Cambridge Assessment International Education

Cambridge IGCSE™

5: Reaction rates – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2016	March	42
4	2016	June	42
8	2016	November	41

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

4 Hydrogen peroxide, H_2O_2, decomposes into water and oxygen in the presence of a catalyst, manganese(IV) oxide.

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

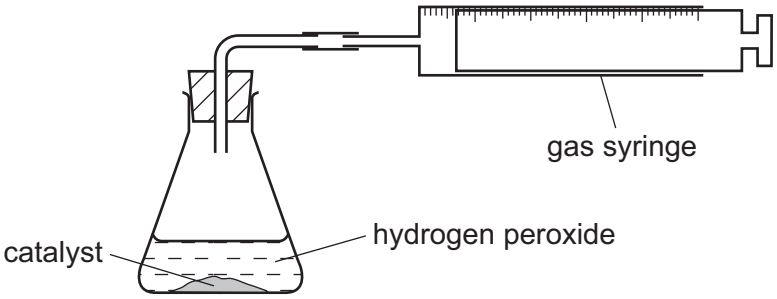
(a) What is meant by the term *catalyst*?

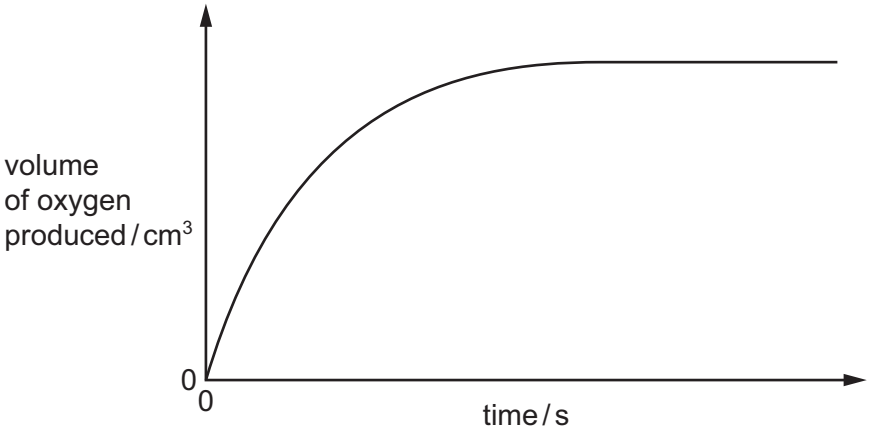
.....

..... [2]

(b) A student studies the rate of decomposition of hydrogen peroxide using the apparatus shown. The student uses 20 cm^3 of 0.1 mol / dm^3 hydrogen peroxide and 1.0 g of manganese(IV) oxide.

The student measures the volume of oxygen given off at regular time intervals until the reaction stops. A graph of the results is shown.





(i) When is the rate of reaction highest?

..... [1]

(ii) Suggest **one** method of increasing the rate of reaction using the same amounts of hydrogen peroxide and manganese(IV) oxide.

..... [1]

(c) (i) Calculate the number of moles of hydrogen peroxide used in this experiment.

..... mol [1]

(ii) Use your answer to **(c)(i)** and the equation to calculate the number of moles of oxygen produced in the reaction.

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

..... mol [1]

(iii) Calculate the volume (at r.t.p.) of oxygen produced.

..... dm^3 [1]

(iv) What would be the effect on the volume of oxygen produced if the mass of catalyst was increased?

..... [1]

(v) Deduce the volume of oxygen that would be produced if 20 cm^3 of 0.2 mol / dm^3 hydrogen peroxide was used instead of 20 cm^3 of 0.1 mol / dm^3 hydrogen peroxide.

..... dm^3 [1]

(d) The student carries out a second experiment to investigate whether another substance, copper(II) oxide, is a better catalyst than manganese(IV) oxide.

Describe how the second experiment is carried out. You should state clearly how you would make sure that the catalyst is the only variable.

.....

.....

.....

.....

.....

..... [3]

[Total: 12]

4 Hydrogen can be manufactured from methane by steam reforming.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

The reaction is carried out using a nickel catalyst at temperatures between 700 °C and 1100 °C and using a pressure of one atmosphere.

The forward reaction is endothermic.

(a) What is meant by the term *catalyst*?

.....

..... [2]

(b) Suggest **two** reasons why a temperature lower than 700 °C is not used.

.....

..... [2]

(c) Suggest **one** advantage of using a pressure greater than one atmosphere.

..... [1]

(d) Suggest **one** disadvantage of using a pressure greater than one atmosphere.

..... [1]

(e) Hydrogen can also be manufactured by electrolysis. The electrolyte is concentrated aqueous sodium chloride. The electrodes are inert.

The products of electrolysis are hydrogen, chlorine and sodium hydroxide.

(i) Define the term *electrolysis*.

.....

..... [2]

(ii) Name a substance that can be used as the inert electrodes.

..... [1]

(iii) Write an ionic half-equation for the reaction in which hydrogen is produced.

..... [1]

(iv) Where is hydrogen produced in the electrolytic cell?

..... [1]

(v) Describe a test for chlorine.

test .....

result .....
[2]

(f) The electrolysis of concentrated aqueous sodium chloride can be represented by the following word equation.

sodium chloride + water → sodium hydroxide + hydrogen + chlorine

Construct a chemical equation to represent this reaction. Do not include state symbols.

..... [2]

(g) State one use of

chlorine, ...

sodium hydroxide, ...

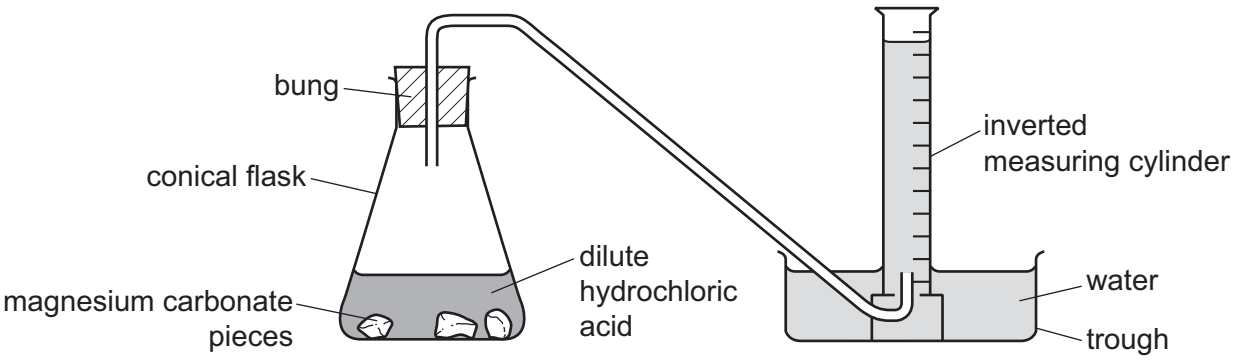
hydrogen. .....
[3]

[Total: 18]

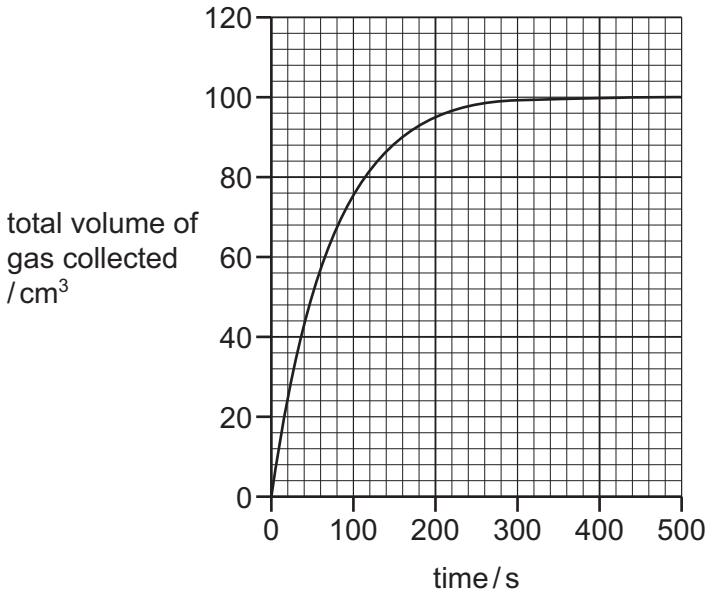
8 Magnesium carbonate reacts with dilute hydrochloric acid.

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of magnesium carbonate pieces was added to dilute hydrochloric acid. The apparatus in the diagram was used to measure the volume of gas produced. The total volume of gas collected was recorded every 20 seconds.



(a) The results obtained are shown on the graph.



(i) Describe how the rate of this reaction changed during the reaction. Explain why the rate changed in this way.

.....

.....

.....

.....

..... [4]

(ii) The experiment was repeated using the same mass of **powdered** magnesium carbonate with the same volume and concentration of dilute hydrochloric acid.

Explain how the initial rate of reaction and total volume of gas collected would compare to the first experiment.

initial rate of reaction .....

.....

.....

total volume of gas .....

.....

.....

[4]

(b) A piece of magnesium ribbon was cleaned. The experiment was repeated using this clean magnesium ribbon instead of magnesium carbonate.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

This reaction is exothermic.
The rate of the reaction gradually increased over the first 2 minutes.

Explain why the rate of the reaction increased.

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 13]

Question	Answer	Marks
4 (a)	**M1** (substance that) speeds up a reaction / increases the rate of a reaction; **M2** any one from: unchanged (chemically at the end) / not used up; lowers activation energy;	**2**
4 (b) (i)	at the start / initially / t = 0;	**1**
4 (b) (ii)	Catalyst should be powdered / increase surface area (of catalyst) / decrease particle size (of catalyst); **OR** Increase temperature / heat / warm;	**1**
4 (c) (i)	0.002 (mol);	**1**
4 (c) (ii)	0.001 (mol);	**1**
4 (c) (iii)	0.024 (mol);	**1**
4 (c) (iv)	no change / no effect;	**1**
4 (c) (v)	0.048 (dm^3);	**1**
4 (d)	same mass / amount of / moles / 1.0 g of catalyst; same temperature; same volume and concentration of hydrogen peroxide / 20 cm^3 of 0.1 mol/dm^3 of hydrogen peroxide or reactant;	**3**
		Total: 12

Continues on next page …

Question	Answer	Marks
4 (a)	**M1** substance that speeds up a reaction / increases rate; **M2** unchanged (chemically) at the end / not used up / lowers activation energy / provides alternative pathway	**2** 1 1
4 (b)	**M1** too slow / slower; **M2** lower yield / less product(s) / equilibrium shifts to left / equilibrium shifts in direction of reactants / backward reaction favoured / reverse reaction favoured;	**2** 1 1
4 (c)	faster / increase rate	**1**
4 (d)	lower yield / less product(s) / equilibrium shifts to left / equilibrium shifts in direction of reactants / backward reaction favoured / reverse reaction favoured; **OR** higher cost / expensive; **OR** safety risks;	**1**
4 (e) (i)	**M1** breakdown of an ionic compound when molten or in aqueous solution; **M2** (using) electricity / electric current / electrical energy;	**2** 1 1
4 (e) (ii)	carbon / graphite / platinum;	**1**
4 (e) (iii)	$2H^+ + 2e(^-) \rightarrow H_2$; **OR** $2H_3O^+ + 2e(^-) \rightarrow H_2 + 2H_2O$;	**1**
4 (e) (iv)	cathode / negative electrode;	**1**
4 (e) (v)	**M1** damp blue litmus paper; **M2** bleaches / loses colour / turns white / turns colourless'	**2** 1 1
4 (f)	$2NaCl + 2H_2O \rightarrow 2NaOH + H_2 + Cl_2$ all formulae correct; balancing;	**2**
4 (g)	**M1** *chlorine*: treating (drinking) water / treating water in swimming pools / kill bacteria in water / chlorination of water / (manufacture of) paper products / plastics / PVC / dyes / textiles / medicines / antiseptics / insecticides / herbicides / fungicides / solvents / paints / disinfectant / bleach / hydrochloric acid; **M2** *sodium hydroxide*: drain cleaner / oven cleaner / extraction of aluminium / purification of bauxite / (manufacture of) biodiesel / paper / soap / detergents / washing powder / textiles / dyes; **M3** *hydrogen*: fuel / rocket fuel / fuel cells / in welding / (manufacture of) ammonia / NH_3 / margarine / methanol / hydrochloric acid / refrigerants;	**3** 1 1 1
		Total: 18

Continues on next page …

Question	Answer	Marks
8 (a) (i)	any 4 from: slowed down acid became less concentrated **OR** fewer particles per unit volume fewer collisions per second **OR** lower collision rate (then the reaction) stopped all the hydrochloric acid reacted	**4**
8 (a) (ii)	any 4 from: faster (reaction) (powder has) larger surface area more collisions per second **OR** higher collision rate same volume of gas amount / moles hydrochloric acid is not changed	**4**
8 (b)	any 5 from: temperature increased particles have more energy (particles) move faster more collisions per second **OR** higher collision rate more particles have sufficient energy to react / activation energy more of the collisions are successful	**5**
		Total: 13