Candidate Name	Centre Number					Candidate Number				
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GCSE

PHYSICS

UNIT 1: ELECTRICITY, ENERGY and WAVES

HIGHER TIER

SAMPLE ASSESSMENT MATERIALS

(1 hour 45 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**6**	
3.	**9**	
4.	**9**	
5.	**13**	
6.	**6**	
7.	**12**	
8.	**11**	
Total	**80**	

ADDITIONAL MATERIALS
In addition to this paper you will require a calculator.

INSTRUCTIONS TO CANDIDATES
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
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 **4(a)** is a quality of extended response (QER) question where your writing skills will be assessed.

Equations

current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
total resistance in a series circuit	$R = R_1 + R_2$
total resistance in a parallel circuit	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
energy transferred = power × time	$E = Pt$
power = voltage × current	$P = VI$
power = current^2 × resistance	$P = I^2R$
% efficiency = $\frac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}} \times 100$	
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
wave speed = wavelength × frequency	$v = \lambda f$
speed = $\frac{\text{distance}}{\text{time}}$	
pressure = $\frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
p = pressure V = volume T = kelvin temperature	$\frac{pV}{T}$ = constant
	T / K = θ / °C + 273
change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = mc\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$Q = mL$
force on a conductor (at right angles to a magnetic field) carrying a current = magnetic field strength × current × length	$F = BIl$
V_1 = voltage across the primary coil V_2 = voltage across the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

SI multipliers

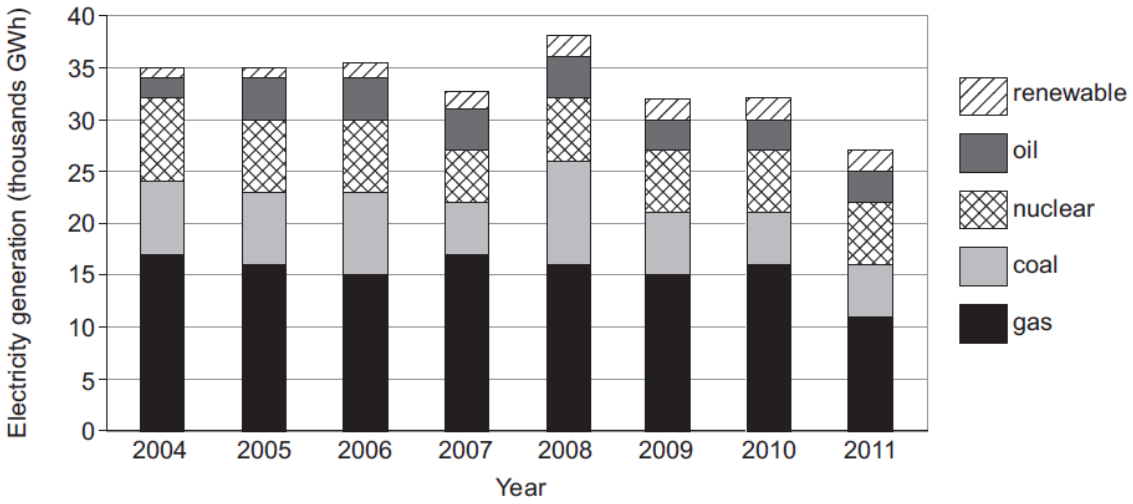
Prefix	Multiplier
p	1×10^{-12}
n	1×10^{-9}
μ	1×10^{-6}
m	1×10^{-3}

Prefix	Multiplier
k	1×10^{3}
M	1×10^{6}
G	1×10^{9}
T	1×10^{12}

Answer **all** *questions*

1. Renewable energy is a general term used to describe any source of energy that occurs naturally and is not exhaustible. Developing renewable energy sources for electricity generation is necessary to meet EU and UK Government targets on greenhouse gas emissions and to ensure fuel security. In its 2010 Energy Policy Statement, "*A low carbon revolution",* the Welsh Government set out aspirations totalling 22.5 gigawatts (22.5 GW) of installed capacity from different renewable energy technologies in Wales by 2020/25.

Figure 1: Generation of electricity by energy sources in Wales 2004 -2011



Source: Department of Energy and Climate Change, Welsh Government.

Between 2004 and 2010 the total amount of electricity generated in Wales fluctuated between 32 000 GWh and 38 000 GWh with no consistent trend. In 2011 the total amount of electricity generated in Wales fell to 28 000 GWh.

There are proposals for new power stations to be built in Wales. The most significant is a new nuclear power station at Wylfa B. It has the potential to generate 23 000 GWh each year.

(a) (i) In the article published by the Welsh Government, the 2010 Energy Policy Statement refers to "*A low carbon revolution".* Discuss what this term means for the future of electricity generation in Wales. [2]

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(ii) Use **Figure 1** to identify the trends in the generation of electricity using different energy sources between 2009 and 2011. [2]

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(iii) In 2011 consumers in Wales used 45 000 GWh of electrical energy. Describe how the shortfall between supply and demand was met. [2]

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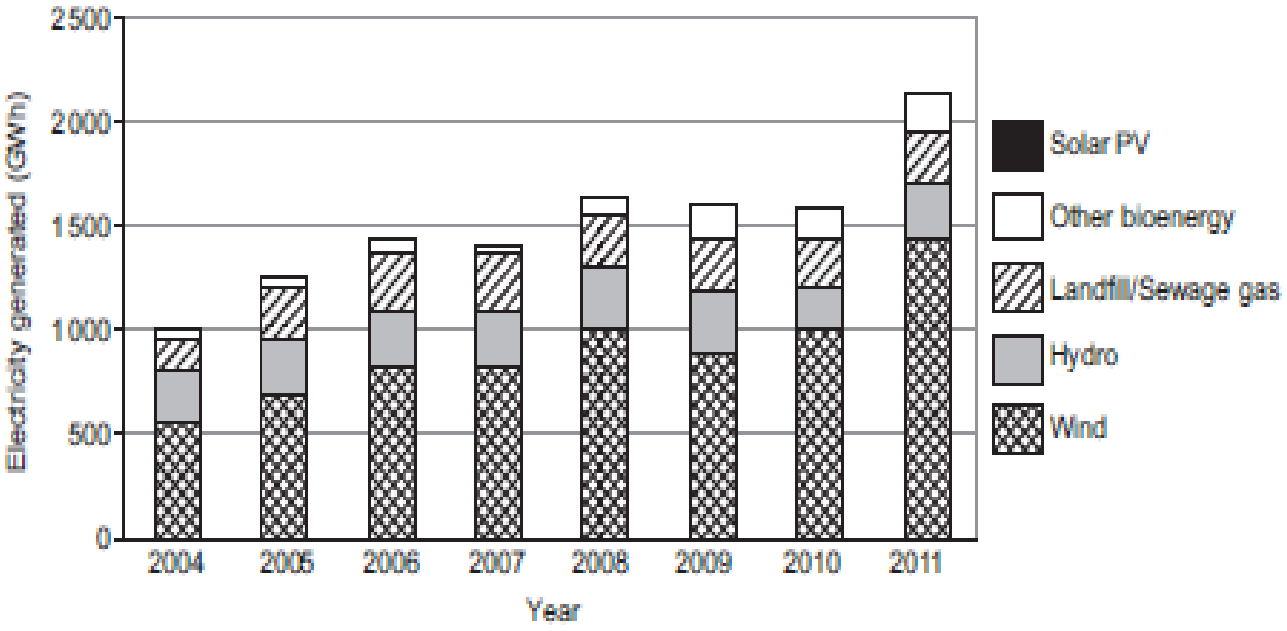
(iv) If the new nuclear power station at Wylfa B had been commisioned and used at maximum power in 2011 how much surplus electrical energy would Wales have produced? [2]

electrical energy = ……..GWh

(b) **Figure 2** shows a general upward trend in the amount of electrical energy generated from renewable sources in Wales between 2004 and 2011, reaching a maximum of 2 160 GWh in 2011.

Figure 2: Electricity generated from renewable sources in Wales, 2004 - 2011



(i) State which renewable energy source didn't make a contribution to the electrical energy generated in Wales between 2004 and 2011. [1]

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(ii) For the period considered (2004-2011) the total amount of electricity generated from renewables in Wales changes considerably. Explain which renewable energy source was mainly responsible for this change. [2]

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(c) Since 2011 considerably more Welsh homes have had PV cells installed. Describe and explain how a bar on the chart of **Figure 2** could look for 2015. [3]

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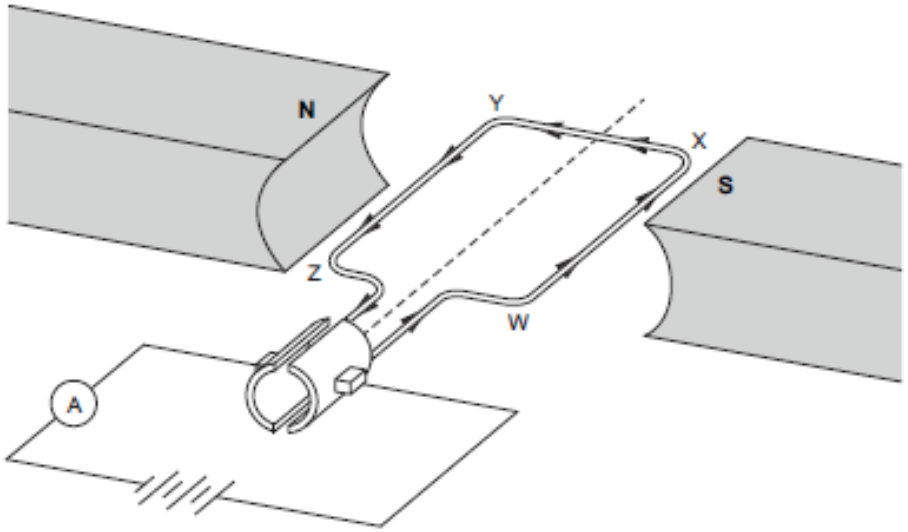
2. The diagram represents a simple electric motor that a pupil investigates in their lesson.



The current in the coil flows from **W** to **Z**. This is shown on the diagram.

(a) (i) Explain clearly how you would use Flemings left hand rule to determine the direction of the force on the side **YZ**. [3]

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(ii) State **one** change the student could make so that side **YZ** of the coil moves in the opposite direction. [1]

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(b) State **two** changes that could be made to make the coil rotate faster. [2]

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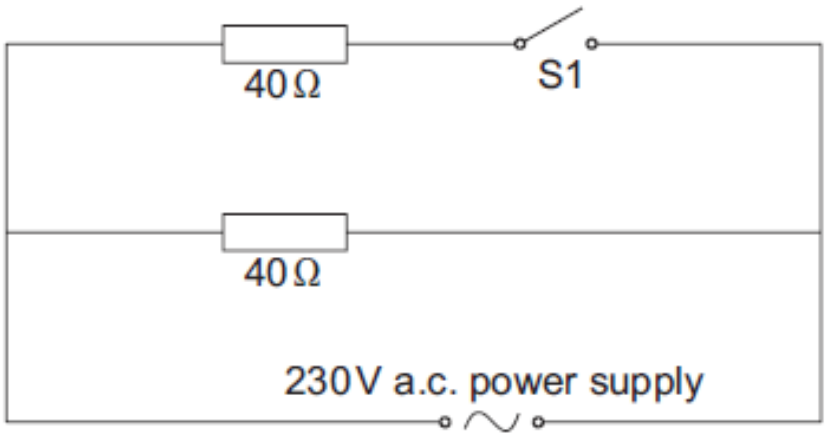
3. The circuit diagram shows a simplified version of the heating circuit used in a hairdryer. The switch (S1) can be closed so that the hairdryer blows hotter air.



Select and use equations from page 2 to answer the following questions.

(a) (i) Calculate the current supplied by the a.c.power supply when **S1 is open**. [3]

current = ……. A

(ii) Calculate the power produced by the resistor when **S1 is open**. [3]

power =…….. W

(b) The company who make the hairdryer state that the amount of heat energy produced each second will double when the switch (S1) is closed. Discuss if their claim is correct. [3]

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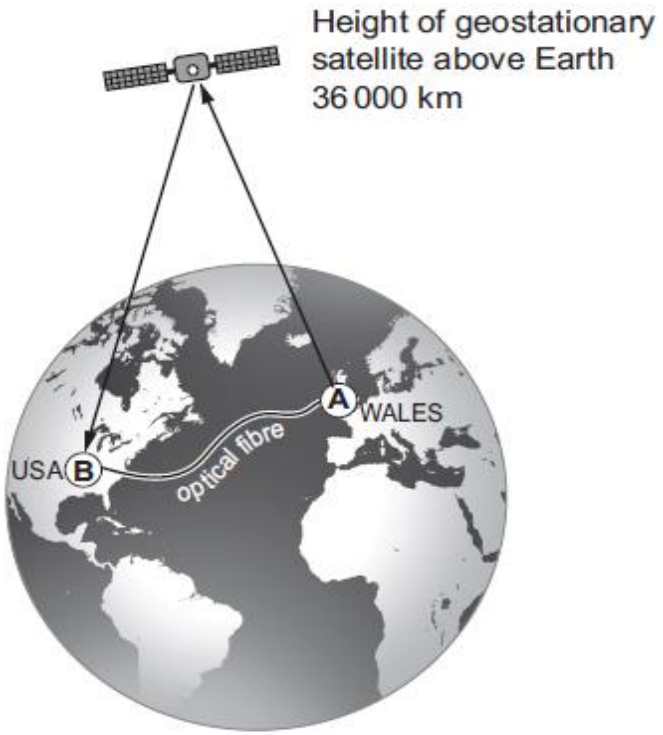
4. An optical fibre between Wales and the USA has a length of 9 000 km. The electromagnetic wave used to send information along the optical fibre travels at ½ the speed of an electromagnetic wave in a vacuum (space).



(a) A top secret and urgent message needs to be sent from the Welsh Government (Wales) to the White House (USA). The two methods available are:

1. via geostationary satellite;
2. via optical fibre.

Compare the two methods, stating any advantages or disadvantages (other than cost) of using them. [6 QER]

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(b) A geostationary satellite is a special type of satellite as it stays directly above the same point on the Earth. State the conditions needed to achieve this. [3]

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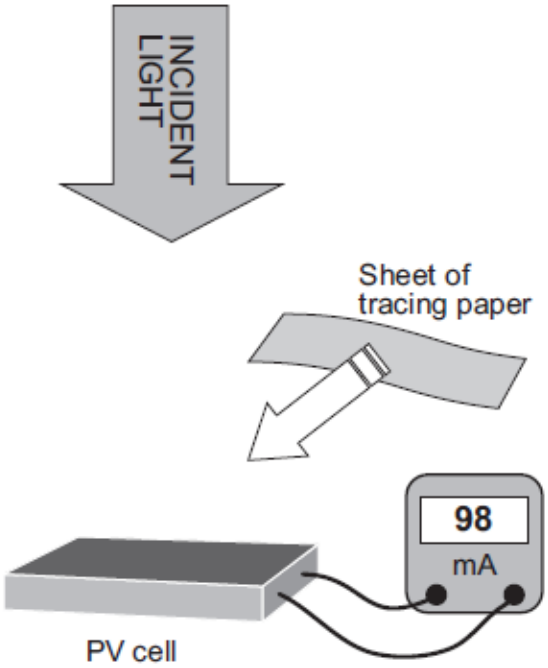
9

5. Solar cells (PV cells) are used on many houses to generate electrical energy, saving each homeowner money for every kWh of energy produced.

A student makes this prediction to his teacher.
"*I think that thicker clouds will reduce the electrical current generated from a PV cell. The current they produce will be inversely proportional to the thickness of the cloud.*"

The teacher decides to test out this prediction with 6 groups in his class. He decides that tracing paper will be a suitable way to model clouds.



A large sheet of tracing paper is placed over the PV cell.
The current on the milliammeter is recorded.
Extra sheets of tracing paper are then placed over the PV cell. More data are collected.
More sheets of tracing paper model thicker clouds.

Group 1 results

Number of sheets of tracing paper	Trial 1 Current (mA)	Trial 2 Current (mA)	Mean current (mA)
0	100	99	100
1	77	79	78
2	61	60	61
3	50	46	48
5	32	32	32
7	25	19	22
8	18	17	.....

(a) (i) **Complete the table** opposite for the missing mean current when 8 sheets of tracing paper are covering the PV cell. [1]

(ii) Which pair of readings from the experiment are **least** repeatable? [1]

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(iii) To find an uncertainty of a mean value obtained from two pieces of data the following expression can be used:

$$\text{uncertainty} = \frac{\text{trial 1 value} - \text{trial 2 value}}{2}$$

Using data in the table, calculate the uncertainty in the mean for 3 sheets of tracing paper. [1]

uncertainty = …….mA

(iv) The teacher asks the 6 groups to compare their results with each other. Explain the purpose of comparing results with other groups. [2]

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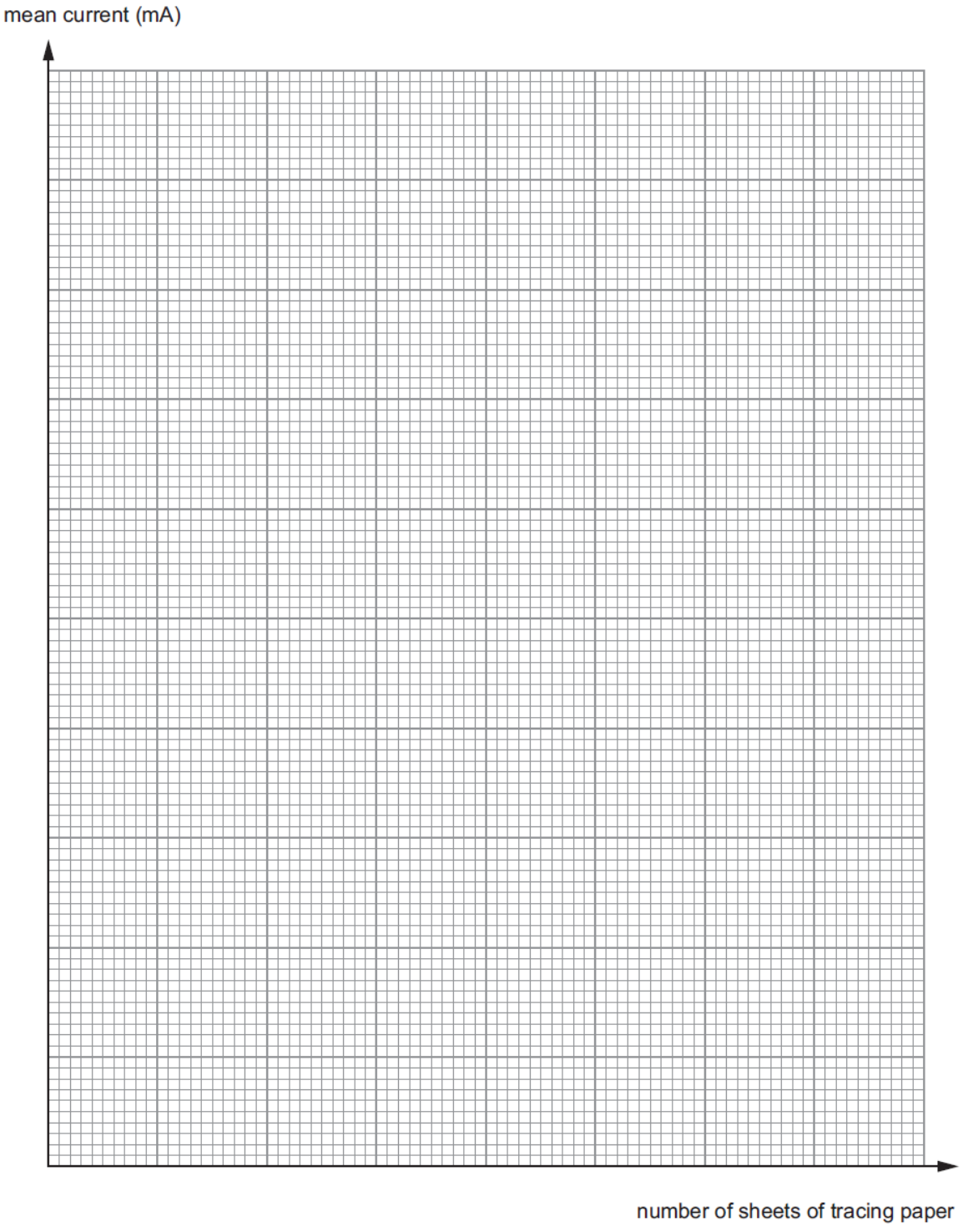
(b) (i) Use the data in the table to plot a graph on the grid below. [3]



(ii) Using information from **the graph** discuss if the student's prediction is justified. [3]

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(c) Use the findings from this experiment to explain why, in practice, the amount of money saved per day by a homeowner will vary. [2]

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13

6. Metal aerosol cans contain a gas at high pressure. For safety reasons the can must be able to withstand pressures up to 620 kPa. A pressure greater than this value will cause the can to explode.

A can containing a fixed mass of gas is thrown into a bonfire. It is heated from 27 ^{o}C to 227 ^{o}C.

(a) Using the model of molecular motion explain why the pressure of the gas inside the can will increase when thrown into the bonfire. [2]

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(b) The original pressure (at 27 ^{o}C) of the gas in the can was 280 kPa.
Use an equation from page 2 to determine whether or not the can explodes when thrown into the bonfire. [4]

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7. The information given in the table below states the specific heat capacity of different substances.

Substance	**Specific heat capacity (J/kg ^{o}C)**
water	4 200
oil	2 100
aluminium	880
copper	380

(a) (i) Aluminium has a specific heat capacity of 880 J/kg ^{o}C. Explain what this statement means. [2]

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(ii) A 0.75 kg block of aluminium is heated from 20 ^{o}C to 80 ^{o}C. Use an equation from page 2 to calculate the heat energy supplied to the aluminium block. [2]

energy supplied = ……J

(b) The hot aluminium block is now submerged into an insulated beaker of water. The mass of the water in the beaker is 0.50 kg. The final temperature of the water and aluminium block is 30.5 ^{o}C. Calculate the original temperature of the water. [5]

temperature = …… ^{o}C

(c) Explain which of oil or water is a better coolant in a car radiator. [3]

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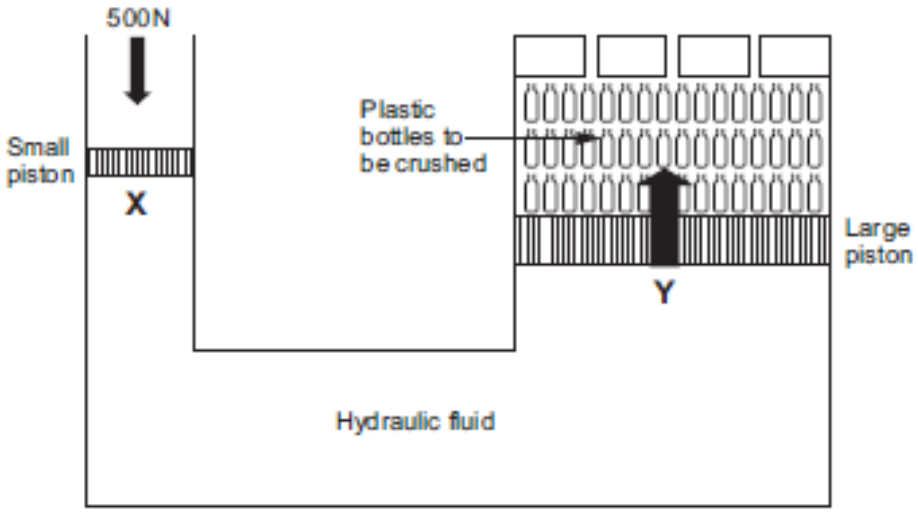
12

8. In Wales it is reported that 7.25×10^5 plastic bottles are used each day but only 45% of them are recycled. They are collected by local councils and then need to be transported to recycling plants that are based all around Wales. One crushed plastic bottle has a mean volume of 50 cm^3. Many plastic bottles are crushed into a single bale of mass of 190 kg. This makes it much easier to transport the plastic to the recycling factory.

A hydraulic press, as shown in the diagram, can be used. It is designed to exert a large force on the plastic bottles to crush them into a compact single bale. Only a relatively small force needs to be applied at **X** to crush the plastic bottles at **Y**. The pressure applied on the big piston at **Y** will be the same as the pressure exerted at **X**, however the area of the piston at **Y** is **15 times** larger than the area of the piston at **X**.



(a) Plastic has a density of 0.95 g/cm^3. How many bales of plastic bottles are produced in Wales **each week**?

You will need to use an equation from page 2. [6]

number of bales = ……..

(b) Use information from the text and an equation from page 2 to calculate the force applied to crush the plastic bottles at **Y**. [3]

force = …… N

(c) Explain why air bubbles in the hydraulic liquid make the press less effective at crushing the plastic bottles. [2]

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END OF PAPER