

Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Secondary Education
January 2008

APPLIED SCIENCE (DOUBLE AWARD)
Unit 2 Science for the Needs of Society
Higher Tier

APSC/2H

H



Friday 18 January 2008 1.30 pm to 3.00 pm

<p>For this paper you must have:</p> <ul style="list-style-type: none"> a ruler. <p>You may use a calculator.</p>

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 to be 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.

Advice

- In all calculations, show clearly how you work out your answer.

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Question	Mark	Question	Mark
1		4	
2		5	
3		6	
		7	
		8	
		9	
Total (Column 1)		→	
Total (Column 2)		→	
TOTAL			
Examiner's Initials			



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

- 1 An agricultural scientist uses his knowledge of plant nutrients to help a farmer improve the yield of his crop.

The scientist sets up an experiment to test the effect of adding minerals, in the form of artificial fertiliser, to the soil.

Read the method for the experiment and answer the questions that follow.

Method

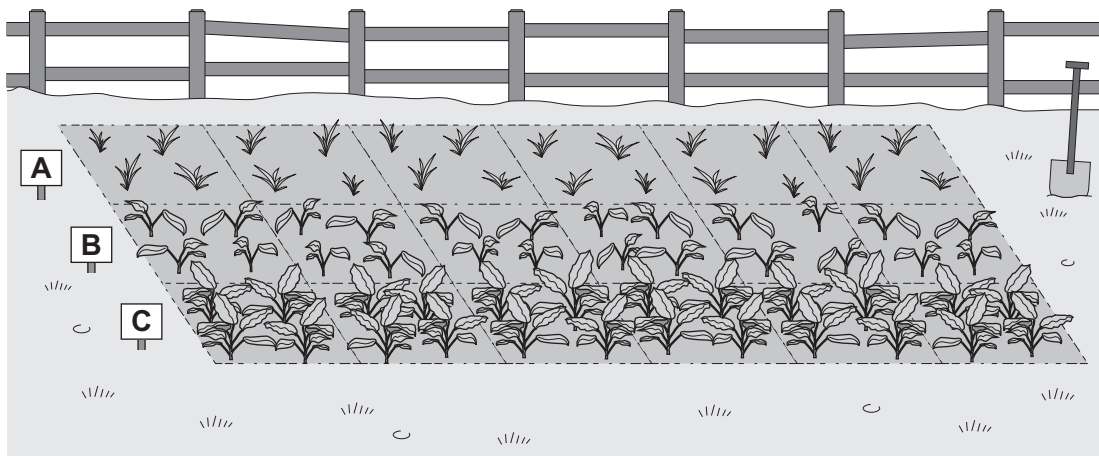
1. Divide a field into eighteen 1 m² plots.
2. Plant the same number of plants in each plot.
3. Give each plant the same amount of water.
4. Apply artificial fertiliser as follows.

EXPERIMENT A Six plots are given water only.

EXPERIMENT B Six plots are given general fertiliser solution containing equal amounts of nitrate, phosphorus and potassium.

EXPERIMENT C Six plots are given nitrogen-rich fertiliser containing nitrate, phosphorus and potassium in the ratio of 5:1:1.

5. Cut the fully grown plants in each plot and place them in plastic bags before weighing them.



- (a) (i) How did the plants growing in **Experiment A** get the minerals they need for healthy growth?

.....
(1 mark)



- (ii) The plants in **Experiment B** and **Experiment C** were given artificial fertiliser containing nitrate, phosphorus and potassium.

Name **one** other mineral needed for healthy plant growth.

.....
(1 mark)

- (iii) Suggest why the plants were placed in plastic bags before they were weighed.

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

- (b) Use the results in the table to help you to answer the questions that follow.

Plot number	EXPERIMENT A Yield in grams	EXPERIMENT B Yield in grams	EXPERIMENT C Yield in grams
1	1306	1395	1530
2	1298	1406	1525
3	1284	1382	1512
4	1329	1379	1532
5	1315	1410	1508
6	1310	1390	1519
Average yield		1394	1521

- (i) Calculate the average yield for **Experiment A**.

.....
Average yield = g
(1 mark)

- (ii) Describe the results of the experiment.

.....
.....
.....
.....
(2 marks)

Turn over ►



(iii) Why does the addition of extra nitrate in **Experiment C** affect the yield in this way?

.....
.....

(1 mark)

(c) The use of large amounts of nitrate in artificial fertiliser causes problems. Rain washes nitrate into rivers, where it causes excessive plant growth and the death of fish. High concentrations of nitrate in drinking water have been linked with health problems in babies.

Explain how the farmer could improve the yield of his crops and at the same time reduce the environmental and health problems described above.

.....
.....
.....
.....

(2 marks)

9

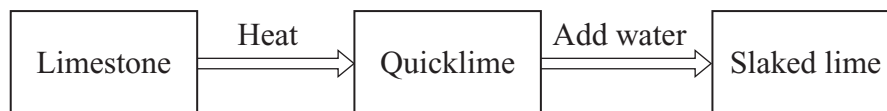


2 Limestone rock is almost pure calcium carbonate.

It is one of the few examples of a compound that can be quarried directly from the earth.

Limestone has a wide variety of uses in the building industry.

Quicklime and slaked lime are important compounds that can be manufactured from limestone.



(a) Give **one** use for limestone in the building industry.

.....
(1 mark)

(b) Complete the table with the chemical names for quicklime and slaked lime.

Common name	Chemical name	Chemical formula
Limestone	Calcium carbonate	CaCO_3
Quicklime		CaO
Slaked lime		Ca(OH)_2

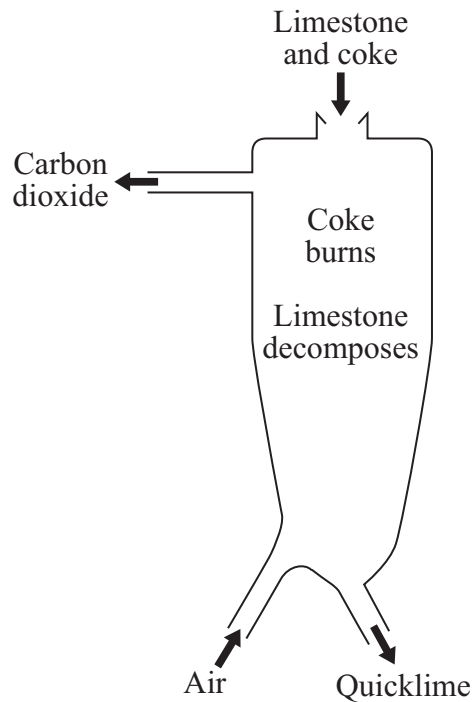
(2 marks)

Question 2 continues on the next page

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(c) Quicklime is manufactured from limestone in a coke-fired kiln.



(i) Coke (carbon) burns in the kiln in an exothermic reaction:



Write the symbol equation for the combustion of coke.

..... + → (2 marks)

(ii) Limestone decomposes in the kiln in an endothermic reaction:



Explain why the limestone does not decompose unless coke is burned in the kiln.

.....

(2 marks)



- (d) A mining company has applied to extend a limestone quarry in an area of natural beauty.

Read the article below and answer the question that follows.

Protesters say NO! to quarry extension

A protest group will march through the village tomorrow to try to prevent the extension of the limestone quarry. Managers from the mining company have agreed to meet the environmental protesters and representatives of local residents so they can present their side of the argument. The mining company has agreed to carry out the blasting and the movement of heavy lorries only at certain times during weekdays. They are keen to stress that the quarry will bring much-needed employment to the area. The company has promised to restore the area when quarrying has finished. They will pay to set up a Ranger service and a local wildlife centre.

Give **two** reasons why you think that the protesters want to prevent the extension of the limestone quarry.

1

.....

2

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(2 marks)

9

Turn over for the next question

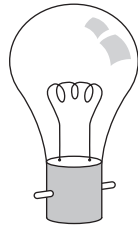
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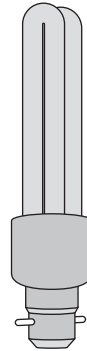
3 Electricity supplied to homes for heating and lighting is expensive.

Efficient electrical devices save money because they use less electrical energy.

The diagram shows two bulbs that give the same amount of light.



60 watt ordinary
light bulb



11 watt low-energy
light bulb

Low-energy light bulbs operate at a much lower temperature than ordinary light bulbs and use less than a quarter of the electricity.

An electrical engineer compared the two types of bulb to encourage customers to buy low-energy bulbs.

	Ordinary light bulb	Low-energy light bulb
Power	60 watts	11 watts
Cost	£0.22	£1.95
Average lifetime	0.5 years	6 years
Cost of electricity used in one year	£14.02	£2.57

- (a) The low-energy light bulb costs less to use per year because it is more efficient.

Percentage efficiency can be calculated using the formula:

$$\% \text{ efficiency} = \frac{\text{useful power transferred by the bulb}}{\text{total power supplied to the bulb}} \times 100$$

- (i) Why are ordinary light bulbs described as being less efficient?

.....

.....

(1 mark)



(ii) Calculate the percentage efficiency of a 60 watt light bulb if 42 watts of power is lost from the bulb as heat.

.....
.....

% efficiency =
(2 marks)

(b) Most customers decide not to buy low-energy light bulbs even though they are more efficient.

(i) Why do most customers decide not to buy low-energy light bulbs?

.....
.....

(1 mark)

(ii) Use calculations, and data from the table, to help you to explain why customers should buy low-energy light bulbs.

.....
.....
.....
.....
.....
.....

(3 marks)

(c) Describe **two** other ways in which customers can reduce the amount of electrical energy used in their homes.

1
.....

2
.....

(2 marks)

9

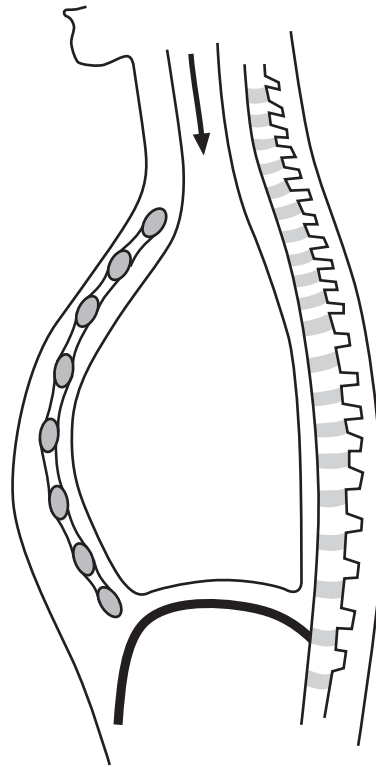
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4 A fitness instructor gives advice to his client about the importance of regular exercise.

He explains to the client how we breathe in and that vigorous exercise will result in deeper breathing and an increase in breathing rate.

(a) The diagram shows the human thorax.



(i) Label the **four** main parts of the thorax that are important in breathing. (4 marks)

(ii) Explain how the movement of parts of the thorax enables you to breathe in.

.....

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(4 marks)



(b) Describe how the fitness instructor could measure the breathing rate of his client.

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.....
.....

(2 marks)

(c) If you exercise vigorously, your breathing rate will increase and you will breathe more deeply.

Explain why.

.....
.....
.....
.....

(2 marks)

12

Turn over for the next question

Turn over ►



5 The properties of a material are controlled by its chemical structure.

Scientists and engineers use their knowledge of chemical structure to make the best use of a material.

The chemical building blocks of all materials are elements and their atoms.

(a) The elements can be divided into metals and non-metals.

Write **four** typical properties of non-metals in the table below.

Properties of non-metals	
1	
2	
3	
4	

(4 marks)

(b) Give the name or symbol of an element to match each of the descriptions below.

(i) An element that can be used straight from the ground.

.....
(1 mark)

(ii) A reducing agent that is used to extract metals from metal ores.

.....
(1 mark)

(iii) An element that is often used to make a roof watertight.

.....
(1 mark)

(iv) A low-density metal that is used to make lightweight structures.

.....
(1 mark)



(c) The element chlorine is a toxic gas that is used to sterilise drinking water.

Particles of chlorine can exist as atoms, as molecules, or as ions.

(i) Write the formula for a chlorine molecule.

.....
(1 mark)

(ii) How does an atom of chlorine become a chloride ion (Cl^-)?

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

10

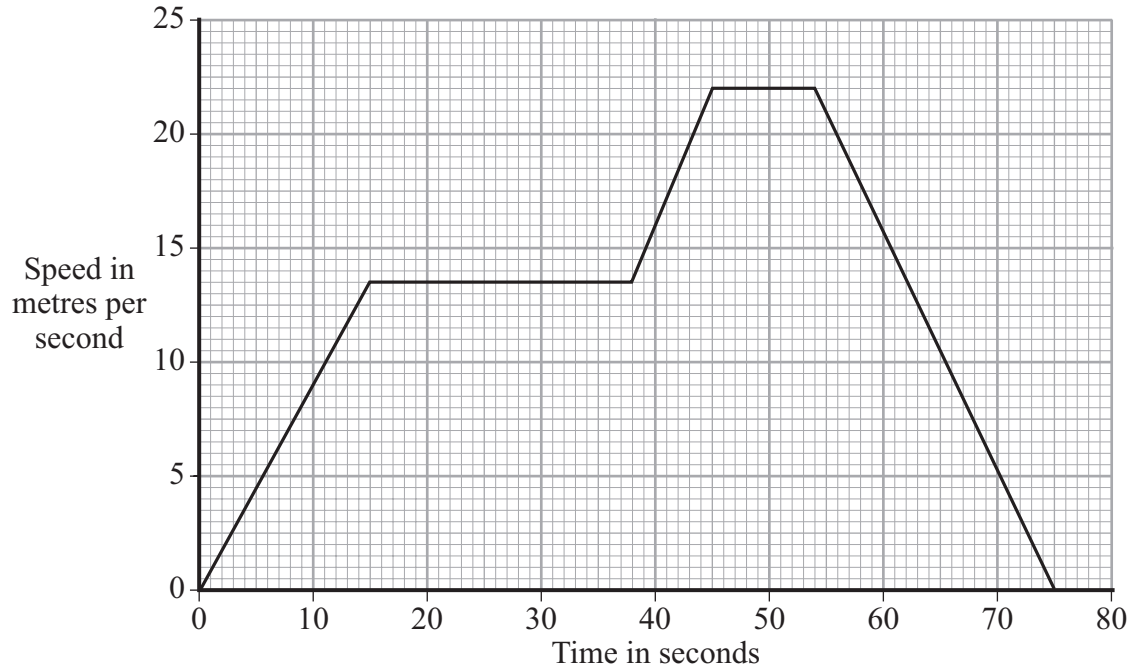
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Turn over ►



- 6 A road transport engineer monitored the flow of traffic by recording the speed of vehicles over a period of time.

She plotted a graph to show how the speed of a car changed during a period of 75 seconds.



- (a) The graph shows that the car travelled at a speed of 13.5 metres per second for 23 seconds.

Calculate the distance travelled by the vehicle in this time.

.....

.....

.....

.....

(3 marks)



- (b) The graph shows that the car accelerated from a speed of 13.5 metres per second to a speed of 22.0 metres per second in 7 seconds.

Calculate the acceleration of the vehicle.

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.....
.....
.....

(3 marks)

- (c) Describe what happens to the movement of the vehicle between the 45th second and the end of the journey.

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

9

Turn over for the next question

Turn over ►



- 7 Medical scientists have discovered how genetic information is stored in our cells and how this information is passed on to our children.

This knowledge can be used to develop treatments for inherited diseases such as cystic fibrosis.

- (a) The information in the boxes describes the structures that store genetic information in cells.

Write the names of the structures described in the boxes below.

Structure	Description
	The densest part of the cell. It contains the genetic information.
	The structures that carry the genes.
	A different version of the same gene. It can be dominant or recessive.

(3 marks)



(b) Cystic fibrosis is the UK's most common life-threatening inherited disease. Symptoms include poor weight gain, breathing problems and repeated chest infections. Cystic fibrosis usually affects the lungs, which become clogged with a thick, sticky mucus. Cystic fibrosis is caused by a faulty gene. One in 25 of the UK population carries the faulty gene. If both parents carry the faulty gene there is a chance that they will have a child with cystic fibrosis. Medical scientists are working towards a cure using genetic engineering and the first step has been to identify the faulty gene.

(i) Using the symbols

F for the normal gene and

f for the faulty gene,

draw a diagram to show how cystic fibrosis can be inherited from two parents who both carry the faulty gene but do not have the disease.

Make sure that your **F** and **f** symbols are clear.

Label the offspring that is affected by cystic fibrosis.

(4 marks)

(ii) What is the chance of the parents in part (b)(i) having a child with cystic fibrosis?

.....
(1 mark)

Question 7 continues on the next page

Turn over ►



(iii) Suggest how medical scientists can cure cystic fibrosis using genetic engineering.

.....
.....

(1 mark)

(iv) Give **two** reasons why some people might object to the use of genetic engineering.

1

.....

2

.....

(2 marks)

11



- 8 The products we buy from the supermarket contain mixtures of materials. The materials may be solids, liquids or gases, and they can be mixed together in different ways.

The labels from three household cleaning mixtures are shown.

Use the information on the labels to help you to answer the questions that follow.

- (a) Cream Cleaner is designed to remove stubborn stains from tiles in the bathroom and kitchen.

Cream Cleaner

Scouring action for removing stubborn stains
500 ml

HOW TO USE
Shake the bottle before use.
Squeeze the suspension onto a damp cloth or directly onto the surface.
Wipe over gently and rinse thoroughly.

CAUTION!
Do not use on soft plastic surfaces, aluminium or glass.
Avoid prolonged contact with skin.
The wearing of rubber gloves is recommended.
Keep away from eyes.
Keep out of reach of children.

CONTENTS
Detergent
100 cm³ of the cleaner contains approximately 20 g of insoluble solid.

- (i) Cream Cleaner is used in the form of a suspension.

Describe the composition of a suspension.

.....

.....

(1 mark)

- (ii) Explain how the composition and form of this mixture make it suitable for removing stubborn stains from tiles in the bathroom and kitchen.

.....

.....

.....

.....

(2 marks)

Turn over ►



(b) Bathroom Power Gel is designed to clean vertical surfaces in the bathroom.

Bathroom Power Gel

Clings to vertical surfaces
Removes limescale, dirt and soap scum
500 ml

How to use
Apply the gel to the surface to be cleaned
Allow to soak for up to 2 minutes
Wipe off with a cloth

Caution
Avoid contact with skin
Irritating to eyes
Keep out of reach of children
If swallowed seek medical advice

Contents
Detergent
Perfume
Colour

(i) Bathroom Power Gel is used in the form of a gel.

Describe the composition of a gel.

.....
.....

(1 mark)

(ii) Explain how the composition and form of this mixture make it suitable for cleaning vertical surfaces in the bathroom.

.....
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.....
.....

(2 marks)



(c) Multi-Purpose Spray is designed to clean a variety of surfaces around the home.

Multi-Purpose Spray
 Leaves a fresh smell around the home
 500 ml

HOW TO USE
 Keep the spray upright
 Spray the soiled surface until thoroughly covered
 Wipe with a dry or damp cloth

CAUTION
 Do not inhale the aerosol
 Rinse hands thoroughly after use
 In case of contact with eyes,
 rinse immediately with plenty of water
 Keep out of reach of children

CONTENTS
 Detergent
 Perfume
 Disinfectant
 Colour

(i) Multi-Purpose Spray is used in the form of an aerosol.

Describe the composition of an aerosol.

.....
.....

(1 mark)

(ii) Explain how the composition and form of this mixture make it suitable for cleaning a variety of surfaces around the home.

.....
.....
.....
.....

(2 marks)

9

Turn over for the next question

Turn over ►



9 Fuel scientists develop and blend fuels for use in motor vehicles.

A good fuel has the following characteristics:

- volatile
- easy to ignite
- produces a large amount of energy when it burns
- produces the minimum amount of pollution.

Information about some of the hydrocarbons that are found in petrol is given in the table.

Name	Chemical formula	Melting point in °C	Boiling point in °C
Butane	C_4H_{10}	-138	0
Pentane	C_5H_{12}	-130	36
Hexane	C_6H_{14}	-95	69

(a) Hydrocarbons are compounds with low boiling points.

(i) Name the type of chemical bonding in hydrocarbons.

.....
(1 mark)

(ii) Explain why hydrocarbons have low boiling points.

.....
.....
(2 marks)

(b) Heptane is a hydrocarbon. It has molecules containing 7 carbon atoms.

Suggest the chemical formula for heptane.

.....
(1 mark)



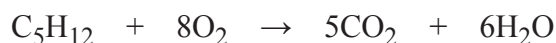
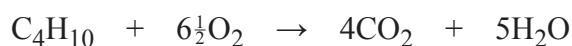
- (c) A fuel scientist recommended increasing the amount of butane and decreasing the amount of hexane in the petrol that is used in the UK in winter.

Use the information in the table to explain why.

.....
.....
.....
.....

(2 marks)

- (d) Balanced equations for the complete combustion of butane and pentane are given below.



- (i) Write a balanced equation for the combustion of hexane.

.....
(1 mark)

- (ii) Describe the pattern in these equations.

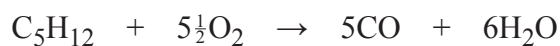
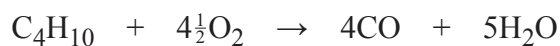
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(2 marks)

Question 9 continues on the next page

Turn over ►



- (e) Balanced equations for the incomplete combustion of butane and pentane are given below.



- (i) Why does incomplete combustion occur in a car engine?

.....
.....

(1 mark)

- (ii) Give **two** disadvantages of incomplete combustion.

1
.....

2
.....

(2 marks)

12

END OF QUESTIONS

