PEARSON EDEXCEL GCSE CHEMISTRY · 1CH0

CHEMISTRY



EXAM QUESTION PACK

TOPIC 7: RATES OF REACTION AND ENERGY CHANGES

SCORE	PERCENTAGE
/168	%

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Q1.

Students are investigating exothermic and endothermic reactions.
They are finding the temperature change in 50 cm^3 water when a solid dissolves in it.
The apparatus is shown in Figure 1.

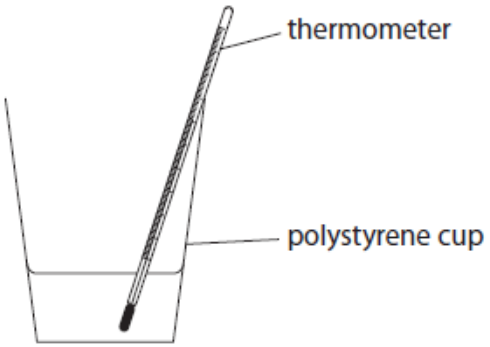


Figure 1

The steps needed to carry out this experiment are **P**, **Q**, **R**, **S** and **T**.
They are shown below.

They are not in the correct order.

P pour the 50 cm^3 water into the polystyrene cup
Q add the solid to the water and stir
R measure 50 cm^3 water using a beaker
S vmeasure the initial temperature of the water
T measure the final temperature of the solution when all the solid has dissolved

Write the steps in the correct order, from left to right.

(2)

(Total for question = 2 marks)

Q2.

Hydrogen peroxide decomposes to form water and oxygen.

The rate of this reaction can be found by measuring the volume of oxygen formed after different time intervals.

Hydrogen peroxide solution is placed in a conical flask.
The apparatus is set up as shown in Figure 5.

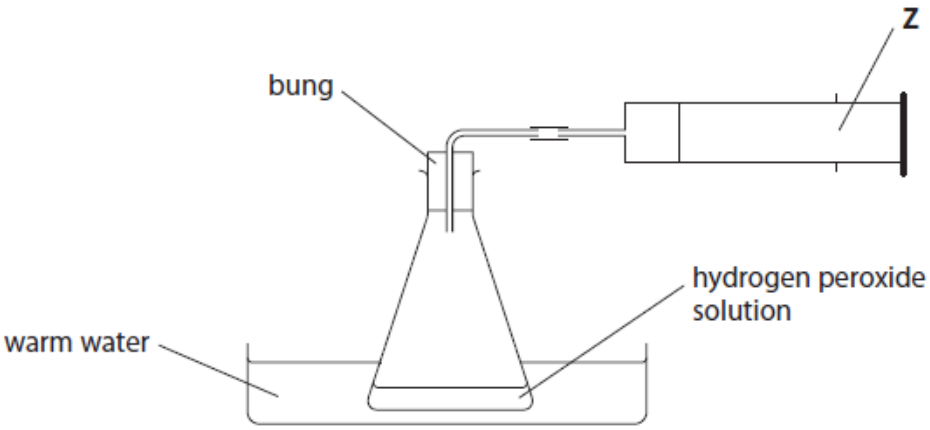


Figure 5

Complete the balanced equation for the reaction and fill in the two missing state symbols.

(2)

.....$H_2O_2(aq) \rightarrow 2H_2O($.....$) + O_2($.....$)$

(Total for question = 2 marks)

Q3.

Two substances, **A** and **B**, each form a colourless solution.

If the solutions are mixed in a beaker, **A** and **B** react to form a coloured product.
The rate of the reaction between **A** and **B** can be investigated by placing the beaker containing the mixture on a cross on a piece of paper and timing how long it takes for enough coloured product to be produced to make the cross invisible when viewed from above, through the solution.

	experiment 1	experiment 2	experiment 3
concentration of **A in solution** in g dm^{-3}	10	10	40
temperature in °C	20	40	40
time for cross to become invisible in s	320	80	20

Figure 13

Use the results of these experiments to explain, in terms of the behaviour of particles, the effect of changing temperature and the effect of changing the concentration of **A** in solution on the rate of this reaction.

(Total for question = 6 marks)

Q4.

* Calcium carbonate reacts with dilute hydrochloric acid to produce carbon dioxide gas.

The word equation for the reaction is

$$\text{calcium carbonate} + \text{hydrochloric acid} \rightarrow \text{calcium chloride} + \text{carbon dioxide} + \text{water}$$

Two samples of calcium carbonate are provided.
One sample is in the form of large marble chips and the other sample is in the form of small marble chips.

Describe, in detail, an investigation to find the effect of using small marble chips rather than large marble chips on the rate of this reaction.

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(Total for question = 6 marks)

Q5.

Dilute hydrochloric acid reacts with calcium carbonate to produce carbon dioxide gas.

Three different experiments were carried out using large pieces of calcium carbonate, small pieces of calcium carbonate and powdered calcium carbonate.
The size of the calcium carbonate pieces was the only factor that was changed.

In each experiment the volume of carbon dioxide released in five minutes was measured.

The results are

size of calcium carbonate pieces used	volume of carbon dioxide released in five minutes / cm^3
large	3
small	7
powdered	50

Describe what this shows about the effect of the surface area of calcium carbonate on the rate of this reaction.

(2)

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Q6.

Magnesium reacts with dilute sulfuric acid to form magnesium sulfate and hydrogen gas.

A student wants to find out the effect of temperature on the rate of this reaction.

The student used the following method.

step 1 pour 25 cm^3 of dilute sulfuric acid into a conical flask

step 2 warm the acid until its temperature is 30 °C

step 3 add a piece of magnesium to the acid

step 4 start a stopwatch

step 5 wait until the reaction has finished

step 6 stop the stopwatch

step 7 repeat steps 1–6 but at 50 °C.

At 50 °C, 15.0 cm^3 of gas was produced during the first 60 seconds of the reaction.

Calculate the average rate of reaction, in $cm^3\ s^{-1}$, for the first 60 seconds of the reaction.

(2)

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average rate of reaction = ... $cm^3\ s^{-1}$

(Total for question = 2 marks)

Q7.

Calcium carbonate reacts with dilute hydrochloric acid to produce carbon dioxide gas.

The rate of reaction between calcium carbonate and dilute hydrochloric acid at room temperature was investigated.

The calcium carbonate powder produced 90 cm^3 of carbon dioxide in five minutes.

Calculate the average rate of reaction in $cm^3\ s^{-1}$.

(3)

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average rate of reaction = ... $cm^3\ s^{-1}$

(Total for question = 3 marks)

Q8.

Methane reacts with chlorine to form chloromethane and hydrogen chloride.

$$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$$

Energies of bonds are shown in Figure 6.

bond	energy of bond / kJ mol^{-1}
C—H	413
Cl—Cl	243
C—Cl	346
H—Cl	432

Figure 6

Use the information in Figure 6 for the following calculation.

Calculate the overall change in heat energy when 1 mol methane, CH_4, reacts with 1 mol chlorine, Cl_2, to form 1 mol of chloromethane, CH_3Cl, and 1 mol hydrogen chloride, HCl, in this reaction, stating, with a reason, whether the reaction is endothermic or exothermic.

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energy change ..... kJ mol^{-1}

(Total for question = 4 marks)

Q9.

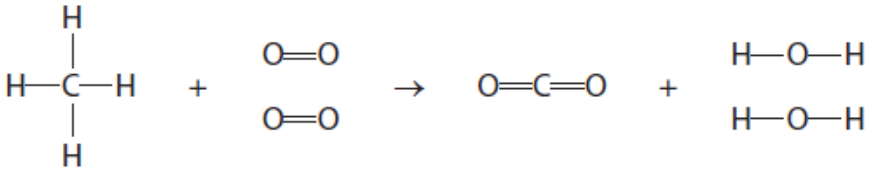
The energies of some bonds are shown in Figure 8.

bond	bond energy in kJ mol^{-1}
C—H	435
O═O	496
C═O	805
H—O	463

Figure 8

Methane burns in oxygen to form carbon dioxide and water.

The equation shows the structures of the molecules.



Calculate the energy change, in kJ mol^{-1}, for this reaction.

(4)

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energy change = ... kJ mol^{-1}

(Total for question = 4 marks)

Q10.

Hydrogen peroxide decomposes to form water and oxygen.

The rate of this reaction can be found by measuring the volume of oxygen formed after different time intervals.

Hydrogen peroxide solution is placed in a conical flask.
The apparatus is set up as shown in Figure 5.

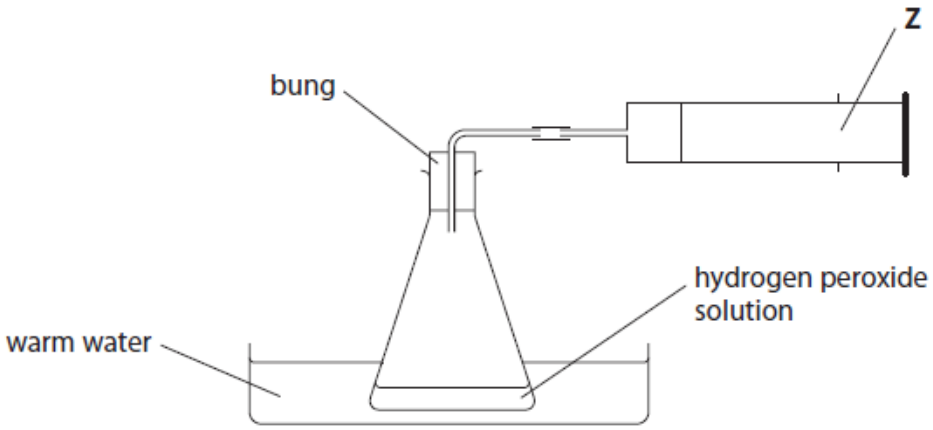


Figure 5

The experiment is repeated three times

once using a more dilute solution of hydrogen peroxide
once using a lower temperature
once using a larger flask

In each case, all other conditions are kept the same.

Circle the word that shows the change in the rate of decomposition in each case.

(2)

	change in rate		
hydrogen peroxide solution is more dilute	faster	slower	unchanged
the temperature used is lower	faster	slower	unchanged
the reaction is carried out in a larger flask	faster	slower	unchanged

(Total for question = 2 marks)

Q11.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Magnesium reacts with dilute sulfuric acid to form magnesium sulfate and hydrogen gas.

A student wants to find out the effect of temperature on the rate of this reaction.

The student used the following method.

step 1 pour 25 cm^3 of dilute sulfuric acid into a conical flask

step 2 warm the acid until its temperature is 30 °C

step 3 add a piece of magnesium to the acid

step 4 start a stopwatch

step 5 wait until the reaction has finished

step 6 stop the stopwatch

step 7 repeat steps 1–6 but at 50 °C.

Which piece of equipment can be used to find the volume of 25 cm^3 of sulfuric acid?

(1)

☐ **A** balance

☐ **B** measuring cylinder

☐ **C** ruler

☐ **D** thermometer

(Total for question = 1 mark)

Q12.

This question is about the rate of reaction between calcium carbonate and dilute hydrochloric acid.

The word equation for this reaction is

calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

Some pieces of calcium carbonate were added to dilute hydrochloric acid in a conical flask and

the volume of carbon dioxide produced was measured.

Complete the diagram in Figure 7 to show the apparatus to collect the gas produced and measure its volume.

(2)

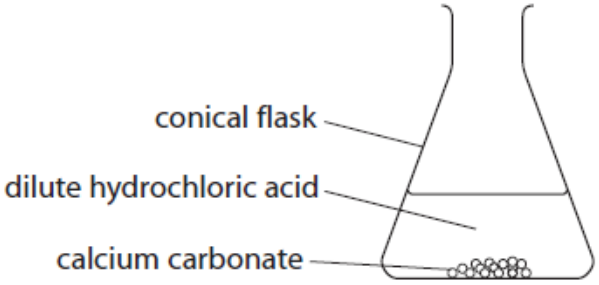


Figure 7

(Total for question = 2 marks)

Q13.

The rate of reaction between magnesium ribbon and dilute hydrochloric acid at room temperature is investigated.

The apparatus used is shown in Figure 11.

The volume of hydrogen gas given off was measured at regular intervals during the reaction.

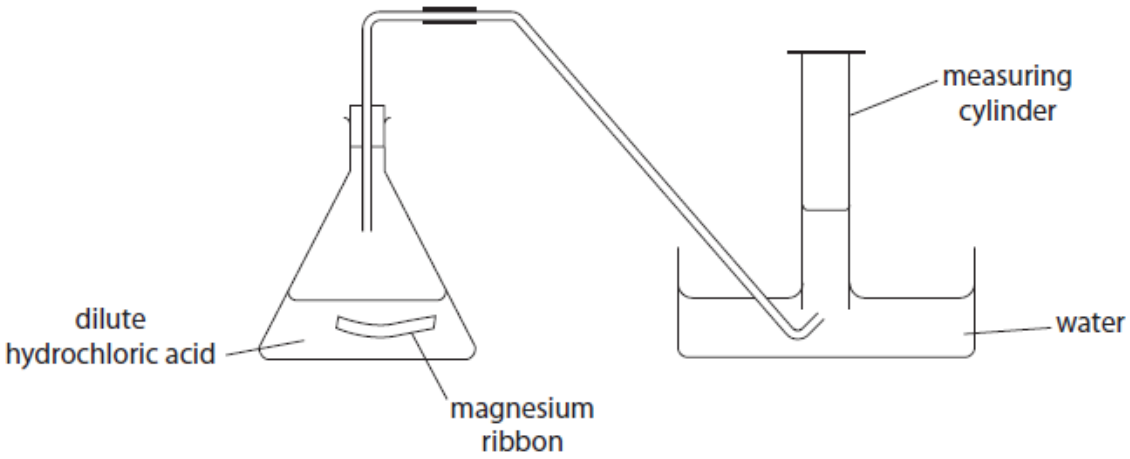


Figure 11

The graph in Figure 12 shows the results of this experiment.

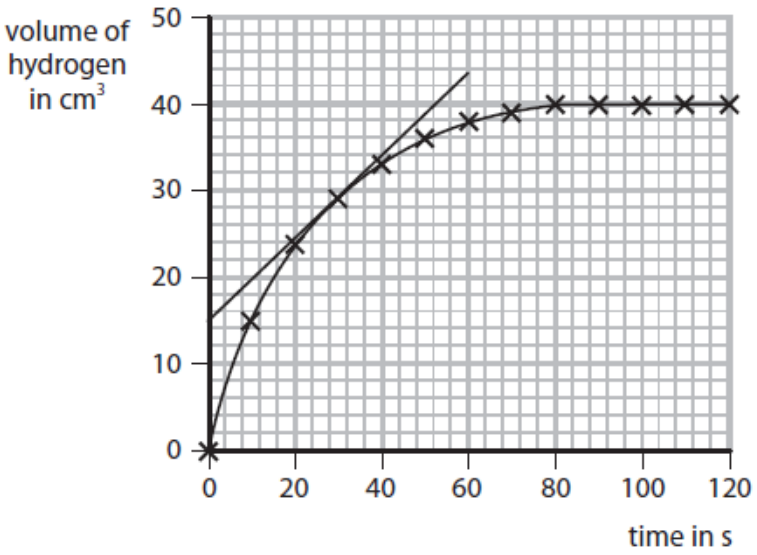


Figure 12

(i) State a change that can be made to the apparatus in Figure 11 to measure the volumes of gas more accurately.

(1)

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(ii) A tangent has been drawn to the line on the graph in Figure 12.

Calculate the rate of reaction at this point.

(2)

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rate of reaction = ... $cm^3\ s^{-1}$

(iii) On the graph in Figure 12, draw the line you would expect to obtain if the magnesium ribbon in this experiment was replaced with an equal mass of powdered magnesium. All other conditions are kept the same.

(1)

(Total for question = 4 marks)

Q14.

Crude oil is a complex mixture of substances.

When crude oil is separated into fractions, the amount of each fraction obtained rarely matches the demand for that fraction.

Figure 9 shows the relative amounts of six of the fractions present in a crude oil and the relative demand for each of these fractions.

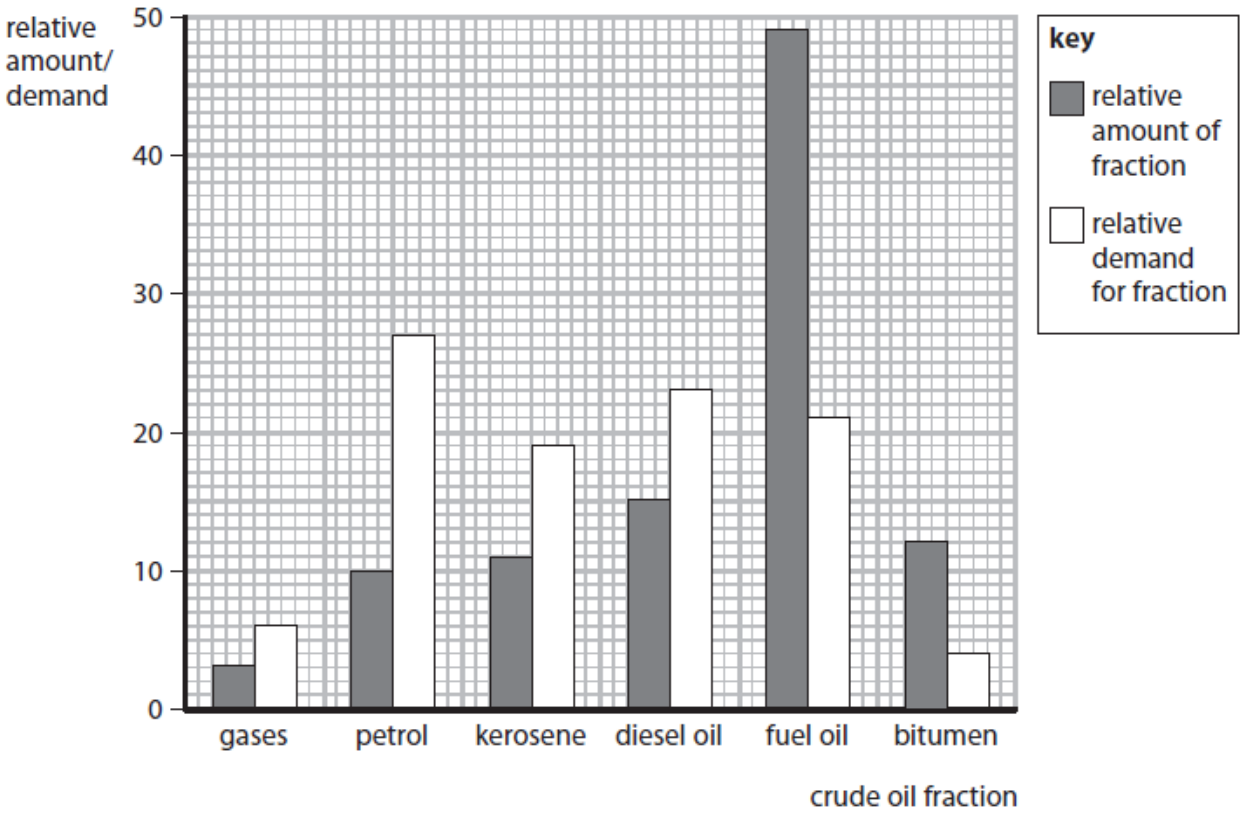


Figure 9

Cracking is used to match the relative amount of a fraction of crude oil to the demand for that fraction.

(i) Use the information in Figure 9 to give the name of the fraction that is most likely to need to be cracked.

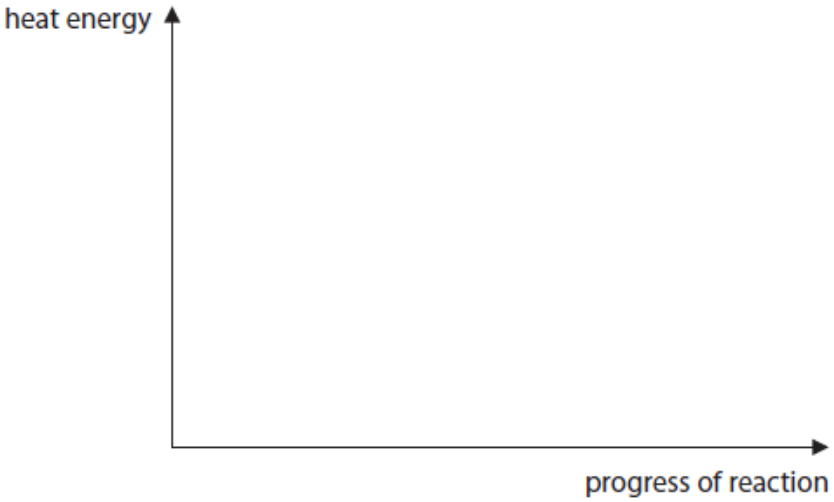
(1)

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(ii) In a cracking reaction, reactants are heated to form products.
This reaction is endothermic.

On the axes provided, draw the reaction profile of this reaction.
Label the energy of the reactants, the energy of the products and the activation energy of the reaction.

(3)



(iii) Dodecane, $C_{12}H_{26}$, can be cracked to form useful products.

Complete the equation for the cracking of dodecane by filling in the formula of the single molecule needed to balance the equation.

(1)

$$C_{12}H_{26} \rightarrow \text{.....} + 3C_2H_4$$

(Total for question = 5 marks)

Q15.

A catalyst is added to some reactions.

Explain the meaning of **catalyst.**

(2)

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Q16.

*Zinc metal reacts with dilute hydrochloric acid to produce hydrogen gas.

zinc + hydrochloric acid → zinc chloride + hydrogen

A student investigated the effect of doubling the concentration of the hydrochloric acid on this reaction.

The student made the following prediction.

> When the concentration of the hydrochloric acid is doubled the rate of reaction will double and the reaction will be more exothermic.

Devise a plan, including the apparatus you would use, to test the student's prediction.

You are provided with pieces of zinc and two bottles of dilute hydrochloric acid.
One bottle of hydrochloric acid is double the concentration of the other.

(6)

(Total for question = 6 marks)

Q17.

Hydrogen reacts with oxygen to form steam.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Bond energies are shown in Figure 14.

bond	bond energy in kJ mol^{-1}
H—H	435
O═O	500
O—H	460

Figure 14

Calculate the energy change for the reaction of 2 mol of hydrogen gas, H_2, with 1 mol of oxygen gas, O_2, to give 2 mol of steam, H_2O.

(4)

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energy change = ... kJ mol^{-1}

(Total for question = 4 marks)

Q18.

Energy changes and rates of reaction

(a) When zinc reacts with copper sulfate solution, zinc sulfate solution and copper are formed.

(i) An experiment was carried out to measure the temperature change when zinc powder reacts with copper sulfate solution.

initial temperature of copper sulfate solution = 20 °C
final temperature of mixture after the reaction = 46 °C

Explain what the temperature readings show about the type of heat change that occurs during this reaction.

(2)

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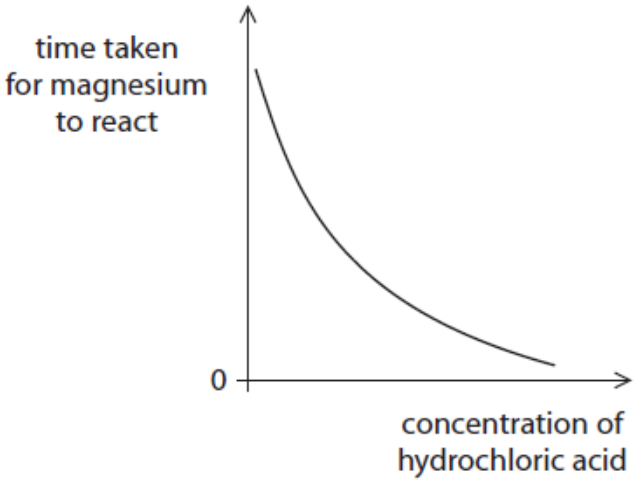
(ii) Complete the equation for the reaction between zinc and copper sulfate by putting formulae in the spaces provided.

(2)

$Zn + CuSO_4 \rightarrow$ ..... + ...

(b) A length of magnesium ribbon was added to excess hydrochloric acid. The time for all of the magnesium to react was recorded. The experiment was repeated with the same lengths of magnesium ribbon but different concentrations of the acid.

The graph shows the time taken for the magnesium to react with different concentrations of this acid.



Use the graph to explain how the rate of this reaction changes as the concentration of hydrochloric acid increases.

(2)

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*(c) Marble chips react with dilute hydrochloric acid to produce carbon dioxide gas. The rate of this reaction can be changed by changing the size of the marble chips.

Describe experiments to investigate what effect using smaller marble chips has on the rate of this reaction.

(6)

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(Total for question = 12 marks)

Q19.

Students are investigating exothermic and endothermic reactions.
They are finding the temperature change in 50 cm^3 water when a solid dissolves in it.
The apparatus is shown in Figure 1.

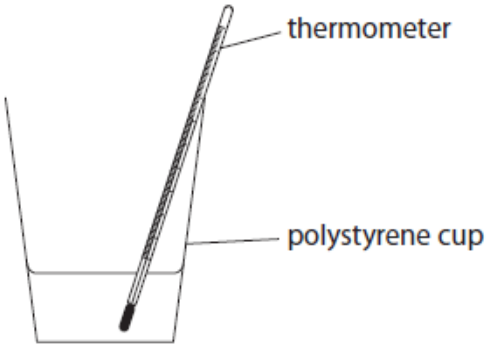


Figure 1

The dissolving of this solid in water is an exothermic change.
The experiment is repeated a number of times.
Compared with the initial temperature of the water, the final temperature of the solution is

(1)

☒ **A** always higher

☒ **B** always lower

☒ **C** sometimes higher and sometimes lower

☒ **D** always unchanged

(Total for question = 1 mark)

Q20.

Zinc is reacted with copper sulfate solution.
The equation for the reaction is

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

(i) What type of reaction is this?

(1)

Put a cross (☒) in the box next to your answer.

☒ **A** decomposition

☒ **B** displacement

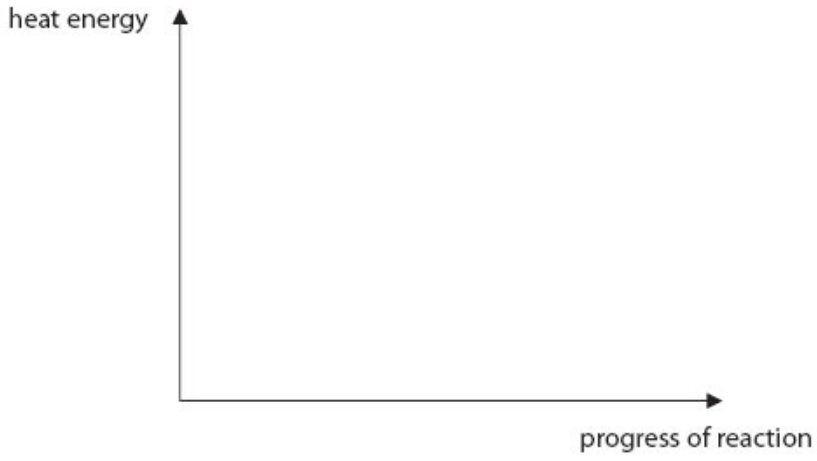
☒ **C** dissolving

☒ **D** neutralisation

(ii) This reaction is exothermic.

On the diagram below draw labelled lines to show the relative energies of the reactants and products in this reaction.

(2)



Q21.

Dissolving ammonium chloride in water is an endothermic process.
Figure 17 shows part of the reaction profile for this process.

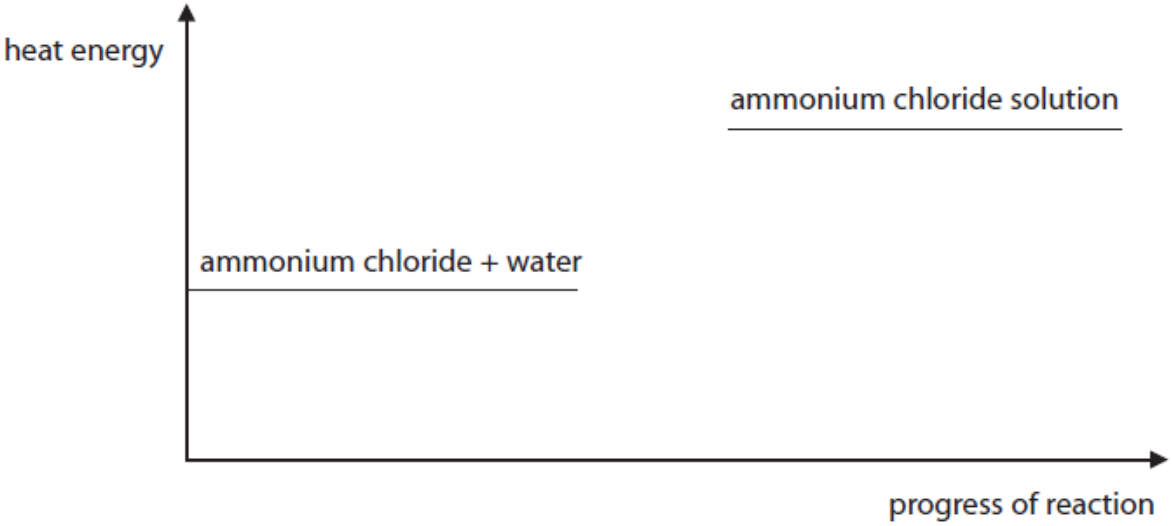


Figure 17

(i) Explain how Figure 17 shows that dissolving ammonium chloride in water is an endothermic process.

(2)

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(ii) Complete the reaction profile in Figure 17 and label the activation energy.

(2)

(Total for question = 4 marks)

Q22.

Dissolving ammonium chloride in water is an endothermic process.
Figure 2 shows part of the reaction profile for this process.

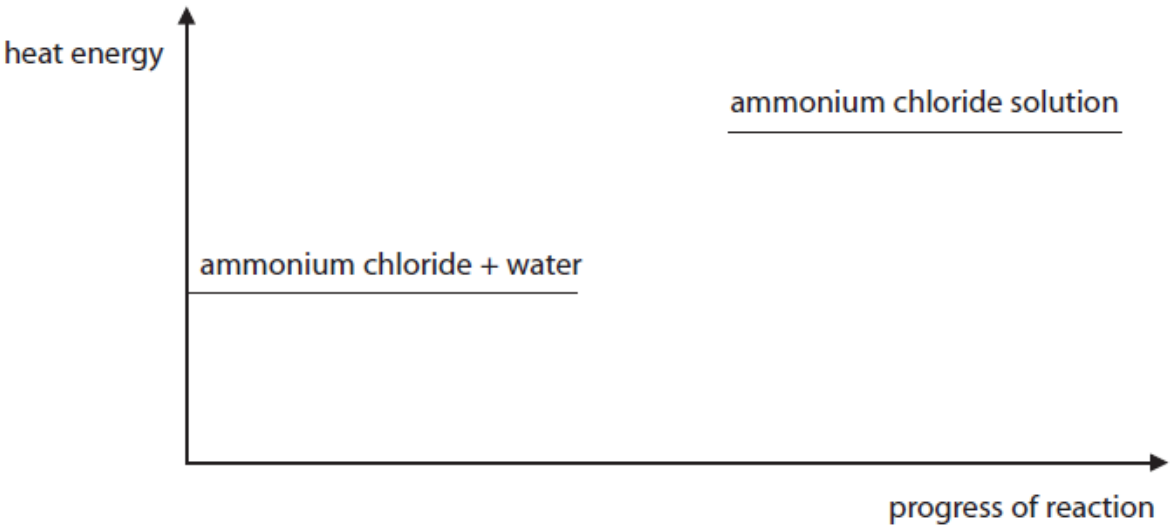


Figure 2

(i) Explain how Figure 2 shows that dissolving ammonium chloride in water is an endothermic process.

(2)

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(ii) Complete the reaction profile in Figure 2 and label the activation energy.

(2)

(Total for question = 4 marks)

Q23.

Explain the advantage of using catalysts made of nanoparticles rather than larger particles.

(2)

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(Total for question = 2 marks)

Q24.

Calcium carbonate reacts with dilute hydrochloric acid to produce calcium chloride, water and carbon dioxide.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

An investigation was carried out into the rate of reaction of calcium carbonate with dilute hydrochloric acid.

5.0 g of small lumps of calcium carbonate were reacted with 50 cm^3 of 0.50 mol dm^{-3} hydrochloric acid.
Another 5.0 g of the same sized lumps of calcium carbonate were reacted with 50 cm^3 of 1.0 mol dm^{-3} hydrochloric acid.
The volume of gas collected in two minutes was recorded for each experiment.

The two experiments were then repeated, each using 5.0 g of large lumps of calcium carbonate.

Figure 5 shows the results.

concentration of hydrochloric acid in mol dm^{-3}	volume of gas collected in cm^3	
	small lumps of calcium carbonate	large lumps of calcium carbonate
0.50	17.2	3.1
1.0	35.1	5.6

Figure 5

Explain, in terms of collision of particles, how these results show the effect of the size of the lumps of calcium carbonate and the effect of the concentration of the acid on the rate of this reaction.

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(Total for question = 6 marks)

Q25.

A student poured 50 cm^3 water into a beaker and measured the water's temperature.

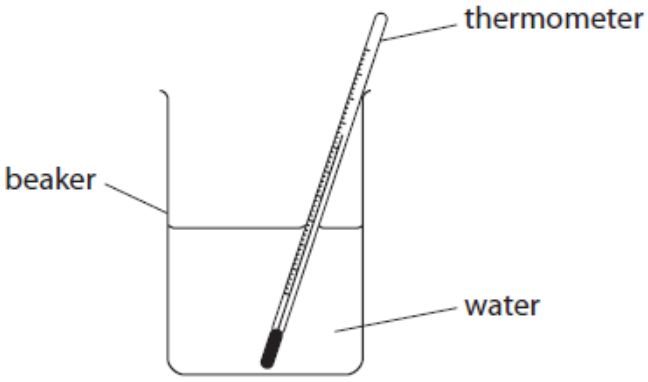


Figure 7

The student added 1.00 g calcium chloride to the water, stirred the mixture and then recorded the temperature.

The student's results were

temperature of water at start	= 21 °C
temperature of mixture after stirring	= 32 °C

Explain, using these results, the type of heat energy change that occurs when calcium chloride dissolves in water.

(2)

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(Total for question = 2 marks)

Q26.

Calcium carbonate reacts with dilute hydrochloric acid to produce calcium chloride, water and carbon dioxide.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

The reaction between calcium carbonate and dilute hydrochloric acid is exothermic.

Explain, in terms of bond breaking and bond making, why some reactions are exothermic.

(3)

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(Total for question = 3 marks)

Q27.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Sodium thiosulfate solution, $Na_2S_2O_3$, reacts with dilute hydrochloric acid.

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

(i) When dilute hydrochloric acid is mixed with sodium thiosulfate solution, the mixture turns cloudy.

Explain why the mixture turns cloudy.

(2)

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(ii) In an investigation, different concentrations of hydrochloric acid are reacted with sodium thiosulfate solution.

The mixture goes cloudy at different rates.

Describe how the rate at which the mixture goes cloudy can be measured.

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(iii) You are provided with some dilute hydrochloric acid which has a concentration of 50 g dm^{-3}.

For this experiment, dilute hydrochloric acid with a concentration of 20 g dm^{-3} is required.

How much water must be added to 100 cm^3 of 50 g dm^{-3} hydrochloric acid to make dilute hydrochloric acid with a concentration of 20 g dm^{-3}?

(1)

☒ **A** 200 cm^3

☒ **B** 150 cm^3

☒ **C** 100 cm^3

☒ **D** 50 cm^3

(Total for question = 6 marks)

Q28.

The word equation for the reaction between magnesium and dilute hydrochloric acid is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The reaction was carried out using the apparatus shown in Figure 11.

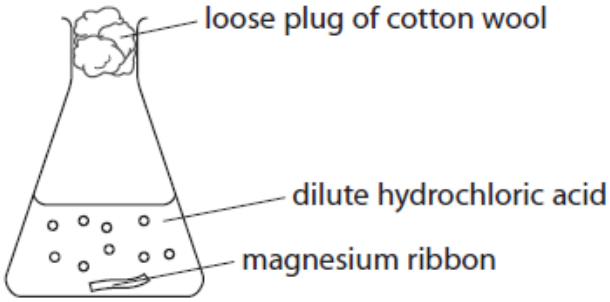


Figure 11

A strip of magnesium ribbon was placed in the conical flask.
100 cm^3 of dilute hydrochloric acid was added to the conical flask.

The mass of the flask and contents was measured at regular intervals.
The loss in mass was calculated.
Figure 12 shows a graph of the results.

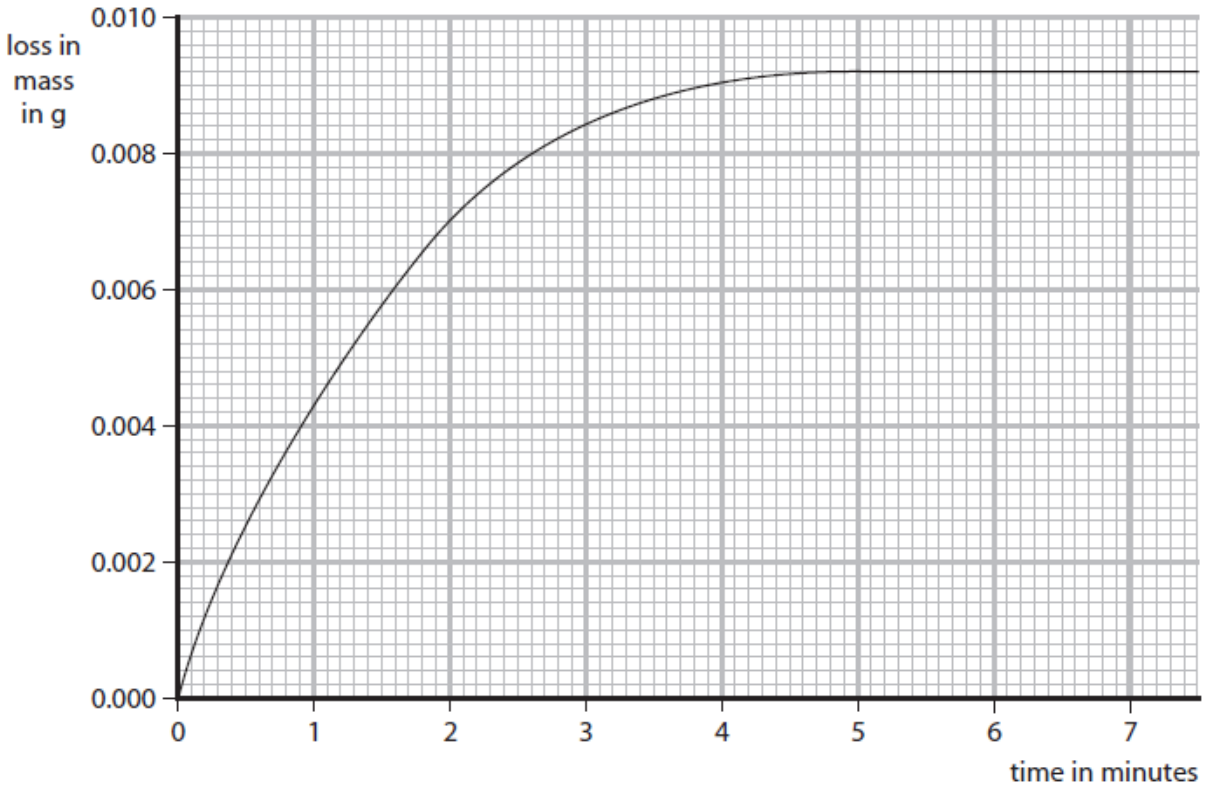


Figure 12

The graph shows that the rate of reaction slows as the reaction takes place.

Explain, in terms of particles, why the rate of reaction between magnesium ribbon and dilute hydrochloric acid slows as the reaction takes place.

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(Total for question = 3 marks)

Q29.

The word equation for the reaction between magnesium and dilute hydrochloric acid is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The reaction was carried out using the apparatus shown in Figure 11.

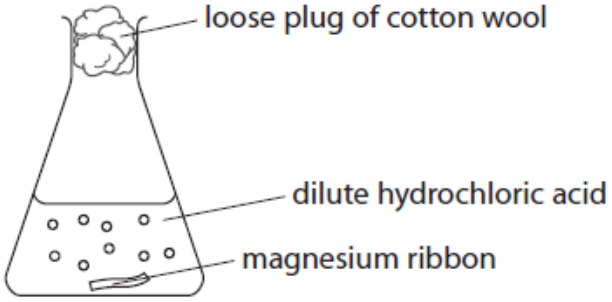


Figure 11

A strip of magnesium ribbon was placed in the conical flask.
100 cm^3 of dilute hydrochloric acid was added to the conical flask.

The mass of the flask and contents was measured at regular intervals.
The loss in mass was calculated.
Figure 12 shows a graph of the results.

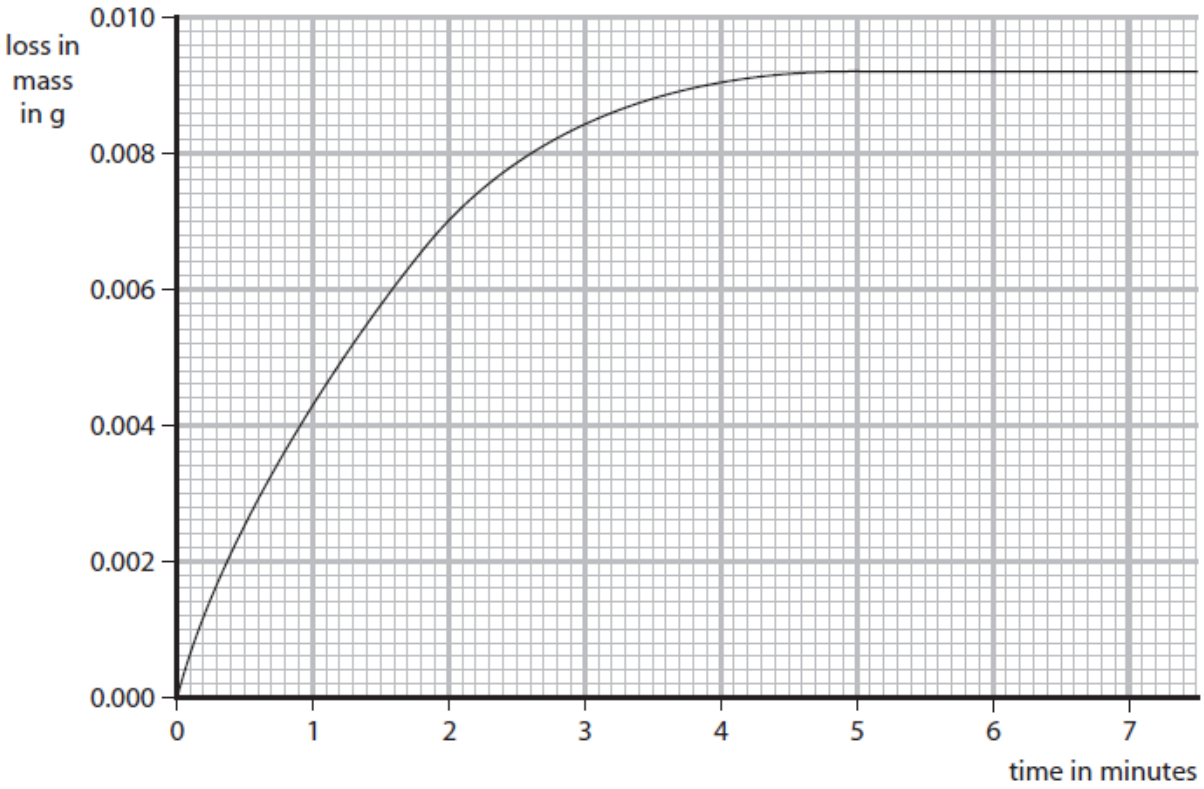


Figure 12

Explain why there is a loss in mass of the flask and contents.

(2)

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(Total for question = 2 marks)

Q30.

Calcium carbonate reacts with dilute hydrochloric acid to produce carbon dioxide gas.

The rate of reaction between calcium carbonate and dilute hydrochloric acid at room temperature was investigated.

The experiments were repeated at a higher temperature.
The rate of reaction for each experiment increased.

Explain, in terms of particles, why the rate of reaction increased when the temperature was increased.

(3)

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(Total for question = 3 marks)

Q31.

Magnesium reacts with dilute sulfuric acid to form magnesium sulfate and hydrogen gas.

A student wants to find out the effect of temperature on the rate of this reaction.

The student used the following method.

step 1 pour 25 cm^3 of dilute sulfuric acid into a conical flask

step 2 warm the acid until its temperature is 30 °C

step 3 add a piece of magnesium to the acid

step 4 start a stopwatch

step 5 wait until the reaction has finished

step 6 stop the stopwatch

step 7 repeat steps 1–6 but at 50 °C.

The reaction at 50 °C was faster than the reaction at 30 °C.

Give **one** reason, in terms of particles, why the reaction at 50 °C was faster than the reaction at 30 °C.

(1)

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.....

(Total for question = 1 mark)

Q32.

A student poured 50 cm^3 water into a beaker and measured the water's temperature.

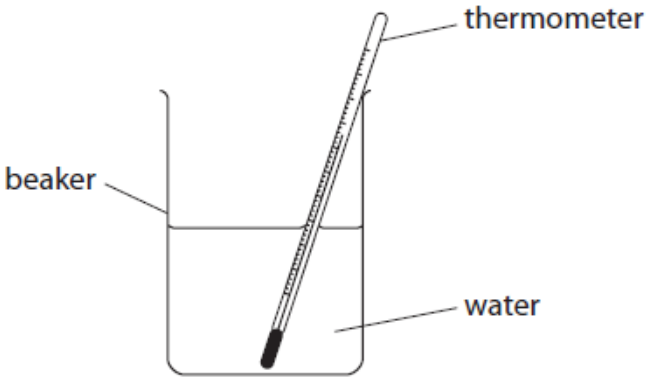


Figure 7

The student added 1.00 g calcium chloride to the water, stirred the mixture and then recorded the temperature.

Give the name of the apparatus that could be used to measure 1.00 g of calcium chloride.

(1)

.....

(Total for question = 1 mark)

Q33.

When solid ammonium chloride is added to water a colourless solution is formed.

During the process the temperature of the liquid decreases.

Describe how you would measure the change in temperature.

(2)

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(Total for question = 2 marks)

Q34.

* Hydrochloric acid reacts with magnesium metal to produce hydrogen gas.

magnesium + hydrochloric acid → magnesium chloride + hydrogen

Describe how you could use magnesium ribbon and a solution of hydrochloric acid to show that decreasing the concentration of the hydrochloric acid changes the rate of this reaction.

(6)

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Q35.

In another experiment, a student investigated the temperature decrease when different amounts of ammonium nitrate crystals were dissolved in 100 cm^3 of water.

The apparatus used is shown in Figure 5.

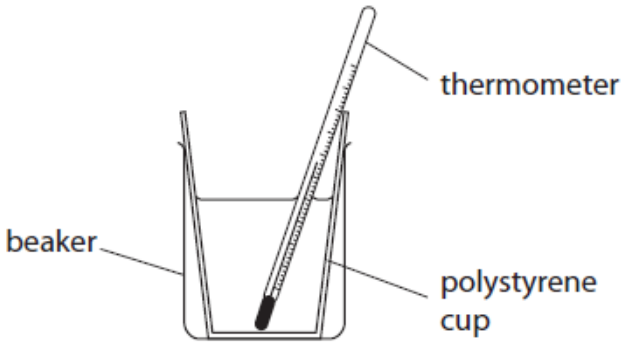


Figure 5

The student used the following method.

step 1 pour 100 cm^3 of water into the polystyrene cup

step 2 add one spatula of ammonium nitrate crystals to the water

step 3 stir the mixture

step 4 use the thermometer to record the lowest temperature reached by the mixture

step 5 repeat steps 1 to 4 using different amounts of ammonium nitrate

(i) Name a piece of apparatus that should be used to measure the 100 cm^3 of water in **step 1**.

(1)

.....

(ii) The student cannot work out the temperature decrease using the method described.

State what the student must do before **step 2** to be able to work out the temperature decrease.

(1)

.....

.....

(iii) State why a polystyrene cup is used in this experiment.

(1)

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.....

(iv) Figure 6 shows the reaction profile for this reaction.

Use the words from the box to complete the labels on Figure 6.

activation energy	products	reactants

(2)

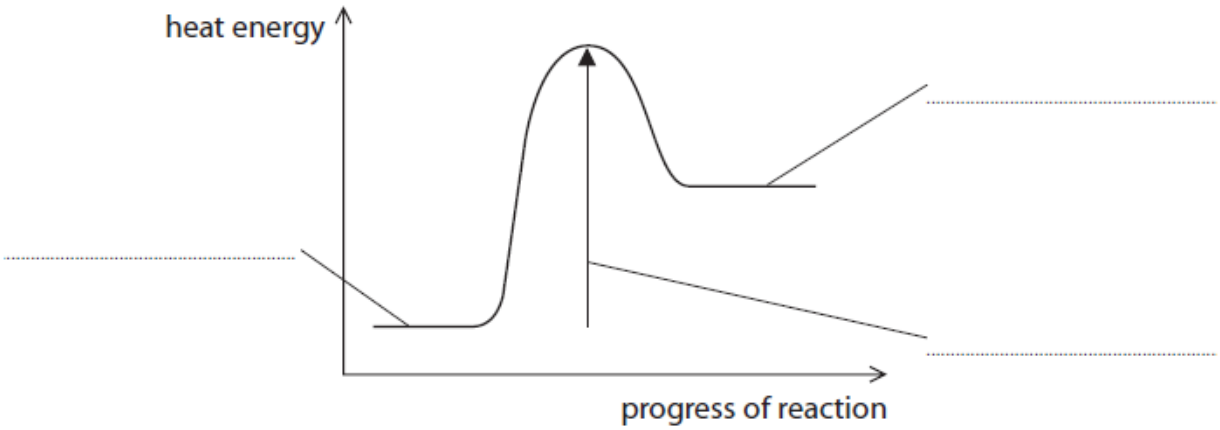


Figure 6

(Total for question = 5 marks)

Q36.

When solid ammonium chloride is added to water a colourless solution is formed.

What type of chemical change causes a decrease in temperature?

(1)

☒ **A** combustion

☒ **B** endothermic

☒ **C** exothermic

☒ **D** neutralisation

(Total for question = 1 mark)

Q37.

A student poured 50 cm^3 water into a beaker and measured the water's temperature.

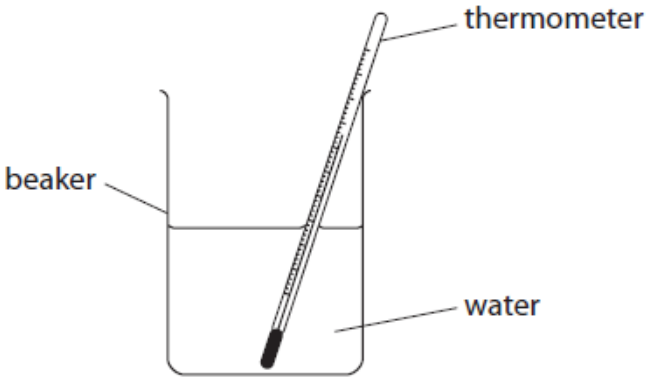


Figure 7

The student added 1.00 g calcium chloride to the water, stirred the mixture and then recorded the temperature.

Calcium chloride is hazardous to health.

(i) Which hazard symbol would be expected to be seen on a container of calcium chloride?

(1)

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(ii) Give a safety precaution that the student should take during the experiment.

(1)

.....

.....

(Total for question = 2 marks)

Q38.

When solid ammonium chloride is added to water a colourless solution is formed.

What process has occurred?

(1)

☒

A displacement

☒ **B** dissolving

☒ **C** neutralisation

☒ **D** precipitation

(Total for question = 1 mark)

Q39.

This question is about the rate of reaction between calcium carbonate and dilute hydrochloric acid.

The word equation for this reaction is

calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

The reaction between calcium carbonate and dilute hydrochloric acid was investigated at different temperatures.

(i) State what could be used to keep the temperature of the conical flask and its contents at a temperature of 45 °C throughout the reaction.

(1)

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(ii) Figure 8 shows a graph of volume of gas collected in this investigation.

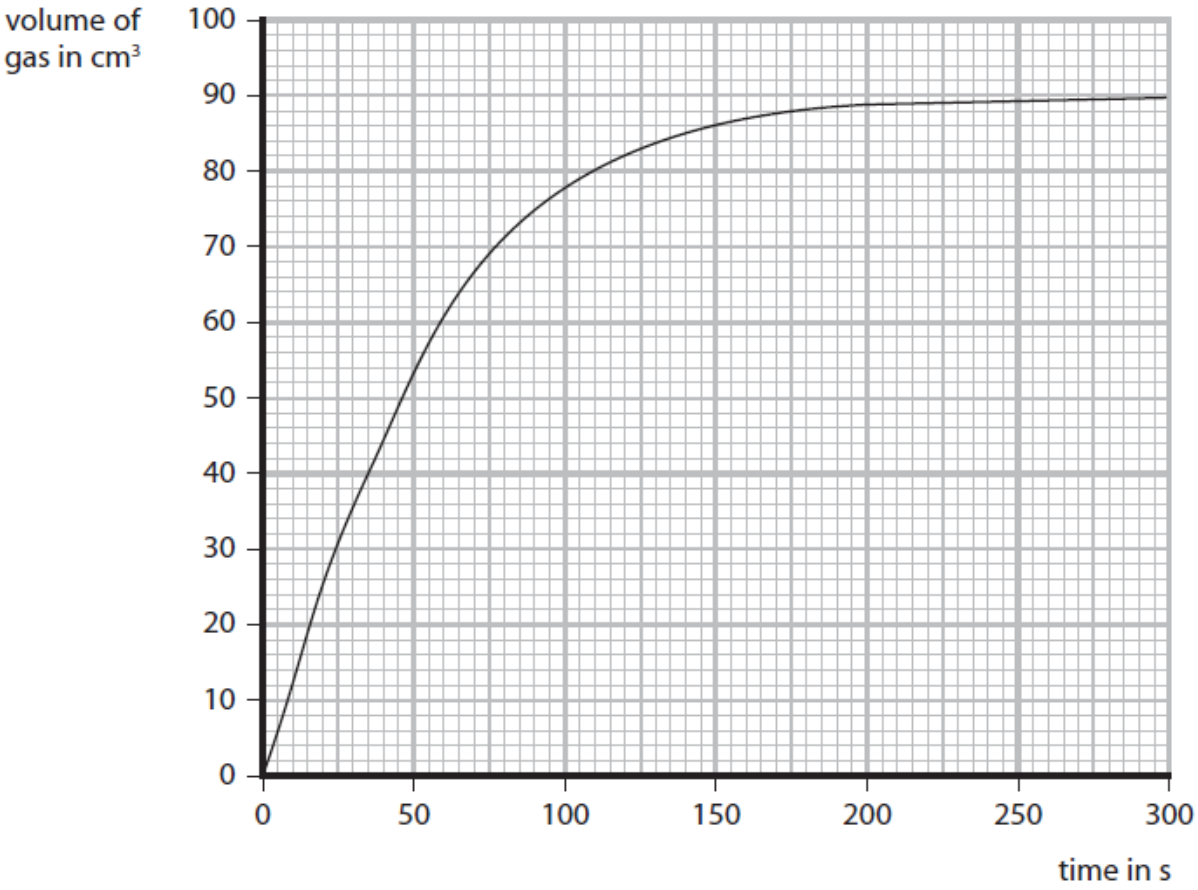


Figure 8

Draw a tangent at 100 seconds on Figure 8.
Use this tangent to calculate the rate of reaction at this time.

(2)

.....

.....

rate of reaction = ... $cm^3\ s^{-1}$

(iii) The temperature of the acid was kept at 45 °C.

State **one** other variable that needs to be controlled during this investigation.

(1)

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(iv) Explain, in terms of particles, how decreasing the temperature affects the rate of this reaction.

(3)

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(Total for question = 7 marks)

Q40.

A student investigated the rate of reaction between magnesium ribbon and excess dilute hydrochloric acid.

The word equation for the reaction is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The total volume of hydrogen evolved was measured every 10 seconds for 120 seconds.

The graph in Figure 10 shows the results obtained by the student.

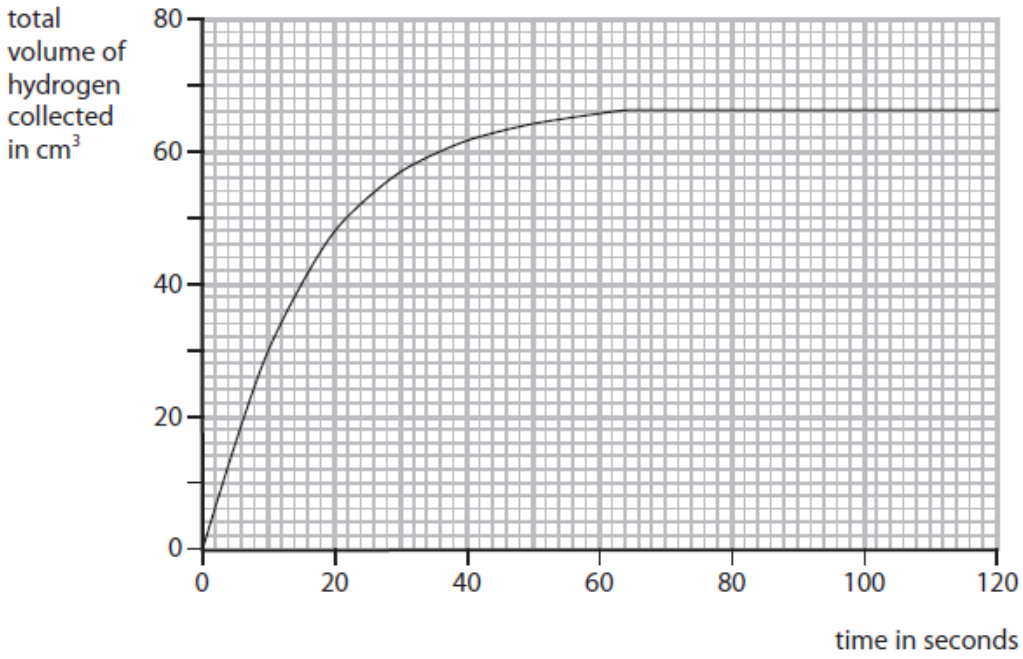


Figure 10

(i) Using the graph, give the time in seconds at which the reaction stopped.

(1)

..... s

(ii) Give the reason why the reaction stopped.

(1)

.....

.....

(iii) Use the graph to calculate the average rate of reaction during the first 20 seconds, in cm^3 of hydrogen produced per second.

(2)

.....

.....

.....

average rate of reaction = ... $cm^3\ s^{-1}$

(iv) The experiment was repeated at a higher temperature, keeping all other conditions exactly the same.

This change caused the reaction to take place more quickly.

On the graph in Figure 10, sketch a line to show the results you would expect in this experiment.

(2)

(v) The rate of the reaction can be changed by adding a solid catalyst to the reaction mixture.

Which line in the table shows how the final volume of hydrogen produced and the mass of the catalyst change?

(1)

	change in final volume of hydrogen	change in mass of catalyst
☒ **A**	increases	no change
☒ **B**	no change	decreases
☒ **C**	no change	no change
☒ **D**	increases	decreases

(Total for question = 7 marks)

Q41.

A student investigated the rate of reaction between magnesium ribbon and excess dilute hydrochloric acid.

The word equation for the reaction is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The total volume of hydrogen evolved was measured every 10 seconds for 120 seconds.

The graph in Figure 1 shows the results obtained by the student.

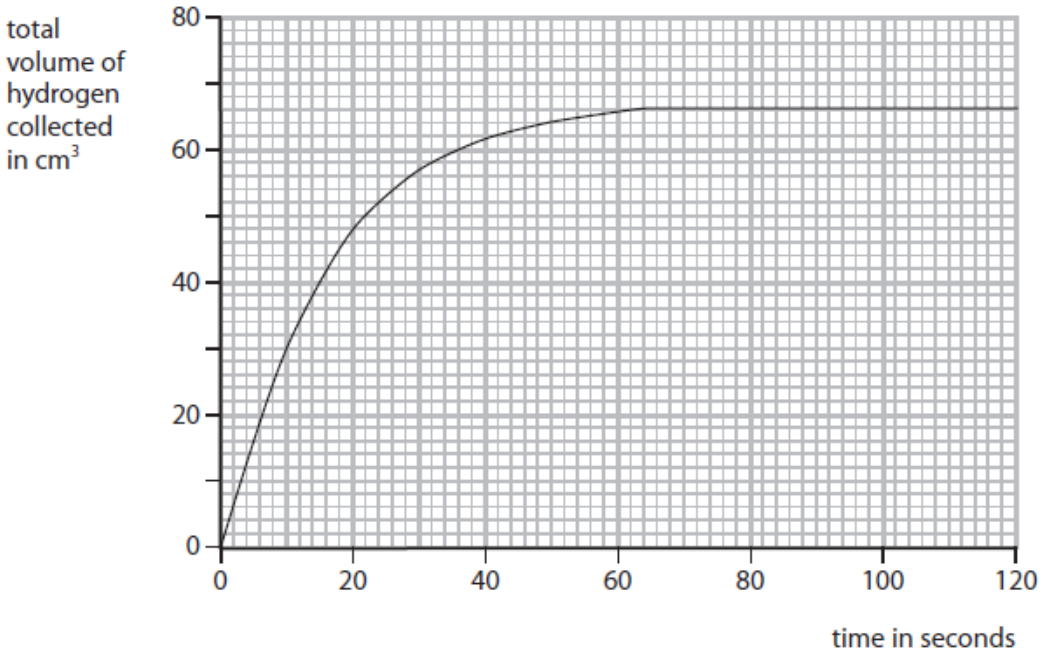


Figure 1

(i) Using the graph, give the time in seconds at which the reaction stopped.

(1)

..... s

(ii) Give the reason why the reaction stopped.

(1)

.....

.....

(iii) Use the graph to calculate the average rate of reaction during the first 20 seconds, in cm^3 of hydrogen produced per second.

(2)

.....

.....

.....

average rate of reaction = ... $cm^3\ s^{-1}$

(iv) The experiment was repeated at a higher temperature, keeping all other conditions exactly the same.

This change caused the reaction to take place more quickly.

On the graph in Figure 1, sketch a line to show the results you would expect in this experiment.

(2)

(v) The rate of the reaction can be changed by adding a solid catalyst to the reaction mixture.

Which line in the table shows how the final volume of hydrogen produced and the mass of the catalyst change?

(1)

	change in final volume of hydrogen	change in mass of catalyst
☒ **A**	increases	no change
☒ **B**	no change	decreases
☒ **C**	no change	no change
☒ **D**	increases	decreases

(Total for question = 7 marks)

Q42.

Liver contains the enzyme catalase.

A piece of liver was added to another sample of hydrogen peroxide solution.

Figure 12 shows the results.

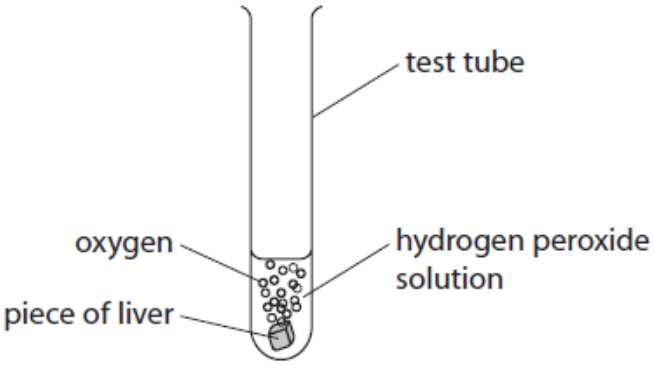


Figure 12

Figure 13 shows a graph of the volume of oxygen produced from the hydrogen peroxide with and without liver.

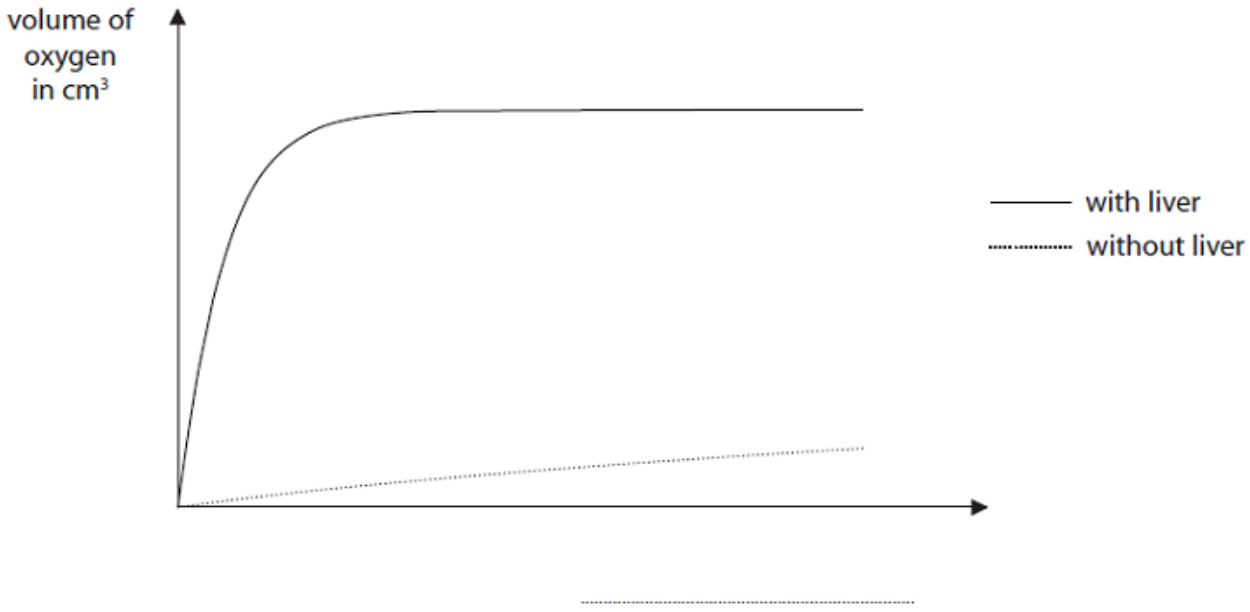


Figure 13

(i) Complete the missing label on the axis of the graph.

(1)

(ii) Describe what the graph shows about the difference in decomposition of hydrogen peroxide with and without liver.

(2)

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.....

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.....

(iii) Describe how the apparatus in Figure 12 could be modified to find the volume of gas produced when the liver is added to the hydrogen peroxide.

(2)

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(Total for question = 5 marks)

Q43.

Hydrogen peroxide decomposes to form water and oxygen.

The rate of this reaction can be found by measuring the volume of oxygen formed after different time intervals.

Hydrogen peroxide solution is placed in a conical flask.
The apparatus is set up as shown in Figure 5.

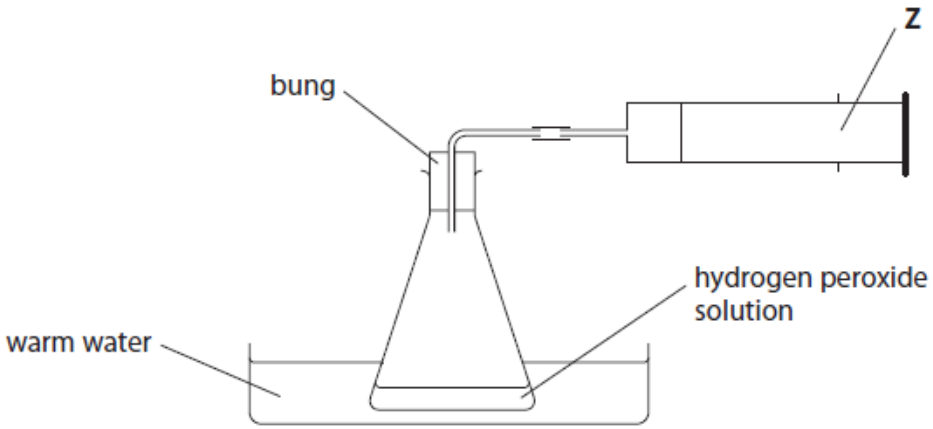


Figure 5

State the name of the piece of apparatus labelled **Z** in Figure 5.

(1)

.....

.....

(Total for question = 1 mark)

Q44.

Complete the balanced equation for the reaction of magnesium with dilute hydrochloric acid forming magnesium chloride and hydrogen.

(2)

Mg + ... HCl → ..... + ...

(Total for question = 2 marks)

Q45.

Students are investigating exothermic and endothermic reactions.
They are finding the temperature change in 50 cm^3 water when a solid dissolves in it.
The apparatus is shown in Figure 1.

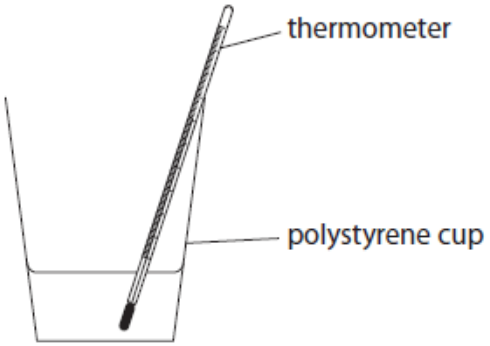


Figure 1

State how step **R** could be changed to measure the volume of water more accurately.

(1)

.....

(Total for question = 1 mark)

Q46.

The word equation for the reaction between magnesium and dilute hydrochloric acid is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The reaction was carried out using the apparatus shown in Figure 11.

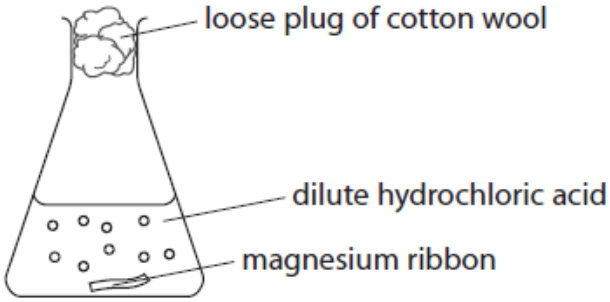


Figure 11

A strip of magnesium ribbon was placed in the conical flask.
100 cm^3 of dilute hydrochloric acid was added to the conical flask.

The mass of the flask and contents was measured at regular intervals.
The loss in mass was calculated.
Figure 12 shows a graph of the results.

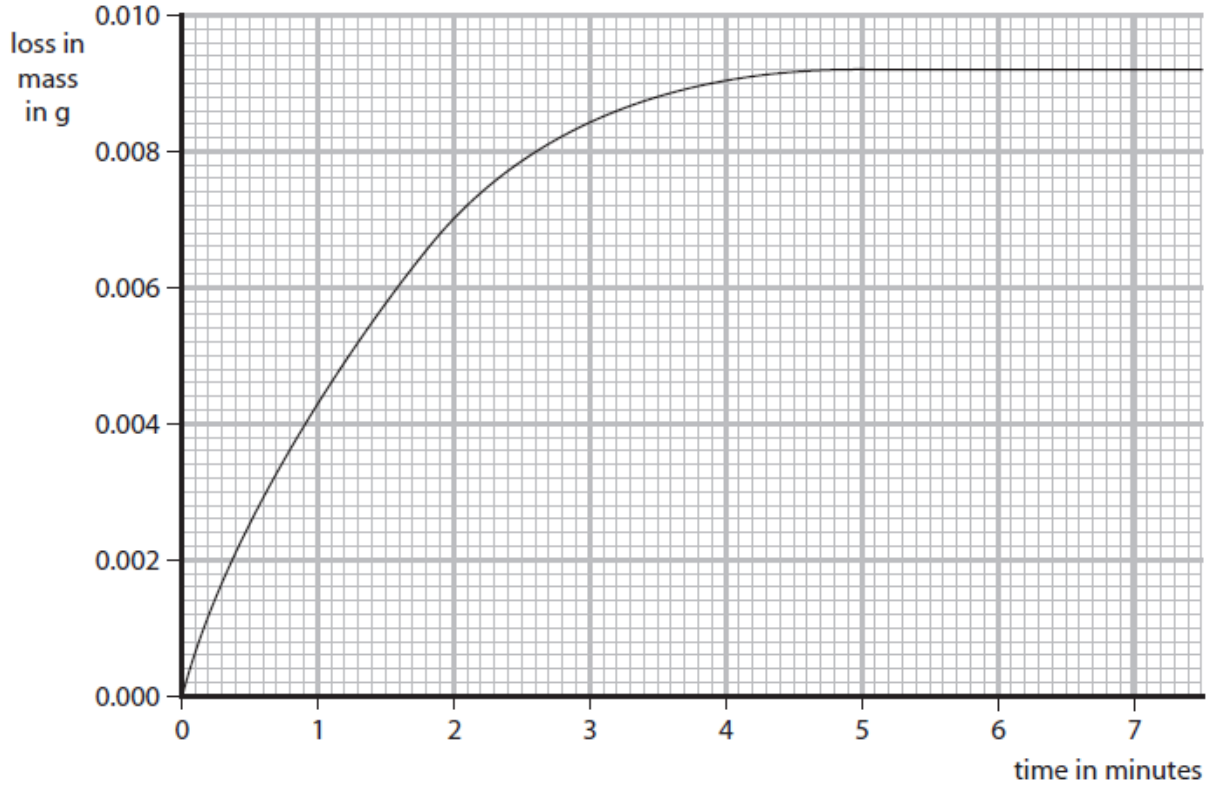


Figure 12

Name the apparatus that could be used to measure out 100 cm^3 of dilute hydrochloric acid.

(1)

.....

(Total for question = 1 mark)

Q47.

When solid ammonium chloride is added to water a colourless solution is formed.

In another experiment the temperature change produced in water by dissolving a different solid can be found.

Give **two** variables that should be kept the same in this experiment, in order to be able to compare this temperature change fairly with the temperature change produced when the ammonium chloride dissolves in water.

(2)

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(Total for question = 2 marks)

Q48.

A student investigated the rate of a reaction.
The student investigated the reaction between zinc and dilute sulfuric acid.
The products are zinc sulfate, $ZnSO_4$, and hydrogen.

(i) Write the balanced equation for this reaction.

(2)

.....

*(ii) The student carried out two experiments.
The same mass of zinc and the same sized pieces of zinc were used in each experiment.

The results are shown in the table.

	experiment 1	experiment 2
concentration of sulfuric acid / mol dm^{-3}	0.5	1.5
temperature / °C	20	40
rate of reaction	slow	fast

Evaluate these results, explaining the reasons why the rate of reaction in experiment 2 is faster than the rate of reaction in experiment 1.
In your answer you should refer to the frequency and energy of collisions between particles.

(6)

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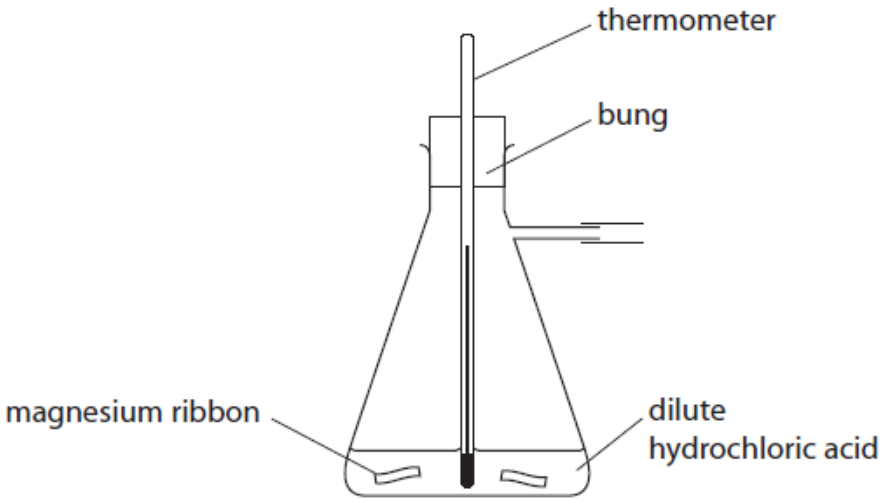
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Q49.

The apparatus shown was used by a student to investigate the reaction between strips of magnesium ribbon and **excess** dilute hydrochloric acid.



The word equation for the reaction is

$$\text{magnesium(s)} + \underset{\text{acid}}{\text{hydrochloric}}\text{(aq)} \rightarrow \underset{\text{chloride}}{\text{magnesium}}\text{(aq)} + \text{hydrogen(g)}$$

(a) States of substances in reactions can be shown by state symbols.

Explain the difference between magnesium chloride(aq) and magnesium chloride(l).

(2)

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(b) Describe what you would **see** when magnesium ribbon reacts with dilute hydrochloric acid.

(1)

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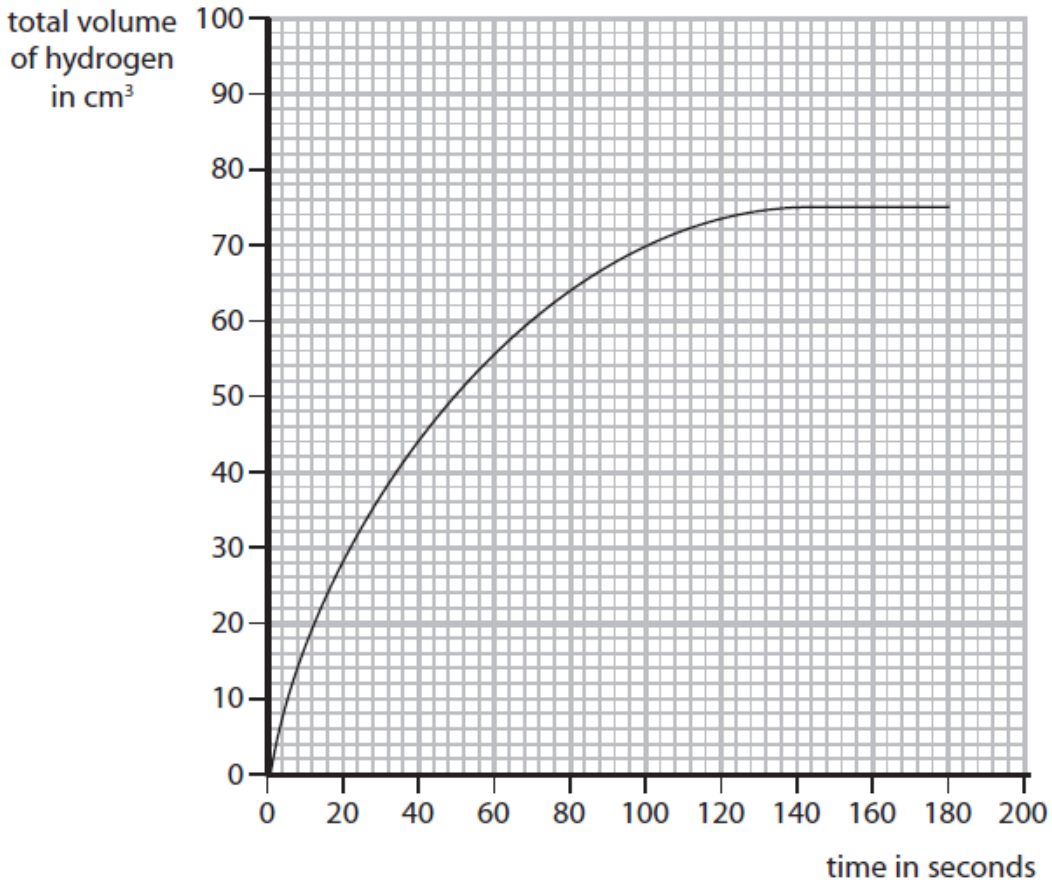
(c) Every 20 seconds, the student recorded the total volume of hydrogen produced in the reaction.

(i) Name a piece of apparatus the student should use to measure the volume of hydrogen produced.

(1)

.....

The results are shown on the graph.



(ii) After how many seconds had all the magnesium reacted?

(1)

..... seconds

(iii) The experiment is repeated using the same volume of a more concentrated hydrochloric acid solution.
All other conditions were kept the same.

On the graph draw a curve to show how the volume of hydrogen changes with time during this experiment.

(2)

(d) A student repeated the original experiment using the same mass of magnesium as a powder instead of as ribbon.
All other conditions were the same as in the first experiment.

Explain the effect on the rate of reaction of using magnesium powder instead of magnesium ribbon.

(2)

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(e) When magnesium reacts with dilute hydrochloric acid there is a change in temperature.

In an experiment the results were
temperature at start = 21 °C
temperature at end = 62 °C

Explain what conclusion can be made about the type of reaction, from these results.

(2)

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Q50.

Rates of reactions and energy changes

(a) Marble chips react with hydrochloric acid to produce carbon dioxide.

The equation for the reaction is

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Which one of these changes would **decrease** the rate of this reaction?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** use hydrochloric acid which is more dilute

☒ **B** use smaller sized marble chips

☒ **C** use marble chips which have a larger surface area

☒ **D** use a larger volume of the hydrochloric acid

(b) Explain why increasing the temperature of a reaction increases the rate of the reaction.

(2)

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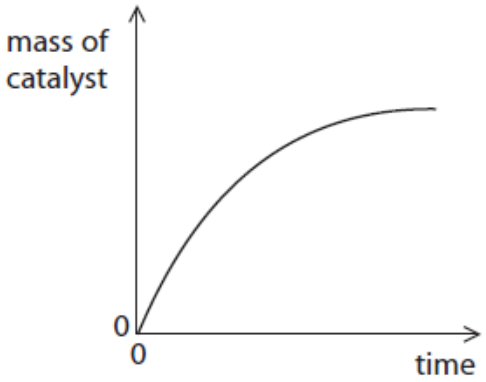
(c) (i) The rate of decomposition of hydrogen peroxide can be increased by adding a catalyst.

Which of these graphs shows the mass of the catalyst during the reaction?

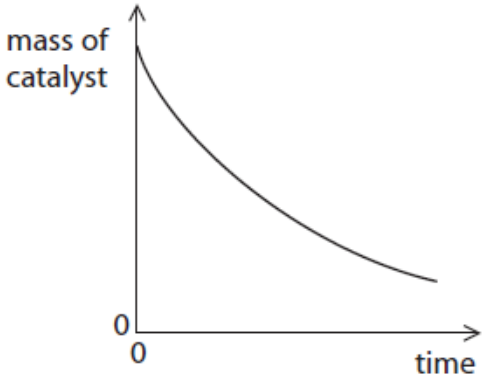
Put a cross (☒) in the box next to your answer.

(1)

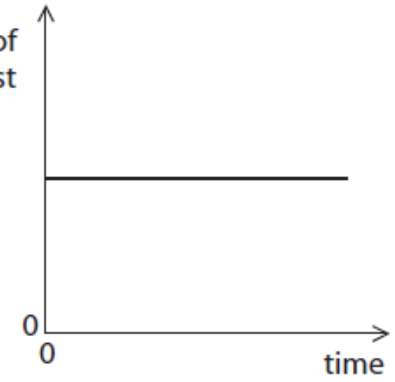
☒ **A**



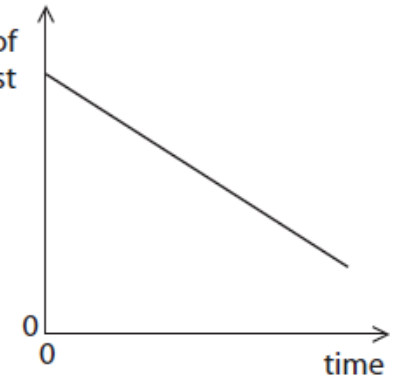
☒ **B**



☒ **C**



☒ **D**



(ii) The decomposition of hydrogen peroxide, H_2O_2, produces oxygen and water.

Give the balanced equation for this reaction.

(2)

.....

(d) Explain, in terms of the energy involved in the breaking of bonds and in the making of bonds, why some reactions are exothermic.

(2)

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(Total for question = 8 marks)

Q51.

(a) A technician made some dilute sodium hydroxide solution by carefully adding some solid sodium hydroxide to pure water.

This is the hazard symbol on a bottle of solid sodium hydroxide.



(i) State what this symbol shows about sodium hydroxide.

(1)

.....

(ii) Sodium hydroxide solution reacts with dilute hydrochloric acid.
During the reaction heat is released.

What type of reaction is this?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** displacement

☒ **B** endothermic

☒ **C** neutralisation

☒ **D** precipitation

(b) A catalyst is added to some reactions.

Explain the meaning of **catalyst.**

(2)

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(c) Dilute hydrochloric acid reacts with calcium carbonate to produce carbon dioxide gas.

Three different experiments were carried out using large pieces of calcium carbonate, small pieces of calcium carbonate and powdered calcium carbonate.
The size of the calcium carbonate pieces was the only factor that was changed.

In each experiment the volume of carbon dioxide released in five minutes was measured.

The results are

size of calcium carbonate pieces used	volume of carbon dioxide released in five minutes / cm^3
large	3
small	7
powdered	50

Describe what this shows about the effect of the surface area of calcium carbonate on the rate of this reaction.

(2)

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*(d) Hydrochloric acid reacts with magnesium metal to produce hydrogen gas.

magnesium + hydrochloric acid → magnesium chloride + hydrogen

Describe how you could use magnesium ribbon and a solution of hydrochloric acid to show that decreasing the concentration of the hydrochloric acid changes the rate of this reaction.

(6)

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(Total for Question = 12 marks)

Q52.

(a) A student investigated the rate of a reaction.
The student investigated the reaction between zinc and dilute sulfuric acid.
The products are zinc sulfate, $ZnSO_4$, and hydrogen.

(i) Write the balanced equation for this reaction.

(2)

.....

*(ii) The student carried out two experiments.
The same mass of zinc and the same sized pieces of zinc were used in each experiment.

The results are shown in the table.

	experiment 1	experiment 2
concentration of sulfuric acid / mol dm^{-3}	0.5	1.5
temperature / °C	20	40
rate of reaction	slow	fast

Evaluate these results, explaining the reasons why the rate of reaction in experiment 2 is faster than the rate of reaction in experiment 1.
In your answer you should refer to the frequency and energy of collisions between particles.

(6)

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(b) Zinc is reacted with copper sulfate solution.
The equation for the reaction is

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

(i) What type of reaction is this?

(1)

Put a cross (☒) in the box next to your answer.

☒ **A** decomposition

☒ **B** displacement

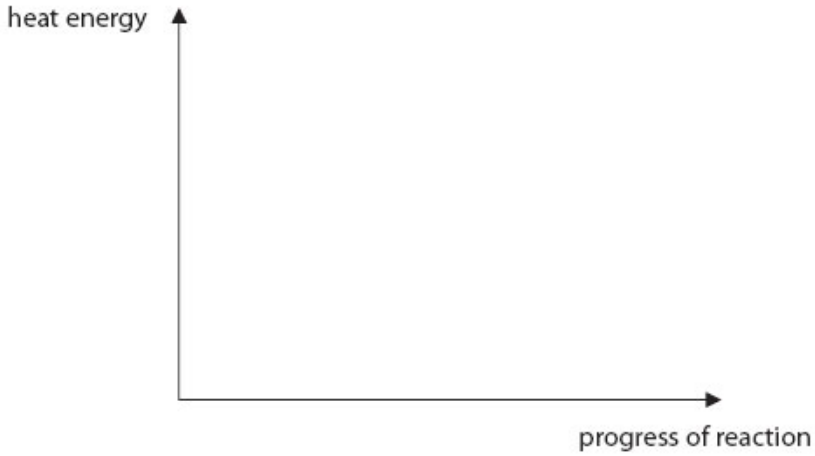
☒ **C** dissolving

☒ **D** neutralisation

(ii) This reaction is exothermic.

On the diagram below draw labelled lines to show the relative energies of the reactants and products in this reaction.

(2)



(Total for Question = 11 marks)

Q53.

Calcium carbonate reacts with dilute hydrochloric acid to produce calcium chloride, water and carbon dioxide.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

A student wanted to measure the amount of gas produced in two minutes.

The student suggested that this could be done by counting the number of bubbles formed. However, the bubbles are produced too quickly to count them.

Figure 4 shows a conical flask in which the calcium carbonate and dilute hydrochloric acid are reacting.

Complete Figure 4 to show the apparatus that could be used to measure accurately the volume of gas given off in two minutes.

(2)

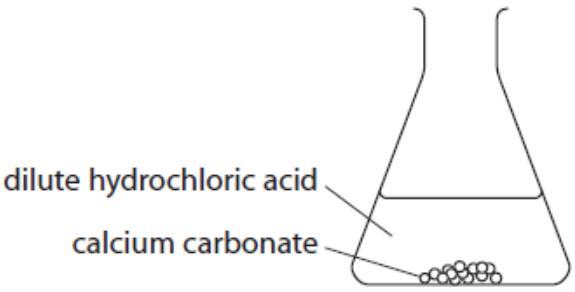


Figure 4

(Total for question = 2 marks)

Q54.

The word equation for the reaction between magnesium and dilute hydrochloric acid is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The reaction was carried out using the apparatus shown in Figure 11.

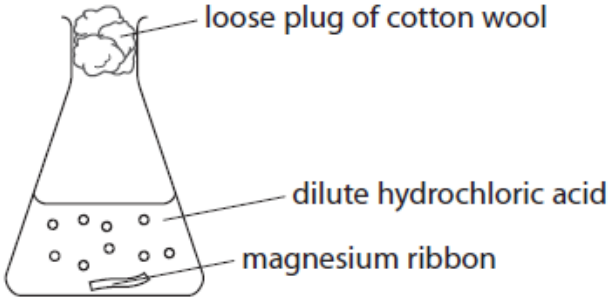


Figure 11

A strip of magnesium ribbon was placed in the conical flask.
100 cm^3 of dilute hydrochloric acid was added to the conical flask.

The mass of the flask and contents was measured at regular intervals.
The loss in mass was calculated.
Figure 12 shows a graph of the results.

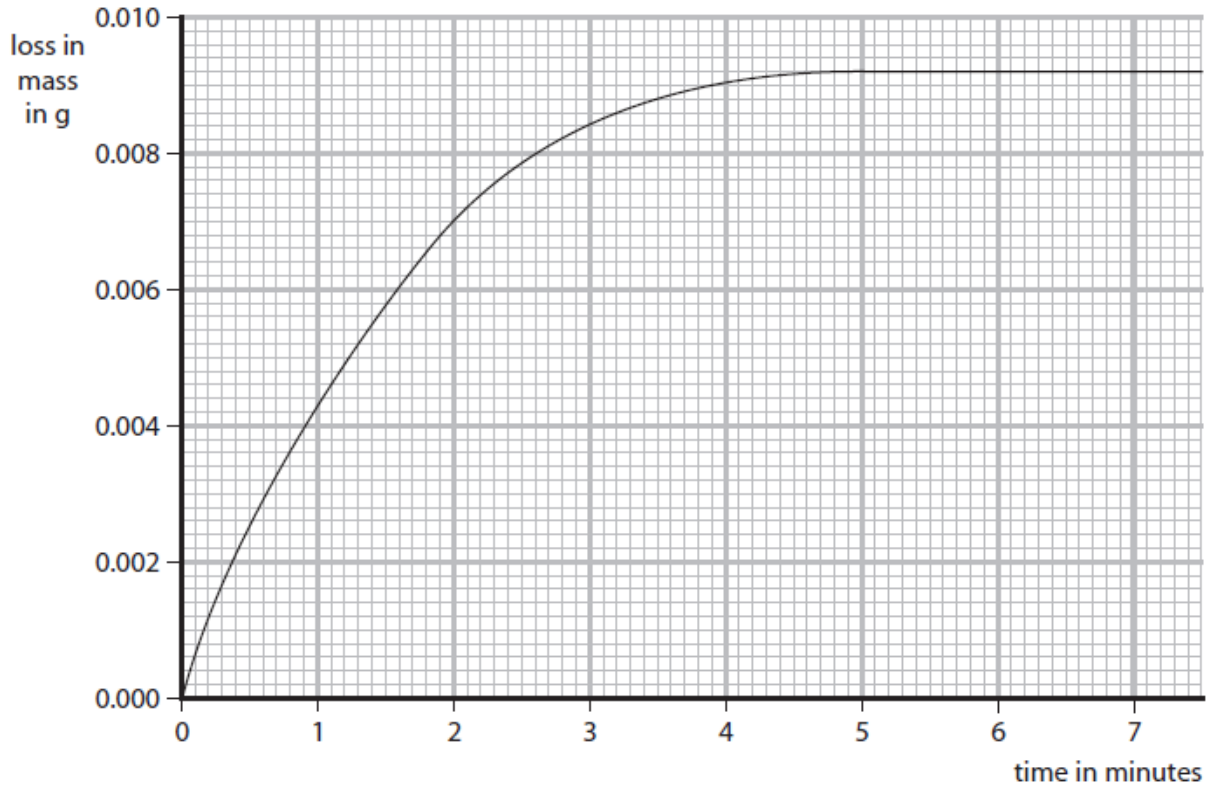


Figure 12

The original experiment was repeated using the same mass of magnesium powder instead of the magnesium ribbon.
All other conditions were kept the same.

Sketch, on the graph in Figure 12, the line you would expect for this experiment.

(2)

(Total for question = 2 marks)

Q55.

A student investigated the change in temperature when sodium hydroxide solution was mixed with dilute hydrochloric acid in a beaker.

The student took the temperature of the solutions before the reaction and of the mixture after the reaction.

temperature of solutions before the reaction = 23.0 °C
temperature of the mixture after the reaction = 24.7 °C

(i) Explain how these results show that the reaction is exothermic.

(2)

.....

.....

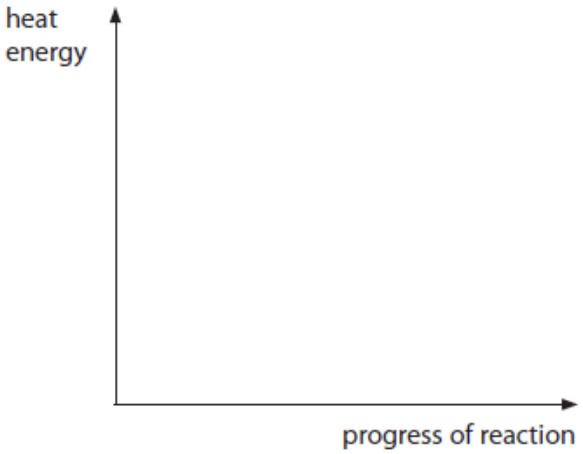
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(ii) As a reaction progresses reactants become products.

On the axes below, draw labelled lines to show the relative heat energies of the reactants and products in this exothermic reaction.

(2)



(iii) In the experiment, the temperature rise is less than expected.

State one way that the student could improve the experiment so that the temperature rise was closer to the expected value.

(1)

.....

.....

.....

.....

(iv) When the reaction takes place there is a heat energy change.

This is the result of heat energy changes that take place when bonds are broken and when bonds are formed.

Which row of the table shows the heat energy changes that occur when bonds are broken and when bonds are formed?

(1)

	bonds broken	bonds formed
☒ **A**	heat energy is released	heat energy is released
☒ **B**	heat energy is released	heat energy is required
☒ **C**	heat energy is required	heat energy is released
☒ **D**	heat energy is required	heat energy is required

(Total for question = 6 marks)

Q56.

A technician made some dilute sodium hydroxide solution by carefully adding some solid sodium hydroxide to pure water.

This is the hazard symbol on a bottle of solid sodium hydroxide.



(i) State what this symbol shows about sodium hydroxide.

(1)

.....

(ii) Sodium hydroxide solution reacts with dilute hydrochloric acid.
During the reaction heat is released.

What type of reaction is this?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** displacement

☒ **B** endothermic

☒ **C** neutralisation

☒ **D** precipitation

Q57.

Students are investigating exothermic and endothermic reactions.
They are finding the temperature change in 50 cm^3 water when a solid dissolves in it.
The apparatus is shown in Figure 1.

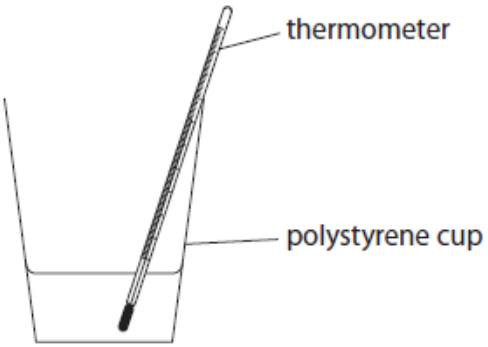


Figure 1

Figure 2 shows a cold pack.

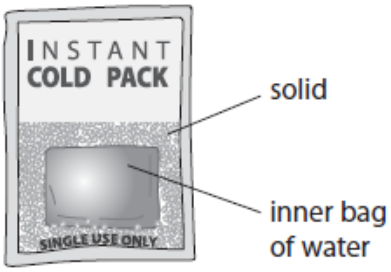


Figure 2

When the pack is squeezed hard the inner bag bursts.
Then the pack goes cold.

(i) Explain why the pack goes cold.

(2)

.....

.....

.....

.....

(ii) Give the reason why the pack can be used only once.

(1)

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.....

(Total for question = 3 marks)