AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.6.1 RATE OF REACTION (PACK 3)

SCORE	PERCENTAGE
/210	%

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Q1.

This question is about rates of reaction.

(a) Hydrogen peroxide (H_2O_2) decomposes very slowly at room temperature.

(i) Complete the balanced chemical equation for this reaction by writing in the formula of the missing product.

$2H_2O_2 \rightarrow 2$ _____ $+ O_2$

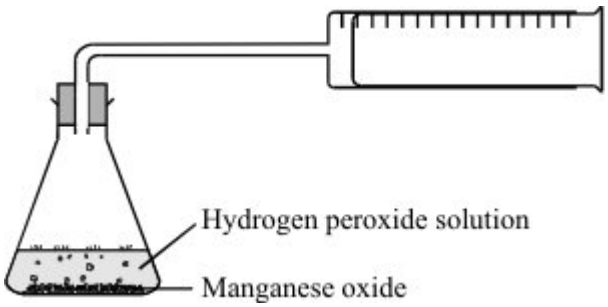
(1)

(ii) The decomposition is much faster if manganese oxide is mixed with the hydrogen peroxide. Complete the sentence.

Manganese oxide acts as a _____ for decomposition of hydrogen peroxide.

(1)

(b) In an experiment 1g of manganese oxide was mixed with 50 cm^3 of hydrogen peroxide solution.

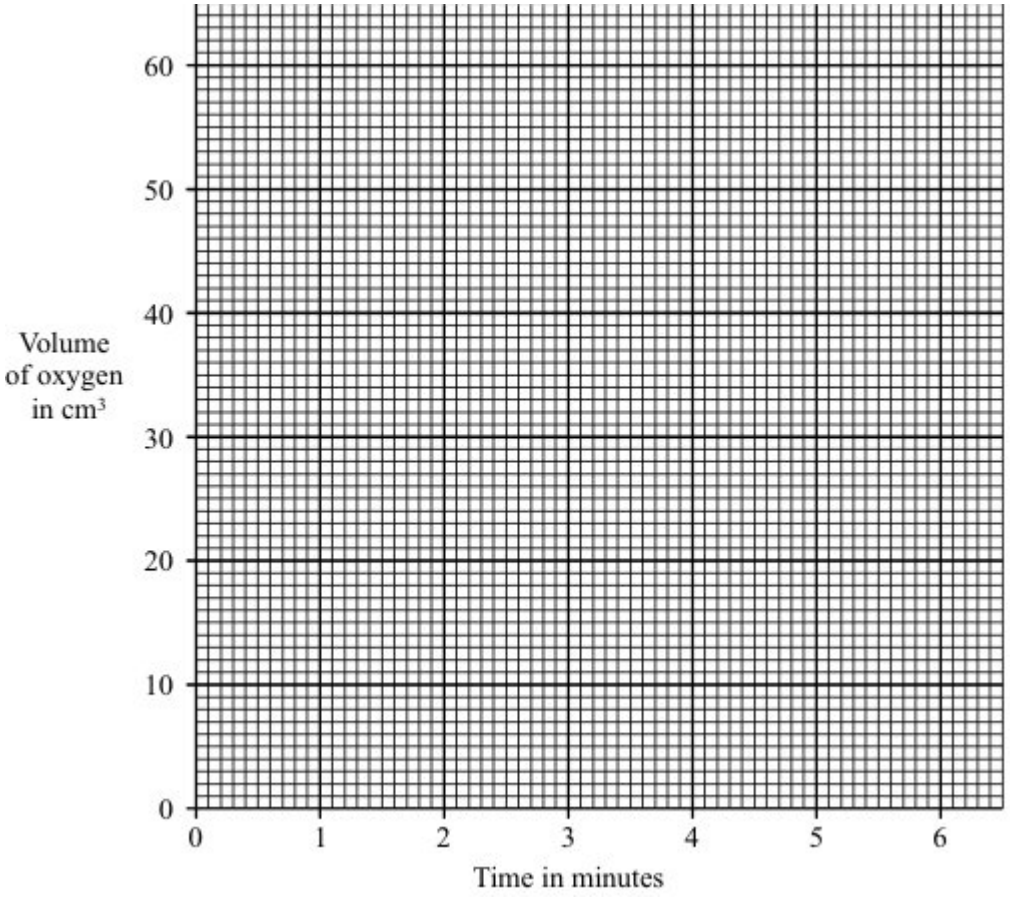


The results show the volume of oxygen collected during six minutes.

Time in minutes	0	1	2	3	4	5	6
Volume of oxygen in cm^3	0	34.5	47.5	54.5	58.5	60.0	60.0

(i) Draw a graph of these results.

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(3)

(ii) How long did it take for the decomposition to stop?

_____

(1)

(iii) Why did the decomposition stop?

_____

(1)

(c) In a second experiment water had been added to the hydrogen peroxide solution. Again 50 cm^3 of this hydrogen peroxide solution was mixed with 1g of manganese oxide.

(i) For this second experiment, sketch, on the same grid, a graph line you would expect to get.

(2)

(ii) In this second experiment, why would the rate of reaction be different to the first experiment?

_____

(1)

(Total 10 marks)

Q2.

Early atmospheres on Earth contained ammonia (NH_3).

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(a) (i) Complete the sentence.

Our atmosphere today is made up of about _____ % nitrogen.

(1)

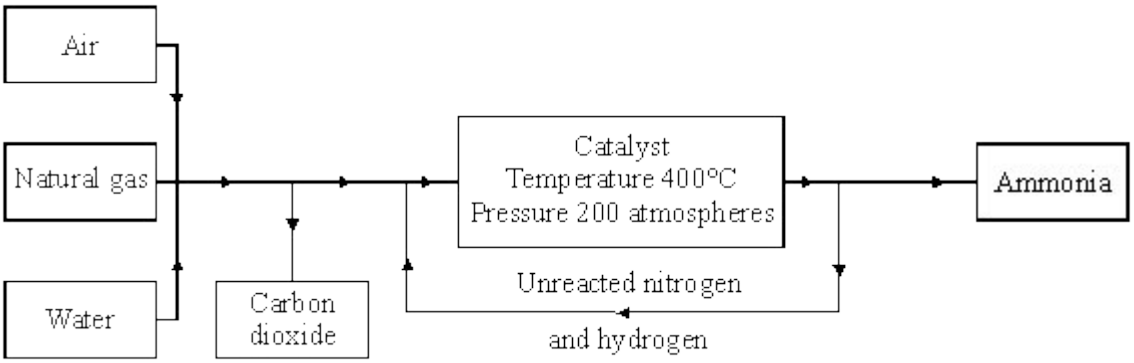
(ii) Today we convert nitrogen back to ammonia mainly for the production of fertilisers. What do plants convert the nitrogen in these fertilisers into?

_____

_____

(1)

(b) The conversion of nitrogen to ammonia is shown.



(i) When making ammonia, what is **one** source of hydrogen?

_____

(1)

(ii) Apart from ammonia, name **one** other product formed during this conversion.

_____

(1)

(c) The main reaction is the formation of ammonia from nitrogen and hydrogen.

(i) Complete and balance the equation for this reaction.

_____(g) + _____(g) → _____NH_3(g)

(2)

(ii) Name the metal catalyst used in this reaction.

_____

(1)

(iii) This reaction does not work successfully at room temperature (20 °C) and needs a much higher temperature of 400 °C. Explain why.

_____

_____

_____

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(2)

(d) Draw a diagram to show the arrangement of the electrons in a molecule of ammonia. The electron arrangement of each atom is hydrogen 1 and nitrogen 2.5.

(2)

(Total 11 marks)

Q3.

Calcium tablets are taken to build and maintain strong bones and teeth.



(a) These tablets react with hydrochloric acid in the stomach.

$CaCO_3(\quad) + 2HCl(aq) \rightarrow CaCl_2(\quad) + H_2O(\quad) + CO_2(\quad)$

(i) Add all these missing state symbols [aq g l s] to the balanced chemical equation.

(2)

(ii) The calcium salt that is formed is absorbed during digestion. What is the name of the calcium salt?

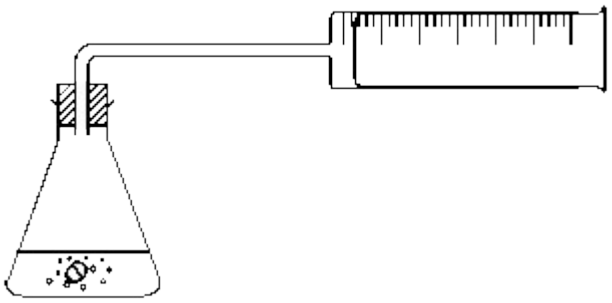
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_____

(1)

(b) The volume of carbon dioxide produced by one calcium tablet in the stomach can be found as shown.

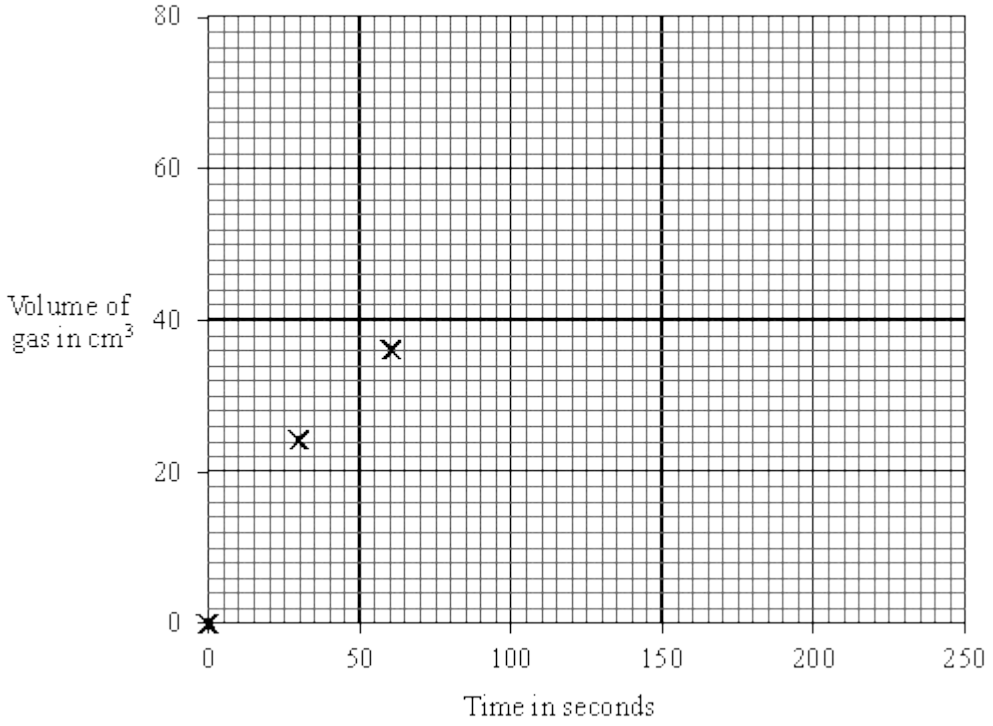
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The volume of carbon dioxide was recorded every 30 seconds until the reaction stopped.

Time in seconds	0	30	60	90	120	150	180	210	240
Volume of gas in cm^3	0	24	36	46	52	56	59	60	60

(i) Complete the graph of these results.



(3)

(ii) Describe **one** way in which this reaction can be made to go faster.

_____

_____

(1)

(iii) A calculation, using the mass of this tablet, showed that 80 cm^3 of carbon dioxide would be produced if the tablet was pure calcium carbonate. What do the results show about the purity of the tablet? Explain your answer by calculating the purity of this tablet.

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_____

_____

_____

_____

_____

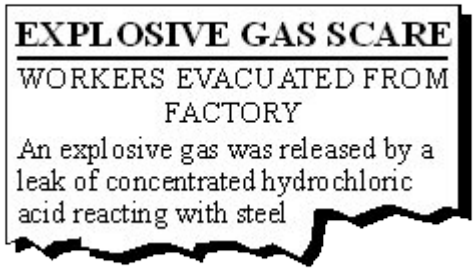
_____

(3)

(Total 10 marks)

Q4.

This article appeared in a newspaper.



(a) The balanced chemical equation shows the reaction between steel and hydrochloric acid.

$Fe(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$

(i) Which metal in steel reacted with the hydrochloric acid?

_____

(1)

(ii) The gas released was described as explosive. Explain why.

_____

_____

_____

_____

_____

(3)

(b) In the factory hydrogen chloride is manufactured by reacting hydrogen with chlorine. Hydrochloric acid is formed when hydrogen chloride forms a solution in water.

(i) Water was sprayed on the steel and hydrochloric acid. This slowed the rate of reaction. Explain why.

_____

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_____

_____

_____

(2)

(ii) It would have been better to neutralise the acid with an alkali rather than to just add water. Hydrochloric acid can be neutralised by reaction with sodium hydroxide. Complete the ionic equation for the neutralisation reaction.

(aq) + (aq) → H_2O(l)

(2)

(iii) In the factory the acid leak was neutralised with slaked lime, $Ca(OH)_2$, and not sodium hydroxide, NaOH. Suggest why.

_____

_____

_____

_____

_____

(2)

(Total 10 marks)

Q5.

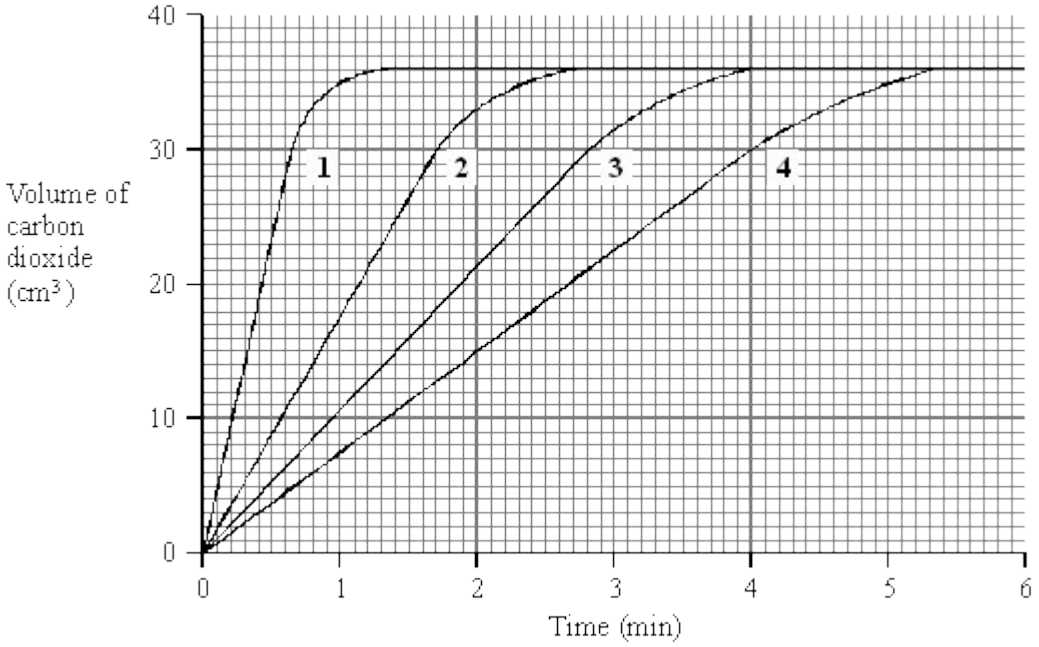
Calcium carbonate reacts with dilute hydrochloric acid as shown in the equation below.

$$CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

The rate at which this reaction takes place can be studied by measuring the amount of carbon dioxide gas produced.

The graph below shows the results of four experiments, 1 to 4. In each experiment the amount of calcium carbonate, the volume of acid and the concentration of the acid were kept the same but the temperature of the acid was changed each time. The calcium carbonate was in the form of small lumps of marble.

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(a) Apart from altering the temperature, suggest **two** ways in which the reaction of calcium carbonate and hydrochloric acid could be speeded up.

1. _____

2. _____

(2)

(b) Which graph, 1 to 4, shows the results of the experiment in which the acid had the highest temperature?

Experiment _____

Explain fully how you know.

_____

_____

_____

_____

(2)

(c) (i) In experiment 2, how does the rate of reaction after one minute compare with the rate of reaction after two minutes?

_____

_____

(1)

(ii) Explain, as fully as you can, why the reaction rate changes during experiment 2.

_____

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_____

_____

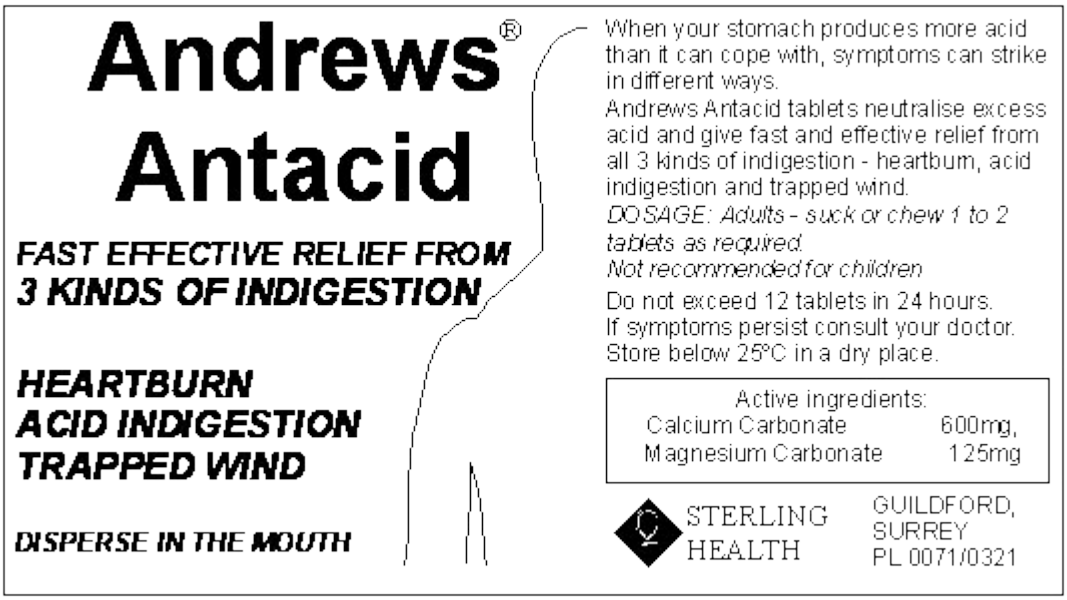
_____

(2)

(Total 7 marks)

Q6.

(a) This label has been taken from a packet of *Andrews Antacid*.



(i) Write the simplest ionic equation which represents a neutralisation reaction.

_____

(1)

(ii) Chewing the tablet cures indigestion faster than swallowing the tablet whole. Explain why.

_____

_____

_____

_____

(1)

(b) The active ingredients in the *Antacid* react with hydrochloric acid in the stomach to give salts, water and carbon dioxide.

A student investigated how quickly the tablets react with **excess** hydrochloric acid.

40 cm^3 of dilute hydrochloric acid were placed in a conical flask. The flask was placed on a direct reading balance. Two *Antacid* tablets were quickly added to the flask. The apparatus was weighed immediately. At the same time, a stop clock was started. The mass was recorded every half minute for 5 minutes.

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The results are shown in the table below.

Mass of flask + contents (g)	92.0	90.0	89.0	88.3	87.8	87.5	87.3	87.1	87.0	87.0	87.0
Time (minutes)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0

The main active ingredient in *Andrews Antacid* is calcium carbonate.

(i) Balance the equation which represents the reaction between calcium carbonate and hydrochloric acid.

$CaCO_{3(s)}$ + _____ $HCl_{(aq)}$ → $CaCl_{2(aq)}$ + $H_2O_{(l)}$ + $CO_{2(g)}$

(1)

(ii) State the meaning of the symbol "(aq)".

_____

(1)

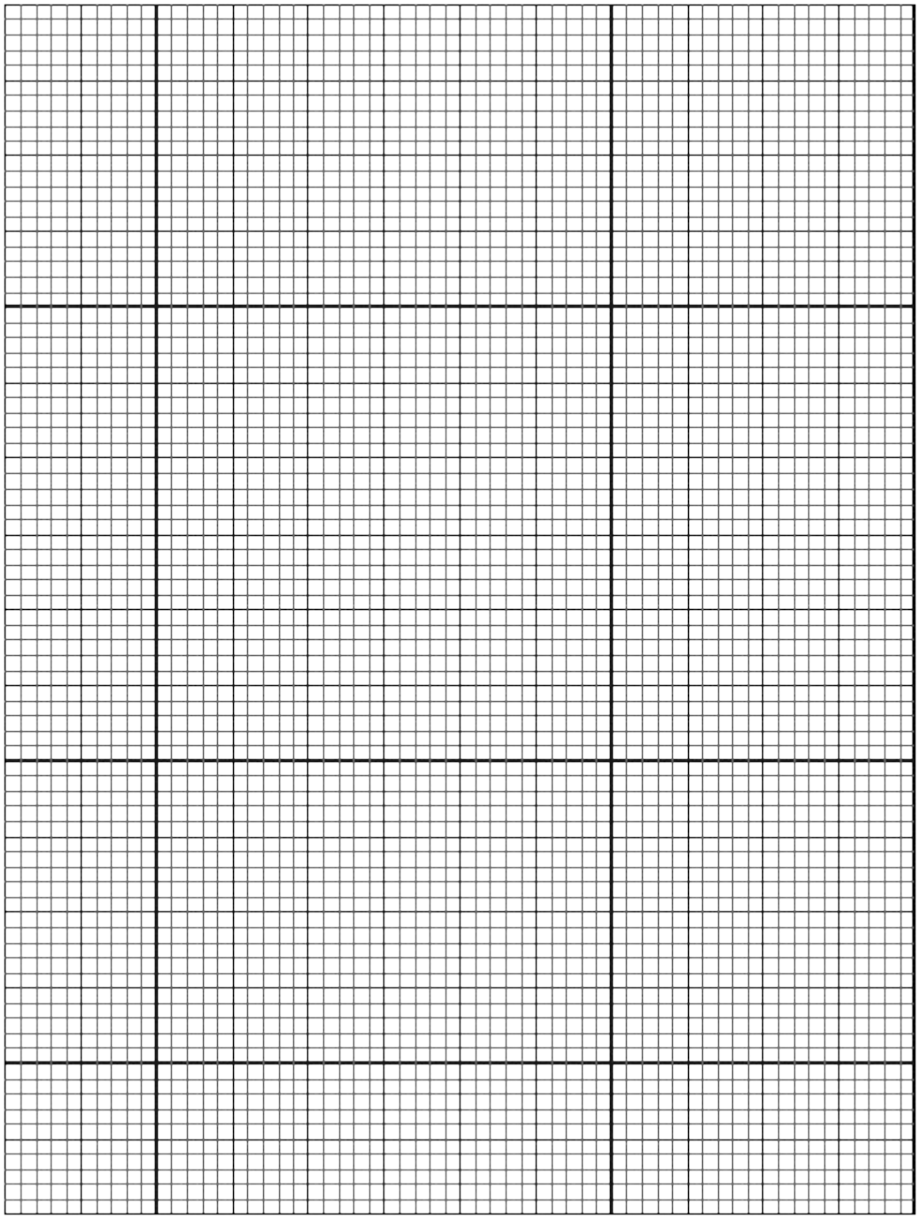
(iii) Why does the mass of the flask and contents decrease?

_____

(1)

(c) (i) Plot the results on the graph below and draw a smooth curve to show how the mass of the flask and its contents changes with time. Label this curve "A".

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(3)

(ii) One of the results does not appear to fit the pattern. Circle this result on the graph.

(1)

(d) The student did a second experiment. The only change was that the acid was twice as concentrated.

On the graph, sketch a second curve to show a possible result for this experiment. Label this curve “B”.

(2)

(Total 12 marks)

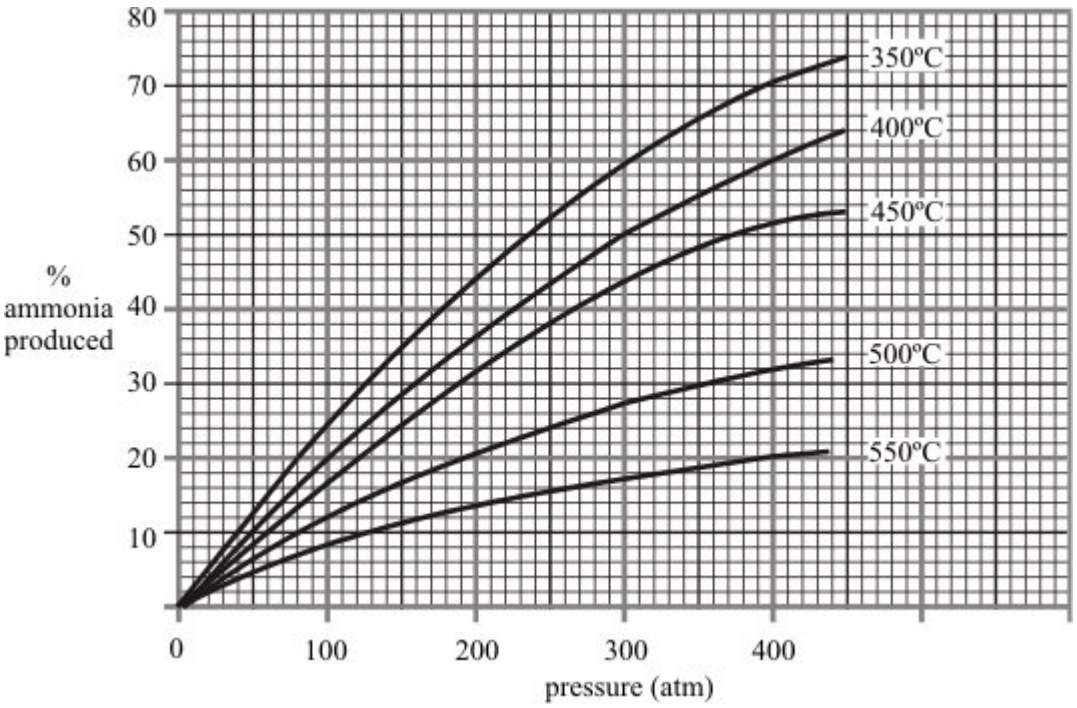
Q7.

Ammonia is produced by the Haber process. In the process nitrogen and hydrogen are mixed. The pressure is increased to about 200 atmospheres. The gases are passed over an iron catalyst at about 450°C. The equation for the reaction is:

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

The reaction between nitrogen and hydrogen is reversible. This affects the amount of ammonia that it is possible to obtain from the process. The graph below shows how the pressure and temperature affect the percentage of ammonia that can be produced.



Use this information, together with your knowledge of the process, to explain why many industrial ammonia plants operate at 200 atmospheres and 450°C.

_____

_____

_____

_____

_____

_____

_____

(Total 5 marks)

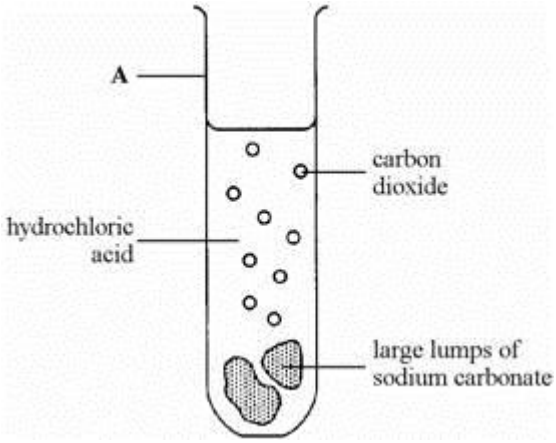
Q8.

Dilute hydrochloric acid reacts with sodium carbonate. The word equation for this reaction is:

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

(a) The diagram shows apparatus used by student X to investigate this reaction.

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(i) Name the piece of apparatus labelled **A**.

_____

(1)

(ii) **$NaCO_3$** **NaCl** **Na_2CO_3** **Na_2Cl**

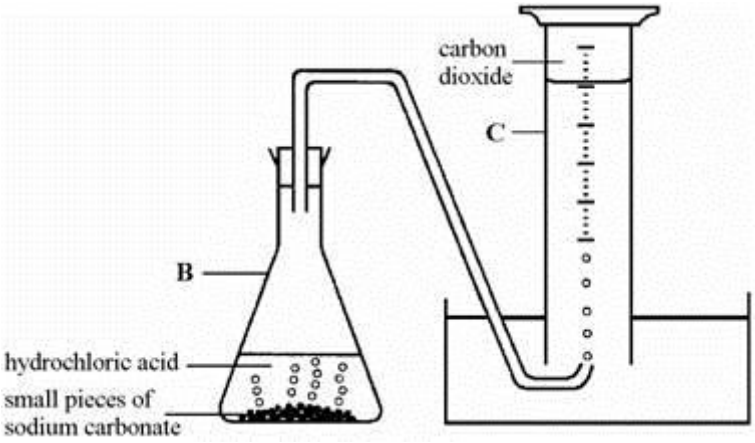
Use the Data Sheet to help you choose the correct formula from the list for:

sodium carbonate, _____

sodium chloride. _____

(2)

(b) The diagram below shows a different apparatus used by student Y to investigate the same reaction.



(i) Name the pieces of apparatus labelled **B** and **C**.

B _____

C _____

(2)

(ii) Both students X and Y used the same

- volume of acid
- concentration of acid

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- temperature
- mass of sodium carbonate

Use information from the diagrams to explain why the reaction that student Y carried out was faster.

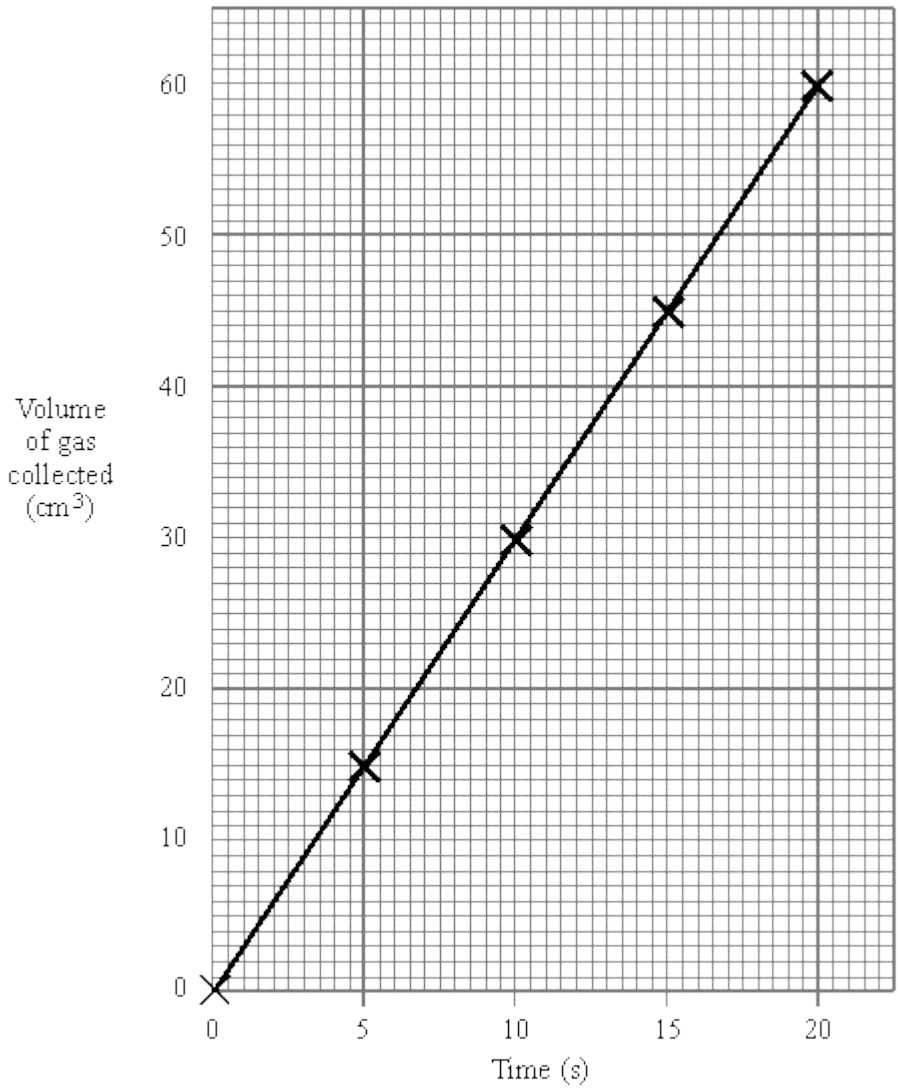
_____

_____

_____

(2)

(c) The results obtained by student Y were plotted as shown below.



(i) Student Y repeated the experiment exactly as before but used warmer acid. This made the reaction faster.
On the graph draw a line for this faster reaction.

(2)

(ii) Explain, in terms of particles, why the rate of the reaction is faster when warmer acid is used.

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_____

_____

_____

(3)

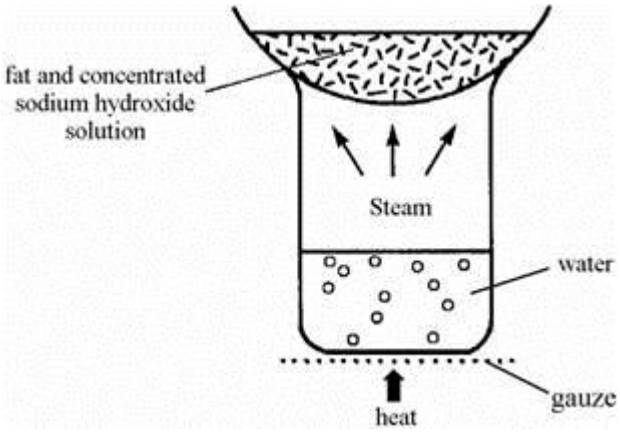
(Total 12 marks)

Q9.

Soap can be made by reacting fats with sodium hydroxide solution.

fat + sodium hydroxide → soap + glycerol

The diagram shows a laboratory experiment to make soap.



From the information in the diagram, give **two** factors which increase the rate of this reaction.
In each case explain, in terms of particles, why the rate of reaction increases.

Factor 1 _____

_____

Reason _____

_____

_____

_____

_____

Factor 2 _____

_____

Reason _____

_____

_____

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_____

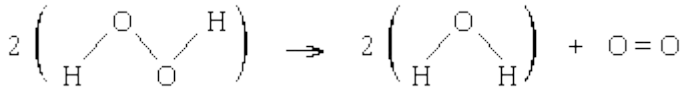
_____

(Total 7 marks)

Q10.

At room temperature, hydrogen peroxide decomposes very slowly to form water and oxygen.
The decomposition is speeded up when a catalyst is added.

(a) The following equation represents the decomposition of hydrogen peroxide.
The structural formulae of the chemicals involved are shown.



Use the following information about bond energies to answer this part of the question.

BOND	BOND ENERGY (kJ)
O = O	498
O – O	146
H – O	464

(i) Calculate the energy needed to break all the bonds in the reactants.

_____

_____

_____

_____ kJ

(2)

(ii) Calculate the energy released when new bonds are formed in the products.

_____

_____

_____

_____ kJ

(2)

(iii) Calculate the energy change for this reaction.

_____

_____ kJ

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(1)

(iv) Is the reaction exothermic or endothermic?

_____

Explain why.

_____

_____

(1)

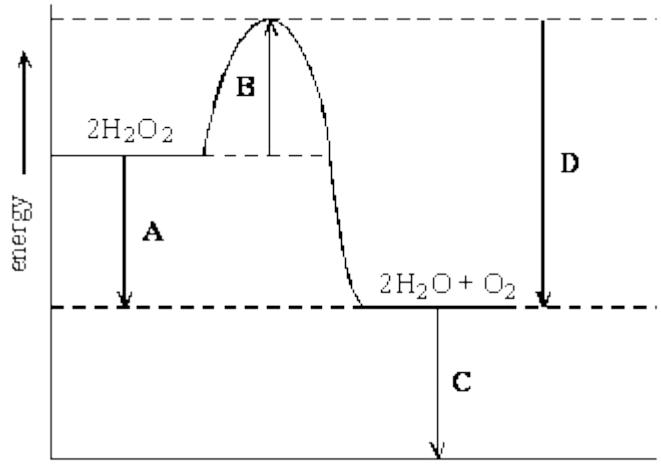
(b) (i) What is meant by 'activation energy'?

_____

_____

(1)

(ii) The energy level diagram for the decomposition of hydrogen peroxide into water and oxygen is shown below.



Which energy change, **A**, **B**, **C** or **D**, is the activation energy? _____

(1)

(iii) Explain, in terms of energy, how a catalyst makes hydrogen peroxide decompose more quickly.

_____

_____

_____

(1)

(Total 9 marks)

Q11.

This item appeared in the Wolverhampton *Express and Star* on October 31st, 1997. Read the passage and answer the questions that follow.

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Fumes scare at factory

Workers were forced to flee a factory after a chemical alert. The building was evacuated when a toxic gas filled the factory.
It happened when nitric acid spilled on to the floor and mixed with magnesium metal powder.

(a) The equation which represents the reaction between magnesium and nitric acid is:

$Mg_{(s)} + 4HNO_{3(aq)} \rightarrow Mg(NO_3)_{2(aq)} + 2H_2O_{(1)} + 2NO_{2(g)}$

Give the formula of the toxic gas that was produced.

_____

(1)

(b) Explain, in terms of particles, how the toxic gas was able to fill the factory quickly.

_____

_____

_____

(2)

(c) The reaction of nitric acid with magnesium metal powder is more dangerous than if the acid had fallen on to the same mass of magnesium bars. Explain why.

_____

_____

_____

(1)

(d) (i) Water was sprayed on to the magnesium and nitric acid to slow down the reaction.
Explain, in terms of particles, why the reaction would slow down.

_____

_____

_____

(2)

(ii) Explain why it is better to add alkali, rather than just add water to the spillage.

_____

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_____

(1)

(Total 7 marks)

Q12.

(a) You may find the Data Sheet helpful to complete the word equation.

These two gases react as shown in the balanced symbol equation.

$$2H_2 + O_2 \rightarrow 2H_2O$$

Complete the word equation for this reaction.

hydrogen + _____ → _____

(2)

(b) Complete this sentence by crossing out the **two** words in the box that are wrong.

catalyst
molecule
solution

This chemical reaction is much faster if a molecule if a is used.

(1)

(Total 3 marks)

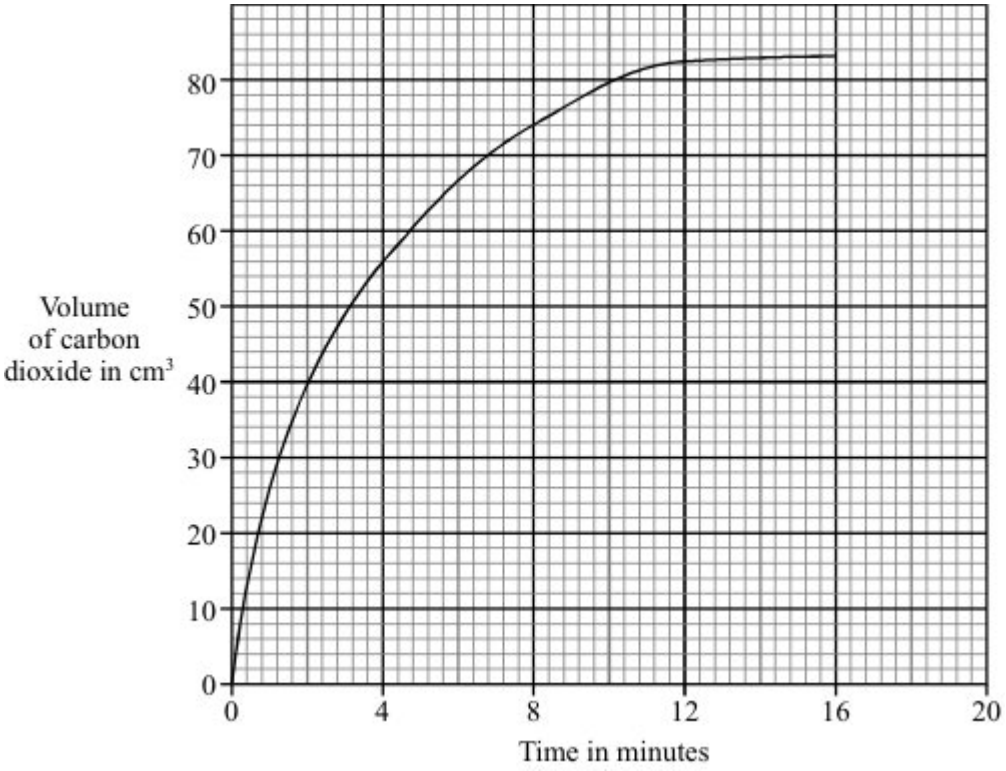
Q13.

Calcium carbonate reacts with nitric acid to produce carbon dioxide.

$$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$$

A 10 g lump of calcium carbonate was reacted with 20 cm^3 of dilute nitric acid. When the reaction was finished, some of the calcium carbonate was left unreacted. The graph shows the volume of carbon dioxide made in each minute for sixteen minutes.

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(a) The volume of carbon dioxide made in each minute decreases until it remains steady at 83 cm^3.
Explain why.

_____

_____

_____

_____

(2)

(b) Draw a graph line, on the axes above, for an experiment where 20 cm^3 of the same dilute nitric acid was reacted with 10 g of **powdered** calcium carbonate.

(2)

(c) Give **one** way of changing the rate of this reaction (other than using powdered calcium carbonate).

_____

_____

(1)

(Total 5 marks)

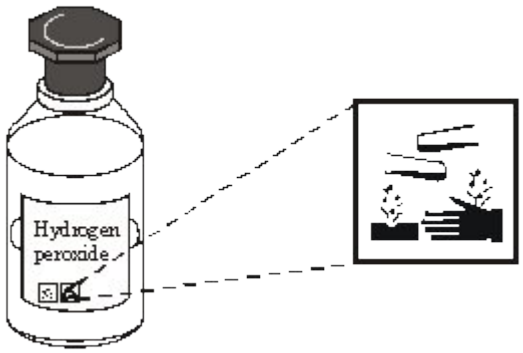
Q14.

Hydrogen peroxide (H_2O_2) contains the same elements as water (H_2O).

(a) Name the hazard symbol shown by using the correct word from the box.

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corrosive	flammable	oxidising	toxic



.....

(1)

(b) Hydrogen peroxide decomposes in the presence of a catalyst.

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

(i) Complete the word equation for this chemical reaction.

hydrogen peroxide → water + _____

(1)

(ii) What does a catalyst do to a chemical reaction?

_____

_____

(1)

(Total 3 marks)

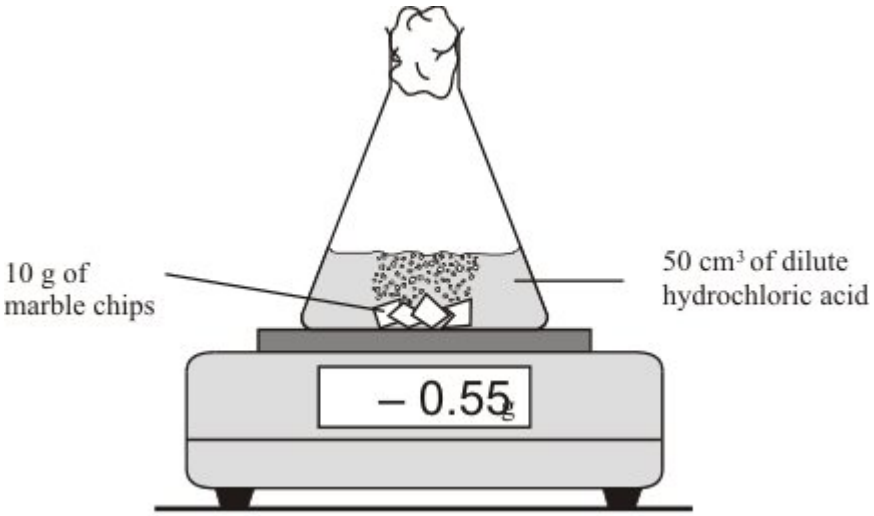
Q15.

Marble is a rock that contains mainly calcium carbonate. This reacts with hydrochloric acid.

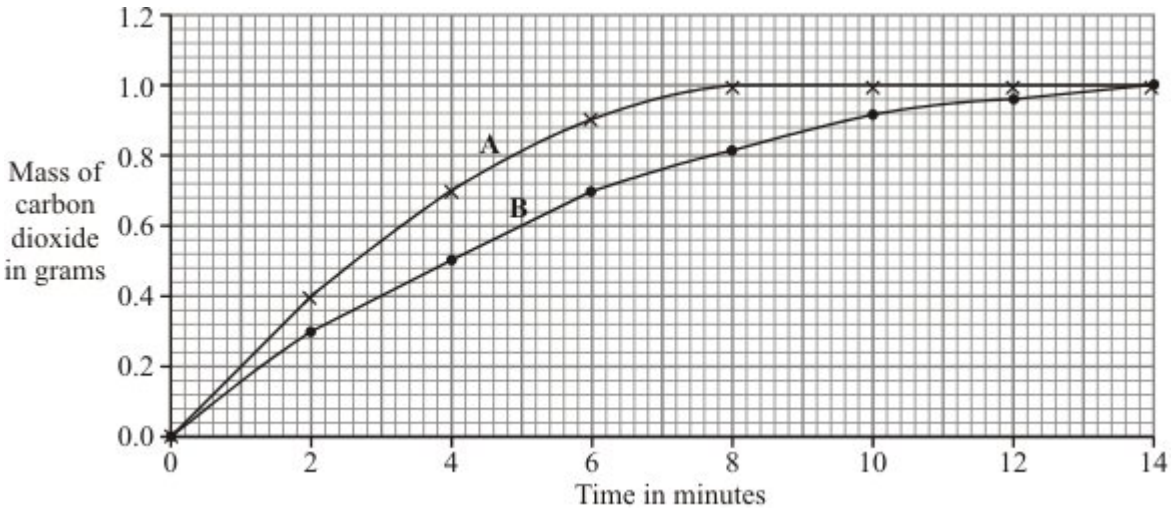
calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

The rate of this reaction was followed by measuring the mass of carbon dioxide formed.

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Two 10 g samples of marble, **A** and **B**, were each reacted with 50 cm^3 of dilute hydrochloric acid, at different temperatures. The mass of carbon dioxide formed in each reaction was recorded and plotted to produce the graph below.



Each reaction stopped when no more carbon dioxide was formed.
In both experiments some marble was left unreacted when the reaction stopped.

(a) Explain how you can tell which sample, **A** or **B**, reacted faster with the dilute hydrochloric acid.

_____

_____

(2)

(b) The faster rate of reaction was caused by using a higher temperature. Explain, in terms of particles, why a higher temperature causes a faster rate of reaction.

_____

_____

_____

_____

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_____

_____

_____

(3)

(Total 5 marks)

Q16.

In the Haber process, nitrogen and hydrogen react to make ammonia.

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

nitrogen + hydrogen $\rightleftharpoons$ ammonia

Pressure in atmospheres	% ammonia present at equilibrium				
	Temperature in ºC				
	100	**200**	**300**	**400**	**500**
10	88.2	50.7	14.7	3.9	1.2
25	91.7	63.6	27.4	8.7	2.9
50	94.5	74.0	39.5	15.3	5.6
100	96.7	81.7	52.5	25.2	10.6
200	98.4	89.0	66.7	38.8	18.3
400	99.4	94.6	79.7	55.4	31.9
1000	99.9	98.3	92.6	79.8	57.5

The actual conditions used in the Haber process are usually 450 °C and 200 atmospheres.

(a) What effect does increasing the pressure have on the percentage of ammonia made? Use the balanced symbol equation to explain why.

_____

_____

_____

_____

_____

_____

(2)

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(b) A lower temperature of 100 °C gives high percentages of ammonia at most pressures. Why is this temperature **not** used in the Haber process?

_____

_____

_____

(1)

(c) Describe and explain the effect of an increase in the temperature on the reaction between nitrogen and hydrogen in the Haber process.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q17.

Hydrogen peroxide slowly decomposes into water and oxygen.

hydrogen peroxide → water + oxygen

The reaction can be speeded up by adding manganese dioxide.

(a) (i) What do we call a substance that speeds up a chemical reaction without being changed itself?

_____

(1)

(ii) Give **two** other ways of increasing the rate of this reaction.

1. _____

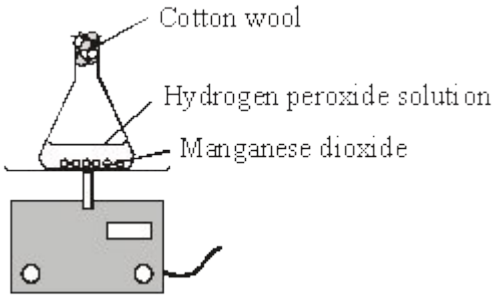
2. _____

(2)

(b) The diagram shows how the rate of this reaction can be measured.

As the hydrogen peroxide decomposes, the mass of the flask and its contents decreases.

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Why does this decrease in mass take place?

_____

_____

(1)

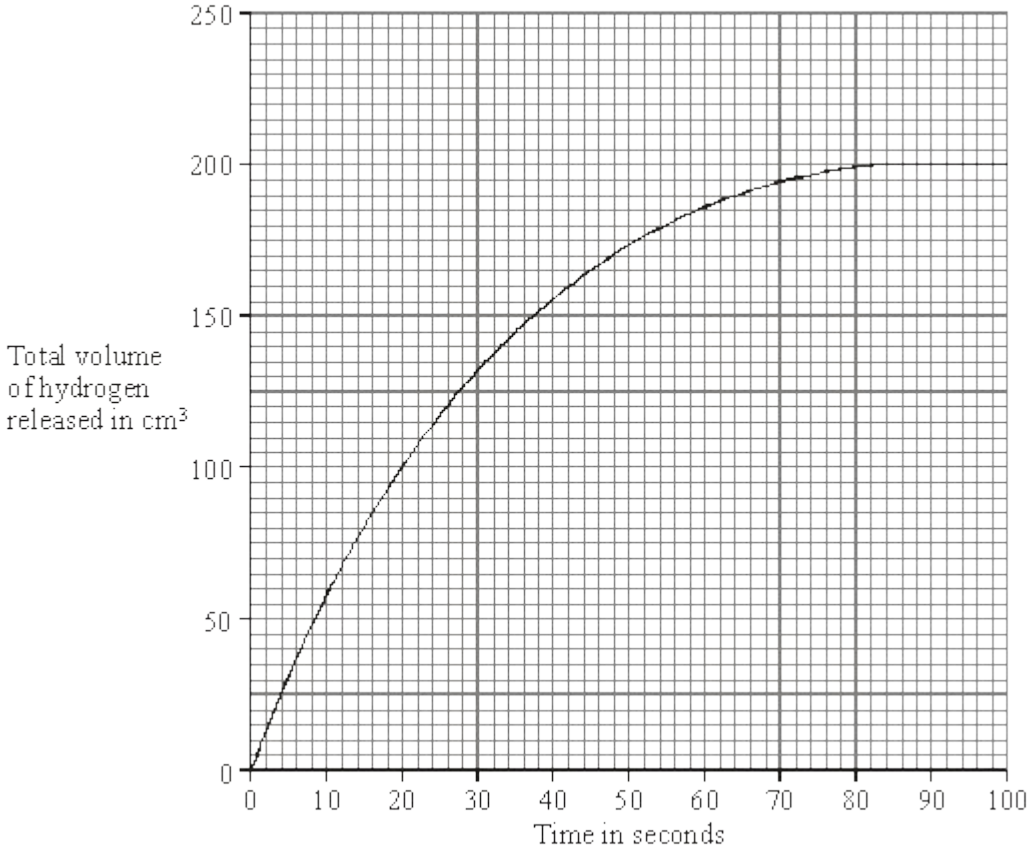
(Total 4 marks)

Q18.

Magnesium reacts with dilute sulphuric acid.

magnesium + sulphuric acid → magnesium sulphate + hydrogen

A student measured the volume of hydrogen given off every 10 seconds. The results are shown on the graph.



(a) The average rate of hydrogen production in the first 10 seconds is (60 cm^3 ÷ 10 s) = 6 cm^3/s.

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(i) Calculate the average rate of production of hydrogen between 30 seconds and 50 seconds. Show clearly how you work out your answer.

_____

_____

_____

Rate _____ cm^3/s

(3)

(ii) Explain, as fully as you can, why the average rate between 30 and 50 seconds is different from the rate between 0 and 10 seconds.

_____

_____

_____

_____

(2)

(b) In industry, enzymes are used in both batch processes and continuous processes.

Give **one** reason why continuous processes are usually more profitable than batch processes.

_____

_____

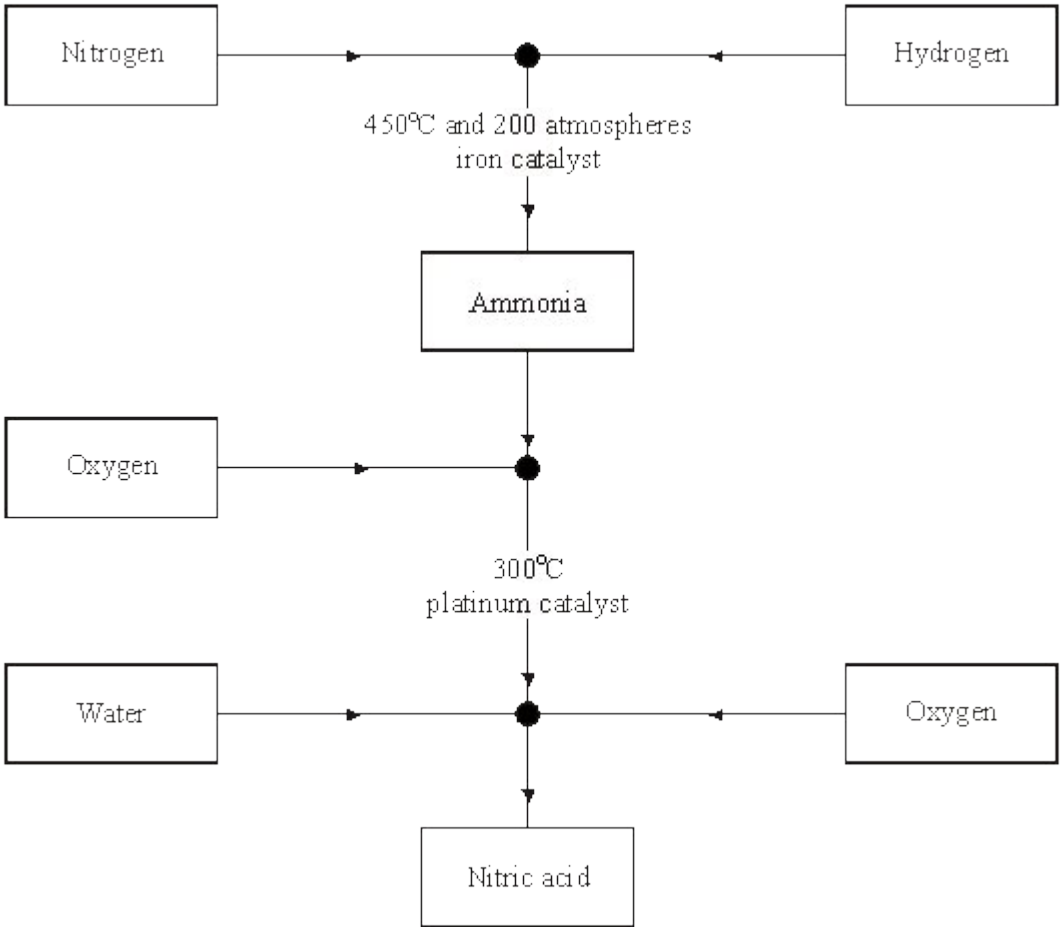
(1)

(Total 6 marks)

Q19.

The flow diagram shows how to make ammonia and nitric acid from the nitrogen in the air.

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(a) A fertiliser is made by neutralising ammonia with nitric acid. What is the name of this fertiliser?

_____

(1)

(b) In the flow diagram, why are two different catalysts used?

_____

_____

(1)

(c) What happens to catalysts at the end of a reaction?

_____

_____

(1)

(d) Explain why catalysts are used in many industrial chemical reactions.

_____

_____

_____

(2)

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(e) Explain, in terms of collisions between molecules, why a high pressure is used in the reaction between nitrogen and hydrogen.

_____

_____

_____

_____

(2)

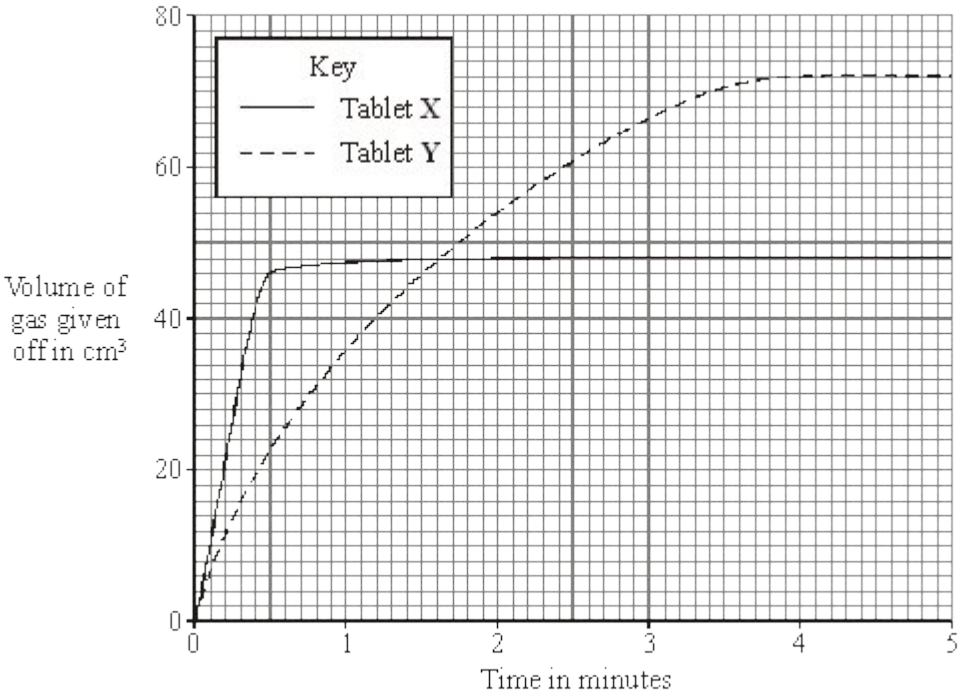
(Total 7 marks)

Q20.

Many indigestion tablets contain calcium carbonate as their only active ingredient. Calcium carbonate neutralises some of the hydrochloric acid in the stomach.

Two different indigestion tablets, **X** and **Y**, were separately reacted with excess hydrochloric acid. The volume of gas given off in each reaction was measured every minute.

The results are shown in the graph.



(i) Which tablet, **X** or **Y**, contained most calcium carbonate? _____

Explain the reason for your answer.

_____

_____

(1)

(ii) Which tablet, **X** or **Y**, reacted faster with hydrochloric acid?_____

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Explain the reason for your answer.

_____

_____

(1)

(iii) Explain the shape of the graph for tablet **X** between 3 and 5 minutes.

_____

_____

_____

_____

(1)

(Total 3 marks)

Q21.

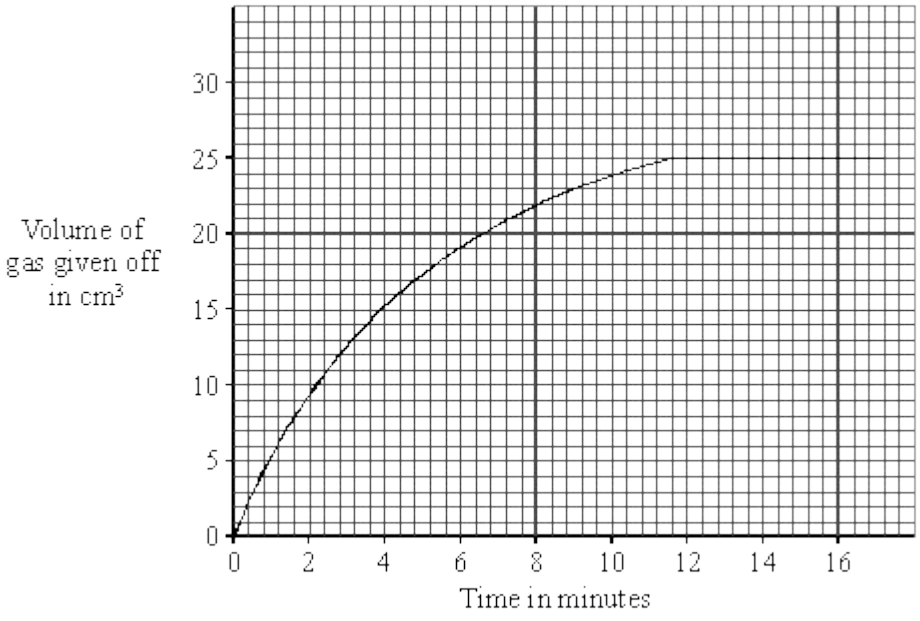
Zinc powder normally reacts slowly with hydrochloric acid.

(a) Balance the symbol equation for the reaction.

$Zn + HCl \rightarrow ZnC1_2 + H_2$

(1)

The graph shows the results from a reaction of 1.0 g of zinc powder with 20 cm^3 of dilute hydrochloric acid. It gives off a gas and forms zinc chloride, $ZnCl_2$. Some unreacted zinc is left at the end.



(b) Copper powder is a good catalyst for the reaction of zinc with hydrochloric acid.

(i) A mixture of 10 cm^3 of the same dilute hydrochloric acid and 1.0 g of copper powder was added to 1.0 g of zinc powder. What is the maximum volume of gas which could be given off?

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_____ cm^3

(1)

(ii) Draw a graph, on the axes above, for an experiment where 20 cm^3 of the same dilute hydrochloric acid was added to 1.0 g of copper powder mixed with 1.0 g of zinc powder.

(2)

(iii) Give **two** other ways the reaction described in part (i) could be made to go faster.

1. _____

2. _____

(2)

(c) Copper powder can be formed by adding copper sulphate solution to the mixture of zinc powder and acid.

(i) Why does zinc react with copper sulphate solution to produce copper?

_____

_____

(1)

(ii) Write the word equation for the reaction.

_____

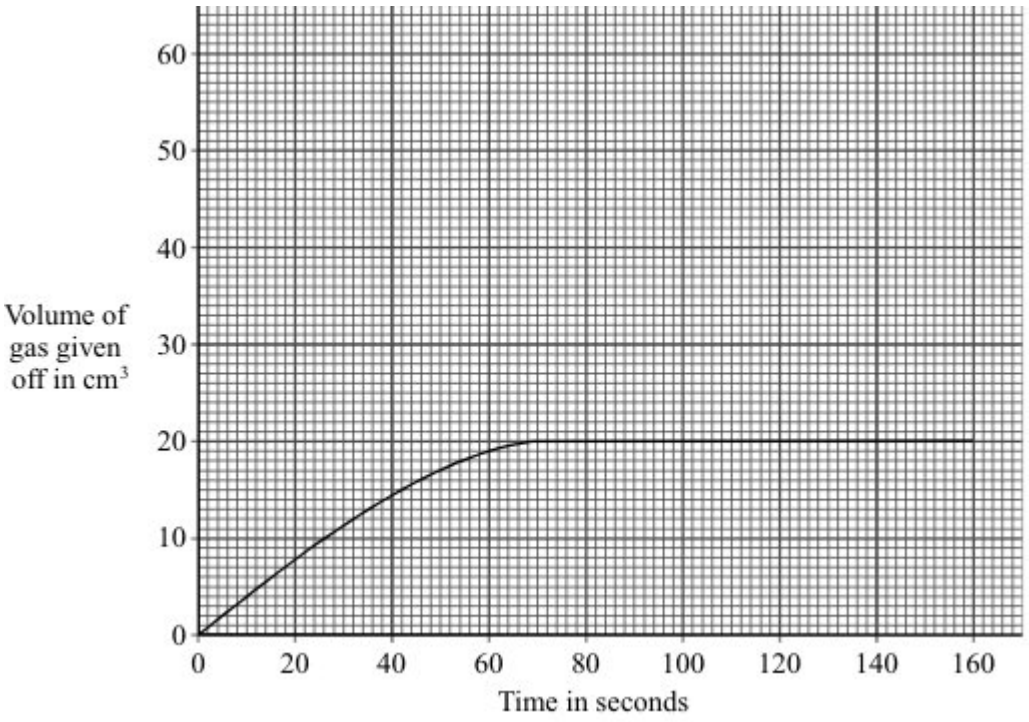
(1)

(Total 8 marks)

Q22.

The graph shows the volume of gas given off during an experiment using hydrogen peroxide solution and manganese oxide.

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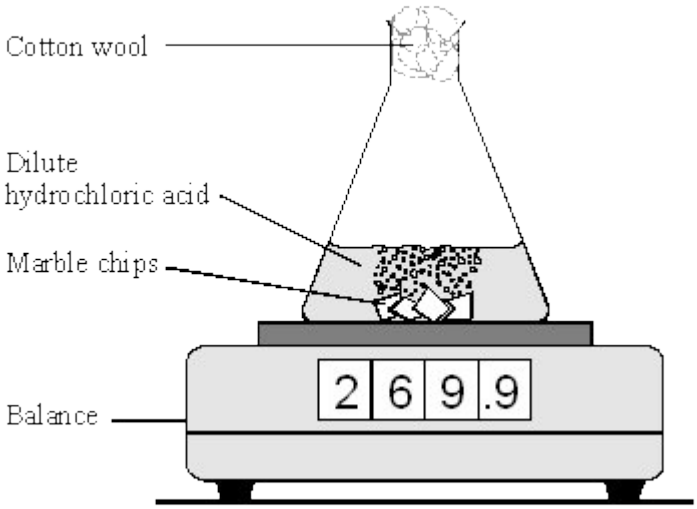


Draw, on the axes above, a graph to show the result you would expect if the volume of hydrogen peroxide solution had been the same, but it was **twice** as concentrated.

(Total 3 marks)

Q23.

The apparatus shown in the diagram was used to investigate the rate of reaction of excess marble chips with dilute hydrochloric acid, HCl. Marble is calcium carbonate, formula $CaCO_3$. The salt formed is calcium chloride, $CaCl_2$.



(a) Write a balanced equation for the reaction.

_____

_____

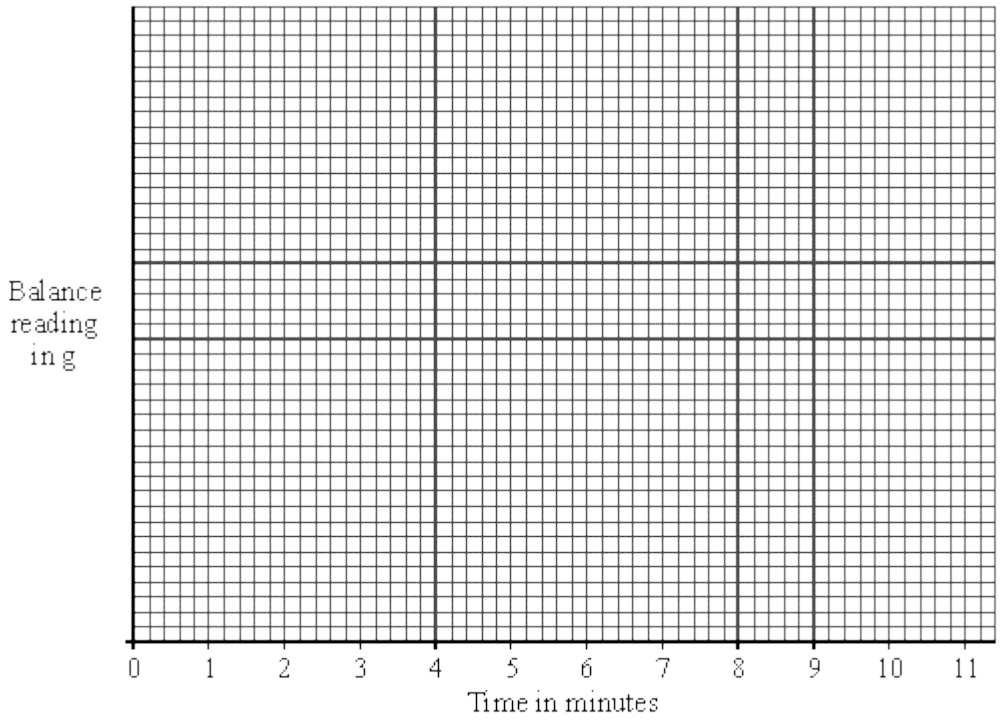
(2)

The following results were obtained from the experiment.

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Time in minutes	Reading on balance in g
0.5	269.6
1.0	269.3
2.0	269.0
3.0	268.8
5.0	268.7
9.0	268.6

(b) (i) Plot the results and draw a graph on the axes below.



(3)

(ii) Continue the graph you have drawn to show the expected reading after11 minutes.

(1)

(iii) On the axes above, sketch a graph of the result which would be obtained if in a similar experiment the same mass of powdered marble was used instead of marble chips.

(2)

(Total 8 marks)

Q24.

Potassium reacts violently with cold water.

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It forms an alkaline solution of potassium hydroxide and hydrogen.

potassium + water → potassium hydroxide + hydrogen

(a) In what physical state is hydrogen given off?

Choose your answer from the words in the box.

gas	liquid	solid	solution

_____

(1)

(b) (i) What type of substance will neutralise potassium hydroxide solution?

_____

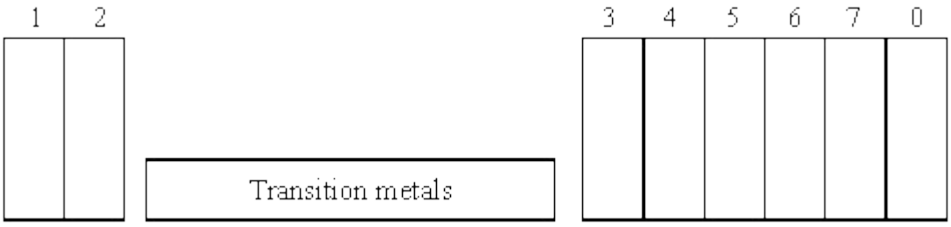
(1)

(ii) What is the pH of the neutral solution?

_____

(1)

(c) In the Periodic Table there are eight main groups.



What is the number of the group that has potassium in it?

_____

(1)

(d) Sodium is in the same group as potassium.

(i) How does sodium react with cold water and what is formed?

_____

_____

(2)

(ii) How can you prove that an alkaline solution is formed when sodium reacts with water?

_____

_____

(2)

(e) Lithium reacts more slowly with cold water than sodium.

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State **two** ways the reaction can be made to go faster.

_____

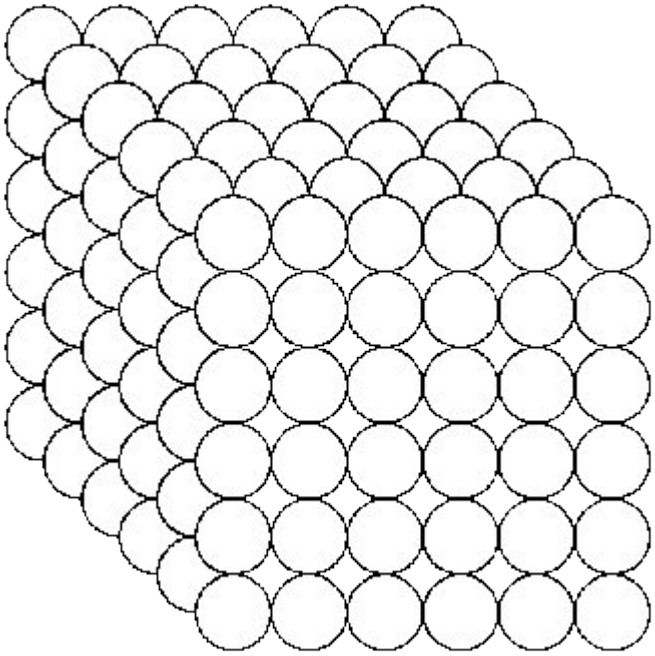
_____

(2)

(Total 10 marks)

Q25.

The diagram represents the particles in a piece of reactive metal.



The piece of reactive metal is added to dilute hydrochloric acid.

(a) (i) Which particle will probably react first?

Choose from:

- a particle inside the piece;
- a particle at the centre of a face;
- a particle on one of the corners.

_____

(1)

(ii) Explain the reason for your choice.

_____

_____

(1)

(b) The reaction can be speeded up by making changes to the hydrochloric acid or the solid.

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(i) State **two** ways to speed up the reaction by changing the hydrochloric acid. In each case explain in terms of particles why the reaction is faster.

1. _____

_____

_____

(2)

2. _____

_____

_____

(2)

(ii) What change can you make to the piece of solid to speed up the reaction? Explain in terms of the particles why the reaction is able to speed up.

_____

_____

(2)

(Total 8 marks)

Q26.

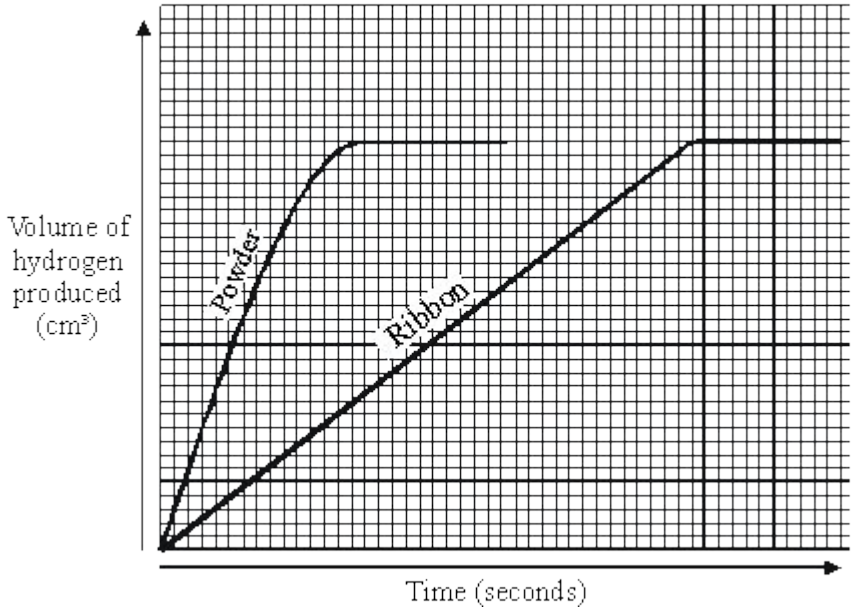
Some students were investigating how fast hydrogen gas is released in the reaction between magnesium and dilute hydrochloric acid.

To begin with they used 0.1 g of magnesium ribbon.

Next, they repeated the experiment using 0.1 g of magnesium powder.

In each case, they used enough acid to react with all the metal.

(a) Their results are shown on the graph below.



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Hydrogen is produced in both the reactions.

Use the information on the graph to describe **two other** ways in which the two reactions are similar.

1. _____

_____

2. _____

_____

(2)

(b) Describe **one** way in which the reactions are different.

_____

_____

(1)

(Total 3 marks)

Q27.

Ammonia is manufactured by the Haber Process, where nitrogen and hydrogen react together as follows:

$N_2 + 3H_2 \Leftrightarrow 2NH_3$

The reaction is reversible. A balance is eventually reached when ammonia is being formed at the same rate at which it is decomposing.

This point is called 'equilibrium'.

	PERCENTAGE OF AMMONIA AT EQUILIBRIUM		
PRESSURE (ATM)	100° C	300° C	500° C
25	91.7	27.4	2.9
100	96.7	52.5	10.6
400	99.4	79,7	31.9

(a) (i) What is meant by a 'reversible reaction'?

_____

_____

(1)

(ii) Which substances are present in the mixture at equilibrium?

_____

(1)

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(b) (i) Under what conditions shown in the table is the maximum yield of ammonia obtained?

_____

_____

(2)

(ii) The Haber Process is usually carried out at a higher temperature than that which would produce the maximum yield. Suggest why.

_____

_____

_____

_____

(2)

(c) Ammonia can be converted into nitric acid in three stages:

Stage 1 Ammonia reacts with oxygen from the air to form nitrogen monoxide and water

$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

Stage 2 On cooling, nitrogen monoxide reacts with oxygen from the air to form nitrogen dioxide.

Stage 3 Nitrogen dioxide reacts with water to form nitric acid and nitrogen monoxide.

(i) Describe the conditions under which the reaction in Stage 1 takes place.

_____

_____

_____

_____

(3)

(ii) Balance the equation for the reaction at Stage 2.

$NO + O_2 \longrightarrow NO_2$

(1)

(iii) Balance the equation for the reaction at Stage 3.

$NO_2 + H_2O \longrightarrow HNO_3 + NO$

(1)

(d) The chemical plant for manufacturing ammonia is often on the same site as plants manufacturing nitric acid and fertilisers.

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(i) What advantages will this have for the manufacturing company?

_____

_____

_____

_____

(2)

(ii) Briefly describe **two** important ways in which it is possible to reduce the environmental impact of such plants on the surrounding area.

1. _____

_____

2. _____

_____

(2)

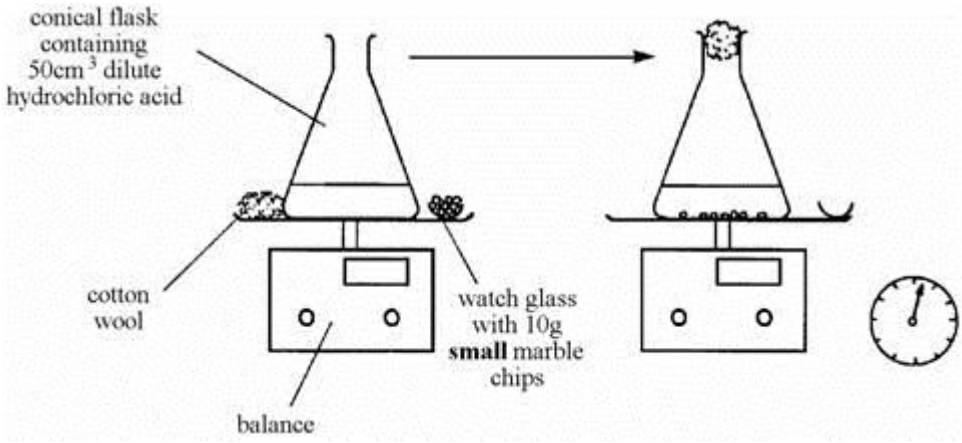
(Total 15 marks)

Q28.

Marble chips (calcium carbonate) react with dilute hydrochloric acid.

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

A student wanted to find out if the size of the marble chips made a difference to how fast the reaction took place.



(a) What readings should she take?

_____

_____

_____

(2)

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(b) She repeated the experiment but this time used the same mass (10g) of **large** marble chips. In both experiments there was some marble left in the flask when the reaction stopped.

These are the results of the two experiments.

TIME (minutes)	0	2	4	6	8	10	12
Loss in mass (g), using small chips	0.00	0.40	0.72	0.91	1.04	1.04	1.04
Loss in mass (g), using large chips	0.00	0.28	0.52	0.70	0.84	0.94	1.04

(i) Explain the loss in mass in the two experiments.

_____

_____

_____

_____

(1)

(ii) What difference does the size of the chips make?

_____

_____

(1)

(c) A chemical reaction occurs when reacting particles collide with sufficient energy. The reaction between marble and hydrochloric acid is faster if the acid is at a higher temperature. Explain why.

_____

_____

_____

_____

(3)

(Total 7 marks)

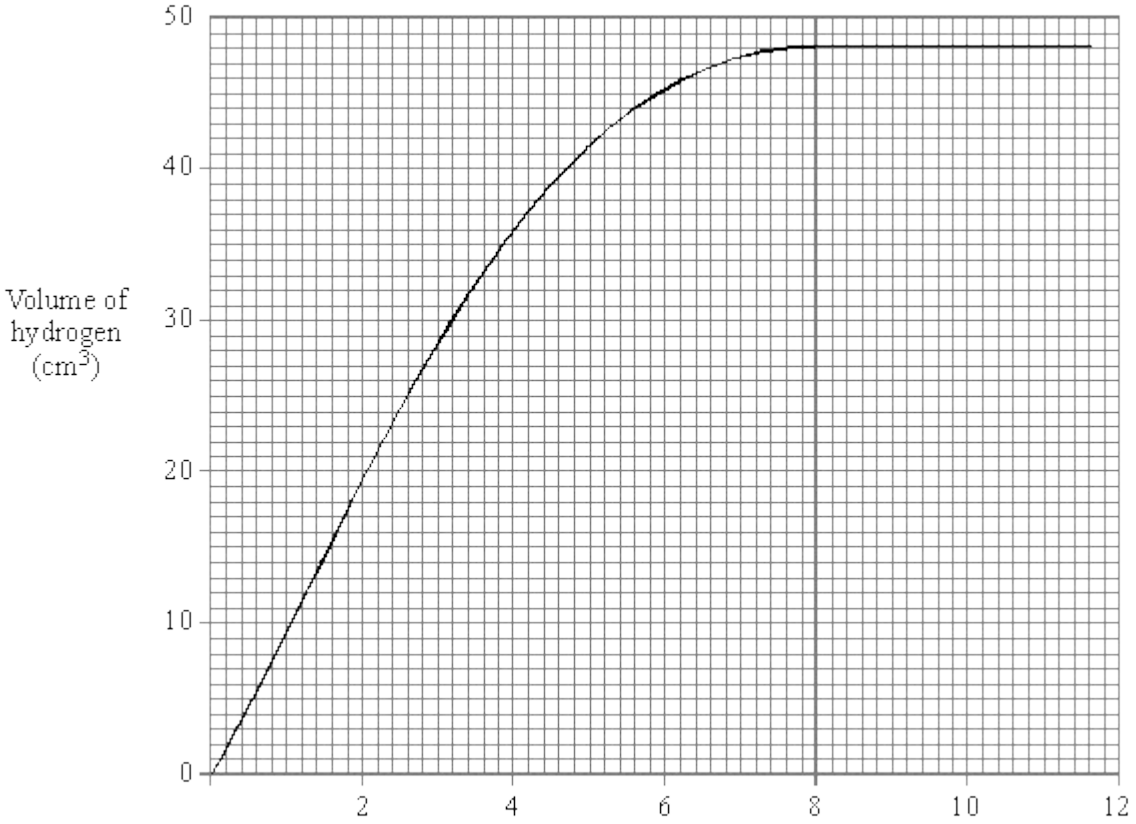
Q29.

A student does an experiment to examine the rate of reaction between magnesium and dilute hydrochloric acid.
She adds 25 cm^3 of the acid to a weighed amount of the metal.
The reaction produces hydrogen gas.

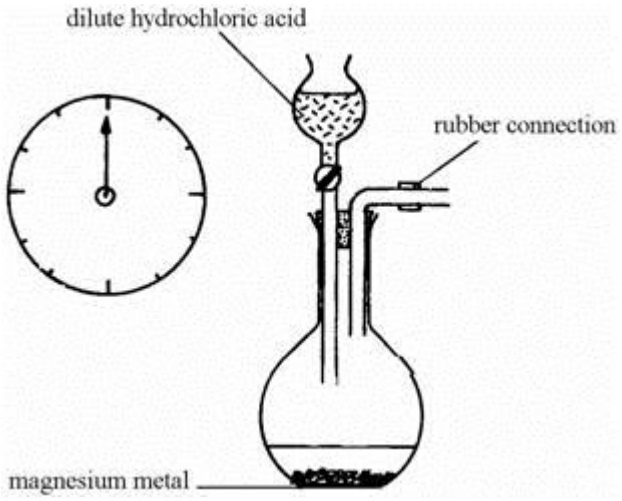
Magnesium + hydrochloric acid ⟶ magnesium + hydrogen chloride

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She collects the gas and measures the volume collected at one minute intervals.
All the metal reacted but there was some acid left unreacted.
Her results are shown on the graph.



(a) The diagram shows part of the apparatus she used for the experiment.
Complete the diagram to show how the student could collect the hydrogen produced and measure the volume after each minute.



(2)

(b) (i) When is the rate of reaction at its fastest?

_____

(1)

(ii) State **one** way in which she could increase the rate of reaction.

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_____

(1)

(c) (i) What is the total volume of hydrogen collected in the experiment?

_____ cm^3

(1)

(ii) State **one** way in which she could increase the final volume of hydrogen collected.

_____

(1)

(Total 6 marks)

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