RATE OF REACTION 1

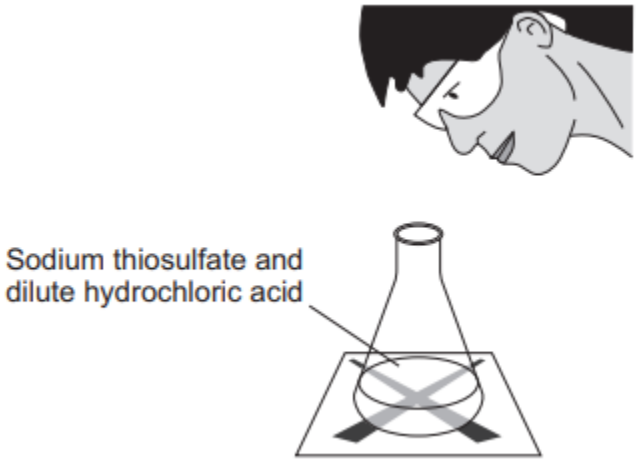
Q1. A student investigated the rate of reaction between sodium thiosulfate and dilute hydrochloric acid.

The student placed a conical flask over a cross on a piece of paper.

The student mixed the solutions in the flask.

The solution slowly went cloudy.

The student timed how long it took until the cross could not be seen.



The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\ HCl(aq) \rightarrow 2\ NaCl(aq) + H_2O(l) + SO_2\ (g) + S(s)$$

The student repeated the experiment with different concentrations of sodium thiosulfate.

Concentration of sodium thiosulfate in moles per dm^3	Time taken until the cross could not be seen in seconds			
	Trial 1	Trial 2	Trial 3	Mean
0.040	71	67	69	69
0.060	42	45	45	44
0.080	31	41	33	

(i) Calculate the mean time for 0.080 moles per dm3 of sodium thiosulfate.

_____

_____

_____

_____

(2 marks)

(ii) Describe and explain, in terms of particles and collisions, the effect that increasing the concentration of sodium thiosulfate has on the rate of the reaction.

_____

_____

_____

_____

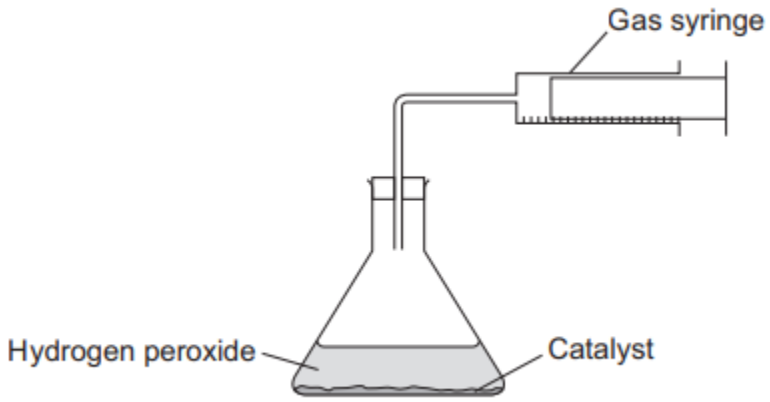
_____

_____

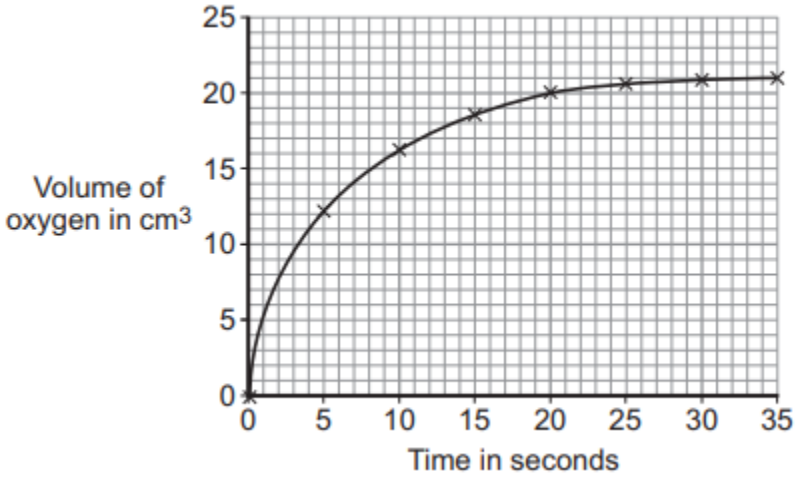
_____

(3 marks)

Q2. A student measured the volume of oxygen produced by 50 cm^3 of hydrogen peroxide.



The graph shows the results.



(a) Use the graph to describe the changes in the rate of the reaction from 0 to 35 seconds.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3 marks)

(b) An increase in the temperature of the hydrogen peroxide increases the rate of the reaction. Use your knowledge of particles to explain why.

_____

_____

_____

_____

_____

_____

(3 marks)

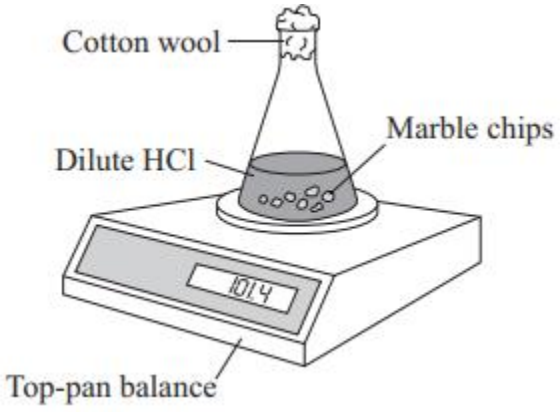
Q3. A student investigated the rate of reaction between marble and hydrochloric acid.

The student used an excess of marble.

The reaction can be represented by this equation.

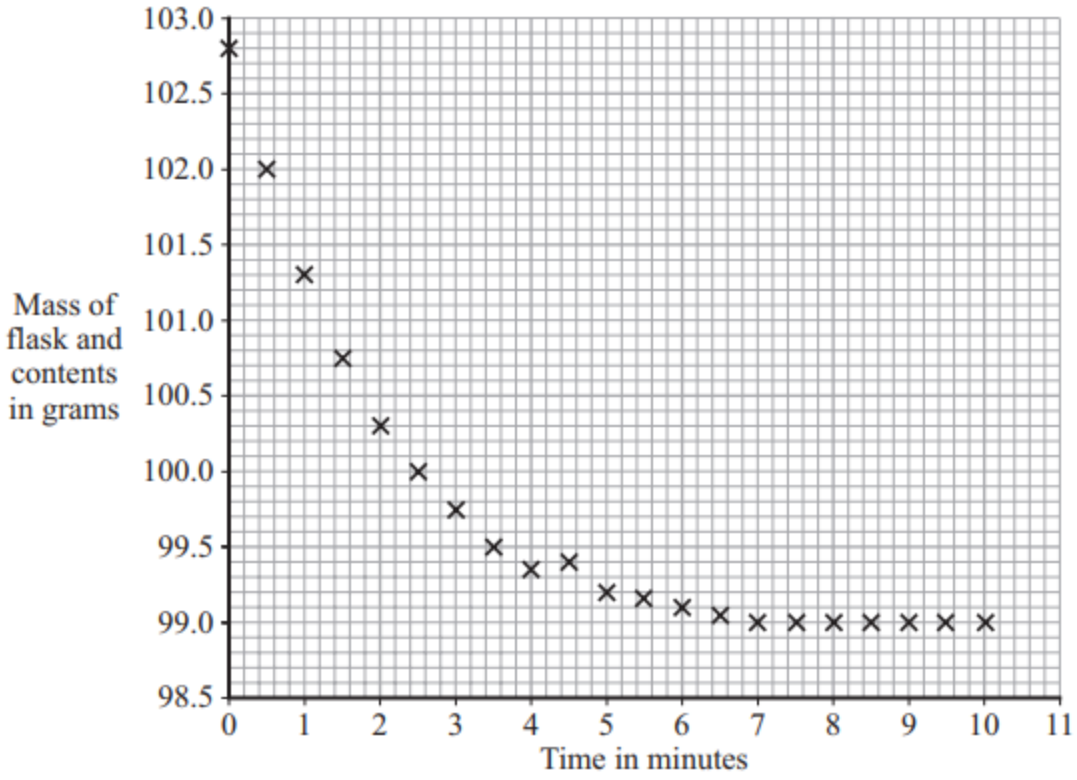
$$CaCO_3\ (s) + 2HCl\ (aq) \rightarrow CaCl_2\ (aq) + H_2O\ (l) + CO_2\ (g)$$

The student used the apparatus shown in the diagram.



The student measured the mass of the flask and contents every half minute for ten minutes.

The results are shown on the graph. Use the graph to answer the questions.



(a) Complete the graph opposite by drawing a line of best fit.

(1 mark)

(b) Why did the mass of the flask and contents decrease with time?

_____

_____

(1 mark)

(c) After how many minutes had all the acid been used up?

_____

_____

(1 mark)

(d) The student repeated the experiment at a higher temperature. All other variables were kept the same as in the first experiment. The rate of reaction was much faster.

(i) Draw a line on the graph opposite to show what the results for this second experiment might look like.

(2 marks)

(ii) Why does an increase in temperature increase the rate of reaction?

_____

_____

_____

_____

_____

_____

(3 marks)

Q4. The following steps show how to use a type of glue.

Step 1 Measure out equal amounts of the liquids from tubes A and B.

Step 2 Mix the liquids to make the glue. Put a thin layer of the glue onto each of the surfaces to be joined.

Step 3 Assemble the pieces to be joined and then hold them together with tape.

Step 4 Leave the glue to set.

The time taken for the glue to set at different temperatures is given in the table below.

Temperature in °C	Time taken for the glue to set
20	3 days
60	6 hours
90	1 hour

Explain, in terms of particles, why increasing the temperature changes the rate of the reaction which causes the glue to set.

_____

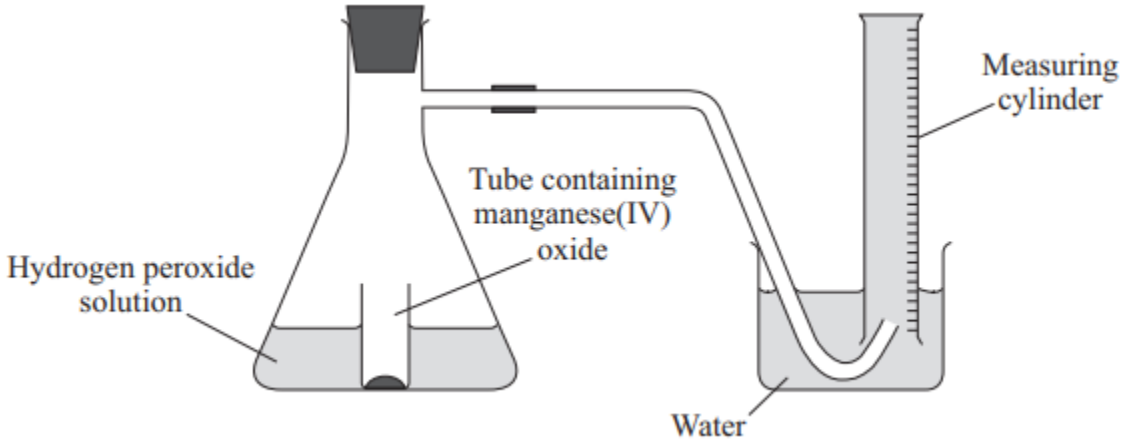
_____

_____

(2 marks)

Q5. A student investigated the effect of temperature on the decomposition of hydrogen peroxide. Hydrogen peroxide decomposes to oxygen and water when a manganese(IV) oxide catalyst is added. The student measured the time taken to collect 5 cm3 of oxygen gas.

The apparatus shown below was used for the investigation. The reaction was started by shaking the flask so that the manganese(IV) oxide and hydrogen peroxide were mixed.



The student did the investigation at two different temperatures. All the other variables were kept constant.

The student's results are shown in the table.

Temperature of the hydrogen peroxide solution in °C	Volume of oxygen collected in cm^3	Time taken to collect the oxygen in seconds	Rate of reaction in cm^3 per second
20	5	40	0.125
25	5	25	

(a)(i) Calculate the rate of reaction at 25 °C.

_____

_____

(2 marks)

(ii) The teacher said that the student should repeat the investigation to get more results. Suggest why.

_____

_____

(1 mark)

(b) The student concluded that:

'the rate of reaction increases when the temperature is increased'.

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

_____

_____

_____

_____

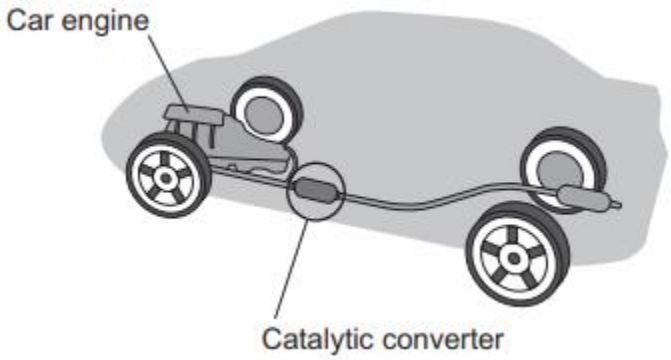
_____

(2 marks)

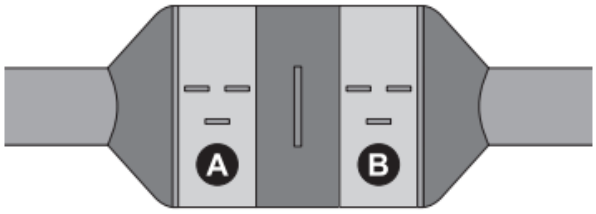
Q6. Read the information about car engines.

Burning petrol in air is an exothermic reaction. This reaction is used in car engines. When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

A catalytic converter stops these harmful substances being released into the air.



(a) The catalytic converter has two parts shown as A and B in the diagram.



Part A contains a catalyst made from platinum and rhodium.

Part B contains a catalyst made from platinum and palladium.

(i) Why are catalysts used in chemical reactions?

_____

_____

(1 mark)

(ii) One reaction in part A is shown by this equation.

$$2NO \rightarrow N_2 + O_2$$

Suggest why this reaction helps the environment.

_____

_____

(1 mark)

(iii) The catalytic converter works for many years without replacing the catalyst.

Explain why the catalyst does not need to be replaced.

_____

_____

(1 mark)

(iv) Suggest why different catalysts are used in parts A and B.

_____

_____

(1 mark)

(b) Modern catalytic converters contain nanosized particles of catalyst. Using nanosized particles reduces the cost of the catalytic converter.

Suggest and explain why the use of nanosized catalyst particles reduces the cost of the catalytic converter.

Your answer should include information about the size and surface area of the particles.

_____

_____

_____

_____

_____

_____

_____

_____

(3 marks)

Q7. Copper oxide reacts much faster with acid at 40 °C than at 20 °C.

Explain why in terms of particles.

_____

_____

_____

_____

(2 marks)

Total marks (35)