General Certificate of Secondary Education
June 2004

**CHEMISTRY (MODULAR) SPECIFICATION A   3423/H
HIGHER TIER**

Monday 14 June 2004   9.00 am to 10.30 am

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

H

In addition to this paper you will require:
- the Data Sheet (enclosed);
- a ruler.

You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 90.
- Mark allocations are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

PATTERNS OF CHEMICAL CHANGE

1 The diagram is of an experiment used to show the process of yeast breaking down sugar.

Mixture of sugar, yeast and water — Water at 30°C — Bubbles of gas — Limewater
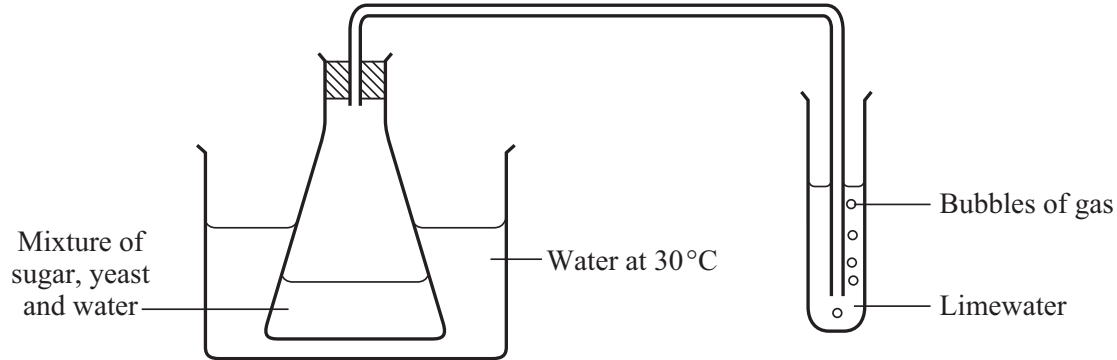
(a) What is the name of the process when yeast breaks down sugar?

....

(1 mark)

(b) Name the gas produced in the experiment.

....

(1 mark)

(c) If the experiment is repeated using water at 60°C no gas bubbles are produced.

Explain why increasing the temperature has this effect on the process.

....

....

....

....

(2 marks)

(d)   The sugar used in this experiment is glucose, $C_6H_{12}O_6$.

   (i)   Calculate the relative formula mass of glucose.
      Relative atomic masses: H = 1; C = 12; O = 16

....

....

(1 mark)

  (ii)   Calculate the percentage of carbon in a molecule of glucose.

....

....

....

....

(2 marks)

$\frac{}{7}$

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

2 Nitrogen reacts with oxygen to form nitrogen dioxide.

$$N_2(g) + 2O_2(g) \rightleftharpoons 2NO_2(g)$$
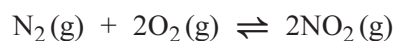
(a) State and explain the effect of increasing the pressure on the rate of this reaction.

....

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....

....

(2 marks)

(b) The reaction is *exothermic*.

What does *exothermic* mean?

....

....
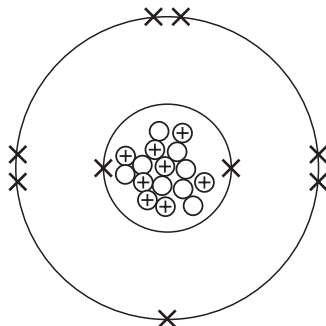
(1 mark)

$\dfrac{}{3}$

STRUCTURES AND BONDING

3 (a) A student draws the structure of an atom in this way:

(i) What mistake has the student made in the drawing?

....

....

(1 mark)

(ii) To which Group of the periodic table could this atom belong?
Explain your answer.

....

....

(2 marks)

(b) Name the **least** reactive element in Group 1 of the periodic table.

....

(1 mark)

(c) (i) Write the word equation for the reaction of sodium with water.

sodium + water → .... + ...

(1 mark)

(ii) Suggest a value for the pH of the solution at the end of the reaction.

....

(1 mark)

(d) Write the balanced symbol equation for the reaction.

calcium + oxygen → calcium oxide

.... + ... → ....
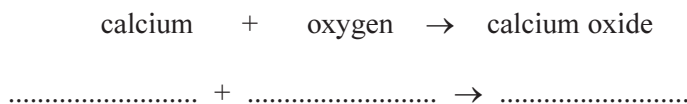
(2 marks)

Turn over ▶

CHEMISTRY IN ACTION

4   (a)   The flow chart shows how concentrated sulphuric acid is manufactured in industry from sulphur.

Step **A**	React molten sulphur with oxygen

↓

Sulphur dioxide

Step **B**	Mix sulphur dioxide with oxygen and pass over vanadium oxide (V_2O_5)

↓

Sulphur trioxide

Step **C**	Dissolve sulphur trioxide in concentrated sulphuric acid

↓

$H_2S_2O_7$

Step **D**	Dilute $H_2S_2O_7$ very carefully with water

↓

Concentrated sulphuric acid
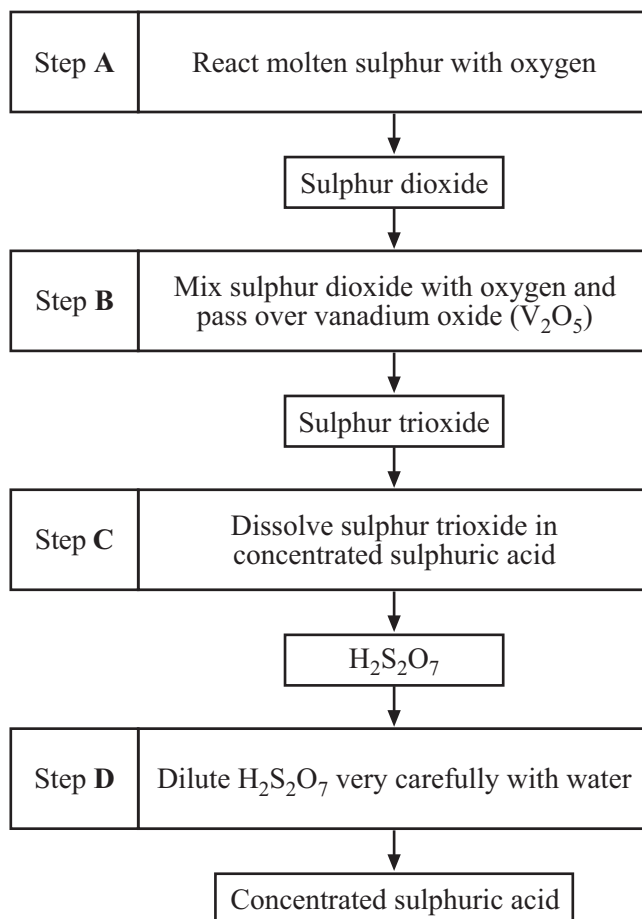
(i)   What type of chemical reaction takes place in Step **A**?

....
(1 mark)

(ii)   What environmental problem would be produced by releasing any unreacted gases into the environment?

....
(1 mark)

(iii)   What is the purpose of using vanadium oxide, V_2O_5, in Step **B**?

....
(1 mark)

(iv) What is the name of the substance $H_2S_2O_7$ made in Step **C**?

....

(1 mark)

(v) Instead of Step **C** and Step **D** the sulphur trioxide could be converted directly into sulphuric acid by adding water in a single step.

$$H_2O \ + \ SO_3 \ \rightarrow \ H_2SO_4$$
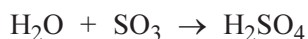
What are the problems caused by this single step reaction?

....

....

....

....

(2 marks)

(vi) Balance the chemical equation for Step **D**.

$$H_2S_2O_7 \ + \ H_2O \ \rightarrow \ .... \ H_2SO_4$$
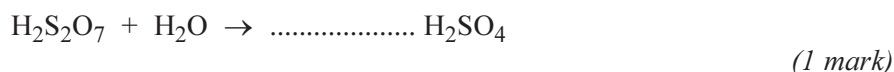
(1 mark)

(b) The diagram shows the effect of adding concentrated sulphuric acid to sugar.
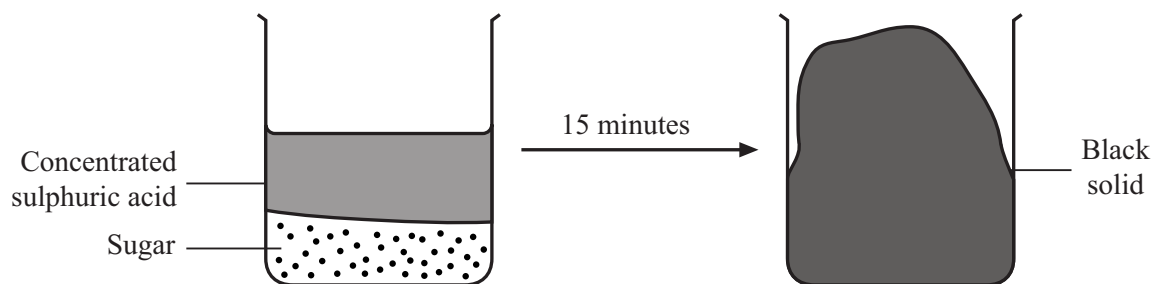
Which property of sulphuric acid does this experiment show?

....

(1 mark)

8

Turn over ▶

QUESTIONS RELATING TO PREVIOUSLY TESTED MODULES

5 In 1915 the scientist Alfred Wegener proposed the theory that millions of years ago the continents had all been joined together, but had drifted apart over time. His theory of continental drift was not accepted, at that time, by other scientists. They thought that a cooling effect had caused the formation of mountain ranges, oceans and the continents. New evidence found by studying the ocean floor, in the 1960s, showed that Wegener's theory was correct.

Explain in more detail the theory of continental drift by:

- giving **two** pieces of evidence Wegener used to support his theory;

- explaining why scientists in 1915 thought a "cooling effect" was responsible;

- giving **two** pieces of evidence, found by studying the ocean floor, that supported the theory of continental drift.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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(5 marks)

5

6 The transition elements, e.g. iron and copper, and the elements of Group 1 are metals and so they have some properties that are similar. However, they also have properties that are very different from each other.

(a) Give **one** physical property that will be similar for the two groups of metals.

....

(1 mark)

(b) Complete the table using the words *high* or *low* to show the differences between these metals.

Property	Group 1	Transition elements
Density		
Reactivity with oxygen		

(2 marks)

(c) A piece of copper left exposed to the atmosphere for a long time changes colour due to the formation of a layer of a copper compound called verdigris.

What is the colour of verdigris?

....

(1 mark)

(d) Transition elements are extracted from their ores by reduction using carbon.

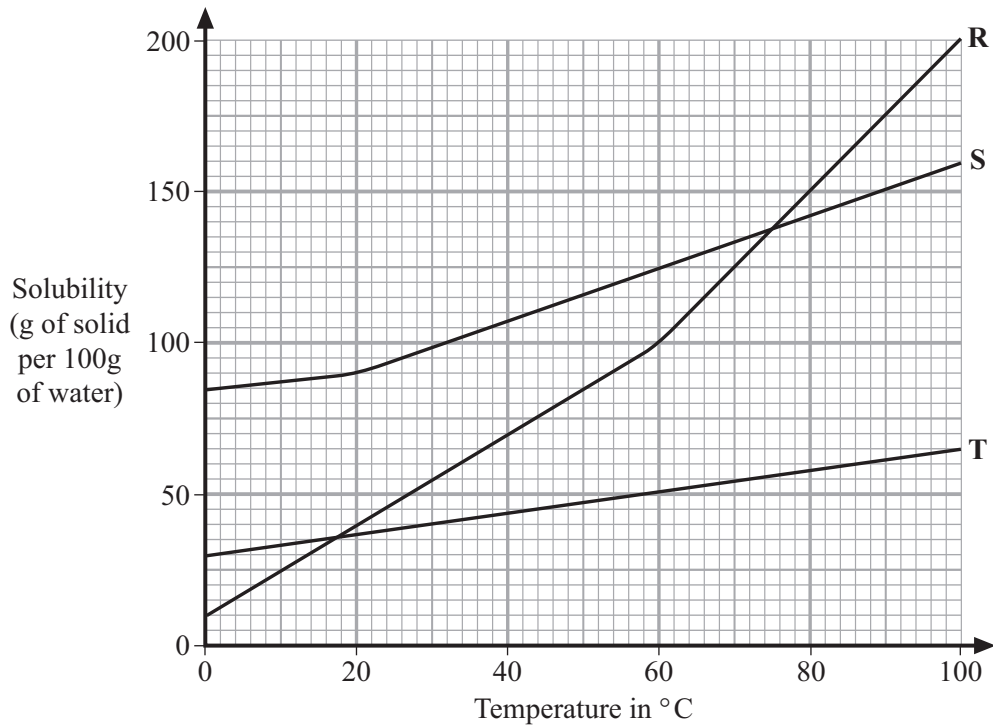Explain why this method **cannot** be used for Group 1 metals.

....

....

(1 mark)

5

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

7 The graph shows the solubility curves for three ionic solids **R**, **S** and **T**.

(a) (i) How many grams of solid **T** could be dissolved in 100 g of water at 60° C?

.........................g
(1 mark)

(ii) At what temperature would 200 g of water dissolve 200 g of solid **S**?

........................° C
(1 mark)

(b) A saturated solution of solid **R** was made at 80° C using 100 g of water.

(i) Explain the term *saturated solution*.

....

....
(1 mark)

(ii) The saturated solution of **R** was cooled from 80° C to 20° C.

Calculate the mass of **R** that would separate out of the solution.

....

....
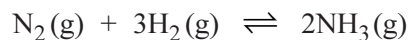*(1 mark)*

4

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TURN OVER FOR THE NEXT QUESTION

PATTERNS OF CHEMICAL CHANGE

8   The reaction for making ammonia in the Haber process is:

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

The forward reaction is exothermic.

The graph shows how temperature and pressure affect the yield of ammonia.
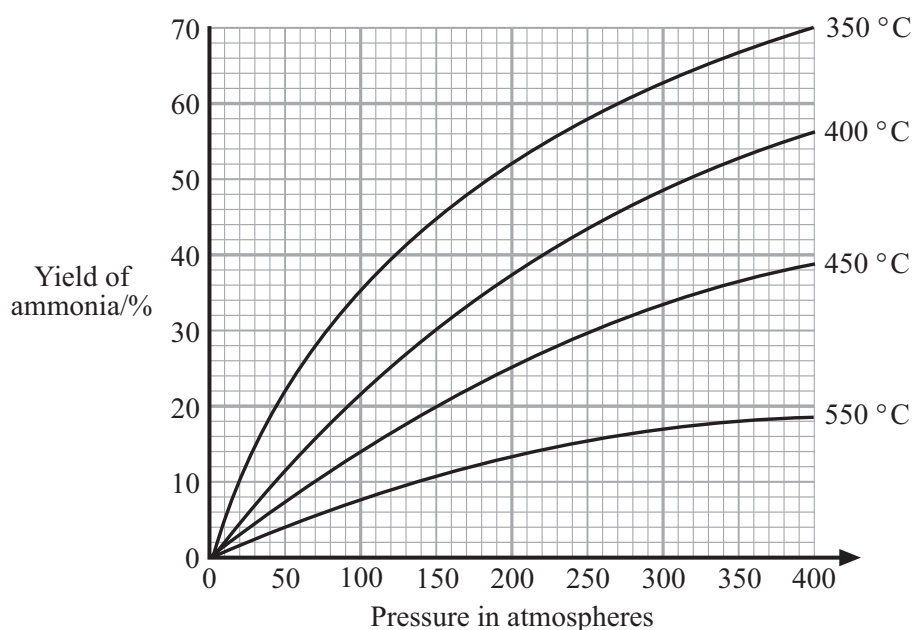
(a)   (i)   Using the graph, state how increasing the pressure alters the yield of ammonia produced.

....

....

(1 mark)

(ii)   Using the graph, state how increasing the temperature alters the yield of ammonia.

....

....

(1 mark)

(iii)   Explain why increasing temperature has this effect on the yield of ammonia.

....

....

(1 mark)

(iv) A Company operates the Haber Process at 450°C. Explain why this temperature is chosen.

....

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....

(2 marks)

(b) Explain why the process is more economical if the gaseous reaction takes place over iron.

....

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(1 mark)

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

9 The equation shows the decomposition of magnesium carbonate when it is heated.

$$MgCO_3\,(s) \rightarrow MgO\,(s) + CO_2\,(g)$$

21 g of magnesium carbonate are heated until it all decomposes.

Relative atomic masses: C = 12; O = 16; Mg = 24

1 mole of CO_2 has a volume of 24 dm^3 at room temperature and pressure.

Calculate:

(a)   the mass of magnesium oxide formed;

(b)   the volume of carbon dioxide formed.

Show clearly how you work out your answers and give the units for each.

(a)   ....

....

....

....

(b)   ....

....

....

....

(4 marks)

4

10   Enzymes are widely used in industry as catalysts for various processes.

(a)   Give **one** advantage of using enzymes as industrial catalysts.

....

....
(1 mark)

(b)   Industry uses enzymes in *batch processes* and in *continuous flow* processes.

Explain the main difference between these two types of process.

....

....
(1 mark)

(c)   In *continuous flow* processes the enzymes are immobilised.

Give **one** way in which enzymes can be immobilised.

....

....
(1 mark)

(d)   When using enzymes in industry *continuous flow* processes are considered to be more economical than batch processes. Suggest **one** reason why.

....

....
(1 mark)

$\frac{}{4}$

TURN OVER FOR THE NEXT QUESTION

STRUCTURES AND BONDING

11 How can the ability of metals to conduct electricity be explained by their structure and the arrangement of electrons?

In your answer you should include the following points:

* a description of the structure of metals;

* how electrons are involved in the structure;

* how the structure explains the ability of metals to conduct electricity.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.
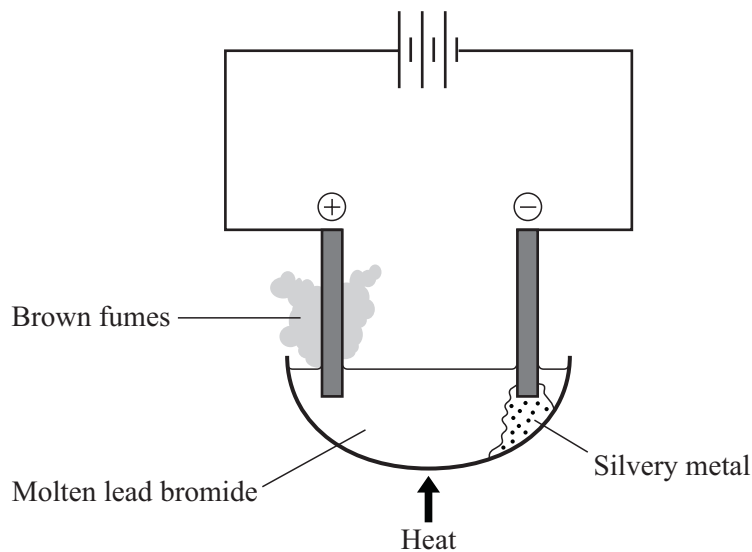
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(4 marks)

4

12 The diagram shows the electrolysis of molten lead bromide, $PbBr_2$ which is an ionic compound.

(a) Explain why solid lead bromide will **not** conduct electricity.

....

....

(1 mark)

(b) Balance the half equations for the processes taking place at the electrodes.

(i) .... $Br^- \rightarrow Br_2 +$ .... e^-

(1 mark)

(ii) $Pb^{2+} +$ .... $e^- \rightarrow Pb$

(1 mark)

(c) Why does bromine have a low boiling point?

....

....

(1 mark)

Turn over ▶

13   When sodium chloride solution is electrolysed two gases are formed.
At the end of the electrolysis the solution will turn universal indicator purple.

(a)   Chlorine is one of the two gases formed.

Name the other gas.

....
(1 mark)

(b)   Name the substance in the solution that turns universal indicator purple.

....
(1 mark)

(c)   Describe a simple chemical test for chlorine gas, and give the result of the test.

Test ....

....

Result...

....
(2 marks)

(d)   When chlorine gas is passed through potassium bromide solution the solution changes from colourless to a yellow/brown colour.

Write the balanced symbol equation for this displacement reaction.

.... + ... $\rightarrow$ .... + ...

(2 marks)

6

CHEMISTRY IN ACTION

14 A student carries out four tests on a solid mixture of two salts.

Test	**Result**
1. Add sodium hydroxide solution to the mixture, and warm.	An unpleasant smelling gas is produced that turns damp litmus paper from red to blue.
2. Perform flame test on the mixture.	Lilac-coloured flame seen.
3. Dissolve the mixture in water. Add dilute hydrochloric acid then barium chloride solution.	White precipitate formed.
4. Dissolve the mixture in water. Add dilute nitric acid then silver nitrate solution.	Yellow precipitate formed.

Identify the ions present in the sample of two mixed salts from the tests carried out by the student.

Test **1**   ion present   ....

Test **2**   ion present   ....

Test **3**   ion present   ....

Test **4**   ion present   ....

(4 marks)

4

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

**15** The manufacture of steel takes place in a series of steps:

Step **1**. The blast furnace produces molten iron.

Step **2**. Recycled scrap iron is mixed with the molten iron and oxygen is passed through it. This converts the non-metal impurities into acidic oxides.

Step **3**. Calcium carbonate is added to remove the acidic impurities and produce pure iron.

Step **4**. Varying quantities of carbon and other elements are added to make different types of steel.

(a) In Step **1** the reaction that produces molten iron in the blast furnace is a *redox* process.
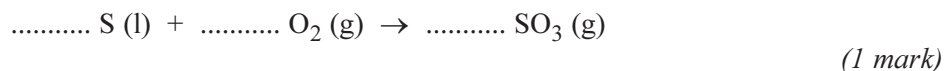
$$Fe_2O_3 \text{ (s)} + 3CO \text{ (g)} \rightarrow 2Fe \text{ (l)} + 3CO_2 \text{ (g)}$$
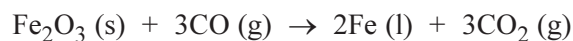
Which substance is the reducing agent?

....
(1 mark)

(b) In Step **2** one of the acidic oxides is sulphur trioxide.

Balance the chemical equation for the reaction.

.... $S \text{ (l)}$ + ... $O_2 \text{ (g)}$ $\rightarrow$ .... $SO_3 \text{ (g)}$

(1 mark)

(c) What type of chemical process takes place in Step **3** to remove the acidic impurities?

....
(1 mark)

(d) Name **one** element, other than carbon, that could be added to pure iron in Step **4** to produce a stainless steel.

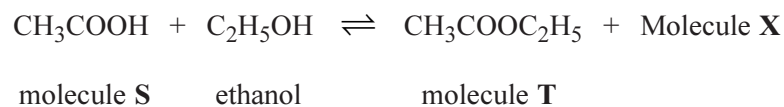...
(1 mark)

4

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QUESTIONS RELATING TO PREVIOUSLY TESTED MODULES

16 Alcohols form an homologous series with $-OH$ as its functional group.

(a) What is meant by the term "homologous series"?

....

....

(1 mark)

(b) Butanol is an alcohol. One isomer of butanol is given below.

```
        H    H    H    H
        |    |    |    |
 H — C — C — C — C — OH
        |    |    |    |
        H    H    H    H
```

Give the structural formula of another *isomer* of butanol.

(1 mark)

(c)   A reaction of ethanol, C_2H_5OH, is shown below.

$$CH_3COOH \; + \; C_2H_5OH \; \rightleftharpoons \; CH_3COOC_2H_5 \; + \; \text{Molecule } \textbf{X}$$

molecule **S**   ethanol   molecule **T**

(i)   What is the name of molecule **X**?

....
(1 mark)

(ii)   Name the group of organic compounds to which molecule **T** belongs.

....
(1 mark)

(iii)   What is the name of molecule **S**?

....
(1 mark)

(d)   Ethanol can be converted into molecule **S**.

Name the type of chemical process that is used for this conversion.

....
(1 mark)

6

**TURN OVER FOR THE NEXT QUESTION**

Turn over ▶

17 A student carried out a titration to find the concentration of sulphuric acid in a solution.

<u>Method</u>

1. Dissolve 4.00 g of sodium hydroxide in water and make up to 250 cm^3.

2. Using a pipette, put 25.0 cm^3 of the sodium hydroxide solution into a conical flask and add indicator.

3. Put the sulphuric acid solution into a burette.

4. Add the sulphuric acid to the sodium hydroxide solution until the indicator changes colour.

5. Repeat the titration process until the burette readings are in agreement.

    The student found that it took 32.00 cm^3 of sulphuric acid solution to neutralise 25.0 cm^3 of sodium hydroxide solution.

The equation for the reaction is:

$$H_2SO_4\,(aq) \; + \; 2NaOH\,(aq) \; \rightarrow \; Na_2SO_4\,(aq) \; + \; 2H_2O\,(l)$$
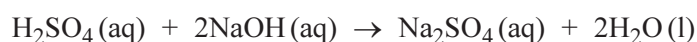
(a) Calculate the number of moles of NaOH that were made up to 250 cm^3 of solution.

....

....

....

(1 mark)

(b) How many moles of NaOH are there in 25.0 cm^3 of the solution?

....

....

....

Number of moles =...

(1 mark)

(c) How many moles of H_2SO_4 would the moles of NaOH in (**b**) react with?

....

....

Number of moles =..

(1 mark)

(d) Use the answer from (**c**) and the volume of $32.00\,cm^3$ to calculate the concentration of the sulphuric acid.
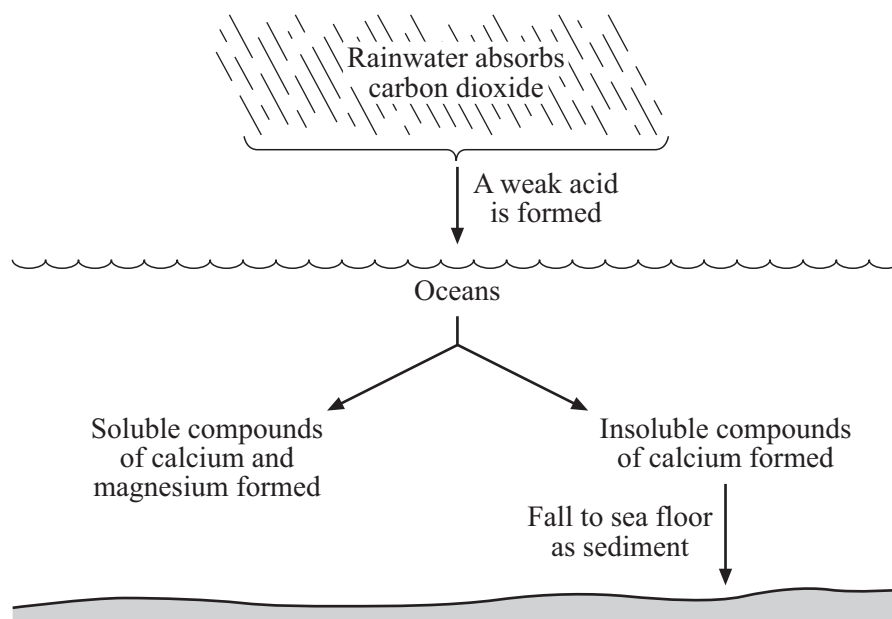
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Concentration =.. mol per dm^3

(1 mark)

4

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

18 The diagram shows the role played by oceans in absorbing carbon dioxide from the atmosphere.

Rainwater absorbs
carbon dioxide

A weak acid
is formed

Oceans

Soluble compounds
of calcium and
magnesium formed

Insoluble compounds
of calcium formed

Fall to sea floor
as sediment

(a) What is the formula of the weak acid formed when rainwater dissolves carbon dioxide?

....
(1 mark)

(b) Name the insoluble calcium compound formed when the weak acid reacts with calcium ions.

....
(1 mark)

(c) One of the soluble compounds formed is magnesium hydrogencarbonate.
The hydrogencarbonate ion is HCO_3^-.

What is the chemical formula of magnesium hydrogencarbonate?

....
(1 mark)

(d) Give a reason why the oceans cannot solve problems caused by increasing amounts of carbon
dioxide in the atmosphere.

....

....
(1 mark)

END OF QUESTIONS

4

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THERE ARE NO QUESTIONS PRINTED ON THIS PAGE