Controlling Reactions (F)

1. A student investigates the decomposition of hydrogen peroxide.

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

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

Your answer ☐ **[1]**

2. A student investigates the reaction between zinc and dilute sulfuric acid.

He measures the time taken to collect 50 cm_3 of hydrogen gas. This time is 65 seconds.

The student investigates four substances which are possible **catalysts** for the reaction.

Substance	Appearance of substance	Time to collect 50 cm^3 of hydrogen (g)	Other observations
A	red-brown powder	19	red-brown powder remains
B	blue solid	15	colourless solution formed
C	red-brown lumps	65	red-brown lumps remain
D	white solid	65	colourless solution formed

Which substance, **A**, **B**, **C** or **D**, is a catalyst for the reaction?

Your answer ☐ **[1]**

3. The rate of a reaction can be changed by adding a catalyst to the reaction mixture.

Which line of the table shows how the **rate of reaction** and the **mass of the catalyst** change as the reaction takes place?

	Change in rate of reaction	Change in mass of catalyst
A	decreases	no change
B	no change	decreases
C	increases	no change
D	increases	decreases

Your answer ☐ **[1]**

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

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

Fig. 18.3 is a diagram of their experiment.

Add dilute hydrochloric acid and start timing

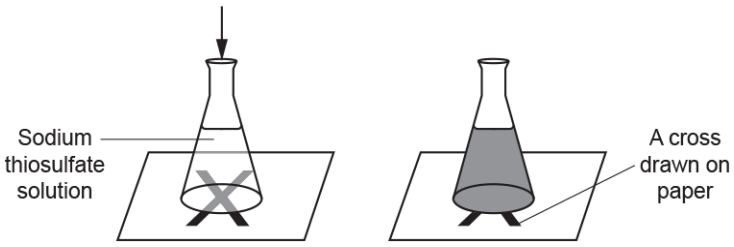


Fig. 18.3

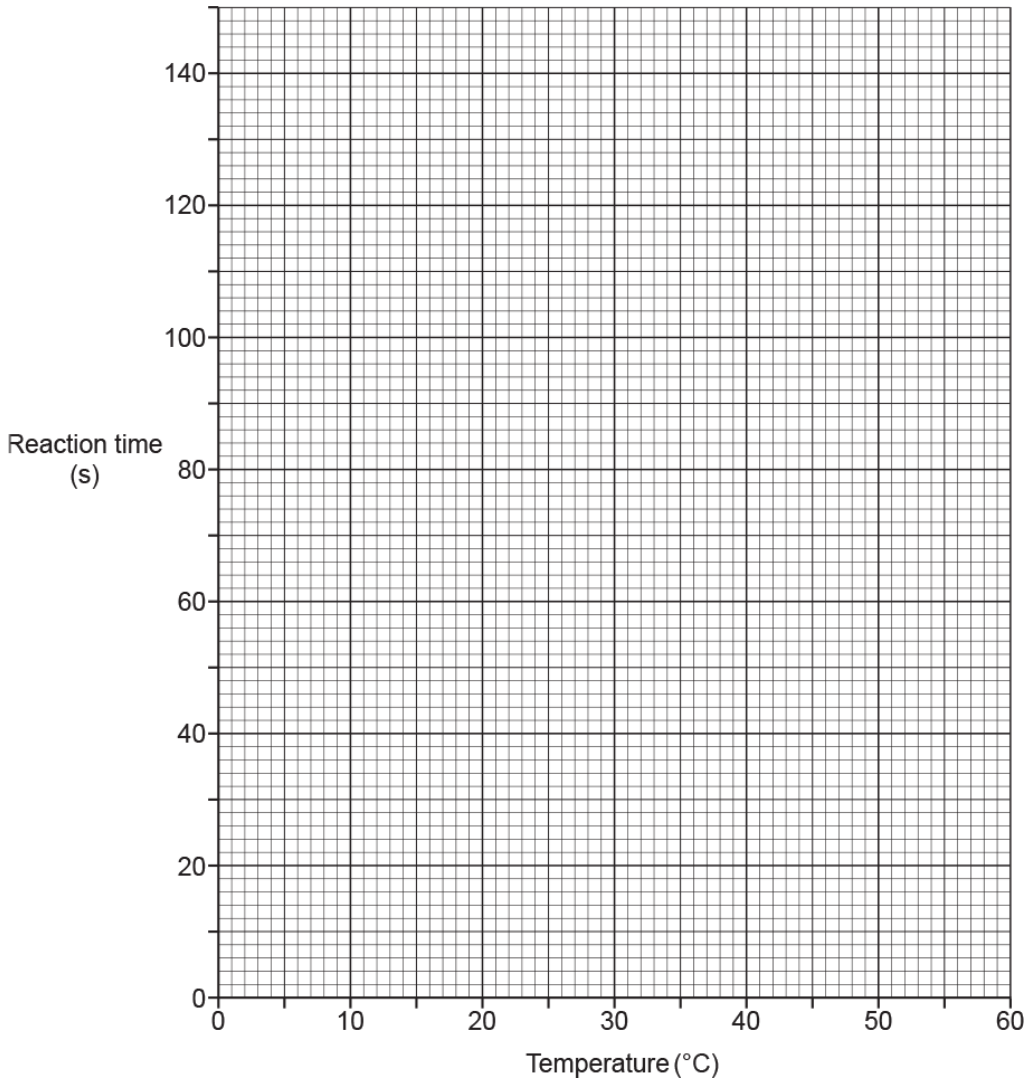
A yellow solid is made during the reaction.

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)
10	140
20	56
30	34
40	26
50	22

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



[3]

ii. What is the reaction time at **25 °C**?

Reaction time = ... s **[1]**

iii. What happens to the **rate of reaction** as the temperature increases?

---

[1]

iv. Explain your answer to **(iii)**. Include ideas about collisions between particles in your answer.

---

[2]

(b). 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.

Fig. 18.1 shows the apparatus she uses.

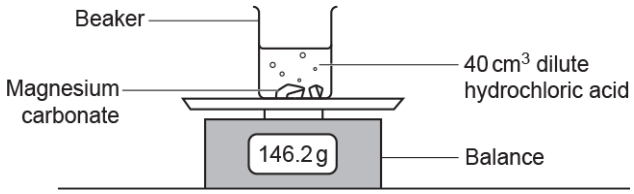


Fig. 18.1

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.

Fig. 18.2 shows diagrams of some of the apparatus he uses.

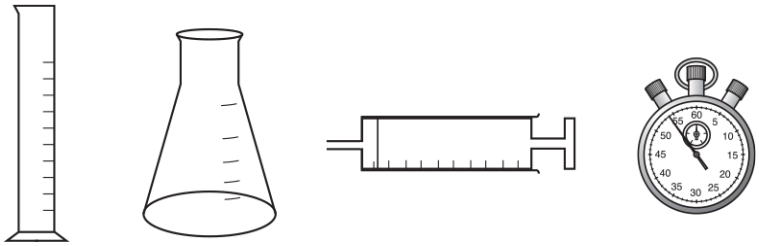


Fig. 18.2

The student also wants to find out how the **concentration** of the acid changes the rate of reaction.

Describe the **method** he follows using the apparatus in **Fig. 18.2**.

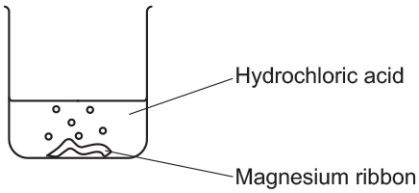
Include a **labelled diagram** of the set-up of the apparatus he uses.

---

[4]

5 (a). A student investigates the reaction between magnesium and dilute hydrochloric acid, HC*l*.

The student adds magnesium ribbon to hydrochloric acid in a beaker, as shown in the diagram.



Magnesium chloride, $MgCl_2$, and hydrogen gas are made.

Write the **balanced symbol** equation for this reaction.

---

[2]

(b). *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 smaller the mass of magnesium, the shorter the reaction time."

Look at the student's results.

Experiment	Mass of magnesium used (g)	Volume of acid used (cm^3)	Concentration of acid (mol / dm^3)	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]

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

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

[3]

(d). During chemical reactions, reactants are used up and the rate of reaction **decreases**.

Explain, in terms of particles, why the rate of reaction decreases.

_____

_____

_____

_____ **[2]**

6. 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]

7 (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]

8. * Kayvan investigates the effect of changing the pressure and changing the temperature on this reaction.

carbon dioxide + hydrogen ⇌ methane + water

The table shows the percentage yield of methane in the equilibrium mixture under different conditions.

		Pressure in atmospheres			
		100	**200**	**300**	**400**
Temperature in °C	**300**	35%	52%	65%	80%
	600	30%	46%	58%	74%
	900	23%	37%	47%	62%
	1200	14%	25%	36%	48%

Describe what happens to the percentage yield as the pressure and temperature change and explain the effect of increasing the pressure on the rate of reaction.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

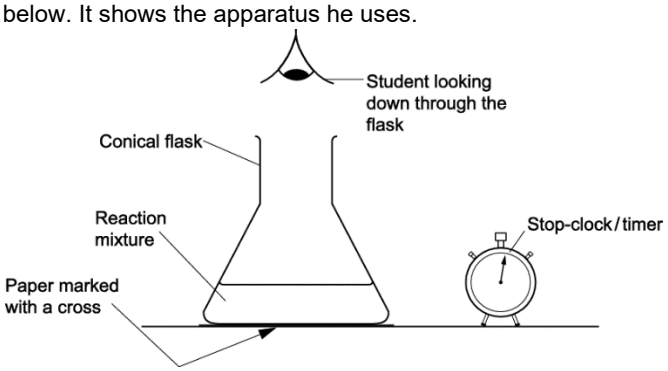
_____

_____

_____

_____ **[6]**

9. A student investigates the reaction between sodium thiosulfate and hydrochloric acid.
Look at the diagram below. It shows the apparatus he uses.



After a time he cannot see the cross because the liquid in the beaker goes cloudy. The student measures the time taken until the cross cannot be seen.

He does the experiment four times, each with a different concentration of sodium thiosulfate solution.

Which of the following must **not** be changed to do a fair test?

A. concentration of sodium thiosulfate used
B. stop-clock or timer
C. total volume of the reaction mixture
D. volume of sodium thiosulfate added

Your answer ☐

[1]

10. A student investigates the reaction between sodium carbonate and dilute nitric acid.

She measures the reaction time with four different concentrations of acid.

She does all the experiments using the

- same temperature
- same mass of sodium carbonate
- same volume of acid.

Look at her results.

Concentration	Reaction time in seconds
A	41
B	74
C	135
D	67

Which concentration of nitric acid gave the **fastest** reaction?

Your answer ☐

[1]

END OF QUESTION PAPER