrogen peroxide in a beaker. What was present in the beaker when the reaction was complete?

A a colourless liquid and a black solid
B a blue liquid only
C a shiny brown solid and a colourless liquid
D a black solid only

☐

- 7 In the graph, curve **Y** represents the results of reacting 1.0 g of magnesium granules with an excess of acid at 40°C.



Which changes could produce curve **Z**?

- A using 1.0 g of magnesium granules and an excess of acid at 30°C
- B using 1.0 g of magnesium powder and an excess of acid at 30°C
- C using 0.5 g of magnesium granules and an excess of acid at 50°C
- D using 0.5 g of magnesium granules and an excess of acid at 30°C

☐

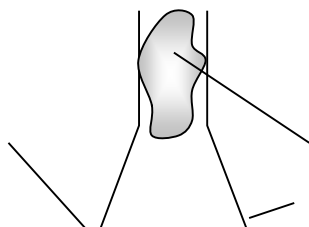
- 8 When a piece of calcium metal is added to dilute hydrochloric acid, the reaction is seen to be faster after 60 seconds than after only 10 seconds. What could explain this observation?

- A Heat is produced in the reaction, which raises the temperature.
- B The concentration of the hydrochloric acid increases during the reaction.
- C Hydrochloric acid is a catalyst.
- D The piece of calcium is smaller at 60 seconds than at 10 seconds.

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- 9 In which reaction is the pressure not likely to affect the rate of reaction?

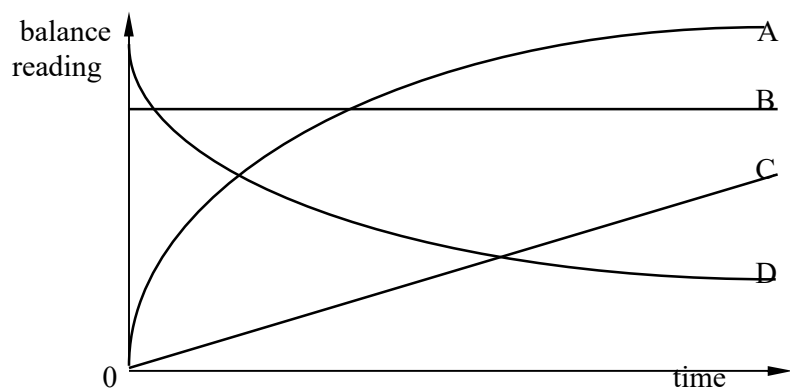
- A $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$
- B $\text{CuO}(\text{s}) + \text{H}_2(\text{g}) \rightarrow \text{Cu}(\text{s}) + \text{H}_2\text{O}(\text{l})$
- C $3\text{H}_2(\text{g}) + \text{N}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
- D $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$

☐

10

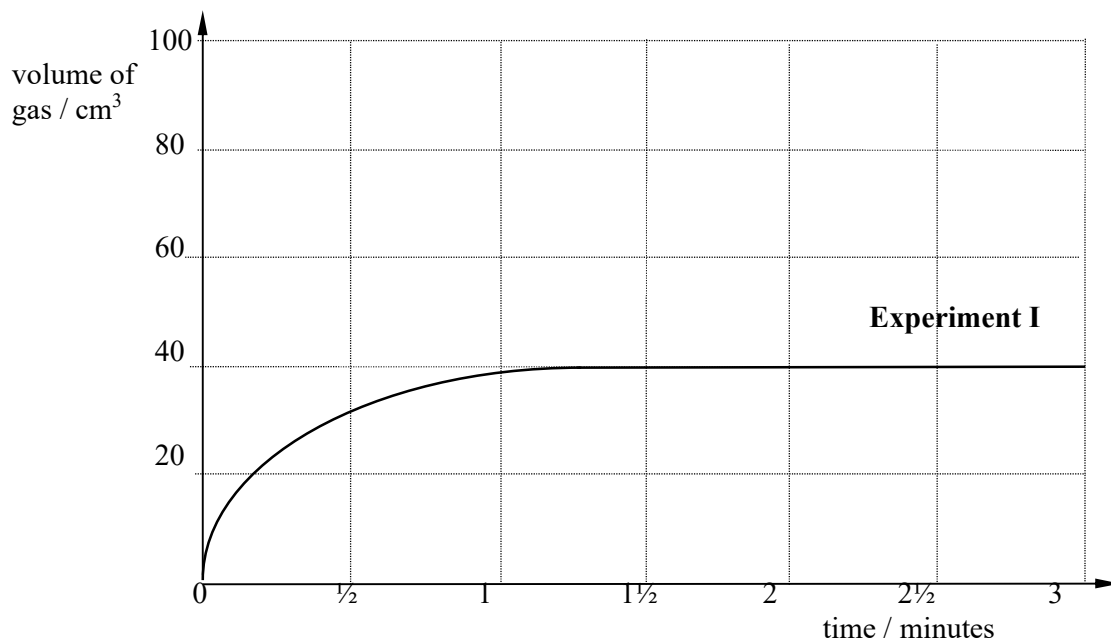
excess sulphuric acid	cotton wool
granules of zinc metal	flask
	balance

Which graph would be obtained for the results of the experiment shown above?



Section B: Structured Questions

- 1 In an experiment (Experiment I), a volume of 0.5 mol/dm^3 hydrochloric acid was added to marble chips in a flask. The marble was in excess. A graph of volume of gas produced against time is shown in the diagram.



- (a) Write the equation, with state symbols, for the reaction.

.....
[2]

- (b) Explain the shape of the graph between 2 and $2\frac{1}{2}$ minutes from the start.

.....
[2]

- (c) State and explain the difference in the rate of reaction at $\frac{1}{2}$ minute and at 1 minute from the start.

(i) *difference in rate:*

.....

(ii) *explanation:*

.....

.....

[2]

- (d) The experiment was repeated three times, with **one change** in conditions in each experiment.

Experiment	Change in conditions
------------	----------------------

II	lower temperature
III	1.0 mol/dm ³ acid used, but the same volume
IV	smaller pieces of marble but the same mass

Sketch on the axes the graphs you would expect for Experiments II - IV. Label each graph.
[4]

2 Chemical reactions need activation energy.

(a) (i) State the meaning of *activation energy*.

.....
.....

[1]

(ii) State in terms of chemical bonds, what activation energy is used for in a reaction.

.....
.....

[1]

(b) Aqueous hydrogen peroxide was decomposed into water and oxygen in two separate experiments. One experiment used manganese(IV) oxide as the catalyst and the other used copper(I) oxide as the catalyst. All other conditions were the same in the two experiments.

(i) Write the equation, with state symbols, for the reaction.

.....

(ii) Define the term *catalyst*.

.....
.....

(iii) The reaction with copper(I) oxide was faster than that with manganese(IV) oxide. State and explain the difference in activation energy for the two reactions.

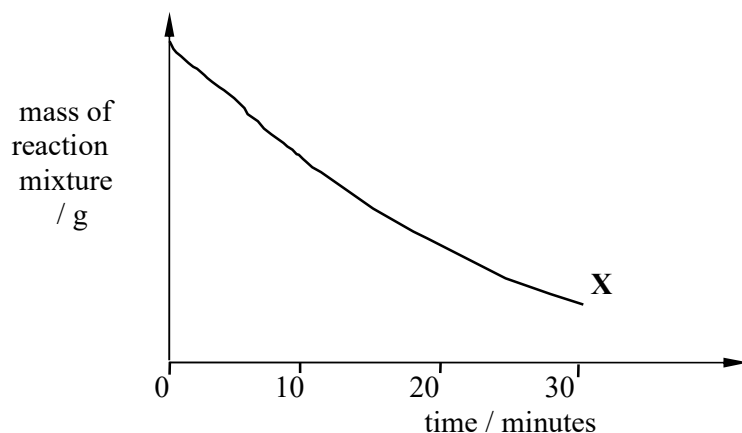
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(iv) In terms of the Periodic Table, what feature is the **same** for the two catalysts?

.....
[5]

3 A student investigates the rate of reaction between solid calcium carbonate and dilute nitric acid by measuring the decrease in mass of the reaction mixture over a period of time, due to the loss of carbon dioxide gas. Graph X below shows the results

obtained when a 5.0 g lump of calcium carbonate was added to an excess of 2.0 mol/dm³ nitric acid.



- (a) Carbon dioxide is one product of the reaction between calcium carbonate and nitric acid. Name the other two products.

..... [1]

- (b) Do you think the reaction between calcium carbonate and nitric acid had finished in 30 minutes. Explain your answer

..... [1]

- (c) The experiment was repeated using another 5.0 g lump of calcium carbonate and 1.0 mol/dm³ nitric acid.

(i) Draw on the diagram above, the graph you would expect. Label this graph **Y**.

- (ii) Graphs **X** and **Y** can be used to show the effect of concentration on the rate of reaction. State two conditions which would have to be the same in the two experiments for the comparison to be valid.

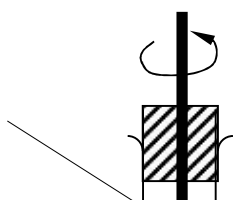
..... [3]

- (d) Another student suggested investigating the rate of the same reaction, but using **powdered** calcium carbonate. Suggest why this method may not be suitable.

-
-
- [1]
- (e) Draw a labelled diagram to show another method of investigating the rate of reaction between a lump of calcium carbonate and dilute nitric acid.

[3]

- 4 Vegetable oil reacts with hydrogen gas to produce margarine. The reaction is catalysed by nickel metal. The diagram shows how this reaction was investigated in the



laboratory. The whole apparatus, including the gas syringe, is filled with hydrogen at the start of the reaction.

stirrer

vegetable oil

metal catalyst

conical flask

gas syringe

(a) The metal catalyst can be in the form of a fine powder or as small lumps.

(i) Which form has the larger surface area?

(ii) Explain, using the idea of colliding particles, why the form you have chosen in (i) results in a greater rate of reaction.

[2]

(b) State the measurements you would make which would enable you to follow the rate of reaction.

[2]

(c) Suggest a reason why nickel is likely to be a better catalyst for this reaction than magnesium.

[1]

(d) Give **one** other example of an industrial reaction that is catalysed by a metal.

(i) name of process

(ii) name of catalyst

.....
[2]

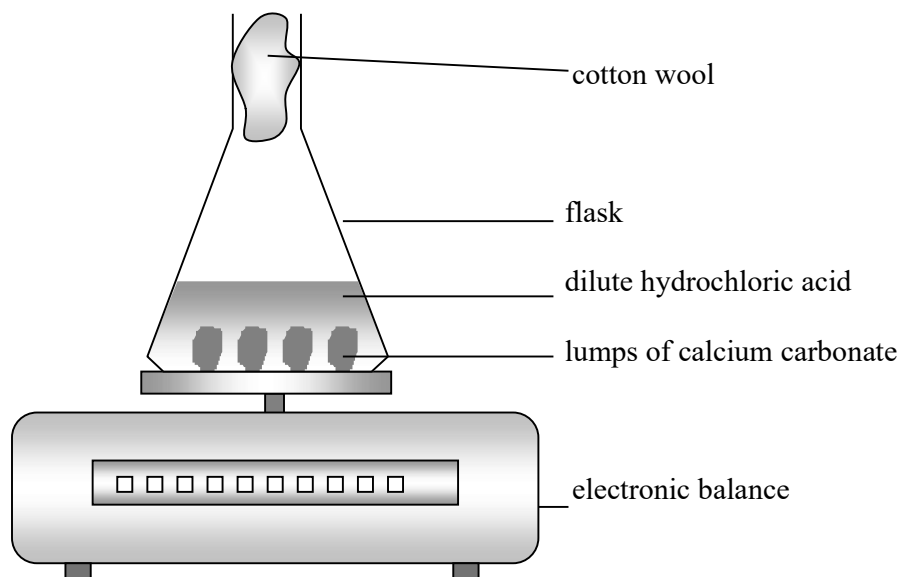
(e) Margarine reacts slowly with oxygen when left exposed to air. This reaction spoils the taste of the margarine and is caused by enzymes in microorganisms. State what is meant by the term *enzyme*.

.....
.....
[1]

Section C : Essay Questions

- 1 Small lumps of calcium carbonate were added to dilute hydrochloric acid in the apparatus shown in the diagram. The balance reading was noted as soon as the lumps were added and again after five minutes. The experiment was repeated using the same

size and number of lumps of calcium carbonate and the same temperature, but changing the concentration of the hydrochloric acid.



The results of both experiments are given in the table.

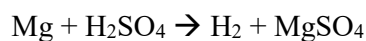
Experiment number	initial balance reading / g	balance reading after 5 minutes / g
I	122.8	117.4
II	107.0	98.7

- (a) Why do the balance readings decrease over the five minutes? [1]
- (b) Suggest the purpose of the cotton wool plug? [1]
- (c) Giving reasons for your answers, explain which experiment, I or II,
(i) had the faster speed of reaction, [4]
(ii) had the higher concentration of acid.
- (d) State and explain, using ideas of collisions between particles, if powdered calcium carbonate would react faster or slower than lumps of calcium carbonate in this experiment. [2]
- (e) Suggest another reaction for which the rate could be followed using this apparatus, by either by writing the equation or by naming the reagents and the products of the reaction, [2]

- 2 In an experiment, 0.10 g of magnesium ribbon was reacted with 50 cm³ of 1.0 mol/dm³ sulphuric acid and the total volume of hydrogen produced was measured every ten seconds. After 80 seconds, the reaction had stopped. The results are given in the table

Time from start of experiment / s	total volume of hydrogen produced / cm ³
0	0
10	31
20	52
30	67
40	78
50	88
60	96
70	100
80	100

- (a) Draw a labelled diagram of suitable apparatus for this experiment. [2]
(b) The equation for the reaction of magnesium and dilute sulphuric acid is given below.



- (i) Calculate the number of moles of magnesium and of sulphuric acid that were used in this experiment.
(ii) Hence explain why the reaction stopped. [2]
- (c) The experiment was repeated using the same mass of magnesium but 50 cm³ of 2.0 mol/dm³ sulphuric acid. State with a reason how
(i) the initial rate of formation of hydrogen,
(ii) the total volume of hydrogen collected when the reaction had stopped, would compare with the original experiment. [2]
- (d) This reaction, procedure and apparatus can be used to investigate the effect of temperature on the rate of reaction by comparing the results of two experiments carried out at different temperatures.
(i) State **two** conditions which must be the same in both experiments.
(ii) Explain how you would use the results to decide the effect of temperature on the rate of reaction. [4]