Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

3420UA0-1

S17-3420UA0-1

PHYSICS – Unit 1:
Electricity, Energy and Waves

HIGHER TIER

MONDAY, 19 JUNE 2017 – MORNING

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**12**	
3.	**10**	
4.	**9**	
5.	**16**	
6.	**13**	
7.	**12**	
Total	**80**	

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01

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator, a ruler and a drawing compass.

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

Equations

current = $\dfrac{\text{voltage}}{\text{resistance}}$	$I = \dfrac{V}{R}$
total resistance in a series circuit	$R = R_1 + R_2$
total resistance in a parallel circuit	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$
energy transferred = power × time	$E = Pt$
power = voltage × current	$P = VI$
power = current^2 × resistance	$P = I^2R$
% efficiency = $\dfrac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}}$ × 100	
density = $\dfrac{\text{mass}}{\text{volume}}$	$\rho = \dfrac{m}{V}$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
wave speed = wavelength × frequency	$v = \lambda f$
speed = $\dfrac{\text{distance}}{\text{time}}$	
pressure = $\dfrac{\text{force}}{\text{area}}$	$p = \dfrac{F}{A}$
p = pressure V = volume T = kelvin temperature	$\dfrac{pV}{T}$ = 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	$\dfrac{V_1}{V_2} = \dfrac{N_1}{N_2}$

SI multipliers

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

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

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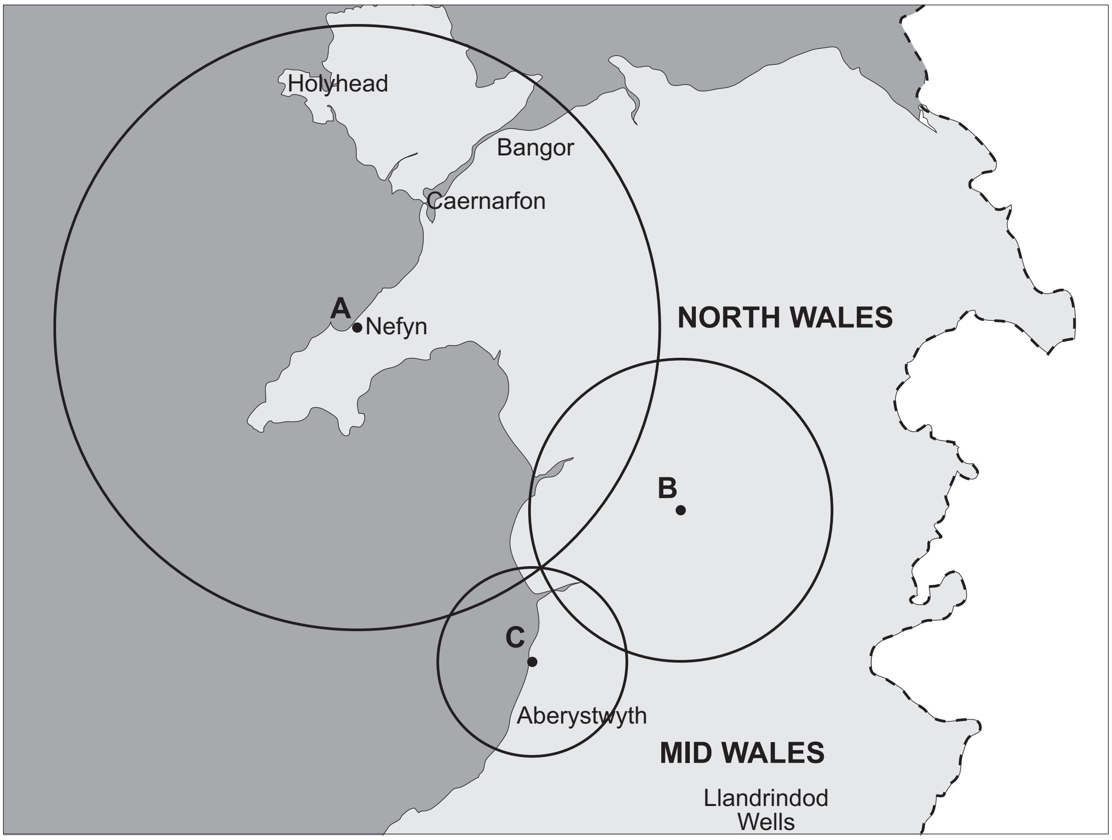
Answer **all** *questions.*

1. The waves from an earthquake can be monitored by seismological stations located on the surface of the Earth.



The diagram shows circles drawn around three seismological stations **A**, **B** and **C** in Mid and North Wales. The radius of each circle shows the distance of the epicentre from each station.

(a) (i) **Label on the diagram** with a cross (X) the location of the epicentre. [1]

(ii) Explain why at least three seismological stations are needed to locate the epicentre. [2]

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(b) Explain which station (**A**, **B** or **C**) detected the earthquake first. [2]

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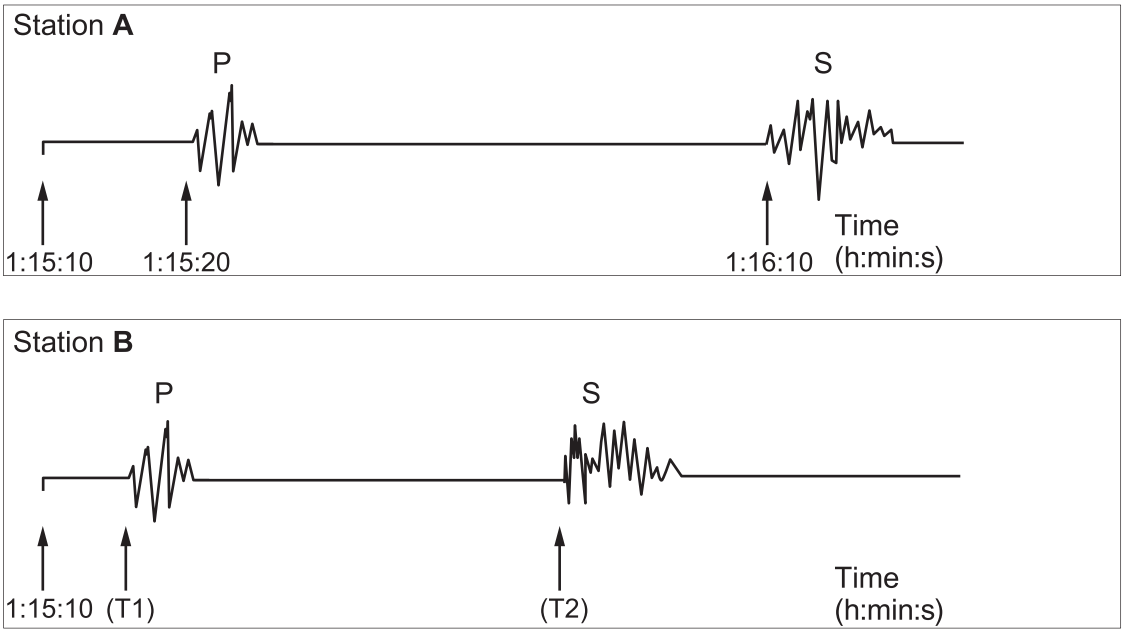
(c) The diameter of the circle around station A **is double** the diameter of the circle around station B.

The earthquake happened at 1 hour : 15 minutes : 10 seconds (1:15:10) in the morning.

The following signals were obtained at stations **A** and **B**.



Due to an error on the equipment the **arrival times** (T1 and T2) for the two signals were not recorded at station **B**.

Using signal information from station **A**, determine the times that the P waves and the S waves arrived at station **B**. Explain how you arrived at your answers. [3]

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Arrival time of P waves (T1) = ... hours .... minutes .... seconds.

Arrival time of S waves (T2) = ... hours .... minutes .... seconds.

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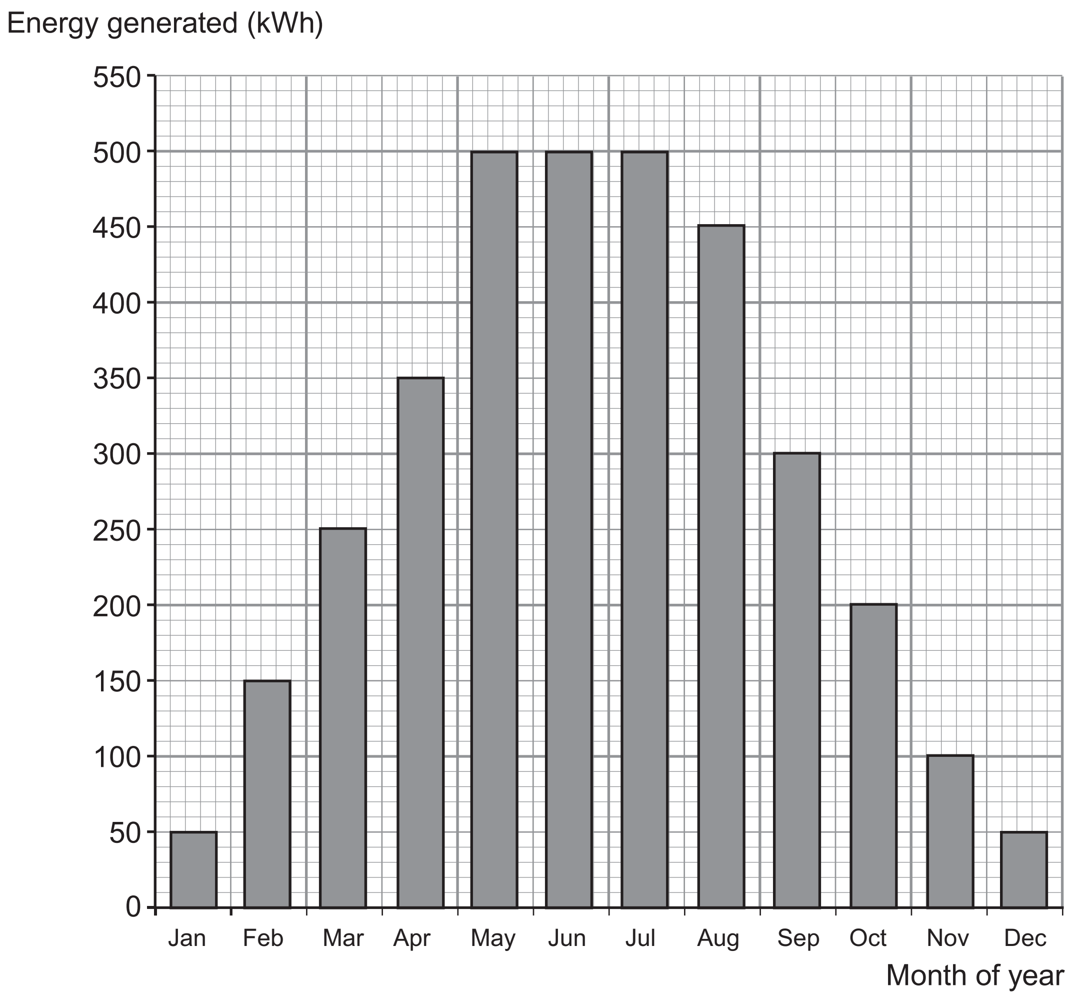
2. A family from Wales researched photovoltaic (PV) cells before they bought some. They were told by the manufacturer that they could expect the PV cells to generate 3400 kWh of electricity per year. **Figure 1** shows the energy generated in kWh from PV cells in a typical year in Wales. This was included in an advert for the PV cells.

Figure 1



(a) Use the information from **Figure 1** to validate the claim that PV cells could generate 3400 kWh annually. [2]

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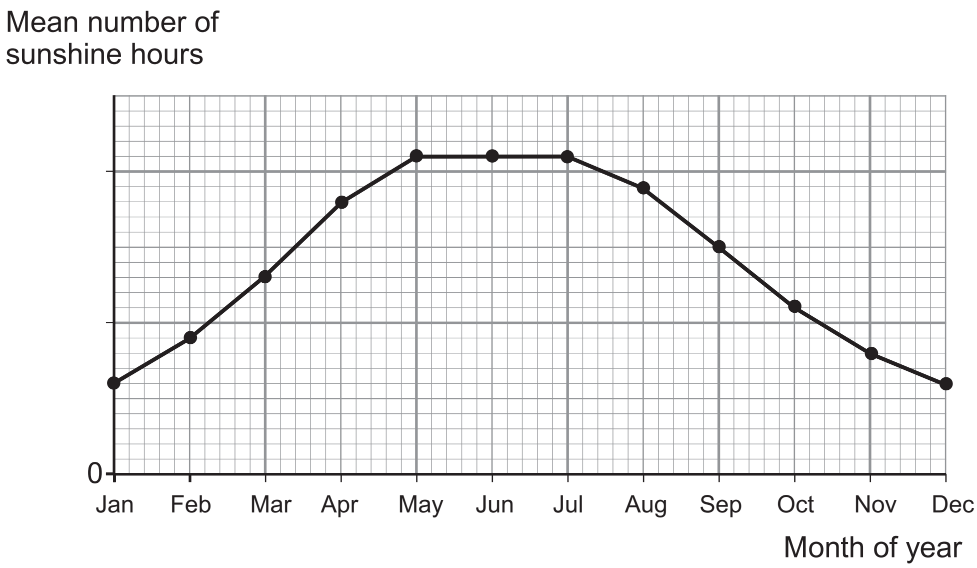
(b) Sunshine data for Wales over the last 30 years was obtained from the Welsh MET weather office. **Figure 2** shows the mean number of sunshine hours for each month in Wales.

Figure 2



(i) Describe how the information from **Figure 2** supports the general trend shown in **Figure 1**. [1]

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(ii) The Welsh MET weather office also had data for the **maximum** number of sunshine hours for each month. State why the manufacturers were **not** allowed to use this data in their advert. [1]

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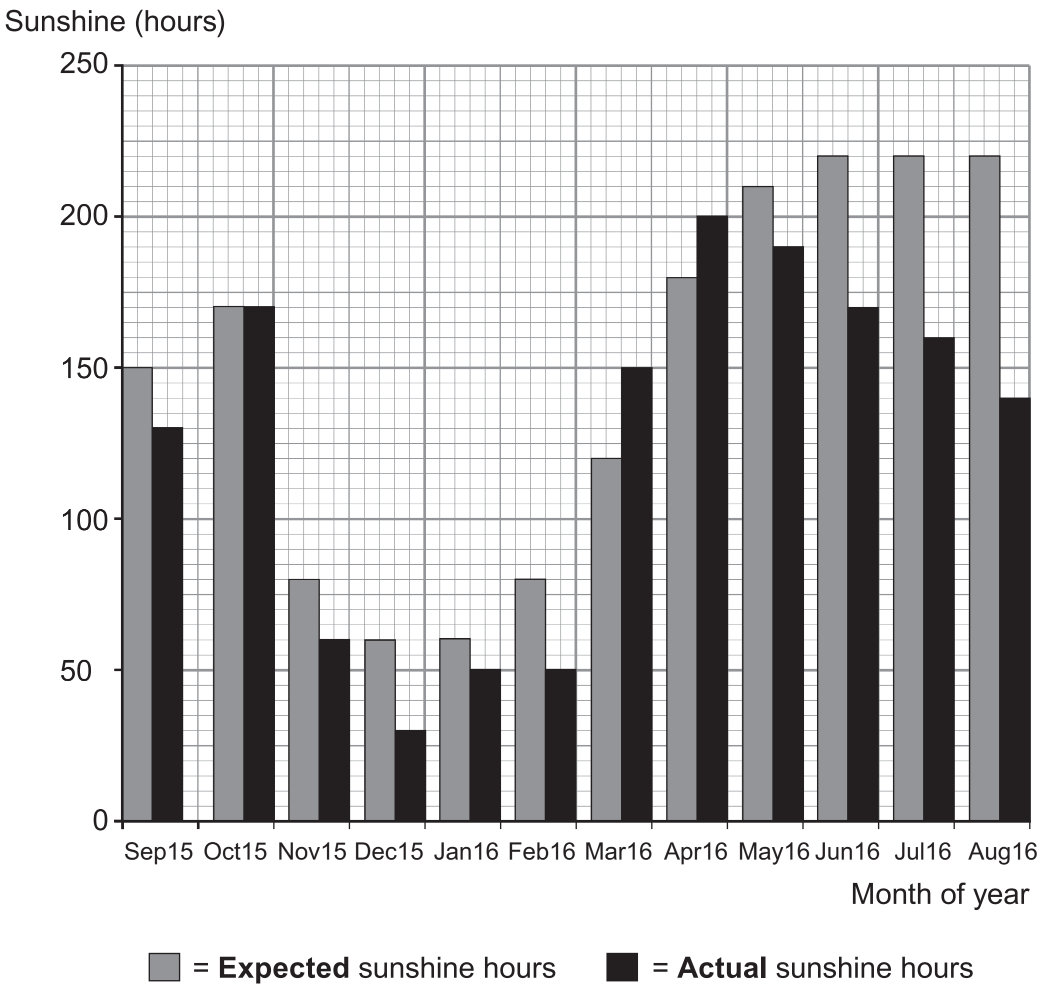
(c) In September 2015 the family had PV cells installed on their south facing roof. They collected 12 months of actual data from their PV cells. **Figure 3** compares the **expected** sunshine hours with **actual** sunshine hours. The **expected** sunshine hours data were obtained from local weather station records.

Figure 3



(i) Use information from **Figure 3** to tick (✓) the **three** correct statements. [3]

In Dec 15 the **actual** number of sunshine hours was double the **expected** number. ☐

Apr 16 was the month that had the most **actual** sunshine hours. ☐

June, July and August have different **expected** sunshine hours. ☐

Jan 16 had the least number of **actual** sunshine hours. ☐

Apr 16 had 4 times the **actual** number of sunshine hours compared to Jan 16. ☐

There is only one month where the **actual** and the **expected** sunshine hours were the same. ☐

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(ii) In April 16 the PV cells generated 600 kWh. The manufacturers claim the PV cells will produce 3 kW in sunshine. Use an equation from page 2 and **Figure 3** to validate this claim. [2]

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(d) The PV cells were expected to produce 3 400 kWh of electricity. However, the total number produced was 3 670 kWh.

(i) The family saves 29 p for each kWh of energy generated. Calculate how much extra money they saved. [2]

Extra savings = ... p

(ii) If the PV cells continue to generate more energy than expected what effect would this have on their payback time? [1]

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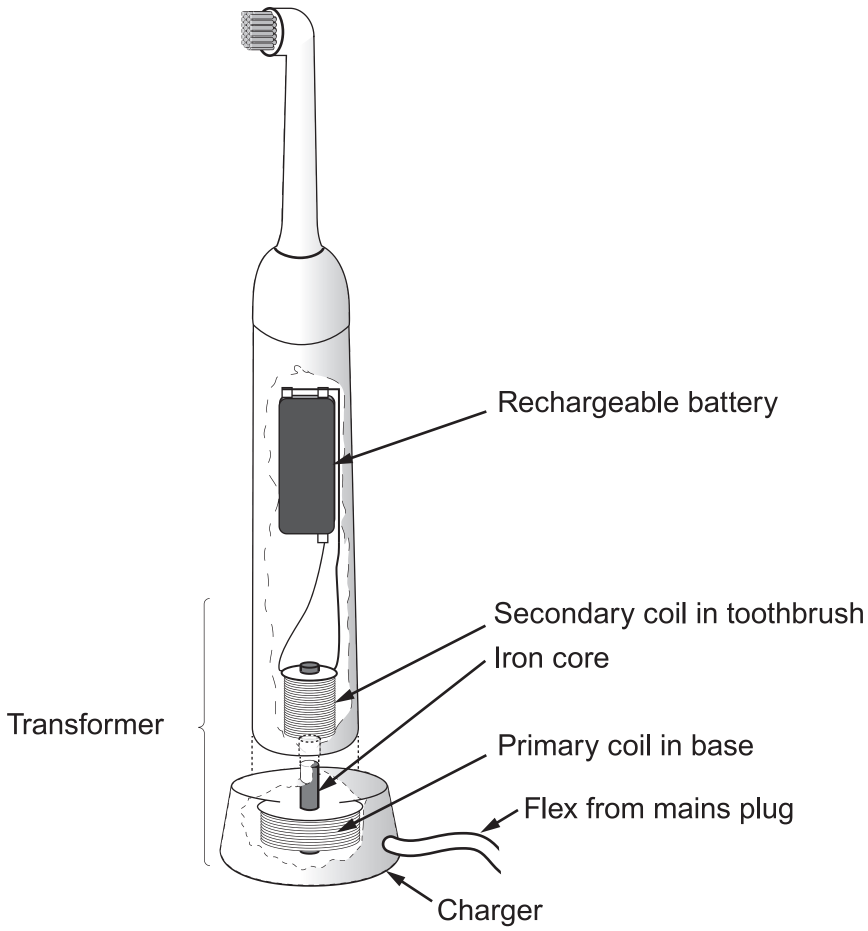
3. The diagram shows a rechargeable toothbrush which contains a transformer.



(a) Explain how a voltage is produced in the secondary coil of the transformer. [3]

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(b) For the following questions, assume that the transformer is 100% efficient.

(i) Describe what is meant by *100% efficient.* [2]

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Examiner only

(ii) The secondary coil inside the toothbrush has 480 turns. The primary coil in the base has 9200 turns and is connected to the 230 V mains. Use an equation from page 2 to calculate the voltage across the secondary coil. [2]

Voltage = ... V

(iii) Given that the current produced in the secondary coil is 100 mA, use an equation from page 2 to calculate the power of the toothbrush. [3]

Power = ... W

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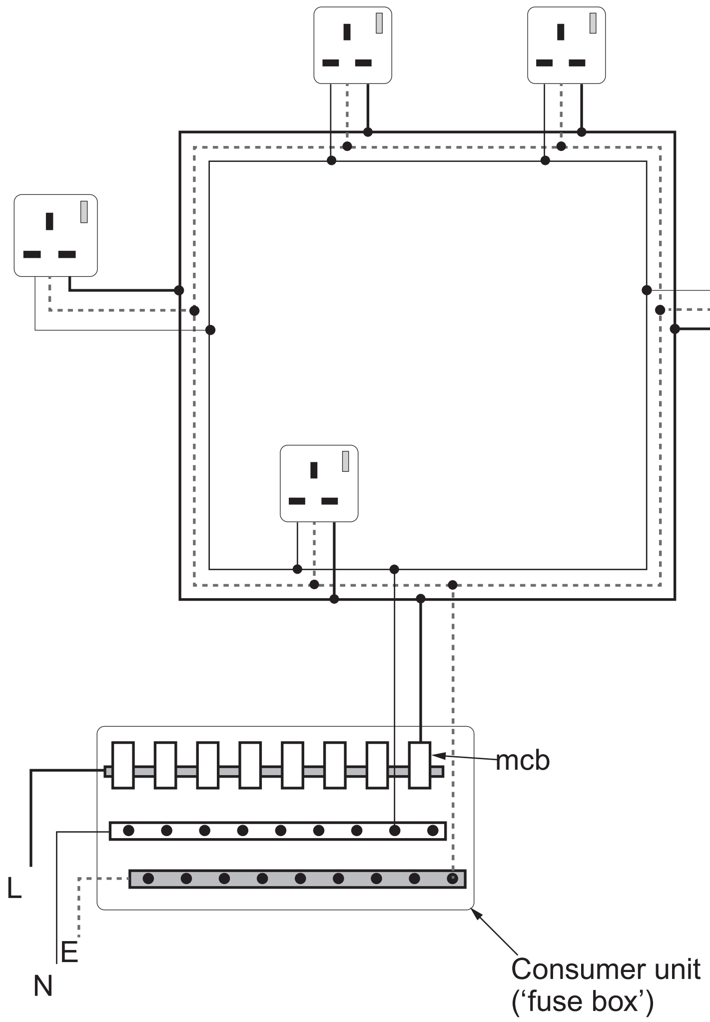
4. *(a)* The diagram shows a simple ring main circuit for the kitchen of a house. The sockets are used to supply a tumble dryer with a current of 9 A, a kettle with 10 A and a toaster with 5 A all at the same time.



(i) Describe the function of the earth wire. [2]

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(ii) State **two** advantages of a miniature circuit breaker (mcb) over a fuse. [1]

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Examiner only

(iii) The cable of the ring main can safely have 21 A passing through it. Explain why it is safe to use all of these appliances at the same time. [2]

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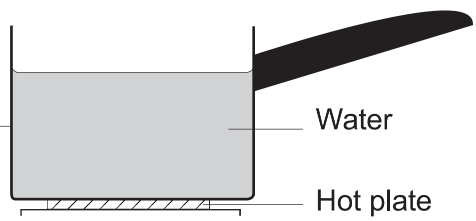
(b) The diagram shows some water being heated in a metal saucepan.



Explain in terms of particles how heat is transferred to **all** of the water by conduction and convection. [4]

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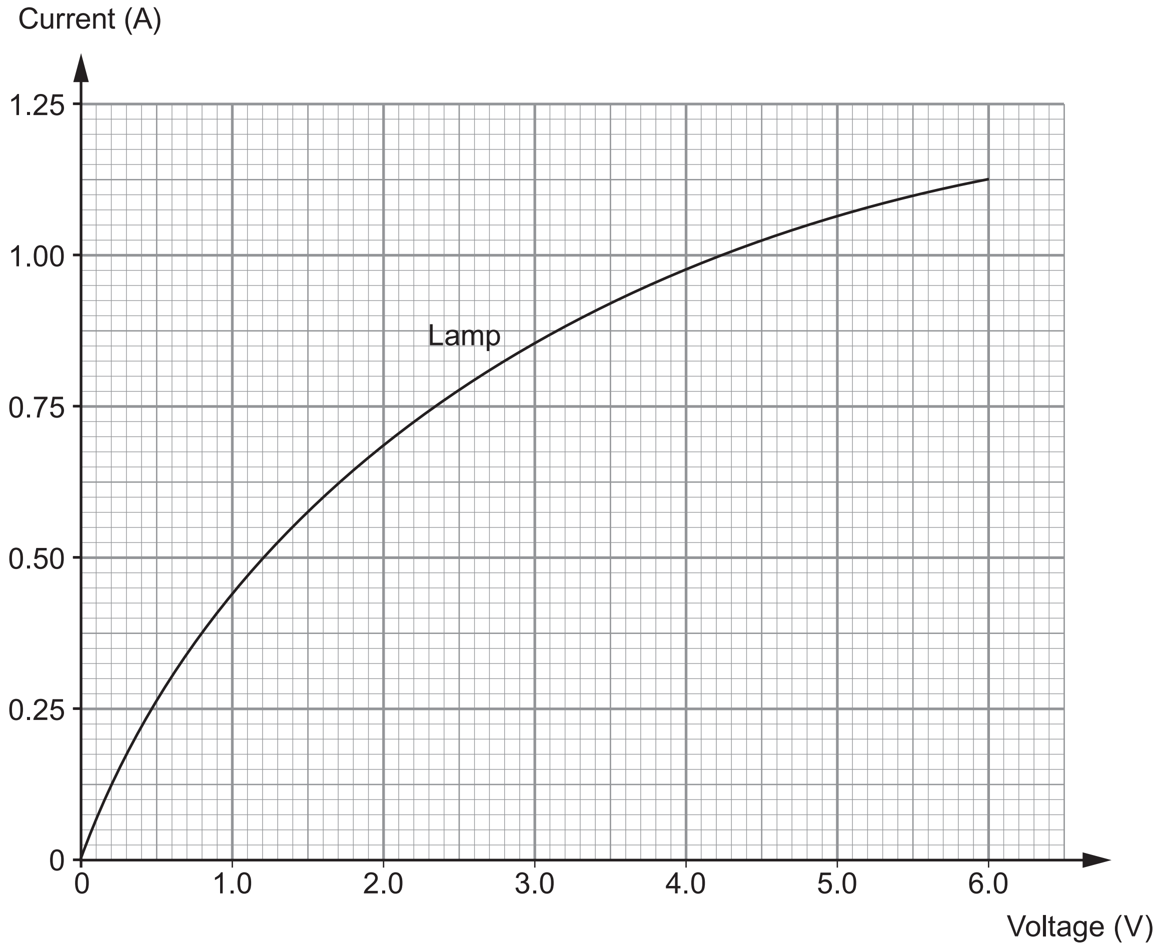
Examiner only

5. In a practical lesson, a group of pupils investigate the voltage across and current through a lamp and a resistor. They draw a graph from their results for the **lamp**. It is shown below.

The current through the resistor is measured and recorded in a table which is shown below.

Voltage across the resistor (V)	1.0	2.0	4.0	6.0
Current through the resistor (A)	0.20	0.40	0.80	1.20

(a) (i) Plot the data for the resistor on the grid below and draw a suitable line. [2]



(ii) Describe how the current through the **lamp** changes as the voltage applied to it is varied. [2]

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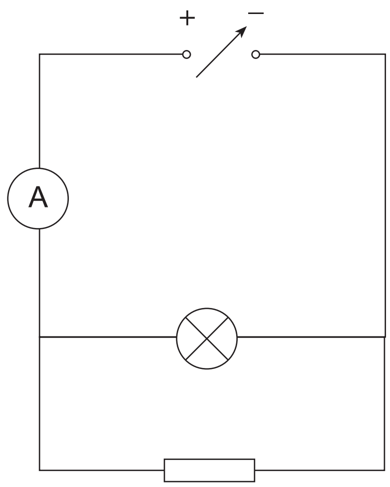
(b) Finally, the group connects the two components in parallel with a variable voltage power supply and an ammeter.



(i) Use the graph and an equation from page 2 to calculate the resistance of the lamp at 3.0 V. [2]

Resistance = ... Ω

(ii) Calculate the ammeter reading at 3.0 V. [2]

Current = ... A

(iii) Calculate the total resistance of the circuit at 3.0 V. [2]

Resistance = ... Ω

Examiner only

(iv) Explain, in terms of current, why the whole circuit has less resistance than the resistance of either component. [2]

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(v) The voltage supply is increased from 0 V to 6.0 V. Explain how **the graph shows** that the lamp has a bigger resistance than the resistor at 6.0 V. [2]

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(vi) Use the graph and without calculations but giving clear reasoning, compare the powers of the lamp and the resistor between 0 and 6.0 V. [2]

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16

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6. *(a)* The meaning of the word “latent” is “hidden”. In terms of latent heat it suggests that the heat does something that is hidden.
The value of the specific latent heat of fusion for ice is 334 000 J/kg and the value of the specific latent heat of vaporisation for water is 2 260 000 J/kg.
Suggest why the word “latent” is used and account for the difference in the two values in terms of the behaviour of molecules. [6 QER]

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(b) (i) A recycling company aims to melt 500 kg of aluminium in one hour. The aluminium, at an initial temperature of 20 °C is to be completely melted at 660 °C in a furnace of power 87 kW.

Use equations from page 2 and the information below to determine whether it is possible to meet the deadline. [6]

Specific heat capacity of aluminium, c = 900 J/kg °C
Melting point of aluminium = 660 °C
Specific latent heat of fusion of aluminium, L = 400 000 J/kg

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(ii) State why, in practice, it would take a lot longer than the time calculated above. [1]

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Examiner only

7. *(a)* (i) **Complete** the list showing the parts of the electromagnetic spectrum in order. [2]

gamma rays

X-rays

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visible light

infra-red

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radio waves

(ii) State **one** property that is common to all electromagnetic waves. [1]

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(b) Visible light has been used to accurately measure the distance between Earth and the Moon. In 1969, Neil Armstrong and Buzz Aldrin became the first humans to stand on the Moon. One of the jobs that they were required to do was to set up a reflector that faced Earth to allow light to be sent from the Earth, directed at it and be received back at Earth.

The reflectors have been used to accurately measure the distance from the Moon to Earth and the outcome is that the Moon is found to be getting further away from Earth by about 3.8 cm per year.

Laser light being sent to the Moon from a telescope in Germany.

The reflectors were illuminated from Earth by laser light of wavelength 532 nm. The reflectors are made from glass or plastic prisms. The light is sent in pulses separated by short intervals of time from a laser in a telescope on Earth.

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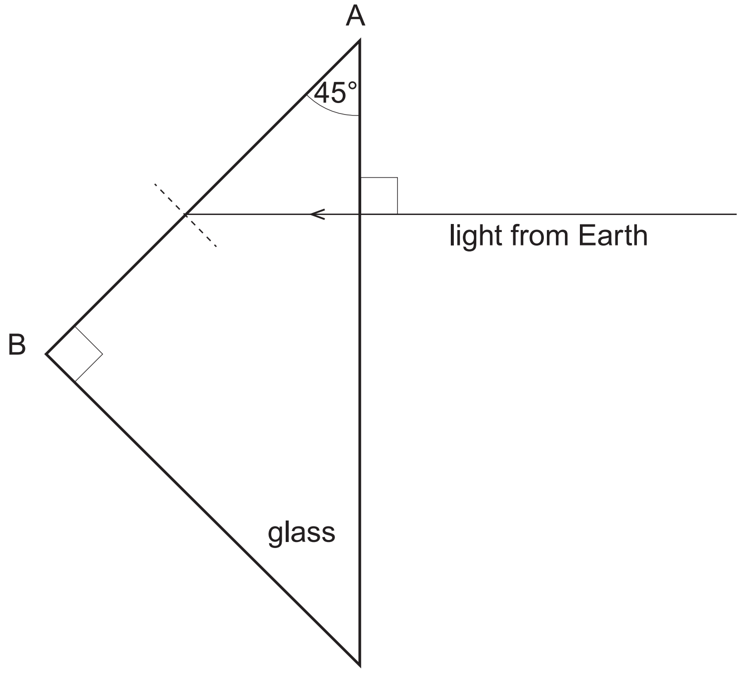
The diagram shows a ray of light entering one of the prisms. The critical angle for the glass is 36°.



(i) **Complete the diagram** to show the path followed by the light ray shown. [2]

(ii) Explain why the ray of light would not be reflected back to Earth if it strikes the side AB of the prism at an angle of incidence of 30°. [2]

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(iii) The wavelength of light used for measuring the distance to the Moon is 532×10^{-9} m and its frequency is 5.639×10^{14} Hz. Use equations from page 2 to calculate the distance between the Earth and the Moon if laser light is directed to the reflector and is received back again on Earth 2.5626 s later. [4]
[All workings must be shown for each stage of your calculation.]

Distance = ... m

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(iv) State why the laser light needs to be sent to the Moon in pulses separated by at least 2.57 s instead of in a continuous beam. [1]

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