General Certificate of Secondary Education
June 2004

APPLIED SCIENCE (DOUBLE AWARD)   **3860/2H**
HIGHER TIER
Unit 2   Science for the Needs of Society

Friday 18 June 2004   9.00 am to 10.30 am

H

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

In addition to this paper you will require:
   a ruler.
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 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.

Answer **all** questions in the spaces provided.

1 Farmers grow plants to provide food, materials for clothing and chemicals for making pharmaceutical products.

(a) During photosynthesis, plant cells use energy from sunlight to convert simple chemicals into glucose.

A chemical equation for this process is given below.

water + Gas **A** $\longrightarrow$ glucose + Gas **B**

(i) Name the green pigment present in plant cells that absorbs light energy to enable them to carry out photosynthesis.

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(1 mark)

(ii) Name Gas **A** ....

Describe where the plant finds this simple chemical and how it absorbs it.

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(3 marks)

(iii) Name Gas **B** ....

Explain how this gas is used by plants and why it is needed.

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(3 marks)

(b) As well as water, plants need minerals from the soil for healthy growth.
If the soil is poor the farmer may need to add extra minerals.

Examples of chemicals added to soil are compounds containing nitrate ions (NO_3^-), and magnesium ions (Mg^{2+}).

(i) Why are nitrate ions needed by plants?

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(1 mark)

(ii) Why are magnesium ions needed by plants?

....

....

(1 mark)

(iii) Suggest the chemical formula for a compound containing both nitrate ions and magnesium ions.

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(2 marks)

(iv) Give **one** other method used by farmers to produce healthy plant growth.

Explain why this method produces healthy plant growth.

Method ....

....

Explanation ....

....

(2 marks)

TURN OVER FOR THE NEXT QUESTION

$\frac{}{13}$

Turn over ▶

2 Hydrogen chloride is an important chemical used in the manufacture of hydrochloric acid.

The flow diagram shows the manufacture of hydrogen chloride from a natural raw material.

```
        ┌─────────────────┐
        │    Rock salt    │
        └─────────────────┘
                 │  Separation
                 ▼
        ┌─────────────────┐
        │ Sodium chloride │
        └─────────────────┘
                 │  Electrolysis
                 ▼
        ┌─────────────────┐
        │     Chlorine    │
        └─────────────────┘
                 │  Reaction with
                 │  hydrogen
                 ▼
        ┌─────────────────┐
        │ Hydrogen chloride│
        └─────────────────┘
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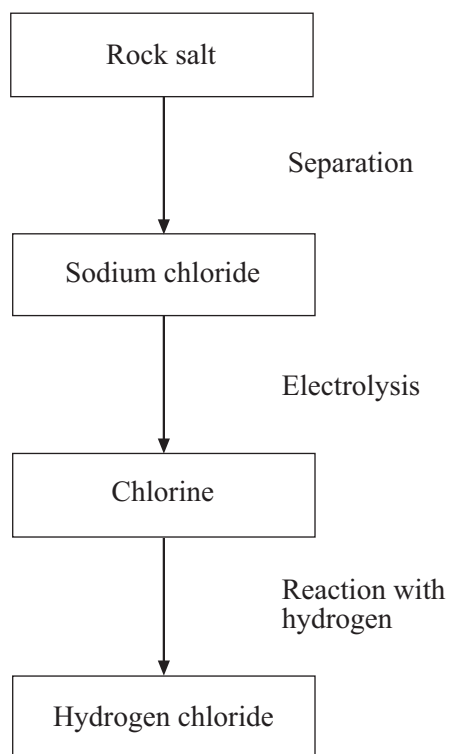
(a) The first stage of the process is the separation of sodium chloride from rock salt.

(i) Describe a method to separate sodium chloride from rock salt.

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(4 marks)

(ii) Explain why sodium chloride is classified as an inorganic compound.

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(2 marks)

(b) An equation for the electrolysis of sodium chloride solution to produce chlorine is given below.

$$..... NaCl \ + \ ..... H_2O \longrightarrow ..... NaOH \ + \ Cl_2 \ + \ H_2$$

(i) Balance the equation by writing numbers in the spaces provided.

(2 marks)

(ii) Chlorine is classified as a non-metal element.

Give **two** properties of chlorine that enable it to be classified as a non-metal element.

1 ....

2 ....

(2 marks)

(c) Chlorine will react directly with hydrogen to produce hydrogen chloride.

Some properties of hydrogen chloride are listed below.

- melting point $= -115\,°C$

- boiling point $= -85\,°C$

- solubility in water – very soluble, dissolves to form hydrochloric acid

(i) Write a balanced symbol equation for the reaction between chlorine and hydrogen.

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(2 marks)

(ii) Name the type of chemical bonding present in hydrogen chloride.

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(1 mark)

(iii) Explain why hydrogen chloride has a low boiling point.

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(2 marks)

15

Turn over ▶

**3**   A student was asked to calculate the cost of electricity used by a range of household appliances.

She used a table to record her calculations.

Electrical appliance	Power rating in kW	Time switched on in hours	Energy used in kWh	Cost in pence
Colour television	0.2	5.0	1.0	7.0
Microwave oven	1.5	0.2	0.3	2.1
Hairdryer		0.1		

(a)   The student collected information about the power rating of each appliance.

Colour television
200 watts

Hairdryer
230 volts
8 amps

Microwave oven
1500 watts
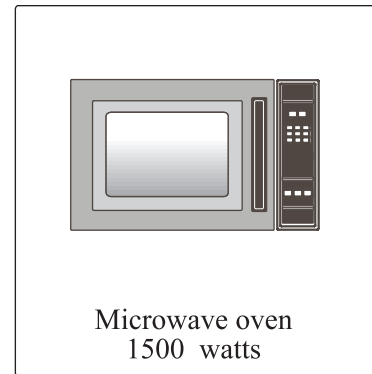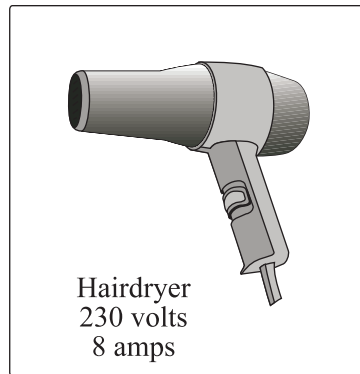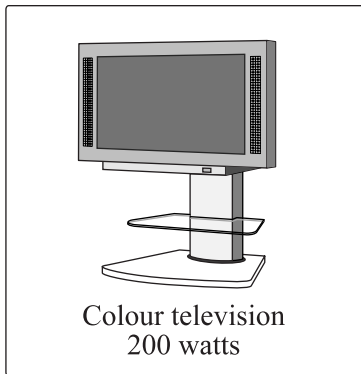
(i)   Calculate the power of the hairdryer.

Show your working.

....

....

....................watts
(3 marks)

(ii)   Write the power rating of the hairdryer in kilowatts in the correct column of the table.
(1 mark)

(b) Use the equation below to calculate the energy used by the hairdryer.

energy use (kilowatt hour) = **power** (kilowatt) × **time** (hour)

Show your working.

....

....

.....................kWh

Write the energy used by the hairdryer in the correct column of the table.

(2 marks)

(c) The cost of electricity is 7p per kilowatt hour (kWh).

Calculate the cost of using the hairdryer.

Show your working.

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.... p

Write the cost of using the hairdryer in the correct column of the table.

(2 marks)

(d) Which of the appliances listed in the table cost the most money to use in the tests?

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Explain why this appliance cost the most money to use in the tests.

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(2 marks)

(e) Modern electrical appliances are designed to work as efficiently as possible.

What is meant by the term *efficiency* when applied to an electrical appliance like a colour television?

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(2 marks)

12
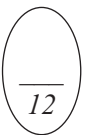
Turn over ▶

4 Yoghurt is produced when certain microorganisms feed on the sugar in milk and turn it into lactic acid.

(a) A simple method for making yoghurt is described below.

The process is started by adding a small quantity of yoghurt to warm milk.

Apparatus

- large pan

- spoon

- thermos flask

Method

1 Heat 500 cm^3 of milk in a pan until it reaches 37 °C.

2 Mix two spoonfuls of yoghurt with a little of the warm milk.

3 Add the yoghurt and milk mixture to the rest of the warm milk.

4 Pour the warm milk into a thermos flask, screw on the top, and leave for six hours.

(i) What type of microorganism turns milk into yoghurt?

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(1 mark)

(ii) Why is it important to use clean equipment for yoghurt making?

....

....
(1 mark)

(iii) Why is it important not to add the milk at too high a temperature?

....

....
(1 mark)

(iv) Why is the mixture left for six hours?

....

....
(1 mark)

(b)   Once the yoghurt has formed, the microorganisms can continue to grow and the mixture becomes acidic and inedible.

(i)   Suggest a method to slow down this process and keep the yoghurt fresh.

....

....

(1 mark)

(ii) Plan a simple experiment that could be carried out in the laboratory to prove that your suggested method keeps the yoghurt fresh for longer.

Your plan should include the following details:

- The apparatus to be used

- The quantities of materials or chemicals to be used

- The measurements or observations to be made

- A brief outline for the experiment

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(5 marks)

10

Turn over ▶

5 Many types of manufactured material can be found in the bathroom of a modern house.

The diagram shows some of the materials used in a wash basin.
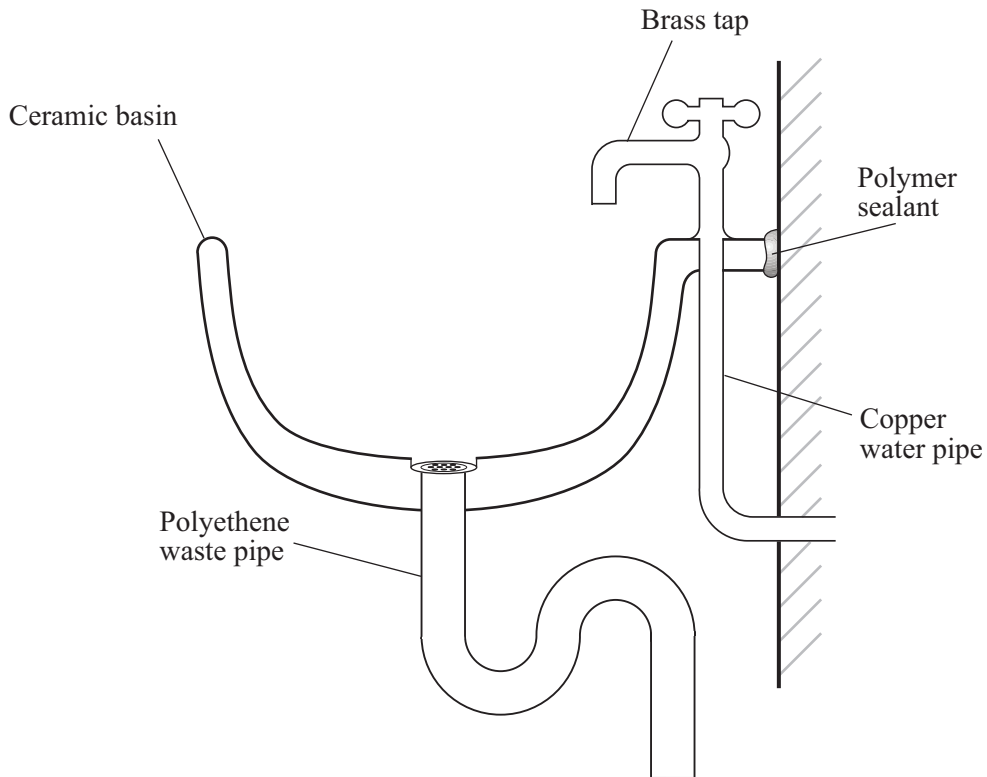
(a) Give **two** properties of copper metal which mean it is a good choice for making the water pipe.

1 ....

2 ....

(2 marks)

(b) Give **two** properties of the ceramic which mean it is a good choice for making the basin.

1 ....

2 ....

(2 marks)

(c) Give **two** properties of polyethene which mean it is a good choice for making the waste pipe.

1 ....

2 ....

(2 marks)

(d)   The sealant is a specialist polymer that must be kept in an airtight container until it is used. When the sealant is exposed to the air it forms cross-links between its molecules.

   (i)   Draw labelled diagrams to show the changes that take place when sealant molecules are exposed to the air.

(3 marks)

   (ii)   Predict the effect of these chemical changes on the properties of the sealant.

   ....

   ....

   Explain your prediction   ....

   ....

   ....
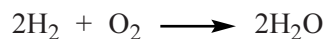
(2 marks)

11

TURN OVER FOR THE NEXT QUESTION

6 It is expected that, in the future, hydrogen will be used as a fuel instead of petrol and natural gas.

When hydrogen burns the reaction between hydrogen and oxygen is very exothermic and the product of this reaction is water.

$$2H_2 \; + \; O_2 \; \longrightarrow \; 2H_2O$$

(a) Why does the combustion of hydrogen cause less pollution than the combustion of petrol or natural gas?

....

....
(1 mark)

(b) Describe the chemical bonding in water.

You may use a labelled diagram.

[Number of Electrons: H = 1; O = 8]

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....
(2 marks)

(c) During the combustion of hydrogen, bonds in hydrogen and oxygen are broken and bonds in water are formed.

$$H\!\!-\!\!H \qquad O\!\!=\!\!O$$

$$H\!\!-\!\!H$$

Bonds broken

$$\longrightarrow \qquad O\!<^{\textstyle H}_{\textstyle H} \qquad O\!<^{\textstyle H}_{\textstyle H}$$

Bonds formed
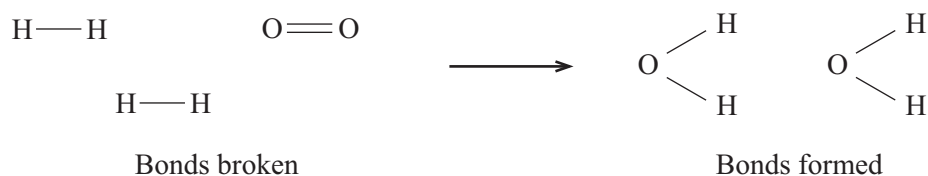
The table gives the energy required to break these bonds.
The number of bonds broken is the same in each case.

Bond	Energy required in kJ
H–H	436
O=O	498
O–H	464

Energy is required to break the bonds in hydrogen and oxygen.
Energy is given out when the bonds in water are formed.

(i) Calculate the total amount of energy required to break the bonds in hydrogen and oxygen in the equation opposite.

....

....

.... kJ

(2 marks)

(ii) Calculate the total amount of energy given out in the reaction when the bonds in water are formed in the equation opposite.

....

....

........................kJ

(2 marks)

(iii) Calculate the overall energy change for the combustion of hydrogen.
Explain why this is an exothermic reaction.

Calculation ....

.... kJ

Explanation ....

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(2 marks)

Turn over ▶

7 Our cells need a constant supply of glucose for respiration.

The hormone insulin, produced in the pancreas, is responsible for the control of blood glucose levels.

Diabetes is a medical condition caused by a patient not being able to produce enough insulin.

(a) Explain fully how glucose gets into our cells from the blood.

You may use a diagram to illustrate your answer.

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(3 marks)

(b) How does the production of insulin in the pancreas control the level of glucose in the blood?

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(3 marks)

(c)   Describe how bacteria can be used to produce human insulin for the treatment of diabetes.

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(3 marks)

9

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

8 We need to know how the properties of a metal are related to its structure and bonding. This enables us to modify the properties so they match the specification for a product.

(a) (i) Draw a labelled diagram to show the structure and bonding in a metal.

(3 marks)

(ii) Explain why metals are good conductors of electricity.

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(2 marks)

(b) Aluminium alloy is used in the construction of aircraft because it is strong and has a low density. The strength of pure aluminium can be increased by adding small amounts of other metals such as copper.

Explain why adding a small amount of copper increases the strength of aluminium.

You may illustrate your answer with a labelled diagram.

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(3 marks)

(c)   The table gives some information about aluminium and copper.

Metal	Atomic number	Relative atomic mass	Atomic radius in nm	Density in gcm^{-3}
Aluminium	13	27	0.130	2.70
Copper	29	64	0.117	8.92

(i)   Using the information in the table, give **two** reasons why copper has a much higher density than aluminium.

1 ....

2 ....

(2 marks)

(ii) Suggest **one** other factor about the structure of a metal that could affect its density.

....

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(1 mark)

11

END OF QUESTIONS