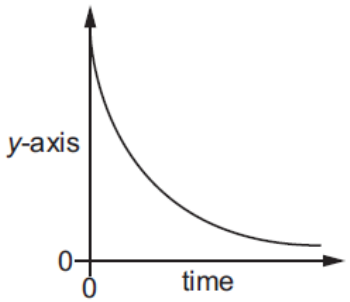
Chemical Reactions – 2023 IGCSE Chemistry 0620

1. Nov/2023/Paper_0620/11/No.13

An experiment is carried out to find the rate of reaction between hydrochloric acid and zinc.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

The results of the experiment are shown.



What is the label on the *y*-axis?

A amount of $ZnCl_2$ produced

B concentration of HCl

C mass of Zn reacted

D volume of H_2 produced

2. Nov/2023/Paper_0620/11/No.14

Solid S changes colour from white to blue when water is added.

What is S?

A anhydrous cobalt(II) chloride

B anhydrous copper(II) sulfate

C hydrated cobalt(II) chloride

D hydrated copper(II) sulfate

3. Nov/2023/Paper_0620/11/No.15

Which equation shows the reduction of copper?

A $CuO + C \rightarrow Cu + CO$

B $2CuS + 3O_2 \rightarrow 2CuO + 2SO_2$

C $Cu(g) \rightarrow Cu(l)$

D $Cu(l) \rightarrow Cu(s)$

4. Nov/2023/Paper_0620/12/No.14

Solid calcium carbonate reacts with dilute hydrochloric acid.

Which changes to the reaction conditions increase the rate of reaction?

	concentration of hydrochloric acid	surface area of calcium carbonate
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

5. Nov/2023/Paper_0620/12/No.15

Zinc reacts slowly with dilute sulfuric acid at room temperature.

Bubbles of a gas, L, form on the surface of the zinc.

When a small amount of copper is added, the reaction is faster.

Which row identifies L and explains why the reaction is faster?

	gas formed in reaction	reason the reaction is faster
A	hydrogen	copper acts as a catalyst
B	hydrogen	copper is more reactive than zinc
C	oxygen	copper acts as a catalyst
D	oxygen	copper is more reactive than zinc

6. Nov/2023/Paper_0620/12/No.16

Which reaction shows a colour change from white to blue?

A adding water to anhydrous copper(II) sulfate

B adding water to hydrated copper(II) sulfate

C heating anhydrous copper(II) sulfate

D heating hydrated copper(II) sulfate

7. Nov/2023/Paper_0620/12/No.17

In a blast furnace, iron(III) oxide is converted to iron and carbon monoxide is converted to carbon dioxide.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

What happens to each of these reactants?

A Both iron(III) oxide and carbon monoxide are oxidised.

B Both iron(III) oxide and carbon monoxide are reduced.

C Iron(III) oxide is oxidised and carbon monoxide is reduced.

D Iron(III) oxide is reduced and carbon monoxide is oxidised.

8. Nov/2023/Paper_0620/13/No.15

Anhydrous cobalt(II) chloride is blue and turns pink when water is added.

How is this reaction reversed?

A adding dilute acid

B filtering

C heating

D cooling

9. Nov/2023/Paper_0620/13/No.16

Ethanol can be turned into ethanoic acid by passing it over hot copper(II) oxide.

$$CH_3CH_2OH + 2CuO \rightarrow CH_3COOH + H_2O + 2Cu$$

What is this type of reaction?

A precipitation

B redox

C thermal decomposition

D neutralisation

10. Nov/2023/Paper_0620/13/No.17

When heated strongly, silicon(IV) oxide reacts with carbon.

$$SiO_2 + 2C \rightarrow Si + 2CO$$

Which term describes what happens to silicon(IV) oxide?

A thermal decomposition

B neutralisation

C oxidation

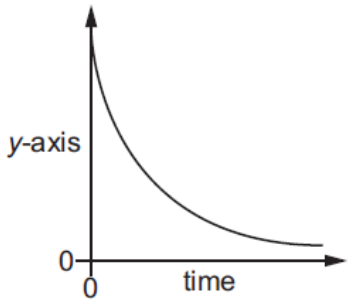
D reduction

11. Nov/2023/Paper_0620/21/No.13

An experiment is carried out to find the rate of reaction between hydrochloric acid and zinc.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

The results of the experiment are shown.



What is the label on the *y*-axis?

A amount of $ZnCl_2$ produced

B concentration of HCl

C mass of Zn reacted

D volume of H_2 produced

12. Nov/2023/Paper_0620/21/No.14

Hydrogen peroxide, H_2O_2, decomposes to form water and oxygen.

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

Manganese(IV) oxide catalyses the decomposition reaction.

The reaction is investigated in four experiments.

experiment	volume and concentration of hydrogen peroxide	conditions
1	12.5 cm^3 of 1.0 mol/dm^3	25 °C with manganese(IV) oxide powder added
2	12.5 cm^3 of 2.0 mol/dm^3	40 °C with manganese(IV) oxide powder added
3	25 cm^3 of 1.0 mol/dm^3	40 °C without manganese(IV) oxide powder
4	25 cm^3 of 1.0 mol/dm^3	40 °C with manganese(IV) oxide powder added

All reactions go to completion and all measurements of gas volumes are at room temperature and pressure.

Which statement is correct?

A Experiment 1 produces less gas than experiment 4, but at the same rate.

B Experiment 2 produces more gas than experiment 1, but at the same rate.

C Experiment 2 and experiment 4 each produce the same volume of gas, but at different rates.

D Experiment 3 and experiment 4 each produce the same volume of gas and at the same rate.

13. Nov/2023/Paper_0620/21/No.15

Sulfuric acid is produced by the Contact process.

Which row shows the typical conditions used in the process?

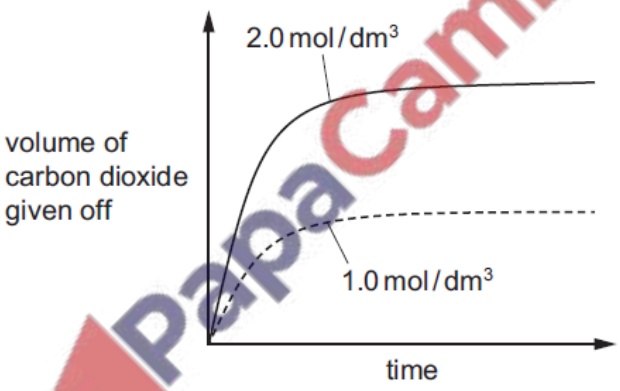
	catalyst	pressure /kPa	temperature /°C
A	iron	200	300
B	iron	20 000	450
C	vanadium(V) oxide	200	450
D	vanadium(V) oxide	20 000	300

14. Nov/2023/Paper_0620/22/No.15

Hydrochloric acid is added to excess calcium carbonate in two separate experiments.

Two different concentrations of hydrochloric acid are used but the temperature is the same in both experiments.

The graph of the results shows the volume of carbon dioxide gas given off over time.



Which row is correct?

	particles in 2.0 mol / dm^3 compared to 1.0 mol / dm^3	
	collision rate	collision energy
A	higher	no change
B	higher	higher
C	lower	no change
D	lower	higher

15. Nov/2023/Paper_0620/22/No.16

The decomposition of dinitrogen tetroxide, N_2O_4, into nitrogen dioxide, NO_2, is a reversible reaction.

The equation for the reaction is shown.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The forward reaction is endothermic.

Which row shows the effect on the position of equilibrium and the rate of the reverse reaction when the temperature is increased?

	position of equilibrium	rate of the reverse reaction
A	shifts to the left	decreases
B	shifts to the left	increases
C	shifts to the right	decreases
D	shifts to the right	increases

16. Nov/2023/Paper_0620/22/No.17

In a blast furnace, iron(III) oxide is converted to iron and carbon monoxide is converted to carbon dioxide.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

What happens to each of these reactants?

A Both iron(III) oxide and carbon monoxide are oxidised.

B Both iron(III) oxide and carbon monoxide are reduced.

C Iron(III) oxide is oxidised and carbon monoxide is reduced.

D Iron(III) oxide is reduced and carbon monoxide is oxidised.

17. Nov/2023/Paper_0620/22/No.18

Which row describes what happens to Fe^{2+} ions when they are oxidised?

	electron movement	oxidation number of iron
A	they gain electrons	decreases
B	they gain electrons	increases
C	they lose electrons	decreases
D	they lose electrons	increases

18. Nov/2023/Paper_0620/23/No.17

The reaction between hydrogen and nitrogen is reversible.

The forward reaction is exothermic.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Which change to the conditions would increase the yield of ammonia?

A add a catalyst

B increase the pressure

C increase the temperature

D reduce the concentration of nitrogen

19. Nov/2023/Paper_0620/23/No.18

Ethanol can be turned into ethanoic acid by passing it over hot copper(II) oxide.

$$CH_3CH_2OH + 2CuO \rightarrow CH_3COOH + H_2O + 2Cu$$

What is this type of reaction?

A precipitation

B redox

C thermal decomposition

D neutralisation

20. Nov/2023/Paper_0620/23/No.19

When heated strongly, silicon(IV) oxide reacts with carbon.

$$SiO_2 + 2C \rightarrow Si + 2CO$$

Which term describes what happens to silicon(IV) oxide?

A thermal decomposition

B neutralisation

C oxidation

D reduction

21. Nov/2023/Paper_0620/31/No.6

A student investigates the reaction of large pieces of magnesium carbonate with dilute hydrochloric acid at 20 °C. The magnesium carbonate is in excess.

(a) Fig. 6.1 shows the volume of carbon dioxide gas released as the reaction proceeds.

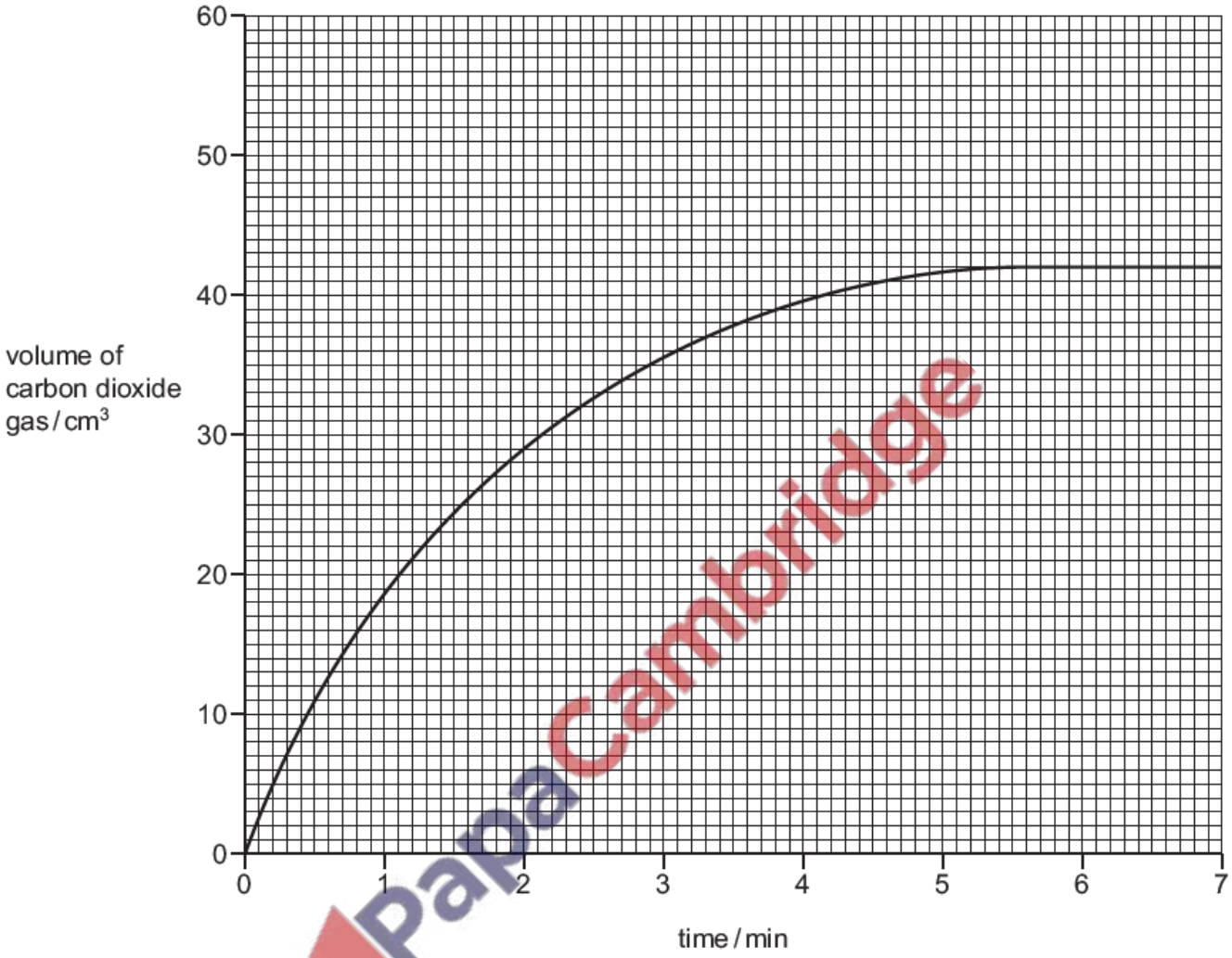


Fig. 6.1

(i) Deduce the volume of carbon dioxide gas released after 2 minutes.

volume of carbon dioxide = ... cm^3 [1]

(ii) The student repeats the experiment using the same volume of hydrochloric acid but with a higher concentration. The magnesium carbonate is still in excess.

All other conditions stay the same.

Draw a line on the grid in Fig. 6.1 to show the volume of carbon dioxide released when hydrochloric acid with a higher concentration is used. [2]

(b) (i) The student repeats the experiment using smaller pieces of magnesium carbonate.

All other conditions stay the same.

Describe how the rate of reaction differs when smaller pieces of magnesium carbonate are used.

..... [1]

(ii) The student repeats the experiment at 10 °C.

All other conditions stay the same.

Describe how the rate of reaction differs when the temperature is 10 °C.

..... [1]

(c) Hydrochloric acid reacts with iron.

Complete the word equation for this reaction.

hydrochloric acid	+	iron	→	....	+	.....

[2]

(d) Acids are used as catalysts in many chemical reactions.

State the meaning of the term catalyst.

.....

..... [2]

[Total: 9]

22. Nov/2023/Paper_0620/32/No.3(d)

(d) Nitrogen dioxide decomposes when heated. Nitric oxide and oxygen are produced.

(i) Complete the symbol equation for this reaction.

$$.....NO_2 \rightleftharpoons 2NO + ...$$ [2]

(ii) State the meaning of the symbol $\rightleftharpoons$.

..... [1]

23. Nov/2023/Paper_0620/32/No.6(a, b)

A student investigates the reaction of large pieces of magnesium with dilute hydrochloric acid at 20 °C. The magnesium is in excess.

(a) Fig. 6.1 shows the volume of hydrogen gas released as the reaction proceeds.

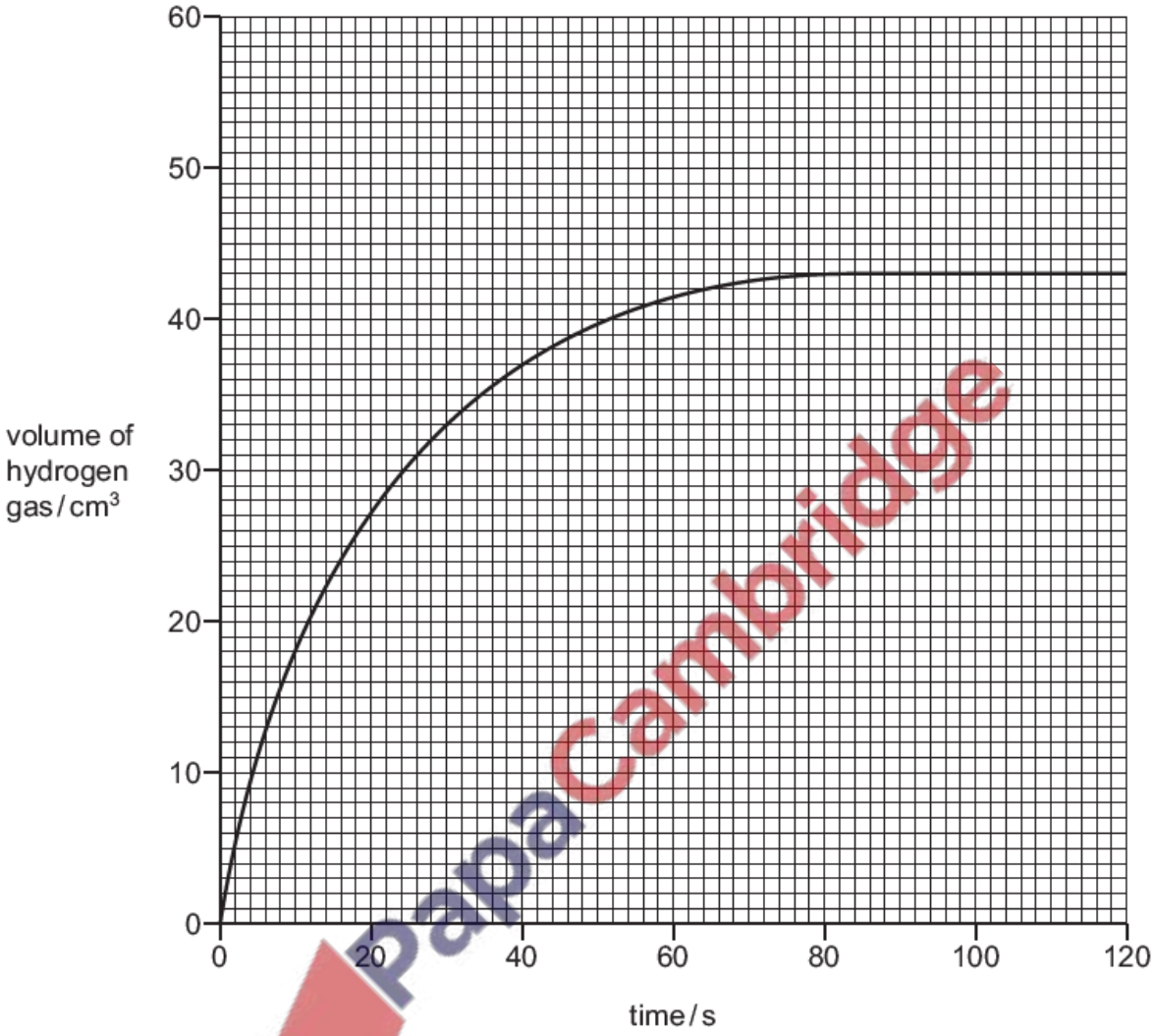


Fig. 6.1

(i) Deduce the volume of hydrogen gas released after 30 seconds.

volume of hydrogen = ... cm^3 [1]

(ii) The student repeats the experiment using smaller pieces of magnesium. The mass of magnesium used remains the same. The magnesium is still in excess.

All other conditions stay the same.

Draw a line on the grid in Fig. 6.1 to show the volume of hydrogen gas released when smaller pieces of magnesium are used. [2]

(b) (i) The student repeats the experiment at a higher temperature of 35 °C.

All other conditions stay the same.

Describe how the rate of reaction differs when a temperature of 35 °C is used.

..... [1]

(ii) The student repeats the experiment using a lower concentration of acid.

All other conditions stay the same.

Describe how the rate of reaction differs when a lower concentration of acid is used.

..... [1]

24. Nov/2023/Paper_0620/33/No.3(d)

(d) Sulfur dioxide reacts with oxygen to produce sulfur trioxide.

(i) Complete the symbol equation for this reaction.

$$.....SO_2 + ... \rightleftharpoons 2SO_3$$ [2]

(ii) State the meaning of the symbol $\rightleftharpoons$.

..... [1]

(iii) Sulfur trioxide reacts with calcium oxide to produce calcium sulfate.

Describe a test for sulfate ions.

test .....

observations .....

[2]

25. Nov/2023/Paper_0620/33/No.6

Hydrogen peroxide, H_2O_2, breaks down slowly at 40 °C to produce oxygen gas and water.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

A student investigates the breakdown of hydrogen peroxide at 40 °C in the presence of a catalyst.

(a) Fig. 6.1 shows the volume of oxygen gas released as the reaction proceeds.

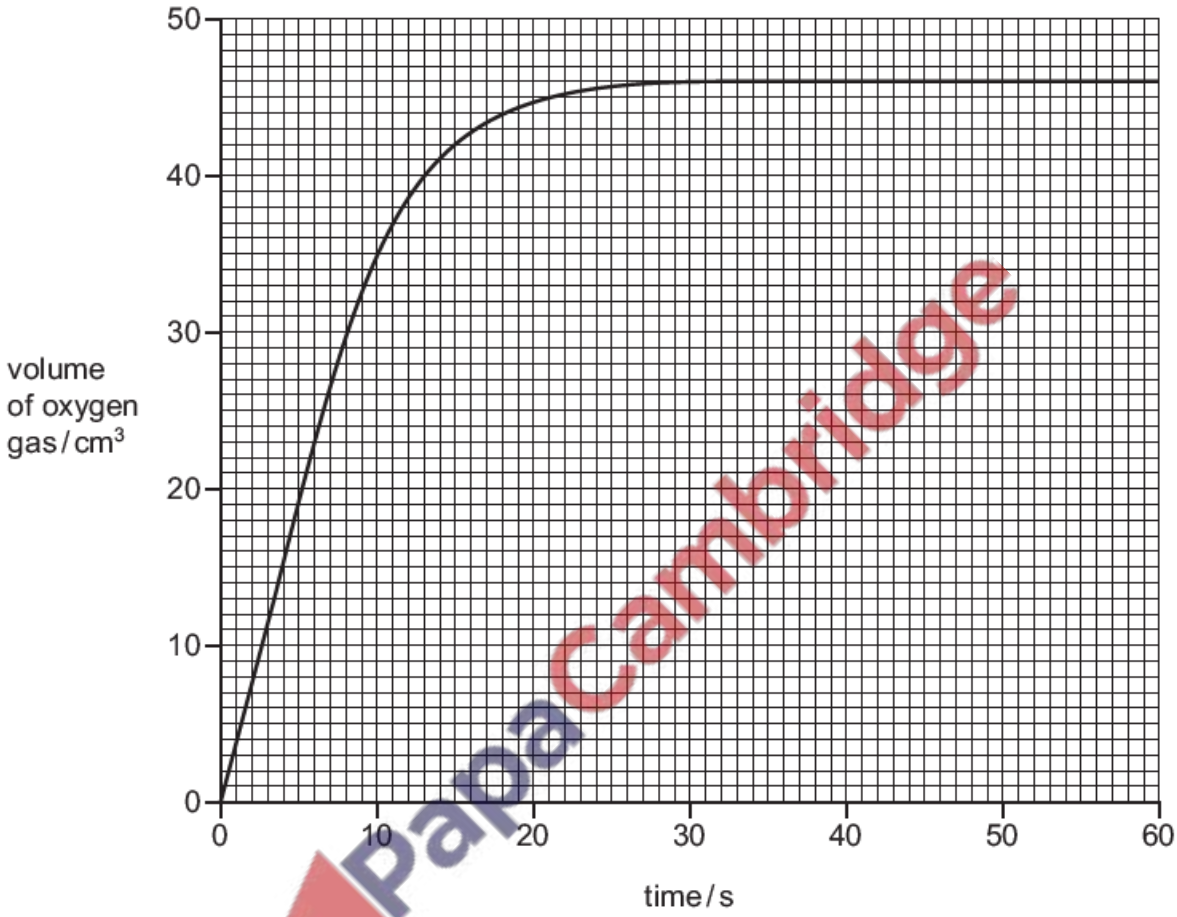


Fig. 6.1

(i) Deduce the volume of oxygen gas released after 15 seconds.

volume of oxygen = ... cm^3 [1]

(ii) The student repeats the experiment at 20 °C.

All other conditions stay the same.

Draw a line on the grid in Fig. 6.1 to show how the volume of oxygen changes when a temperature of 20 °C is used. [2]

(b) (i) The student repeats the experiment without a catalyst.

All other conditions stay the same.

Describe how the rate of reaction differs when no catalyst is used.

..... [1]

(ii) The student repeats the experiment using a lower concentration of hydrogen peroxide.

All other conditions stay the same.

Describe how the rate of reaction differs when a lower concentration of hydrogen peroxide is used.

..... [1]

(c) Hydrogen peroxide can act as a reducing agent in the presence of an alkali.

(i) State the meaning of the term alkali.

..... [1]

(ii) Give the formula of the ion that is present in all alkaline solutions.

..... [1]

(iii) State the colour of methyl orange in an alkaline solution.

..... [1]

(iv) Aqueous ammonia is an alkali.

Complete the word equation for the reaction of aqueous ammonia with hydrochloric acid.

ammonia	+	hydrochloric acid	→	....

[1]

[Total: 9]

26. Nov/2023/Paper_0620/41/No.4(a, b)

Aqueous hydrogen peroxide, H_2O_2, slowly forms water and oxygen at room temperature and pressure, r.t.p. This reaction is catalysed by manganese(IV) oxide.

The equation is shown.

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

(a) State the test for oxygen gas.

test .....

observations .....

[1]

(b) A student investigates the rate of formation of oxygen gas when manganese(IV) oxide is added to aqueous hydrogen peroxide.

The volume of oxygen gas formed is measured at regular time intervals at r.t.p. The results are plotted onto the graph in Fig. 4.1.

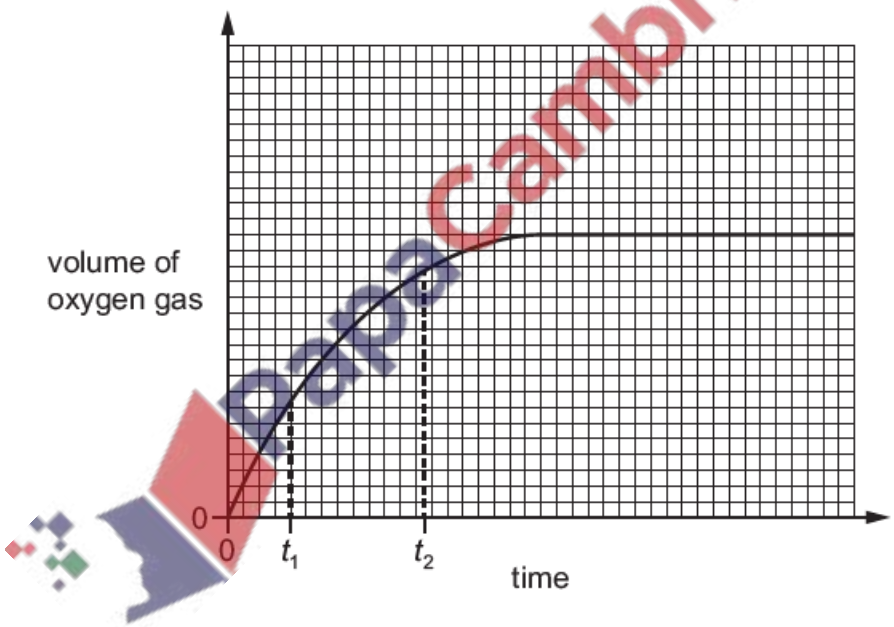


Fig. 4.1

(i) State how the graph in Fig. 4.1 shows the rate of reaction at time t_2, is lower than at time t_1.

..... [1]

(ii) Explain, using collision theory, why the rate of reaction at time t_2 is lower than at time t_1.

.....

.....

..... [2]

(iii) On Fig. 4.1, sketch the graph obtained when the experiment is repeated using aqueous hydrogen peroxide at a higher temperature. All other conditions remain the same. [2]

27. Nov/2023/Paper_0620/41/No.5(a, b)

Methane reacts with steam to produce hydrogen gas.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +200\,kJ/mol$$

The reaction takes place at 1000 °C and 100 kPa pressure.

(a) The reaction is reversible and reaches an equilibrium in a closed system.

State **two** features of an equilibrium.

1 .....

2 .....

[2]

(b) State and explain, in terms of equilibrium, what happens to the concentration of hydrogen when:

(i) the pressure is increased

.....

..... [2]

(ii) the temperature is increased

.....

..... [2]

(iii) a catalyst is used.

.....

..... [2]

28. Nov/2023/Paper_0620/42/No.2(c)

Cobalt and copper are transition elements.

(c) Both copper and cobalt can form coloured compounds. Some of these compounds contain water of crystallisation.

(i) Define the term water of crystallisation.

.....

..... [2]

(ii) State the colour and formula of hydrated cobalt(II) chloride crystals.

colour .....

formula .....
[2]

(iii) State the colour change seen when a few drops of water are added to anhydrous copper(II) sulfate.

from ..... to ..... [2]

(iv) State how this colour change can be reversed.

..... [1]

29. Nov/2023/Paper_0620/43/No.3

This question is about nitrogen and some of its compounds.

(a) Nitrogen is converted into ammonia, NH_3, in the Haber process.

(i) Nitrogen is obtained from air.

State the percentage of nitrogen in clean, dry air.

..... [1]

(ii) State the source of hydrogen for the Haber process.

..... [1]

(iii) Complete the dot-and-cross diagram in Fig. 3.1 for a molecule of ammonia.

Show the outer shell electrons only.

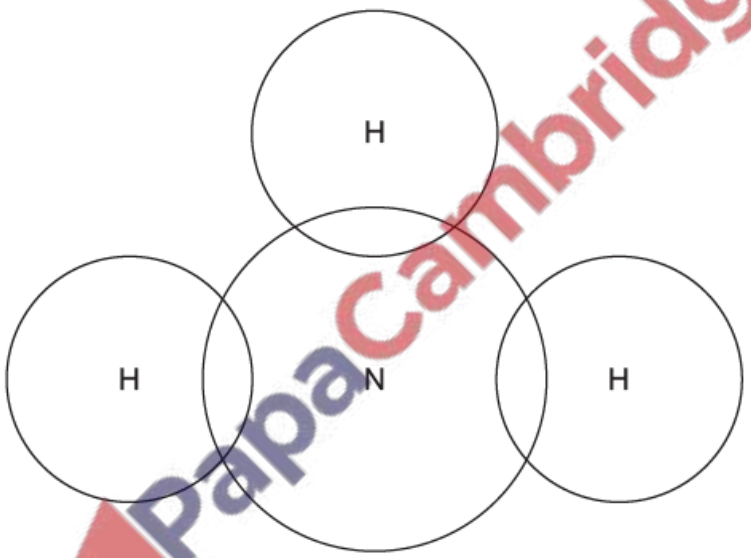


Fig. 3.1

[2]

(iv) Write a chemical equation for the reaction occurring in the Haber process and give the typical reaction conditions. Include units where appropriate.

chemical equation .....

reaction conditions:

temperature .....

pressure .....

catalyst .....

[5]

(b) Ammonia is converted into nitric acid.

The first stage of this conversion uses a catalyst and occurs at a temperature of 900 °C and a pressure of 5 atmospheres.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

The forward reaction is exothermic.

(i) Suggest which of the following elements is most likely to be used as a catalyst.
Draw a circle around your answer.

calcium **lead** **platinum** **sodium** **sulfur** [1]

(ii) State the oxidation number of nitrogen in:

NH_3 .....

NO .....
[2]

(iii) Use your answer to **(ii)** to explain whether the nitrogen in ammonia undergoes oxidation or reduction.

.....

..... [1]

(iv) Complete Table 3.1 using the words **increases**, **decreases** or **no change**.

Table 3.1

	effect on the equilibrium yield of NO(g)	effect on the rate of the forward reaction
decreasing the pressure		
decreasing the temperature		decreases
removing the catalyst		decreases

[4]

(v) Decreasing the temperature causes the rate of the forward reaction to decrease.

Explain, using collision theory, why the rate of the reaction is slower at the decreased temperature.

.....

.....

.....

..... [3]

(c) In the second stage, nitric acid is produced.

Balance the symbol equation for this reaction.

$$.....NO + ...O_2 + ...H_2O \rightarrow .....HNO_3$$ [1]

[Total: 21]