Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

3445UA0-1

S17-3445UA0-1

APPLIED SCIENCE (Double Award)
Unit 1: Energy, Resources and the Environment
HIGHER TIER

WEDNESDAY, 14 JUNE 2017 – MORNING

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**19**	
2.	**12**	
3.	**9**	
4.	**6**	
5.	**13**	
6.	**16**	
Total	**75**	

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ADDITIONAL MATERIALS

In addition to this paper you will require a calculator, pencil and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question 5*(b)* is a quality of extended response (QER) question where your writing skills will be assessed.

You are reminded to show all your workings. Credit is given for correct workings even when the final answer given is incorrect.

A periodic table is printed on page 16.

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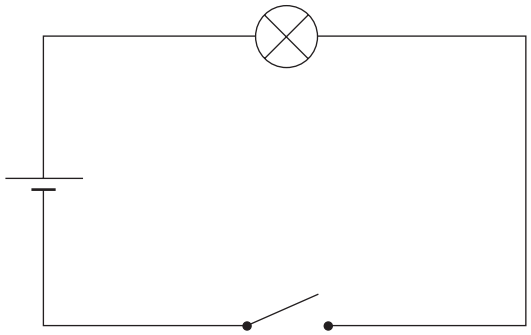
Answer **all** *the questions in the spaces provided.*

1. Students are investigating how the current through a lamp varies with the voltage across it.



(a) (i) Part of the circuit used is shown above. **Add** a variable resistor, ammeter and voltmeter to the circuit diagram. [3]

(ii) Describe the method you would use to take a range of results. [3]

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(b) Results from the experiment are shown below.

Voltage (V)	Current (A)
0.0	0.0
0.5	0.5
2.0	0.8
4.0	1.1
6.0	1.4
8.0	1.6
10.0	1.8
12.0	1.9

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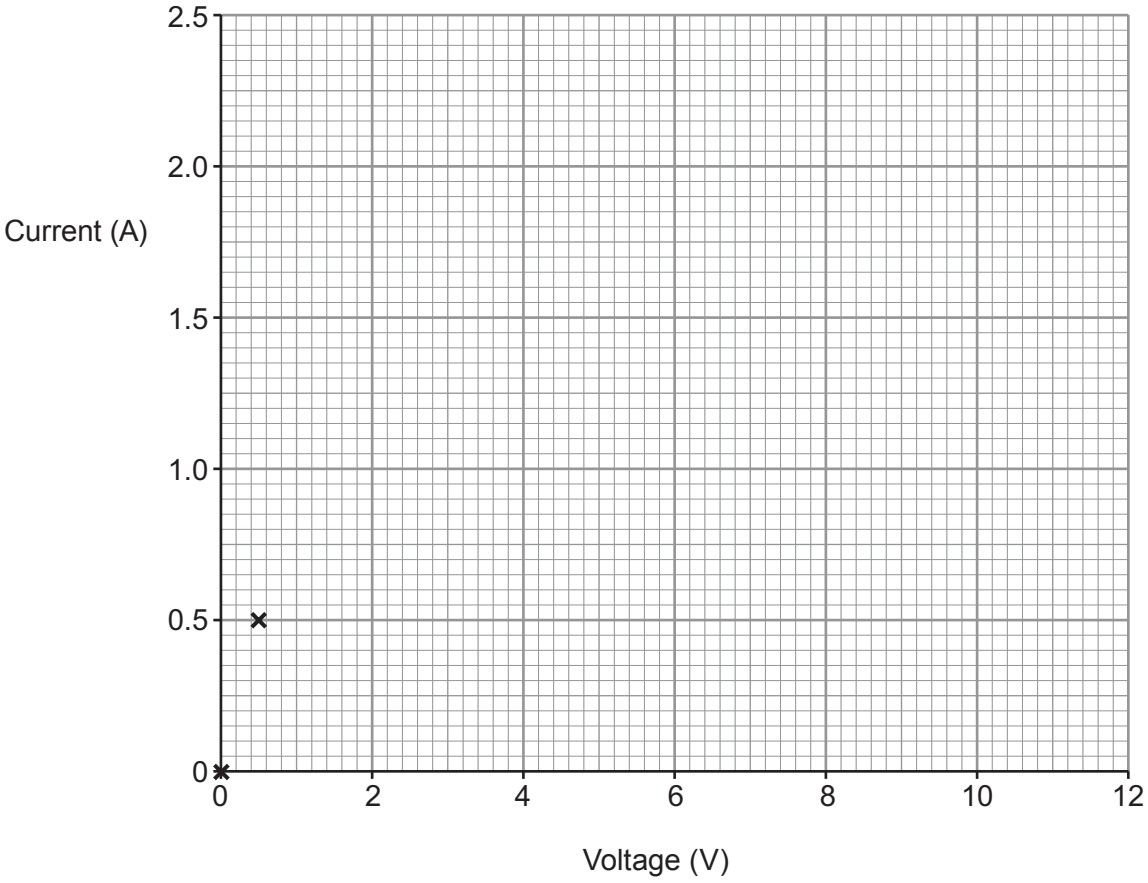
(i) Plot the data on the grid below and draw a suitable line. [3]

The first two points have been plotted for you.



(ii) Describe the relationship between current and voltage for the lamp. [2]

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(c) (i) Use the equation:

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

to calculate the resistance of the lamp at 0.5 V. [2]

resistance = ... Ω

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(ii) State how the resistance of the lamp varies between 0.5 V and 12 V. [1]

.....

(d) (i) Use the equation:

power = voltage × current

to calculate the power of the lamp at 0.5 V. [2]

power = ... W

(ii) State how the power of the lamp varies between 0.5 V and 12 V. [1]

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(e) The experiment was repeated with a length of wire at constant temperature. The current through the wire was 1.5 A when the voltage across it was 12 V.

Add a line to your graph to show how current varies with voltage for this wire. [2]

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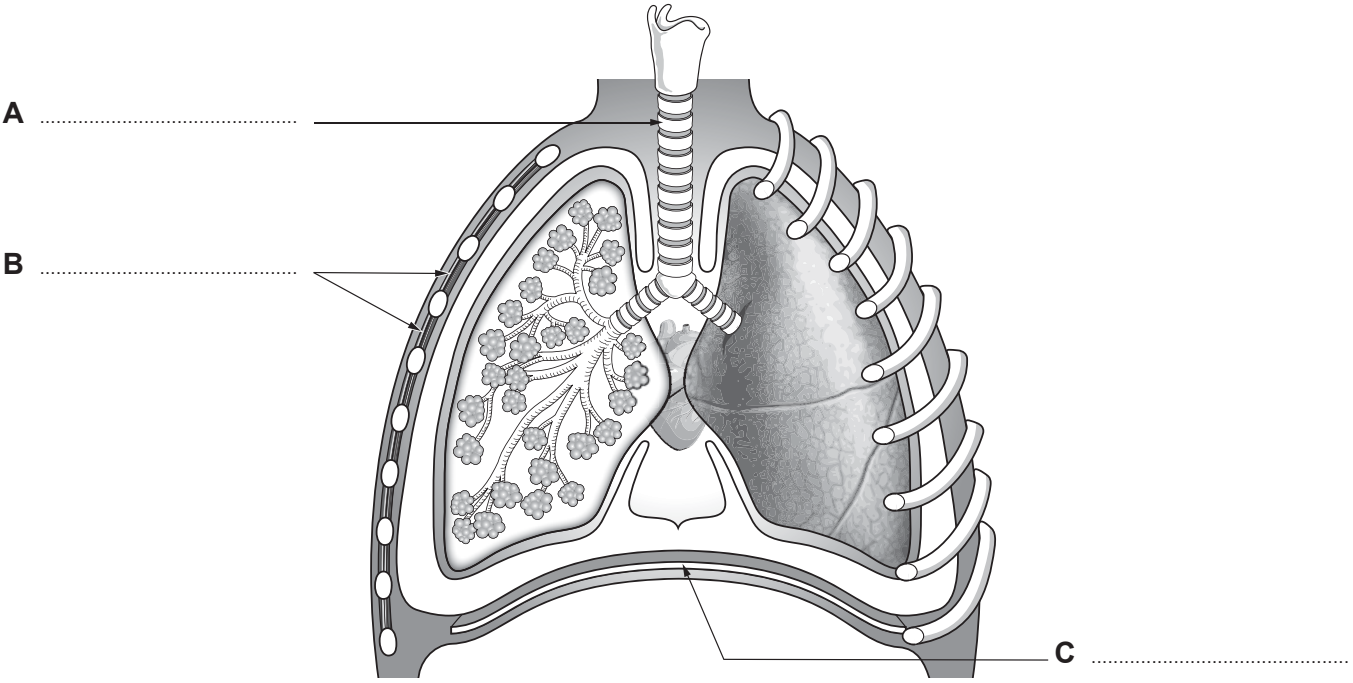
2. Sports science students are learning about the human respiratory system.



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(a) (i) Label the diagram. [3]

(ii) Explain how changes to **B** and **C** allow us to breathe in. [3]

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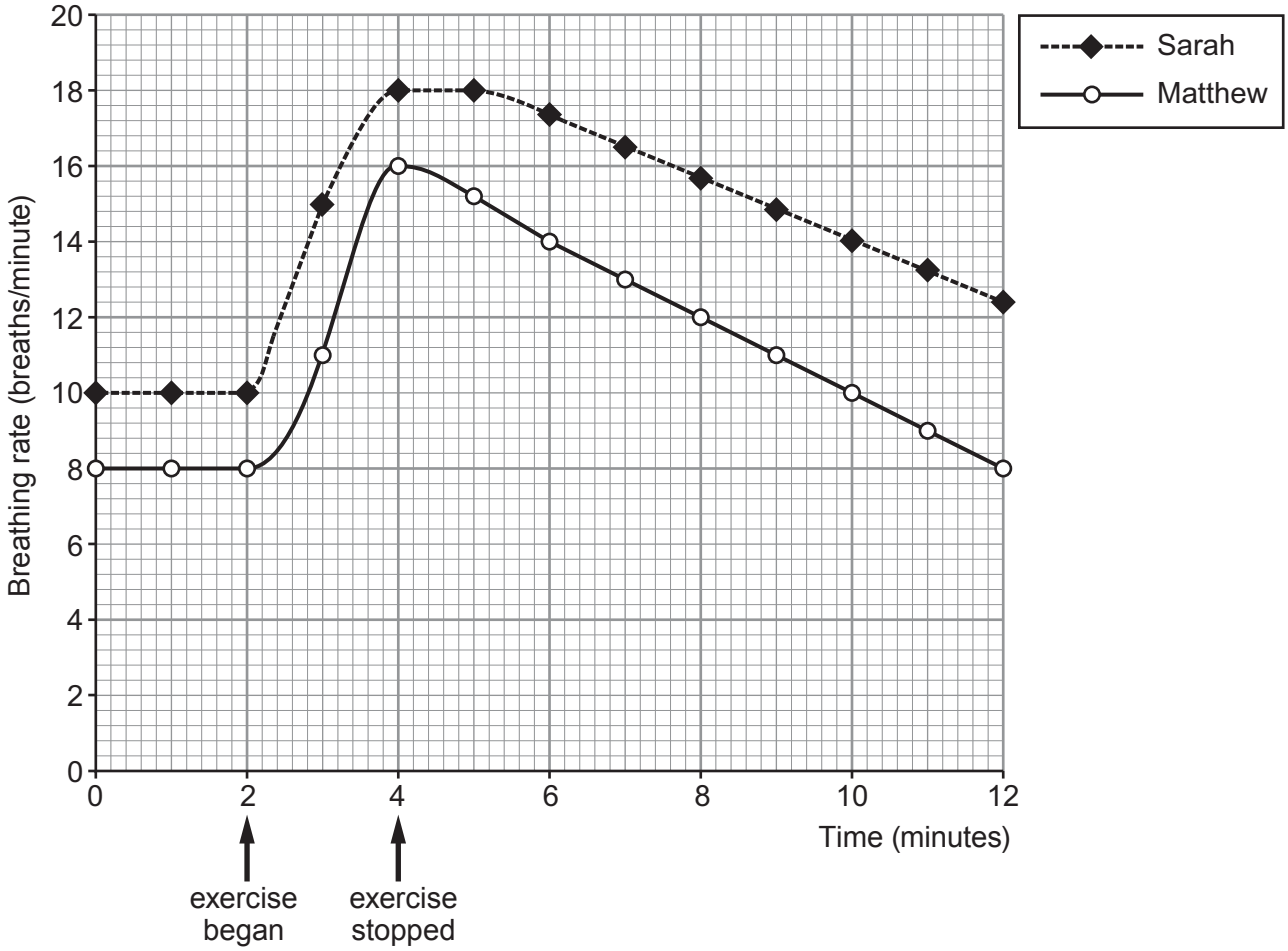
(b) Two students, Matthew and Sarah, studied the effect of exercise on breathing rate. They followed the method below:

1. record breathing rate before exercising
2. exercise for 2 minutes by running on a treadmill
3. measure the breathing rates during and after exercise up until 12 minutes

Their results are shown on the graph below.



Compare the changes in breathing rate of Sarah and Matthew between 8 and 12 minutes. [3]

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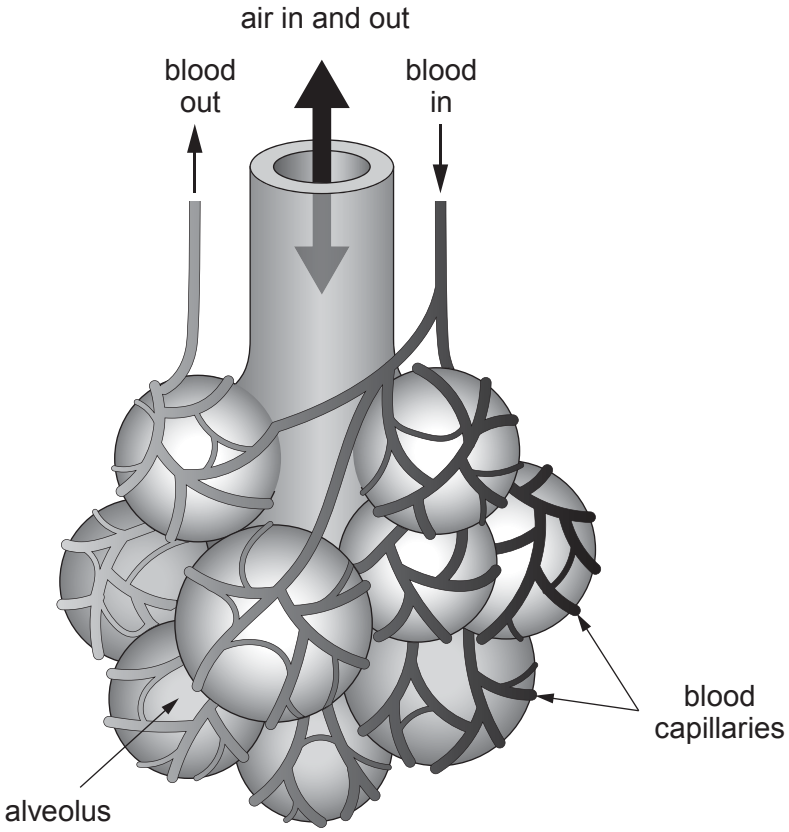
(c) Explain the process of gas exchange between the blood and the air inside the alveoli. [3]



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12

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3. Magnesium oxide has various applications in water treatment. It is an effective base, offering a safe method of changing pH compared to other neutralising agents such as caustic soda. It also helps prevent scale formation in boilers, heat exchangers, and piping.

(a) State **one** adverse effect of scale on household plumbing. [1]

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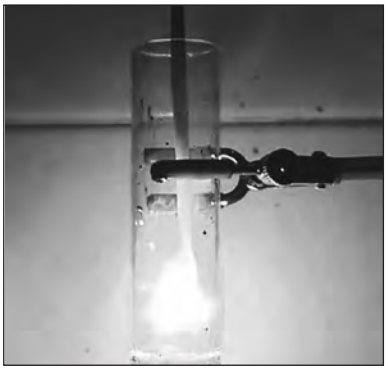
(b) Burning magnesium in a gas jar of oxygen produces magnesium oxide on a small scale.



(i) Describe the atomic structure of magnesium. [3]

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(ii) Draw a diagram to show the electronic structure of a magnesium atom. [1]

(iii) Write a balanced symbol equation for the reaction between magnesium and oxygen. [3]

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(iv) State how the electron configuration of a magnesium atom changes when magnesium reacts with oxygen. [1]

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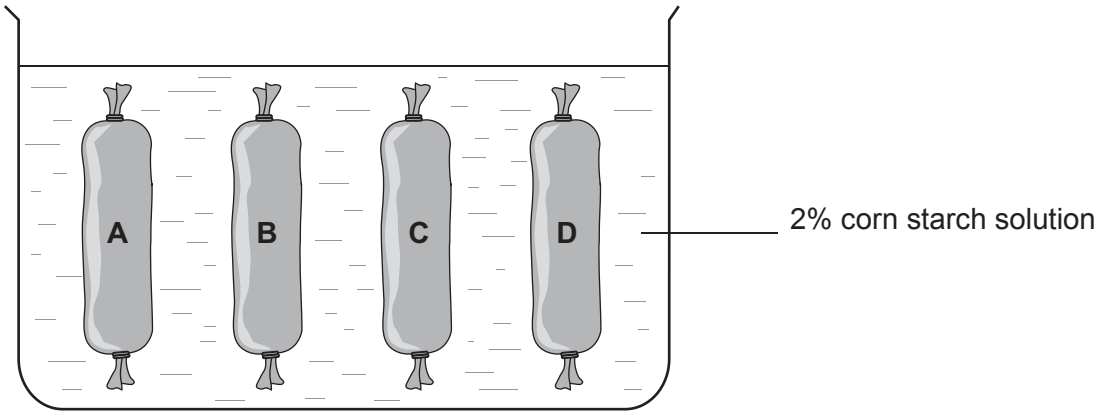
4. Starch is usually insoluble in water, but some types of starch e.g. corn starch can be treated to dissolve in water. Four pieces of Visking tubing **A**, **B**, **C** and **D**, contain equal volumes of corn starch solution of different concentrations. They are placed in a beaker containing a 2% corn starch solution and left for 45 minutes.



(a) Describe, in terms of molecules, the structure of starch. [2]

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(b) After 45 minutes:
- the volume of **A** is unchanged
- the volume of **B** has increased
- the volume of **C** has decreased
- the volume of **D** has increased more than **B**

(i) Explain which tube contained a corn starch solution of lower concentration than that in the beaker. [2]

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(ii) Explain why tube **A** must have contained the 2% corn starch solution. [2]

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6

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5. The periodic table of elements is ordered by atomic number and electron configuration.

The tables below show some properties of alkali metals (group 1) and halogens (group 7).

Alkali metal	Atomic number	Melting point (°C)	Boiling point (°C)	Density at 20°C (g/cm^3)	Radius of the atom (units)
lithium	3	180.5	1 342	0.534	1.67
sodium	11	97.7	883	0.971	.....
potassium	19	.....	759	0.862	2.43
rubidium	37	39.3	688	1.532	2.65
caesium	55	28.4	671	1.873	2.98
francium	87	27.0	677		

Halogen	Atomic number	Melting point (°C)	Boiling point (°C)	Density at 20°C (g/cm^3)	Radius of the atom (units)
fluorine	9	–219	–188	0.0017	0.64
chlorine	17	.....	–34	0.0032	0.99
bromine	35	–7	59	3.1	1.14
iodine	53	114	184	4.9	1.33
astatine	85	302	380	7.0	1.40

Use the information in the tables and your knowledge to answer the following questions.

(a) **Complete** the tables by estimating the missing values. [3]

(b) Compare the properties of the alkali metals and their trends with those of the halogens. [6 QER]

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(c) Explain why the reactivity of halogens changes from the top to the bottom of the group. [3]

(d) **Tick** (✓) the box next to the pair of elements that would react **most** violently. [1]

chlorine and lithium ☐

fluorine and lithium ☐

chlorine and sodium ☐

fluorine and sodium ☐

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6. Rising energy prices are affecting many households. The government can help households keep their energy bills as low as possible. Domestic buildings account for about 35% of final UK energy consumption. Of this, heating rooms is responsible for about 60% and heating hot water accounts for about 15%. The UK is committed to reduce the CO_2 emissions caused by domestic buildings by 80% by 2050.

Statistics for a typical house with no insulation are shown below. The table also shows government estimates of the current usage of each method.

Part of house	Heat loss from uninsulated house (%)	Method of reducing heat loss	Cost (£)	Annual saving on energy bills (£)	% of homes already using this method
roof	25	loft insulation	450	150	91
windows & doors	10	double glazing	3900	90	70
walls	40	cavity wall insulation	1200	250	42
floor	15	carpets	800	40	90
draughts	10	draught excluders	60	5	85

At present, of the 95% of homes with boilers, 800000 have no controls at all and over 70% lack a timer, sufficient hot water tank insulation, room thermostat and thermostatic radiator valves. It is estimated that upgrading all homes so they have these four features could save 30% of the energy used for heating and hot water.

(a) A heating engineer estimates that to maintain the uninsulated house with no heating controls at 20°C will cost £1800 in energy bills per year.

Use the information above to answer the following questions.

(i) Calculate how much of this energy cost is lost through the roof. [2]

cost = £ .....

(ii) The engineer recommends that loft insulation should be installed first.

Explain why this is the best advice even though it will not make the biggest saving in energy bills. [2]

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(iii) Explain why the engineer can only estimate the cost of the energy bills. [3]

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(iv) After fitting a timer, new hot water tank insulation, room thermostat and thermostatic radiator valves a householder's energy bills would reduce to £1 300. Explain whether this is consistent with the estimated saving of 30% of the energy used. [4]

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(v) Use the equation:

$$\text{units used} = \frac{\text{total cost}}{\text{cost of one unit}}$$

to calculate the decrease in units used if the savings in part (iv) above were made. [3]

Assume each unit costs 18 p.

Decrease in units used = ... kWh

(b) Explain how reducing household energy loss will benefit the environment. [2]

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END OF PAPER

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THE PERIODIC TABLE

1	2	Group										3	4	5	6	7	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key