Controlling Reactions (H)

1. The rate of reaction of marble chips with dilute hydrochloric acid depends on the surface area of the marble chips.

Which surface area of the marble chips gives the **highest** rate of reaction?

   A 0.673 mm^2
   B 1030 mm^2
   C 2.18 × 10^3 mm^2
   D 4.98 × 10^{-2} mm^2

Your answer   [ ]   **[1]**

2. Enzymes are a type of catalyst.

Which of the following catalysts is an example of an enzyme?

   A   Amylase – a catalyst found in human saliva.
   B   Iron – a catalyst used in the Haber process.
   C   Manganese(IV) oxide – a catalyst used in the decomposition of hydrogen peroxide.
   D   Vanadium(V) oxide – a catalyst used in the Contact process.

Your answer   [ ]   **[1]**

3. A student investigates the decomposition of hydrogen peroxide.

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$
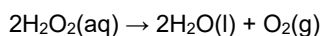
0.2g of oxygen gas is produced in the reaction.

The student uses 0.5 g of manganese(IV) oxide as a catalyst in the reaction.

How much manganese(IV) oxide remains at the end of the reaction?

   A   0.2g
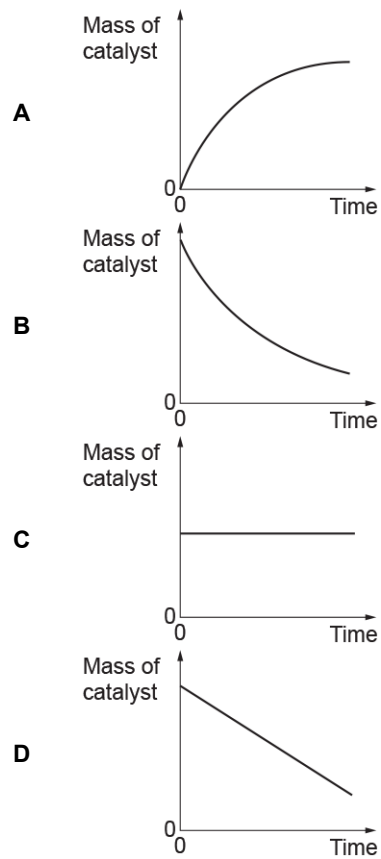   **B**   0.3g
   C   0.5g
   D   0.7g

Your answer   [ ]   **[1]**

4. A catalyst can be used to increase the rate of a reaction.

Which graph shows the **mass of the catalyst** as the reaction takes place?

A

Mass of catalyst / Time

B

Mass of catalyst / Time

C

Mass of catalyst / Time

D

Mass of catalyst / Time

Your answer ☐

[1]

5 (a). A student investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

She wants to find out how the concentration of the acid changes the rate of reaction.

Look at the apparatus she uses.

Carbon dioxide gas is given off in the reaction.

The student measures the loss in mass every 30 seconds for 5 minutes.

Another student also investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

He also wants to find out how the **concentration** of the acid changes the rate of reaction. He uses a **different** method.

Describe the **method** he uses.

Include a **labelled diagram** of the setup of the apparatus he uses.

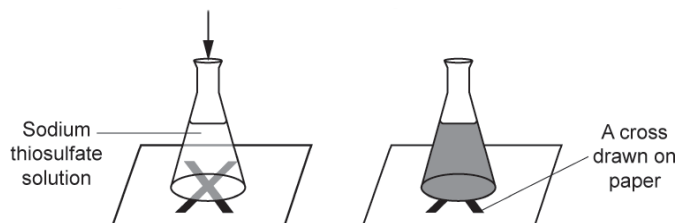--- **[5]**

(b). Some students investigate the reaction between sodium thiosulfate and dilute hydrochloric acid.

They want to find out how **temperature** changes the rate of reaction.

Look at the diagram of their experiment.

Add dilute hydrochloric acid and start timing

A yellow solid is made during the reaction.

The students time how long it takes for the cross to disappear. This is the reaction time.

Look at their results.

Temperature (°C)	Reaction time (s)	Rate of reaction (s⁻¹)
10	140	7×10^{-3}
20	56	2×10^{-2}
30	34	3×10^{-2}
40	26	4×10^{-2}
50	22	5×10^{-2}

i. Plot a graph of the results on the grid. Draw a line of best fit.

rate of reaction
$\times 10^{-2}$
(s^{-1})

Temperature (°C)

[4]
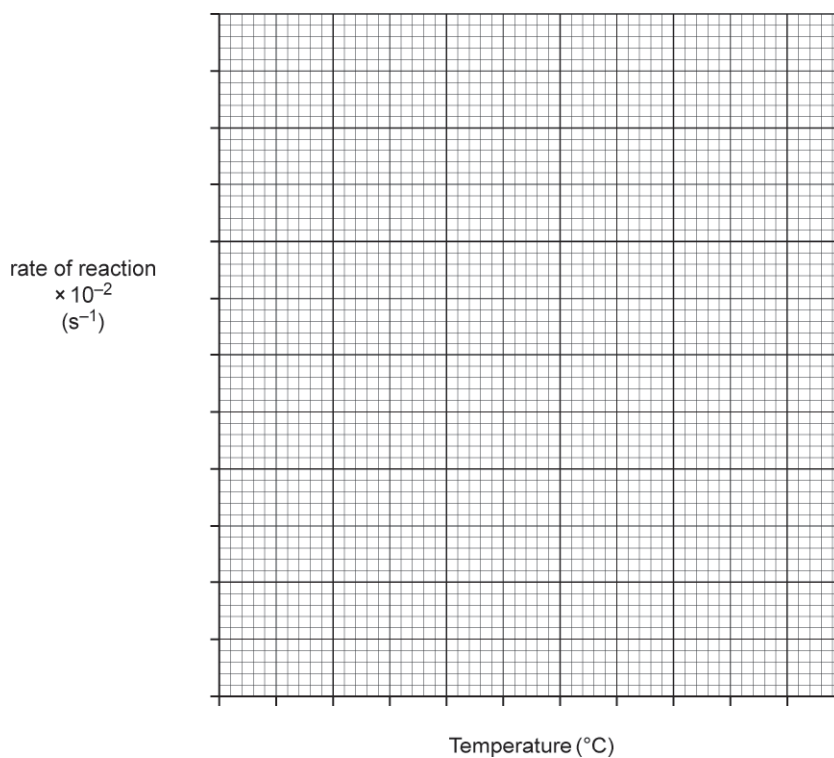
ii. What happens to the **rate of reaction** as the temperature increases?

---**[1]**

iii. Explain your answer to **(ii)**.

   Use ideas about collisions between particles in your answer.

---**[3]**

6 (a). *The student measures the time it takes for all the magnesium to react. This is the reaction time.

The student does five experiments.

This is the student's prediction:

"The smaller the volume of acid and the greater the concentration of acid, the faster the reaction rate."

Look at the student's results.

Experiment	Mass of magnesium used (g)	Volume of acid used (cm³)	Concentration of acid (mol / dm³)	Reaction time (s)
1	0.05	25	1.0	30
2	0.05	50	1.0	30
3	0.05	50	2.0	15
4	0.10	25	1.0	30
5	0.10	50	2.0	15

Describe and explain whether the student's results support his prediction.

Include ideas about the reacting particle model in your answer.

---**[6]**

(b). The student repeats experiment **1**. This time he uses acid at a **higher** temperature.

Explain, using the reacting particle model, **what happens to the rate of reaction** and **predict the reaction time** for this reaction.

---**[3]**

(c). Another student investigates the reaction between marble chips and hydrochloric acid.

She times how long it takes for all the marble chips to react.

Look at her results.

Experiment	Size of marble chips	Reaction time (s)	Mean rate of reaction (g/s)
1	large	240	8.33×10^{-4}
2	large	120	
3	large	100	2.00×10^{-3}
4	small	50	4.00×10^{-3}

Look at the student's results for experiment **2**.

Calculate the **mean rate of reaction** in experiment **2**.

Give your answer to **3** significant figures and in **standard form**.

Mean rate of reaction = ... g/s **[3]**

7. Nanoparticles are being used to make a material that is better than Kevlar® at resisting bullets.

Nanoparticles are often made of silicon dioxide.

A silicon dioxide nanoparticle has a diameter of 18 nm.

The diameter of a silicon atom is 0.22 nm.

   i. Estimate how many times larger the silicon dioxide nanoparticle is, compared to a silicon atom.

      Give your answer to **1** significant figure.

Number of times larger = ... **[3]**
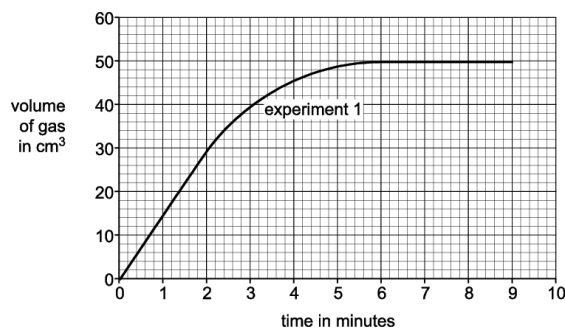
   ii. Silicon dioxide is used as a **catalyst**.

      Suggest why 1 g of silicon dioxide is **more effective** as a catalyst when used as nanoparticles rather than as a powder.

--- **[3]**

8. A student investigates the reaction between calcium carbonate and hydrochloric acid.

He measures the volume of gas made every minute.

Look at the graph. It shows his results for the experiment.

What is the rate of reaction between 0 and 2 minutes in cm³/minute?
    A. 7.5 cm³/min
    B. 15 cm³/min
    C. 30 cm³/min
    D. 60 cm³/min

    Your answer ☐

[1]

9. A student investigates the reaction between 1.0 g of calcium carbonate and 20 cm^3 of 1.0 mol/dm^3 hydrochloric acid at 25°C.

The student does two experiments. He uses different sized pieces of calcium carbonate for each experiment.

The rate of reaction is greater in the first experiment.

Which is the best explanation for this?

    A. Small pieces of calcium carbonate have a larger surface area resulting in less frequent collisions.
    B. Large pieces of calcium carbonate have a larger surface area resulting in less frequent collisions.
    C. Large pieces of calcium carbonate have a smaller surface area resulting in more frequent collisions.
    D. Small pieces of calcium carbonate have a larger surface area resulting in more frequent collisions.

Your answer ☐

[1]

10. The Contact Process is used to manufacture sulfuric acid.

The Contact Process involves the reaction between sulfur dioxide and oxygen.

The conditions used are 450°C and about 10 atmospheres pressure.

    i. If the temperature is increased to 500°C the rate of reaction changes.

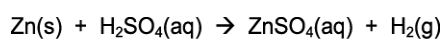   Describe and explain this change in rate of reaction.

--**[2]**

    ii. If the pressure is reduced to 5 atmospheres the rate of reaction changes.

    Describe and explain this change in rate of reaction.

--**[2]**

11 (a). Zinc and dilute sulfuric acid react to make hydrogen.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Inga measures the rate of this reaction by measuring the **loss in mass** of the reaction mixture.

She finds that the change in mass is very small and difficult to measure.

Draw a labelled diagram to show a **better way** of measuring the rate of this reaction.

[3]

(b). The reaction between zinc and dilute sulfuric acid is slow.

Inga decides to try and find a catalyst for this reaction.

She tests four possible substances.

Each time she adds 0.5 g of the substance to 1.0 g of zinc and 25 cm^3 of dilute sulfuric acid.

Look at her table of results.

Substance	Colour of substance at start	Colour of substance at end	Relative rate of reaction
no substance			1
calcium sulfate powder	white	white	1
copper powder	pink	pink	10
copper(II) sulfate powder	blue	pink	30
manganese(IV) oxide powder	black	black	1

    i.   It is important to do the reaction with **only** zinc and dilute sulfuric acid.

            Explain why.

---**[1]**

    ii.   It is important to do all of the reactions with the same concentration of acid.

            Explain why.

---**[1]**

iii. Which of the substances could be a catalyst for the reaction between zinc and dilute sulfuric acid?

Explain your answer.

---**[2]**

iv. There is not enough evidence to confirm which substance is a catalyst.

Suggest an extra piece of experimental evidence that could be collected to confirm which substance is a catalyst.

---**[1]**

v. Inga does the experiment with copper, zinc and dilute sulfuric acid again.

This time she uses a lump of copper rather than copper powder.

Predict, with reasons, the relative rate of reaction.

---**[2]**

END OF QUESTION PAPER