

The rate and extent of chemical reaction – GCSE CS Chemistry

1. June/2024/Paper_8464/C/2F/No.2

0 2

Different tests can be used to identify chemicals.

0 2 . 1

A student measured the melting points of four substances.

Table 1 shows the results.

Table 1

Substance	Melting point in °C
A	52 to 54
B	61
C	-2 to 0
D	80 to 82

Which substance was pure?

Give **one** reason for your answer.**[2 marks]**Substance BReason Melting point of substance B is a
specific value.

Anhydrous copper sulfate can be used to test for water.

The word equation for the reaction is:



0 2 . 2 Complete the sentence.

Choose answers from the box.

[2 marks]

blue	green	red	white	yellow
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When water is added to anhydrous copper sulfate, the colour changes

from white to blue.

0 2 . 3 The reaction between anhydrous copper sulfate and water is reversible.

How does the word equation show that the reaction is reversible?

[1 mark]

The symbol $\rightleftharpoons$

0 2 . 4

The formula of anhydrous copper sulfate is CuSO_4 What is the total number of atoms in the formula CuSO_4 ? $1 + 2 + 3 + 4 = 10$

[1 mark]

Tick (✓) one box.

3	☐	4	☐	6	☒	7	☐
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$\begin{array}{ccc} \text{Cu} & \text{S} & \text{O}_4 \\ 1 & 1 & (1 \times 4) \\ 2 + 4 & = & 6 \end{array}$

0 2 . 5

Chlorine is a gas.

Describe the test for chlorine.

Give the result.

[2 marks]

Test Use a damp litmus paper.Result A blue litmus paper turns red and then it is bleached to white

2. June/2024/Paper_8464/C/2F/No.7

07

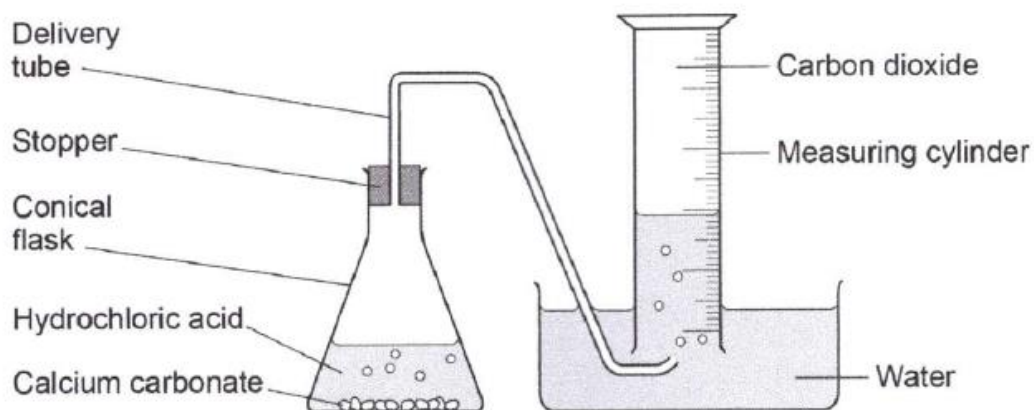
Some factors affect the rates of chemical reactions.

07.1

A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

Figure 6 shows the apparatus.

Figure 6



Describe a method the student could use to produce valid results.

[6 marks]

- Controls:
- Measure the same volume and concentration of HCl .
 - Measure same mass of calcium carbonate using a balance.
 - Use the same temperature for the acid.
- ① Set up the apparatus as shown in fig 3.
 - ② Add measured hydrochloric acid to a conical flask.
 - ③ Add first sample of calcium carbonate to the flask.
 - ④ Immediately place a stopper and delivery tube in the flask and start a timer.
 - ⑤ Record volume of CO_2 collected in the measuring cylinder at regular intervals until the reaction stops.
- Repeat steps 2-5 using same mass of CaCO_3 with different particle size. Repeat entire experiment for each particle to calculate mean and ensure reliability of results.

07.2

The student investigated the effect of increasing the temperature on the rate of a reaction.

Explain the effect of increasing the temperature on the rate of a reaction.

Refer to particles and collisions in your answer.

[3 marks]

An increase in temperature gives the reactant particles more kinetic energy causing them to move faster. Because particles are moving faster, they collide more frequently per unit time. This increases the frequency of successful collisions.

Catalysts affect the rate of reactions.

07.3 What is meant by a 'catalyst'?

[2 marks]

A substance that increases the rate of reaction
and is not used up during the reaction.

07.4 What are catalysts in biological systems called?

[1 mark]

Enzymes.

3. June/2024/Paper_8464/C/2H/No.2

0 2

Some factors affect the rates of chemical reactions.

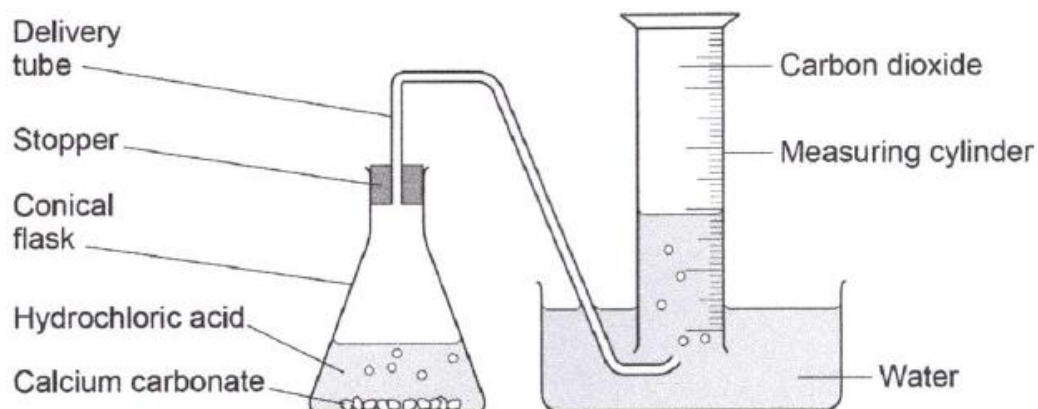
0 2

1

A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

Figure 3 shows the apparatus.

Figure 3



Describe a method the student could use to produce valid results.

[6 marks]

- Control:
- Measure the same volume and concentration of HCl .
 - Measure same mass of calcium carbonate using a balance.
 - Use the same temperature for the acid.
- 1 Set up the apparatus as shown in fig 3-2 Add measured hydrochloric acid to a conical flask.
 - 3 Add first sample of calcium carbonate to the flask.
 - 4 Immediately place a stopper and delivery tube in the flask and start a timer
 - 5 Record volume of carbon dioxide gas collected in the measuring cylinder at regular intervals until reaction stops
- Repeat steps 2-5 using same mass of CaCO_3 but with different particle size. Repeat the entire experiment for each particle size to calculate mean.

0 2 . 2

The student investigated the effect of increasing the temperature on the rate of a reaction.

Explain the effect of increasing the temperature on the rate of a reaction.

Refer to particles and collisions in your answer.

[3 marks]

An increase in temperature gives the reactant particles more kinetic energy causing them to move faster.

Because particles are moving faster, they collide more frequently per unit time. This increases the frequency of successful collisions.

Catalysts affect the rate of reactions.

0 2 . 3 What is meant by a 'catalyst'?

[2 marks]

A substance that increases the rate of reaction
and remains unchanged during the reaction.

0 2 . 4 What are catalysts in biological systems called?

[1 mark]

Enzymes.

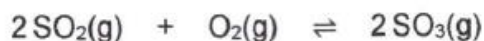
4. June/2024/Paper_8464/C/2H/No.5

0 5

Sulfuric acid is produced by an industrial process.

In the process, sulfur dioxide (SO_2) reacts with oxygen (O_2) to produce sulfur trioxide (SO_3).

The equation for the reversible reaction is:



The forward reaction releases 198 kJ/mol of energy.

0 5 . 1

What is the amount of energy transferred during the reverse reaction?

[1 mark]

Tick (✓) **one** box.

< 198 kJ/mol

☐

= 198 kJ/mol

☒

> 198 kJ/mol

☐

Forward reaction releases 198 kJ mol⁻¹ energy, meaning the reverse reaction will absorb the same amount of energy. Energy transferred in reverse reaction is +198 kJ mol⁻¹

0 5 . 2

The concentration of oxygen is increased.

What is the effect on the position of the equilibrium?

[1 mark]

Tick (✓) **one** box.

Equilibrium position shifts to the left

☐

Equilibrium position does not change

☐

Equilibrium position shifts to the right

☒

Equilibrium changes/shifts to the right to counteract the change, favouring formation of products

0 5 . 3

The pressure is decreased.

What is the effect on the position of the equilibrium?

[1 mark]

Tick (✓) **one** box.

Equilibrium position shifts to the left

☒

Equilibrium position does not change

☐

Equilibrium position shifts to the right

☐*Has 2 moles**Has 2 moles**Equilibrium moves to the side with more moles.*

0 5 . 4

The temperature is increased.

What is the effect on the position of the equilibrium?

[1 mark]

Tick (✓) **one** box.

Equilibrium position shifts to the left

☒

Equilibrium position does not change

☐

Equilibrium position shifts to the right

☐*Endothermic**exothermic**This favours endothermic reaction so equilibrium shifts to the left*

0 5 . 5

A catalyst is used in the reaction.

Suggest what effect the catalyst has on the position of the equilibrium.

Give **one** reason for your answer.

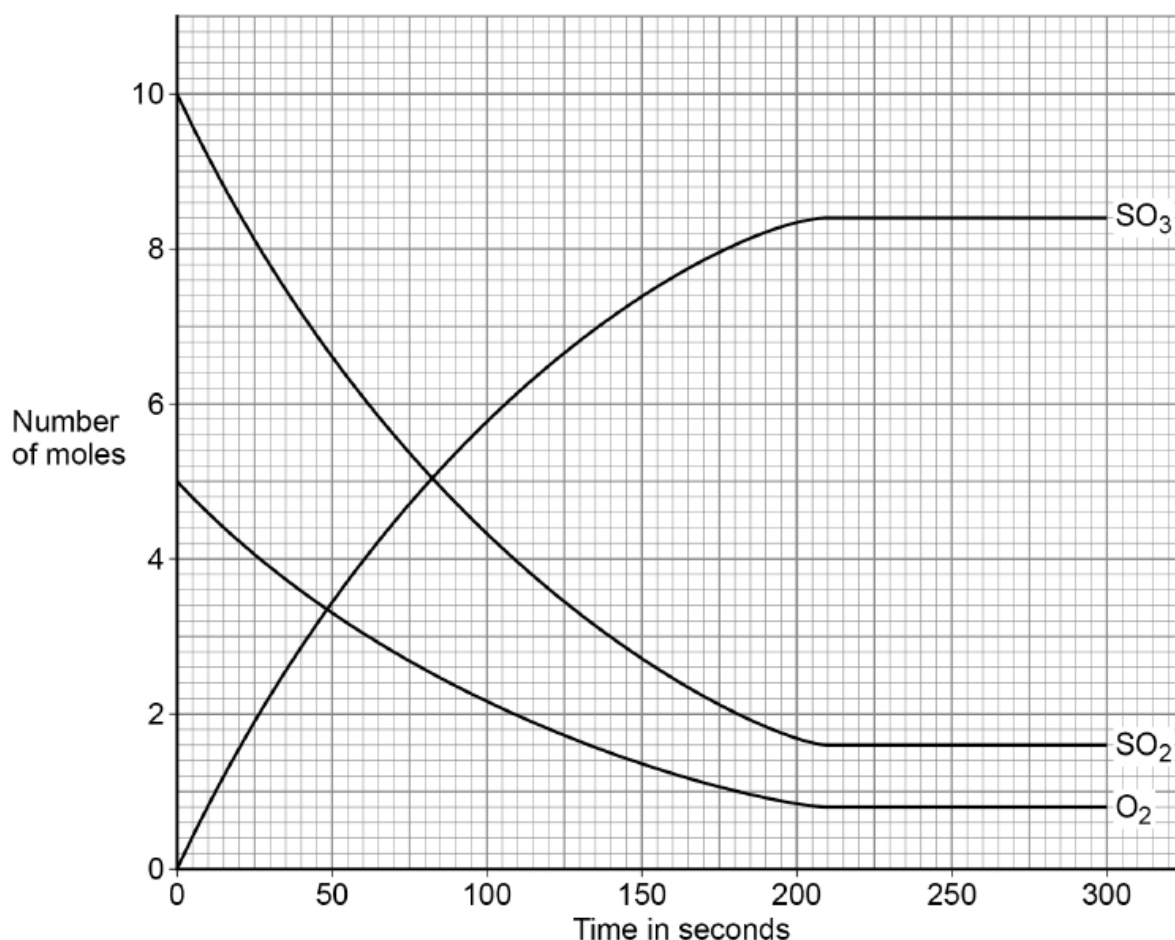
[2 marks]

Effect The equilibrium position does not change.Reason Because a catalyst increases both forward and backward reactions equally.

A scientist measured how the number of moles of sulfur dioxide, oxygen and sulfur trioxide varied with time during the reaction.

Figure 5 shows the results.

Figure 5



0 5 . 6 Determine the time taken for the reaction to reach equilibrium.

Explain your answer.

Use Figure 5.

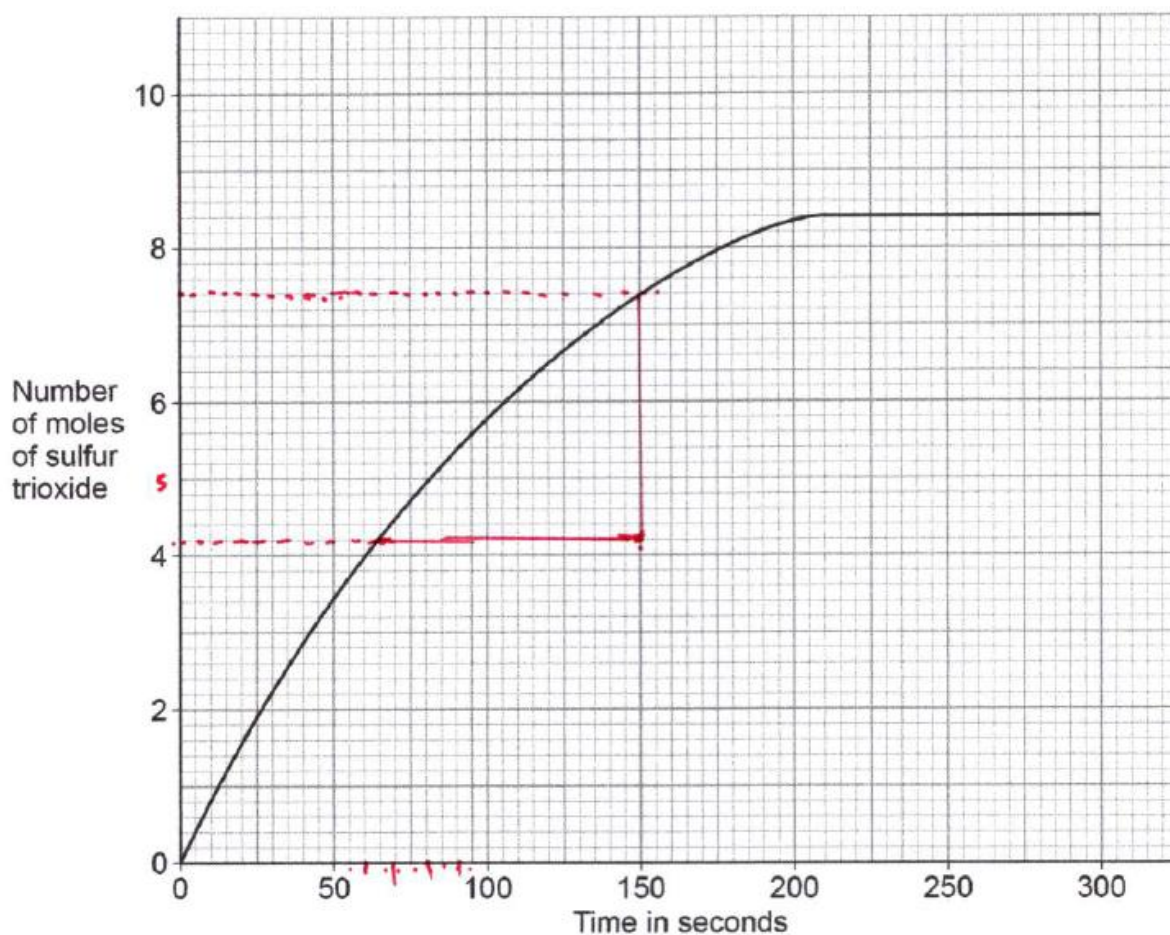
[3 marks]

Time 210 s

Explanation Because the rate of forward and backward reaction is equal at 210 seconds.

0 5 7 Figure 6 shows the results for sulfur trioxide.

Figure 6



Determine the rate of reaction at 60 seconds.

[4 marks]

$$x_2 - x_1 = 150 - 60 = 90 \text{ seconds}$$

$$y_1 = 4.1$$

$$y_2 = 7.2 \quad y_2 - y_1 = 7.2 - 4.1 = 3.1 \text{ moles}$$

$$\text{Rate} = \frac{3.1 \text{ moles}}{90 \text{ seconds}} = 0.03444444 \text{ mol/s}$$

$$\text{Rate} = 0.0344 \text{ mol/s}$$

5. June/2024/Paper_8464/C/2H/No.6

0 6

The Earth's natural resources are used to manufacture useful products.

One useful product is potable water.

Potable water can be produced from sea water by distillation.

0 6 . 1

Give **one disadvantage** of using distillation to produce potable water.

[1 mark]

This process requires a lot of energy because water must be heated to its boiling point to turn it to steam.

0 6 . 2

Describe **one** other method to produce potable water from sea water.

[2 marks]

Reverse osmosis.
Seawater is pumped at a very high pressure through a special filter called a semi permeable membrane.

A student investigated the mass of dissolved solids in a 100 cm^3 sample of sea water.

This is the method used.

1. Weigh an evaporating basin.
2. Measure 100 cm^3 of sea water.
3. Pour the sea water into the evaporating basin.
4. Heat the evaporating basin.
5. Weigh the evaporating basin and contents.
6. Calculate the mass of dissolved solids in the sea water.

0 6 . 3

Explain how repeating steps 4 and 5 would improve this method.

[2 marks]

Heat until you achieve a constant mass of a solid residue.
This ensures all the water has evaporated.

0 6 . 4

The total mass of dissolved solids in a 100 cm^3 sample of sea water is 3.50 g .

The percentage of sodium chloride in the dissolved solids is 77.8% .

Calculate the mass of sodium chloride dissolved in the 100 cm^3 sample of sea water.

[2 marks]

$$\begin{aligned} \text{Mass NaCl} &= \text{Total mass of solids} \times \frac{\% \text{ of NaCl}}{100} \\ &= \frac{3.50 \times 77.8}{100} = \frac{3.50 \times 0.778}{100} \\ &= 2.723 \end{aligned}$$

Mass of sodium chloride = 2.72 g

Biological methods are used to extract metal compounds from metal ores.

0 6 . 5 One method of producing copper from low-grade copper ores is by using bacteria.

The bacteria produce leachate solutions that contain copper compounds.

Give **two** methods that can be used to extract copper from these leachate solutions.

[2 marks]

1 Electrolysis

2 Displacement using scrap iron.

Describe how the metal compounds are obtained from the plants.

Harvested plants are dried and then incinerated in a furnace, to remove organic compounds.
Metal compounds which cannot burn are left behind.
This residue is concentrated metal rich ash.
The metal is extracted from the ash by dissolving the ash in acid.

Nickel is produced by phytomining.

One hectare of plants produces 215 kg of nickel.

Determine the area required to produce 750 kg of nickel.

Give your answer in m^2 .

One hectare = 10 000 m²

[3 marks]

$$\text{ha} = \frac{215 \text{ kg}}{750} = \frac{750}{215} = 3.4883$$

$$1 \text{ ha} = 10000 \text{ m}^2.$$

$$3.49 \text{ ha} \neq 3.49 \times 10,000$$
$$= 34800$$

Area required = 34900 m²