Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature				

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General Certificate of Secondary Education
June 2006

SCIENCE: DOUBLE AWARD B (CO-ORDINATED) 3462/2H
Paper 2
Higher Tier

H

Wednesday 14 June 2006 9.00 am to 10.30 am

For this paper you must have:
- a ruler
- the Data Sheet (enclosed)

You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the 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.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

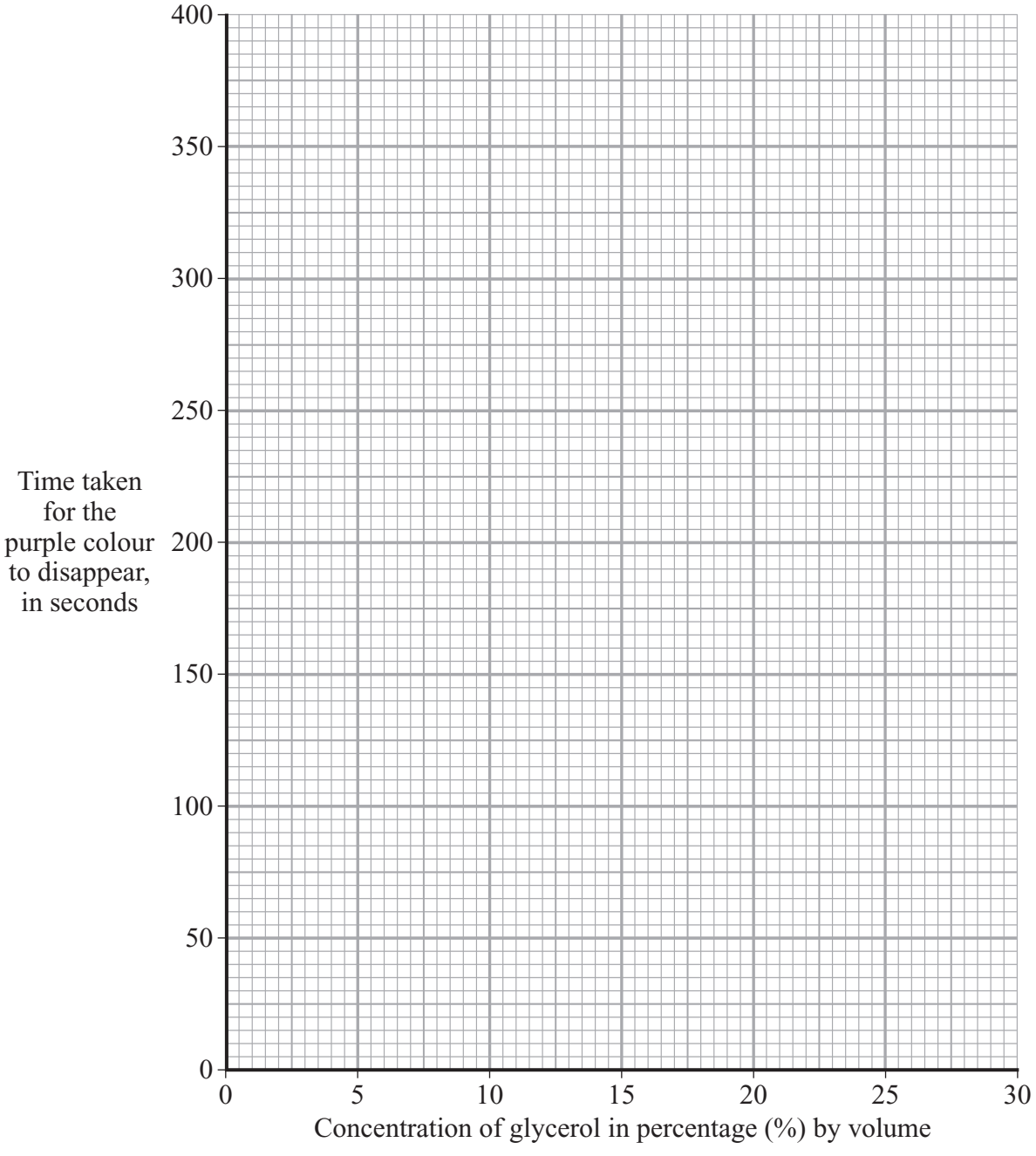
For Examiner's Use			
Number	Mark	Number	Mark
1		8	
2		9	
3		10	
4		11	
5		12	
6		13	
7		14	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

1 Glycerol reacts with a purple solution to form colourless products. The time taken for the purple colour to disappear can be used to measure the rate of this reaction.

A student did some experiments to find out how the concentration of glycerol affects the rate of this reaction. The results are shown in the table.

Concentration of glycerol in percentage (%) by volume	4	10	16	24	30
Time taken for the purple colour to disappear, in seconds	375	150	94	63	50

(a) Plot these points on the graph and draw a smooth curve through the points.



(3 marks)

(b) The time taken for the purple colour to disappear when the concentration of the glycerol is 10 % is 150 seconds.

(i) Use your graph to estimate the time it would take for the purple colour to disappear when the concentration of glycerol is 20 %.

Time = ... seconds

(1 mark)

(ii) If the concentration of glycerol is doubled, what happens to the **rate** of reaction?

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(1 mark)

(iii) Explain, in terms of particles, why increasing the concentration of glycerol increases the rate of this reaction.

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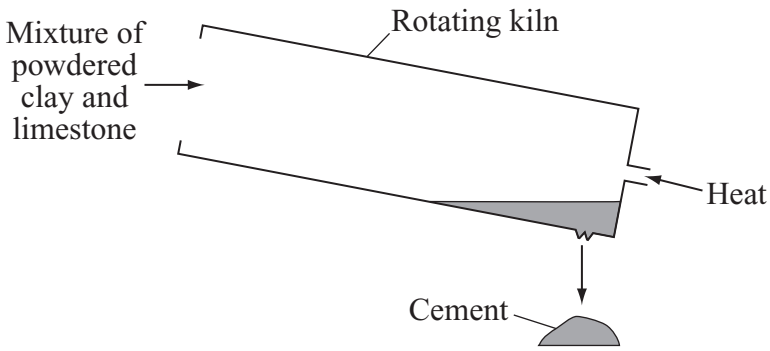
(2 marks)

7

Turn over for the next question

2 (a) Limestone is an important raw material in the manufacture of cement.



In this process:

- powdered limestone and clay are mixed in a rotating kiln;
- *thermal decomposition* of the limestone takes place to produce calcium oxide;
- the calcium oxide then reacts with the clay to make cement.

(i) Explain what is meant by the term *thermal decomposition*.

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(2 marks)

(ii) Thermal decomposition of calcium carbonate also produces a gas which turns limewater milky.

Name this gas. .....

(1 mark)

(iii) Suggest why a rotating kiln is used.

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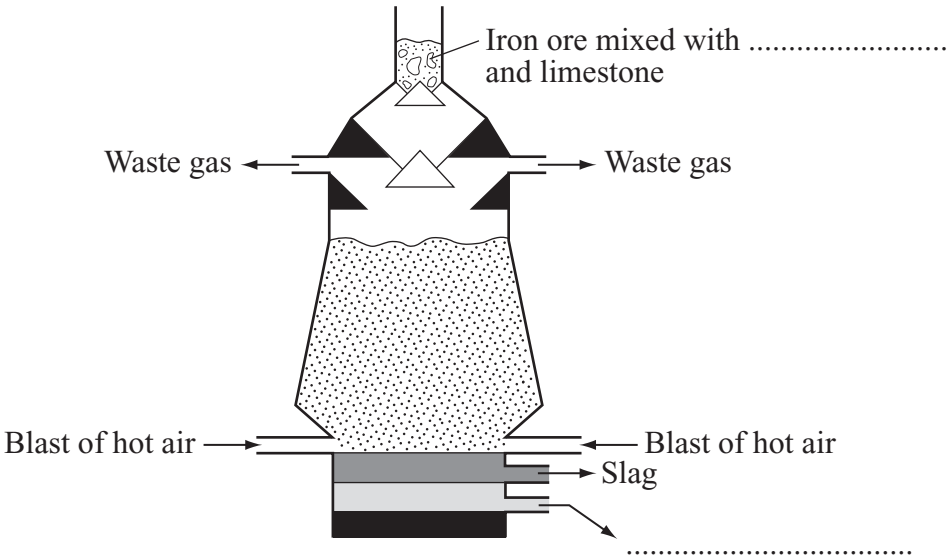
(1 mark)

(b) Limestone is also used in the extraction of iron in the blast furnace.

The diagram shows a blast furnace.

(i) Complete the diagram by adding the **two** missing labels.



(2 marks)

(ii) The iron ore (iron oxide) is *reduced* in the furnace.

Explain what is meant by the term *reduced*.

.....

.....

(1 mark)

(iii) The slag obtained from the blast furnace can be ground up and used to make a type of cement.
This is different from the method described in part (a) of this question.

Suggest and explain **one** advantage of using blast furnace slag to make cement.

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(2 marks)

9

3 Read the information about plastic-tar and then answer the questions.

Plastic-Tar Roads!

A town in India has made a road from plastic-tar. The town mayor is quoted as saying, 'using plastic-tar will reduce the problem of plastic waste'.

Roads are usually made from a mixture of bitumen and gravel. Plastic-tar is made by mixing the bitumen and gravel with plastic. This plastic is obtained from household waste material.

Plastic-tar is harder and more waterproof than ordinary tar. This helps it to last longer.

(a) Use your knowledge of plastics to explain why the disposal of plastic waste is difficult, making it a problem for the environment.

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)

(b) Suggest **two** advantages of using waste plastic to make plastic-tar.

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(2 marks)

6

4 Iron(II) sulphate tablets are used to treat people with iron deficiency.

This label was on a bottle of tablets.

Iron(II) sulphate tablets

$FeSO_4$

100 iron(II) sulphate tablets.
Each tablet contains 0.2 g of $FeSO_4$

(a) Calculate the relative formula mass (M_r) of iron(II) sulphate, $FeSO_4$.

Relative atomic masses: O = 16; S = 32; Fe = 56.

.....

.....

Relative formula mass = ...
(2 marks)

(b) Calculate the percentage by mass of iron in iron(II) sulphate.

.....

.....

Percentage by mass of iron = ... %
(2 marks)

(c) The 100 iron tablets in the bottle contain a total mass of 20 g of iron(II) sulphate.

Calculate the mass of iron in 20 g of iron(II) sulphate.

.....

.....

Mass of iron = ... g
(2 marks)

6

5 The periodic table on the Data Sheet may help you to answer this question.

The diagram shows a Group in a periodic table designed by John Newlands in 1864. The Group contains elements found in Group 7 (the halogens) of the modern periodic table (fluorine, chlorine, bromine and iodine) and other elements.

H
F
Cl
Co/Ni
Br
Pd
I
Pt/Ir

(a) Cobalt, nickel, palladium, platinum and iridium are now classed as transition elements. State **three** ways in which the properties of transition elements are different from halogens.

1 .....

2 .....

3 .....

(3 marks)

(b) Hydrogen is difficult to place in the modern periodic table.

(i) Use the table of ions on the Data Sheet to help you to give **one** way in which hydrogen is similar to the elements in Group 1.

.....

.....

(1 mark)

(ii) Give **one** property of hydrogen which makes it similar to the elements at the top of Group 7.

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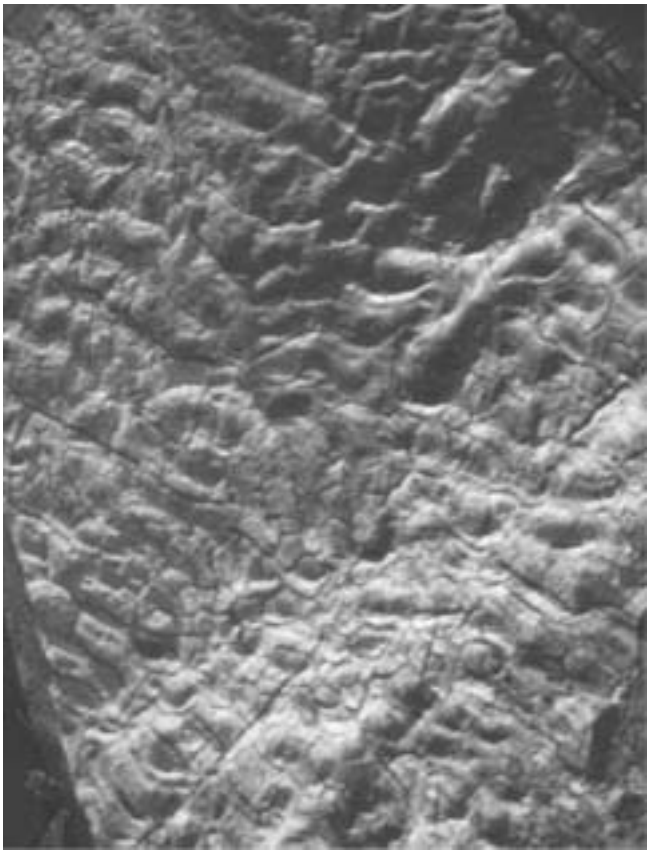
(1 mark)

5

6 The picture shows ripple marks on rock found in Dorset.



These ripple marks were formed when the sediments were first laid down.

Explain how these ripple marks could have been formed.

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(2 marks)

2

Turn over for the next question

7 (a) A solution of magnesium chloride can be made by reacting magnesium oxide with **warm** hydrochloric acid.

(i) Balance the equation for this reaction.

$MgO\ (s) \quad + \quad .....HCl\ (aq) \quad \rightarrow \quad MgCl_2\ (aq) \quad + \quad H_2O\ (l)$

(1 mark)

(ii) Describe how you would make a solution of magnesium chloride starting with magnesium oxide powder and hydrochloric acid.

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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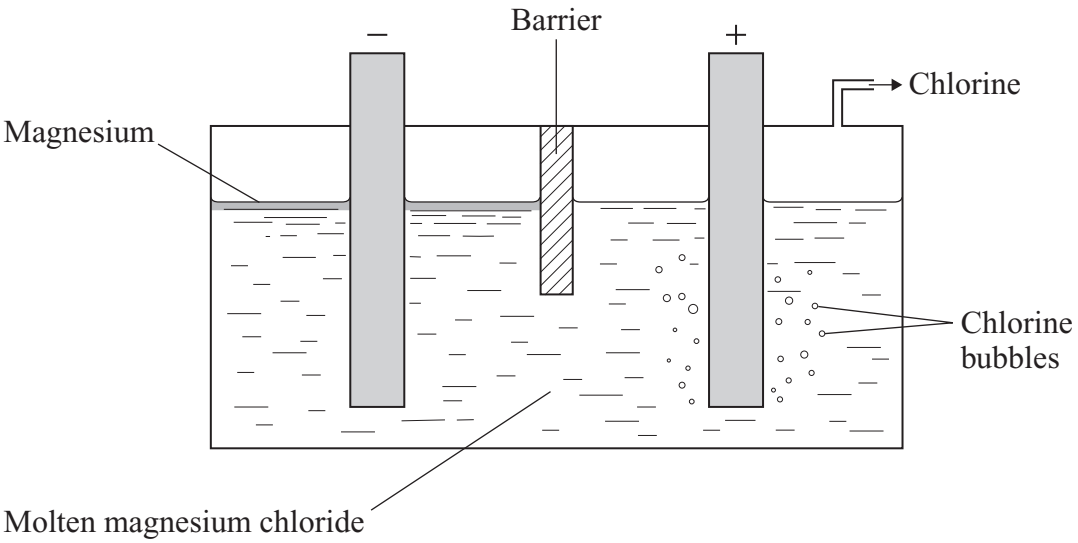
(5 marks)

(b) Magnesium and chlorine can be made by the electrolysis of molten magnesium chloride.



(i) Magnesium is formed at the negative electrode.

Explain why.

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(2 marks)

(ii) Chlorine is often added to drinking water.

Explain why.

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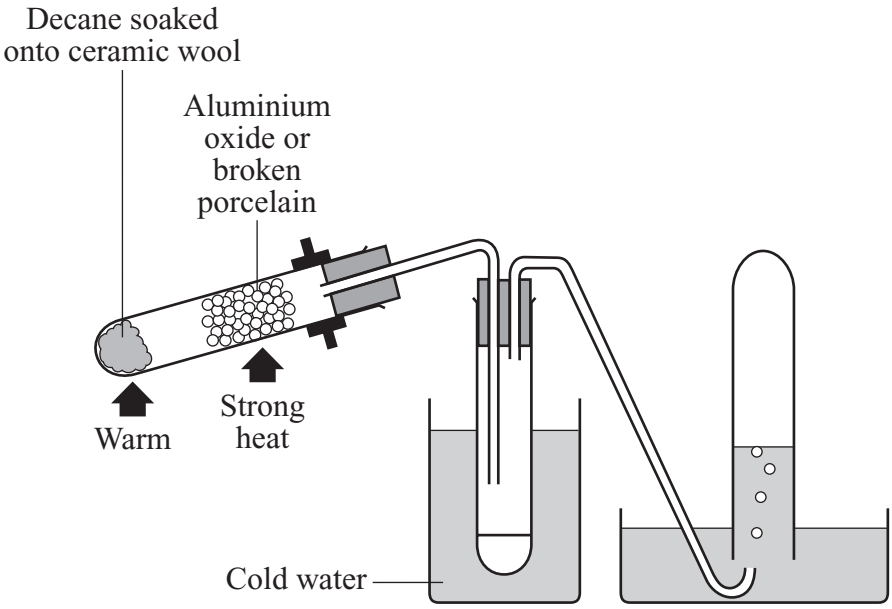
(1 mark)

9

Turn over for the next question

8 Cracking is an important type of reaction used in the oil industry.

The diagram shows an apparatus that can be used in a school laboratory to show cracking.



(a) (i) What is the purpose of the broken porcelain or aluminium oxide?

.....

(1 mark)

(ii) Explain why cracking is used in the oil industry.

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.....

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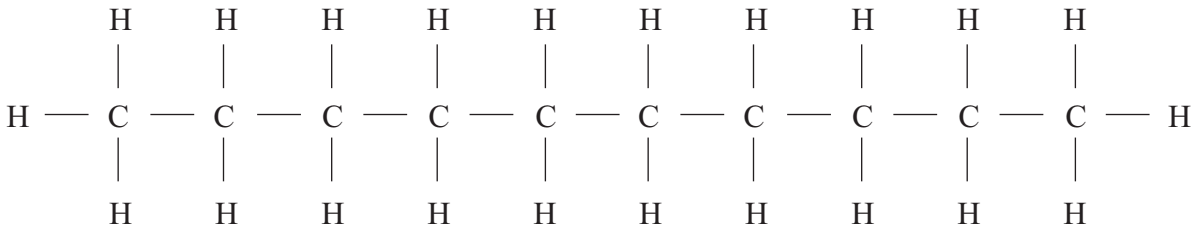
(2 marks)

(b) The equation represents a reaction that takes place when decane, $C_{10}H_{22}$, is cracked.

$$C_{10}H_{22} \rightarrow C_2H_4 + C_8H_{18}$$

Draw an **X** on the diagram to show where ethene, C_2H_4, molecules collect. *(1 mark)*

(c) The diagram below represents a decane molecule.



Draw similar diagrams for:

(i) C_8H_{18}

(1 mark)

(ii) C_2H_4

(1 mark)

6

Turn over for the next question

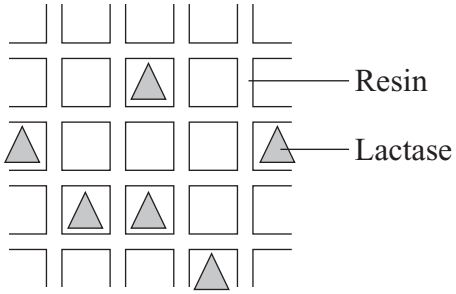
9 Read the information about the use of lactase and then answer the questions.

Lactose is a sugar found in milk. It makes many Thai, Chinese and Afro-Caribbean people ill. One way to help to solve this problem is to use lactase to convert the lactose into the sugars glucose and galactose.

$$\text{lactose} \xrightarrow{\text{lactase}} \text{glucose} + \text{galactose}$$

Lactase is expensive so it is *immobilised* when it is used in industry.

Alginate gel can be used to immobilise lactase. Lactase is mixed with alginate gel solution. Drops of the mixture are then allowed to solidify and form alginate beads.



Magnified cross-section of an alginate bead

A column is filled with the alginate beads. The milk is then poured through the column in a continuous process.

(a) What type of substance is lactase? .....

(1 mark)

(b) Explain the meaning of the term *immobilised*, using the information above.

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(2 marks)

(c) Suggest **one** reason, other than cost, for immobilising the lactase rather than simply adding it to the milk.

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(1 mark)

(d) Suggest **one** advantage of using a continuous process instead of a batch process.

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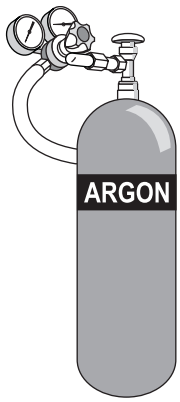
(1 mark)

5

Turn over for the next question

10 Argon gas is extracted from the air and stored in cylinders.
This cylinder contains 180 litres (dm^3) of argon gas.



(a) Air contains 0.9 % of argon by volume.

Calculate the volume of air that would contain 180 litres of argon.

.....

.....

..... litres
(2 marks)

(b) Welding involves heating metals to high temperatures.
Argon is used to provide an unreactive atmosphere around metals during welding.

(i) Explain, in terms of electrons, why argon is unreactive.

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(2 marks)

(ii) Suggest why hot metals need to be protected from the air.

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.....
(1 mark)

5

11 The periodic table on the Data Sheet may help you to answer this question about the alkali metals.

(a) The electronic structure of a sodium atom can be represented as:

2, 8, 1

Give the electronic structure of a potassium atom.

.....

(1 mark)

(b) Explain, in terms of electrons, why sodium and potassium have similar properties.

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.....

(1 mark)

(c) Both sodium and potassium react with water.

Explain, in terms of electrons, why potassium reacts more violently than sodium.

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(3 marks)

(d) Alkali metal compounds have many uses.

Sodium hydroxide reacts with phosphoric acid to make a salt that is used to inhibit the growth of mould on fruit.

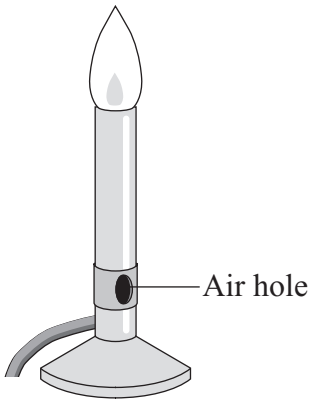
Complete the word equation for this reaction.

phosphoric acid + sodium hydroxide → ..... phosphate + ...

(2 marks)

7

12 The diagram shows a Bunsen burner.



(a) The fuel used is methane, CH_4.

The equation for the complete combustion of methane is shown below.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

The relative formula mass (M_r) of methane is 16.

Calculate the mass of oxygen that reacts with 16 g of methane.

Relative atomic masses: H = 1; C = 12; O = 16.

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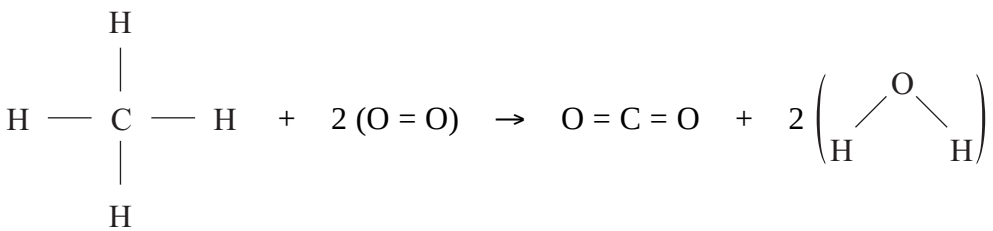
Mass of oxygen = ... g

(2 marks)

(b) The equation for the combustion of methane can also be represented by this equation.



(i) Use the bond energies given in the table to help you to calculate the energy change for this reaction.

Bond	Bond energy (kJ)
C — H	435
O = O	498
C = O	805
O — H	464

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Energy change = ... kJ

(3 marks)

(ii) Explain, in terms of bond energies, why the combustion of methane is exothermic.

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.....

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(1 mark)

(c) The amount of energy you have calculated, in (b)(i), is the maximum amount of energy released on the complete combustion of 16 g of methane, when the air hole is open.

Suggest why the amount of energy released is less when the air hole is closed.

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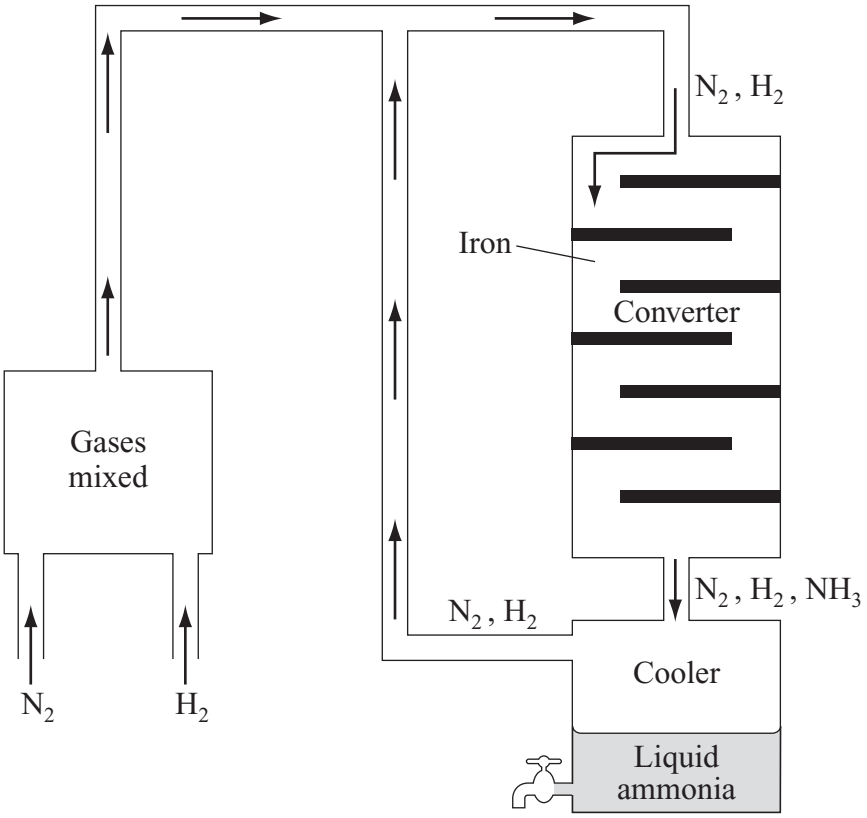
(1 mark)

7

13 The diagram shows the Haber process to make ammonia.



In the converter nitrogen and hydrogen react to form ammonia.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 + \text{heat}$$

(a) Not all of the nitrogen and hydrogen is changed into ammonia. Explain how ammonia is separated from unreacted nitrogen and hydrogen.

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(2 marks)

(b) What is the purpose of the iron in the converter?

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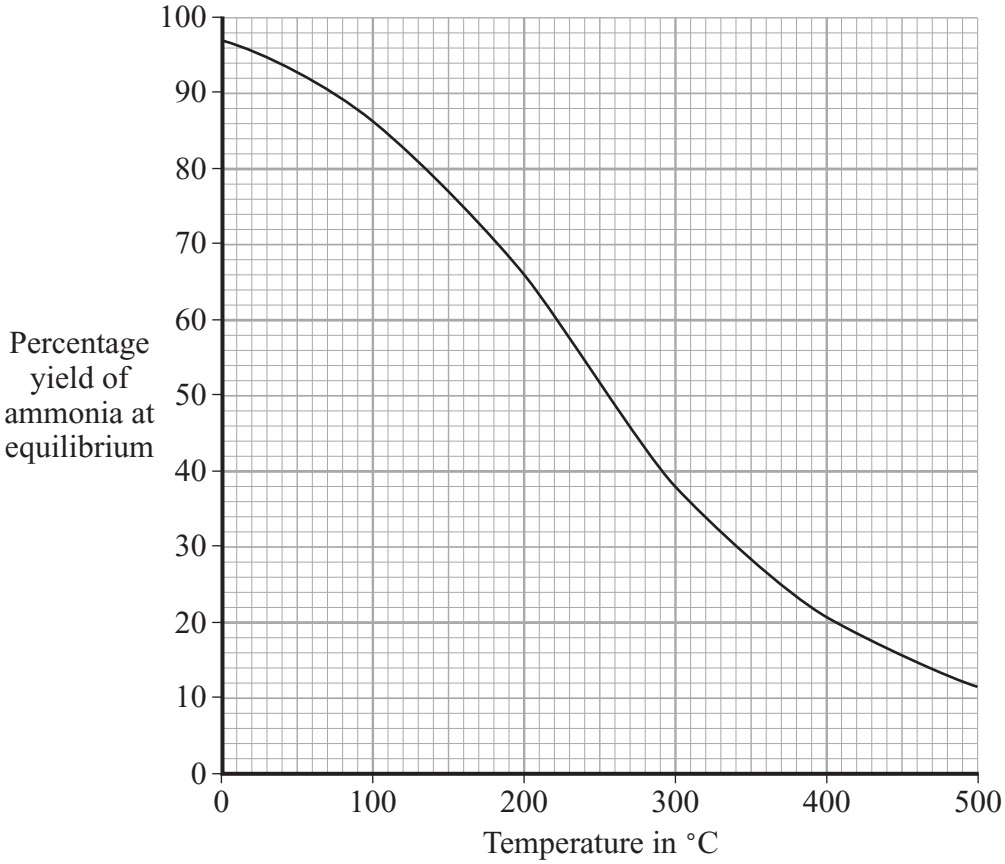
(1 mark)

(c) The graph shows how the percentage yield of ammonia at equilibrium changes as the temperature is increased. The pressure is constant.



(i) Explain why the highest percentage of ammonia at equilibrium is obtained at low temperature.

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(1 mark)

(ii) Explain why the actual temperature used in this process is about 450 ºC.

.....

.....

(1 mark)

5

14 Phosphorus compounds have many uses.

(a) (i) About 250 000 tonnes of phosphorus trichloride, $\mathbf{PCl_3}$, are produced each year.

$\mathbf{PCl_3}$ is made by the reaction of phosphorus, $\mathbf{P_4}$, with chlorine, $\mathbf{Cl_2}$.

The word equation for this reaction is shown below.

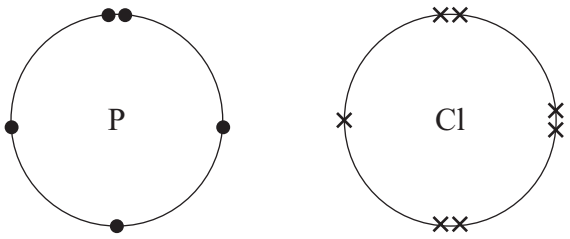
phosphorus + chlorine → phosphorus trichloride

Write a balanced symbol equation for this reaction. State symbols are **not** needed.

.....

(2 marks)

(ii) The diagrams show how the electrons are arranged in the outer shell (highest occupied energy level) of a phosphorus atom and a chlorine atom.



Draw a diagram to show the bonding in a molecule of phosphorus trichloride. Use dots and crosses to represent the electrons. Show only the outer shell electrons.

(2 marks)

(iii) Phosphorus trichloride has a melting point of – 92 ºC and a boiling point of 76 ºC.

Is it a solid, a liquid or a gas at room temperature (20 ºC)?

.....

(1 mark)

(iv) Explain why phosphorus trichloride has a low melting point and boiling point.

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(2 marks)

(b) Phosphorus reacts with zinc to form a compound that is used as a rat poison.

A sample of this compound was found to contain 1.95 g of zinc and 0.62 g of phosphorus.

Calculate the formula of this compound.

You must show all your working to gain full marks.

Relative atomic masses: P = 31; Zn = 65.

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(4 marks)

11

END OF QUESTIONS

There are no questions printed on this page

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