| Surname | Centre Number | Candidate Number |
| --- | --- | --- |
| Other Names | | 0 |

# GCSE – NEW

3420U10-1

S17-3420U10-1

# PHYSICS – Unit 1:
## Electricity, Energy and Waves

**FOUNDATION TIER**

MONDAY, 19 JUNE 2017 – MORNING

1 hour 45 minutes

| For Examiner's use only | | |
| --- | --- | --- |
| **Question** | **Maximum Mark** | **Mark Awarded** |
| **1.** | **8** | |
| **2.** | **9** | |
| **3.** | **15** | |
| **4.** | **7** | |
| **5.** | **13** | |
| **6.** | **8** | |
| **7.** | **8** | |
| **8.** | **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 = $\frac{\text{voltage}}{\text{resistance}}$ | $I = \frac{V}{R}$ |
| total resistance in a series circuit | $R = R_1 + R_2$ |
| energy transferred = power × time | $E = Pt$ |
| power = voltage × current | $P = VI$ |
| % efficiency = $\frac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}}$ × 100 | |
| density = $\frac{\text{mass}}{\text{volume}}$ | $\rho = \frac{m}{V}$ |
| units used (kWh) = power (kW) × time (h)<br>cost = units used × cost per unit | |
| wave speed = wavelength × frequency | $v = \lambda f$ |
| speed = $\frac{\text{distance}}{\text{time}}$ | |
| pressure = $\frac{\text{force}}{\text{area}}$ | $p = \frac{F}{A}$ |
| 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 | $Q = mL$ |
| $V_1$ = voltage across the primary coil<br>$V_2$ = voltage across the secondary coil<br>$N_1$ = number of turns on the primary coil<br>$N_2$ = number of turns on the secondary coil | $\frac{V_1}{V_2} = \frac{N_1}{N_2}$ |

**SI multipliers**

| Prefix | Multiplier |
|---|---|
| m | $1 \times 10^{-3}$ |
| k | $1 \times 10^{3}$ |
| M | $1 \times 10^{6}$ |

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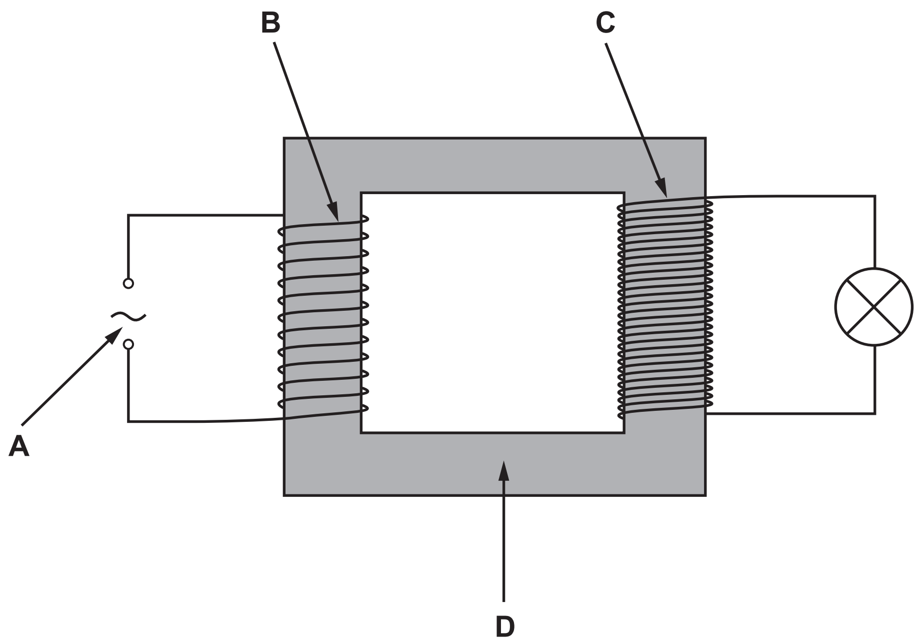
*Answer* **all** *questions.*

**1.** The diagram shows a transformer that is used in a laboratory experiment.




*(a)* **Draw one line** from each letter to the correct label. [3]

| | |
|---|---|
| **A** | primary coil |
| **B** | laminated iron core |
| **C** | secondary coil |
| **D** | a.c. input (supply) |

*(b)* The diagram shows a step-up transformer. Complete the sentences by underlining the correct word or phrase in the brackets. [3]

A step-up transformer that is 100% efficient will:

- make the output voltage (**smaller / stay the same / bigger**).
- make the output current (**smaller / stay the same / bigger**).
- make the output power (**smaller / stay the same / bigger**).

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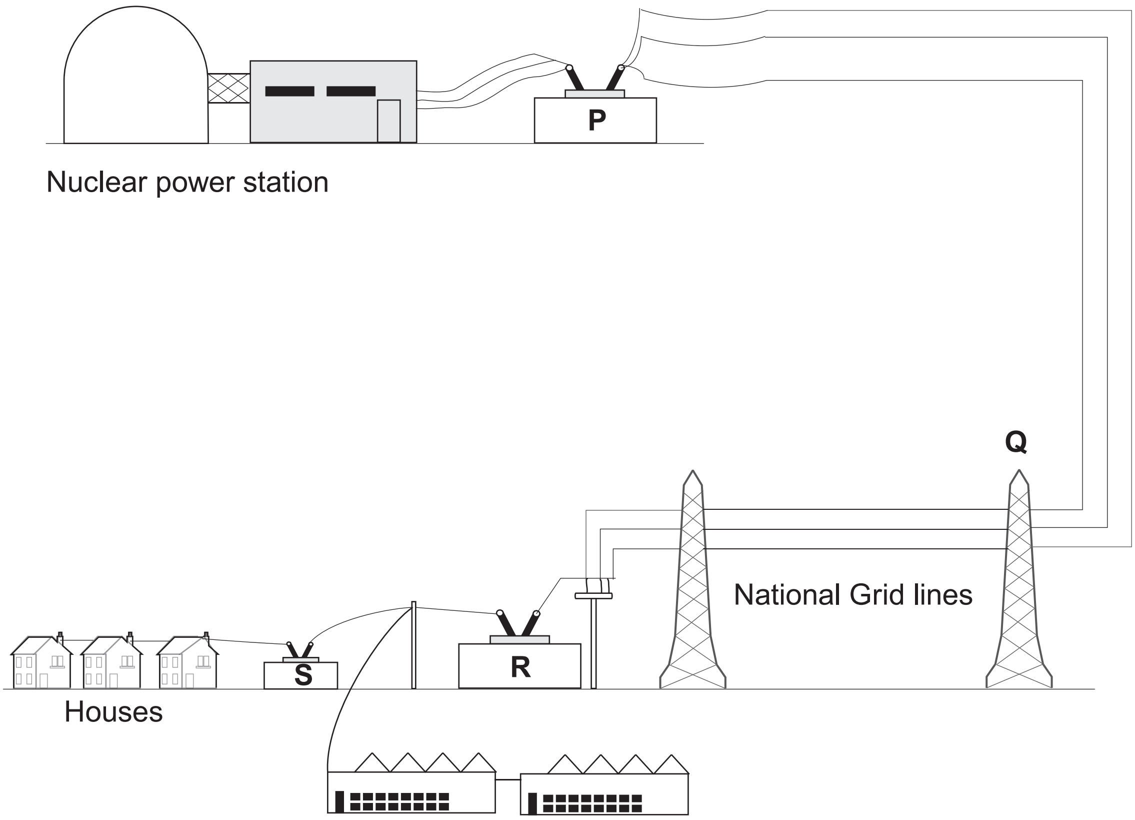
*(c)* The diagram below shows part of the National Grid. Power stations are used to generate electricity. They are linked to houses and factories by a network of cables.

(i) Which letter **P**, **Q**, **R** or **S** shows a step-up transformer? ..................................

[1]




(ii) State **one** environmental advantage of using a nuclear power station compared to a gas-fired power station. [1]

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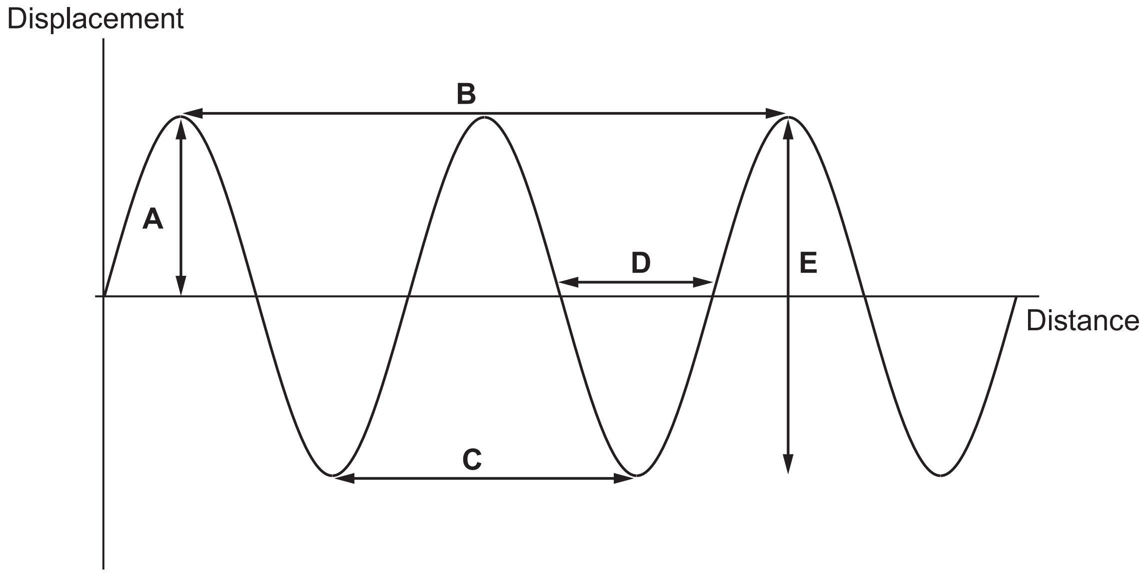
**2.** The diagram represents water waves on the surface of a swimming pool.




*(a)* How many complete waves are shown in the diagram? .................................. [1]

*(b)* Which letter **A**, **B**, **C**, **D** or **E** shows the amplitude of the wave? .................................. [1]

*(c)* Select a word from the box to complete the following sentences.

| | | | | |
|---|---|---|---|---|
| frequency | time | speed | wavelength | amplitude |

(i) The number of waves per second is the .................................................................. . [1]

(ii) The maximum displacement of the wave is the .................................................................. . [1]

*(d)* A wave peak takes 0.5 s to travel the distance labelled **B** on the diagram. The speed of the wave is 20 cm/s.

(i) Use the equation:

distance = speed × time

to calculate the distance travelled by the wave. [2]

Distance = .................................................. cm

(ii) Calculate the wavelength. [1]

Wavelength = .................................................. cm

Examiner only

*(e)* Water waves are transverse waves.

(i) Give another example of a transverse wave. [1]

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(ii) Sound waves are not transverse waves. What type of waves are they? [1]

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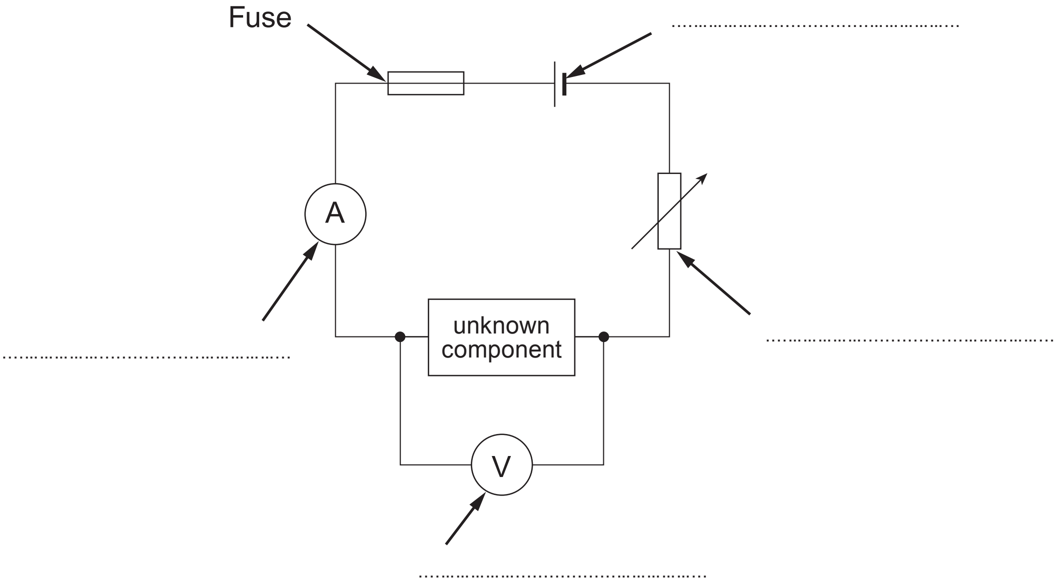
**3.** A student is given an unknown electrical component in a sealed box. He carries out an experiment to identify it.

He sets up the circuit below to investigate how the current changes with voltage for the unknown component.




*(a)* **Complete the labelling** on the circuit diagram. [4]

*(b)* The data shown in the table is collected from the experiment.

| Voltage (V) | –0.4 | –0.2 | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 |
|---|---|---|---|---|---|---|---|---|
| Current (mA) | 0 | 0 | 0 | 0 | 0 | 5 | 20 | 50 |

(i) To prevent the unknown component being damaged the current through it **must not** be greater than 150 mA.

**Circle** the appropriate fuse that should be used in the circuit. [1]

10 mA        100 mA        200 mA        500 mA

(ii) (I) State the current in **amps (A)** when the voltage is 1.0 V. [1]

Current = ..................................................... A

Examiner only

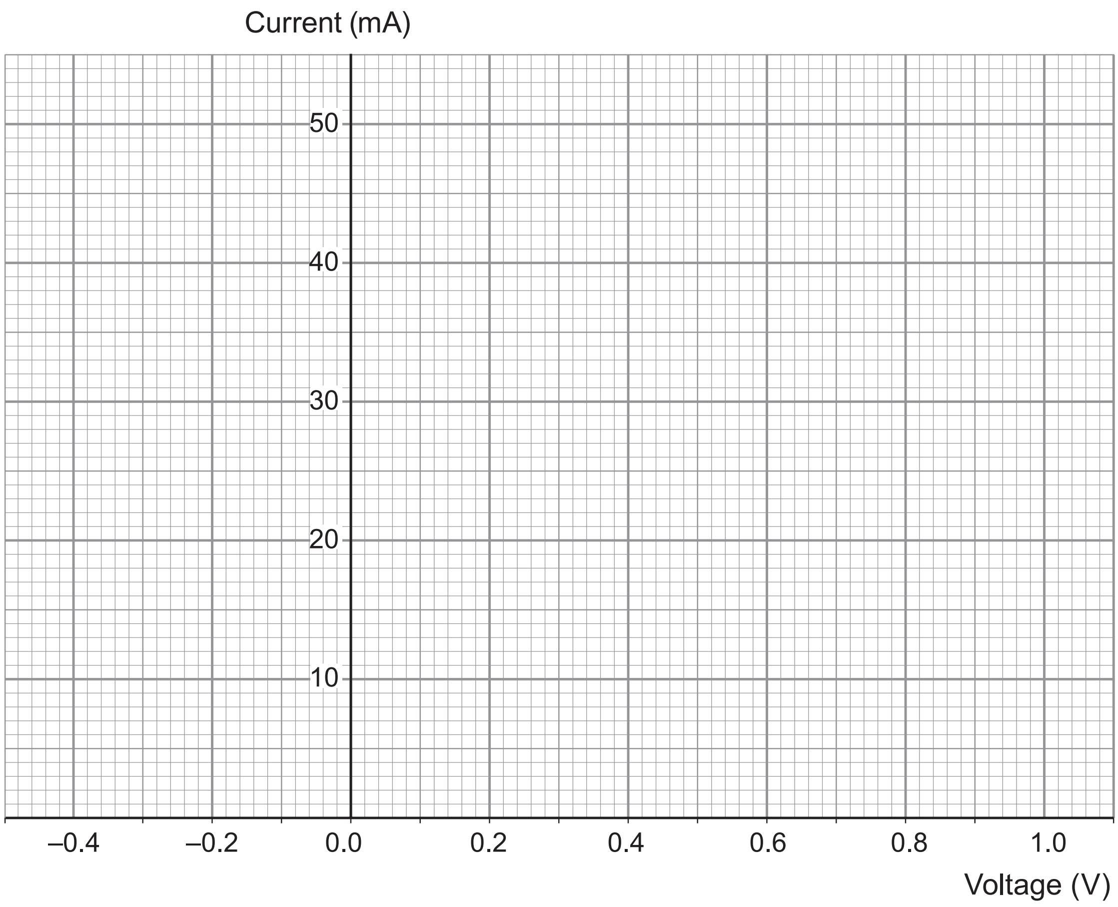
(II) Use the equation: [2]

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

to calculate the resistance of the unknown component at 1.0 V.

Resistance = .................................... Ω

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




(iv) Use the graph to find the current when the voltage is 0.7 V. [1]

Current = .................................... mA

(v) Describe the relationship between the current and the voltage in the range 0.4 V to 1.0 V. [2]

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(vi) Identify the unknown component. .................................................................................... [1]

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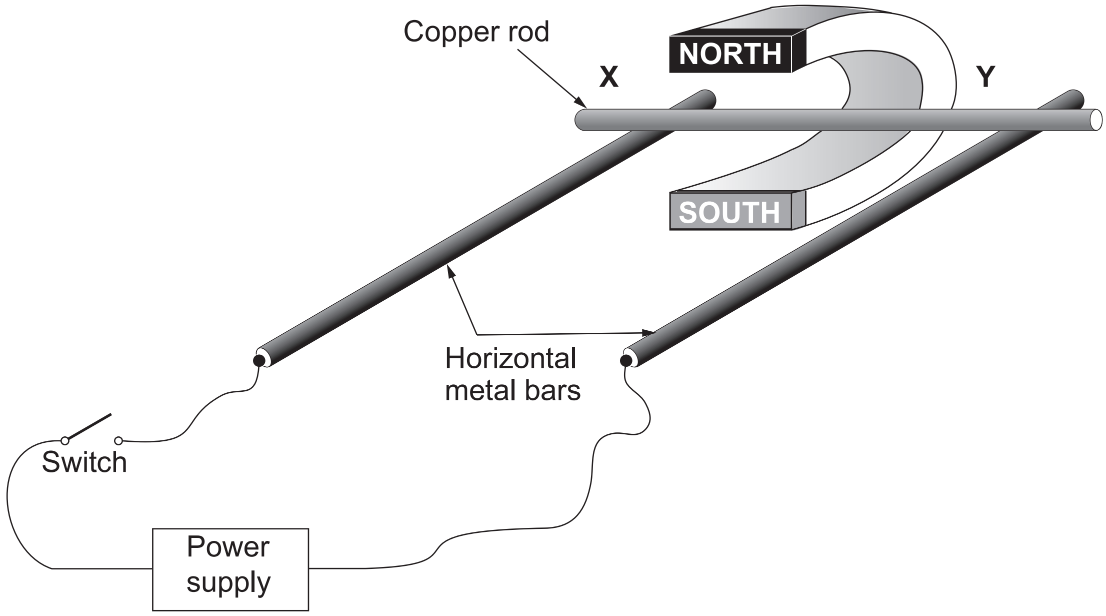
**4.** The following experiment is set up in a school laboratory for students.




*(a)* (i) Explain why, when the switch in the circuit is closed, the copper rod starts to roll along the two horizontal metal bars. [2]

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(ii) When the switch is closed the copper rod moves away from the magnet. One of the students concludes that the direction of the current is from **X** to **Y**. Explain if you agree or disagree with their conclusion. [2]

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(iii) State **two** changes that could be made to the apparatus so that the copper rod moves faster when the switch is closed. [2]

1. .....................................................................................................................................

2. .....................................................................................................................................

*(b)* The effect observed in this experiment is used in many everyday devices. Give an example of **one** such use. [1]

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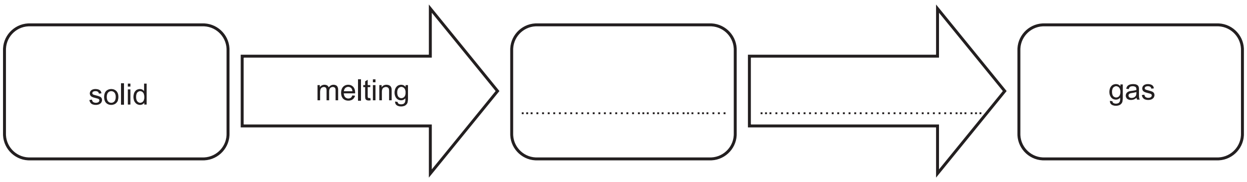
**5.** The diagram gives some information about what happens when a solid is heated.




*(a)* **Complete the diagram.** [2]

*(b)* Tick (✓) the **two** correct statements about a solid. [2]

| | |
|---|---|
| A solid has the lowest density of the three states of matter. | |
| The atoms in a solid are in fixed positions. | |
| The atoms in a solid transfer heat by convection. | |
| A solid is always a good conductor. | |
| A solid has atoms that vibrate more as they gain energy. | |

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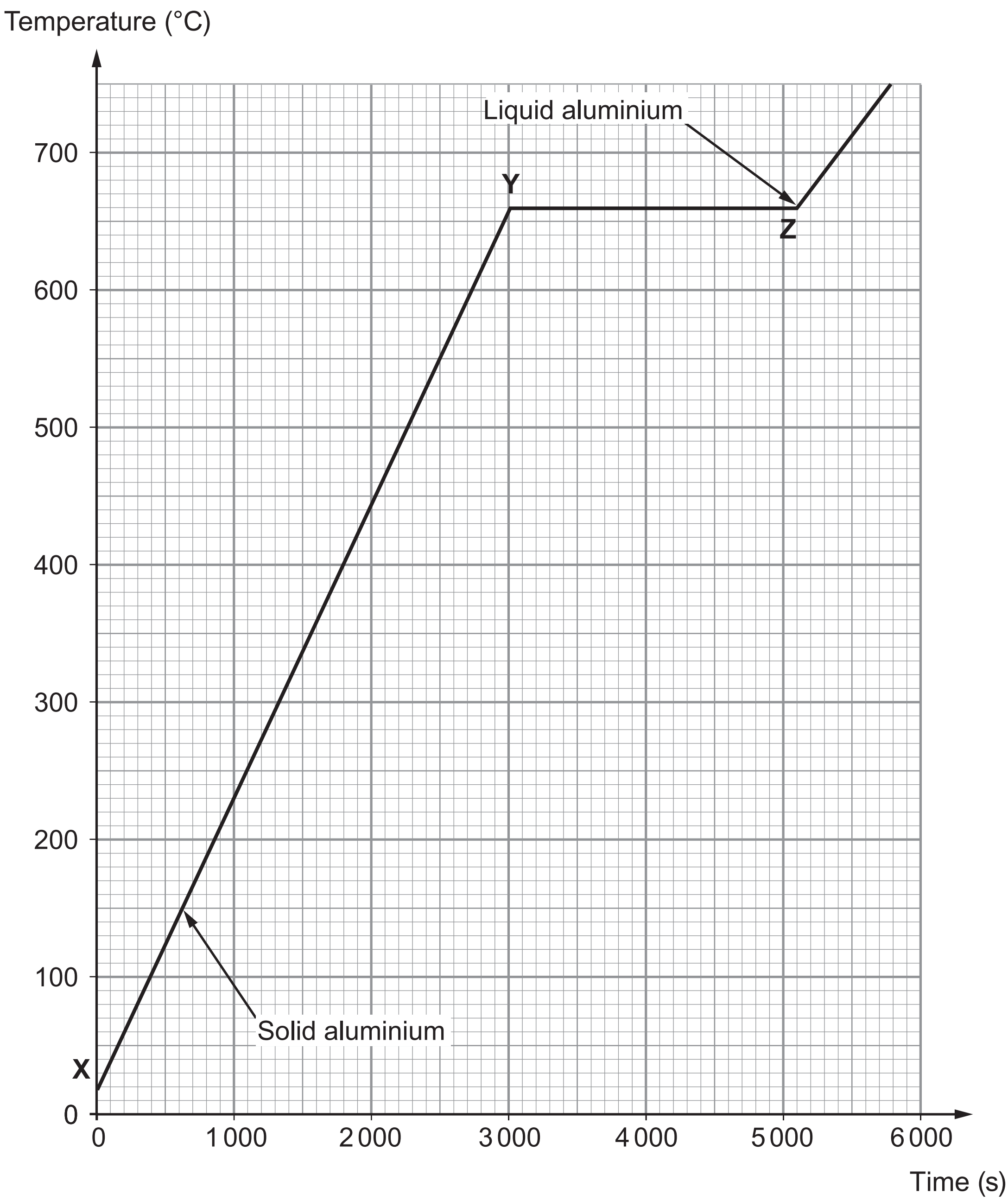
*(c)* Aluminium cans are frequently recycled. The aluminium cans are collected by local councils as part of household waste. They are sent to a furnace where the cans are heated to melt them. The aluminium is then cooled so that it can be reused for the manufacture of other items. The graph shows how the temperature of the aluminium cans in the furnace changes with time.




(i) State the temperature at which the aluminium cans change from a solid into a liquid. [1]

Temperature = .............................. °C

(ii) State the time it takes to heat the aluminium cans to their melting point. [1]

Time = .............................. s

Examiner only

*(d)* The heat transferred during the heating process, between points **X** and **Y** is 288 000 000 J.

(i) Use your answer from *(c)*(ii) and the equation:

$$\text{power} = \frac{\text{heat transferred}}{\text{time}}$$

to calculate the power **in kW** of the heater in the furnace. [3]

Power = .............................................. kW

(ii) The temperature change of the aluminium cans during the heating process **X** to **Y** is 640 °C.

Use information given above and the equation:

$$\text{mass} = \frac{\text{heat transfer}}{(\text{specific heat capacity} \times \text{temperature change})}$$

to calculate the mass of aluminium cans that were heated in the furnace.
(Specific heat capacity of aluminium = 900 J/kg °C ) [2]

Mass = .............................................. kg

*(e)* Use an equation from page 2 to calculate the heat transfer required to melt 1 500 kg of aluminium cans from solid to liquid at its melting point. [2]
(Specific latent heat of fusion of aluminium, $L$ = 400 000 J/kg)

Heat transfer = .............................................. J

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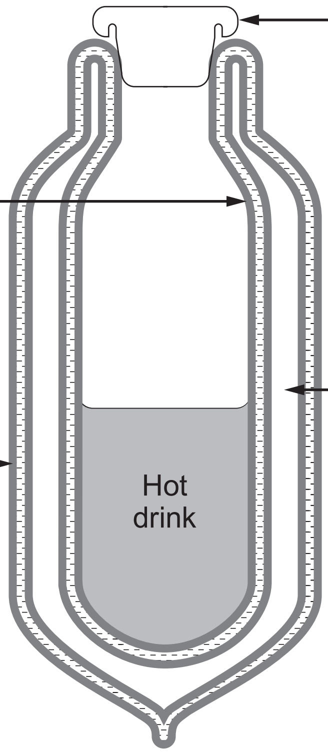
**6.** On a cold day a vacuum flask can be used to keep drinks hot for many hours. The diagram shows a vacuum flask with its main features labelled.




*(a)* Explain in terms of conduction, convection and radiation how the labelled features of the flask help to keep the drink hot for such a long time. [6 QER]

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(b) A drink at 90 °C is poured into the flask. After 2 hours the temperature of the drink is 80 °C. After 10 hours the temperature of the drink is 60 °C.

The company who make the vacuum flask claim that a hot drink contained in the flask will cool down by 5 °C every hour. Explain if the claim made by the company is always correct. [2]

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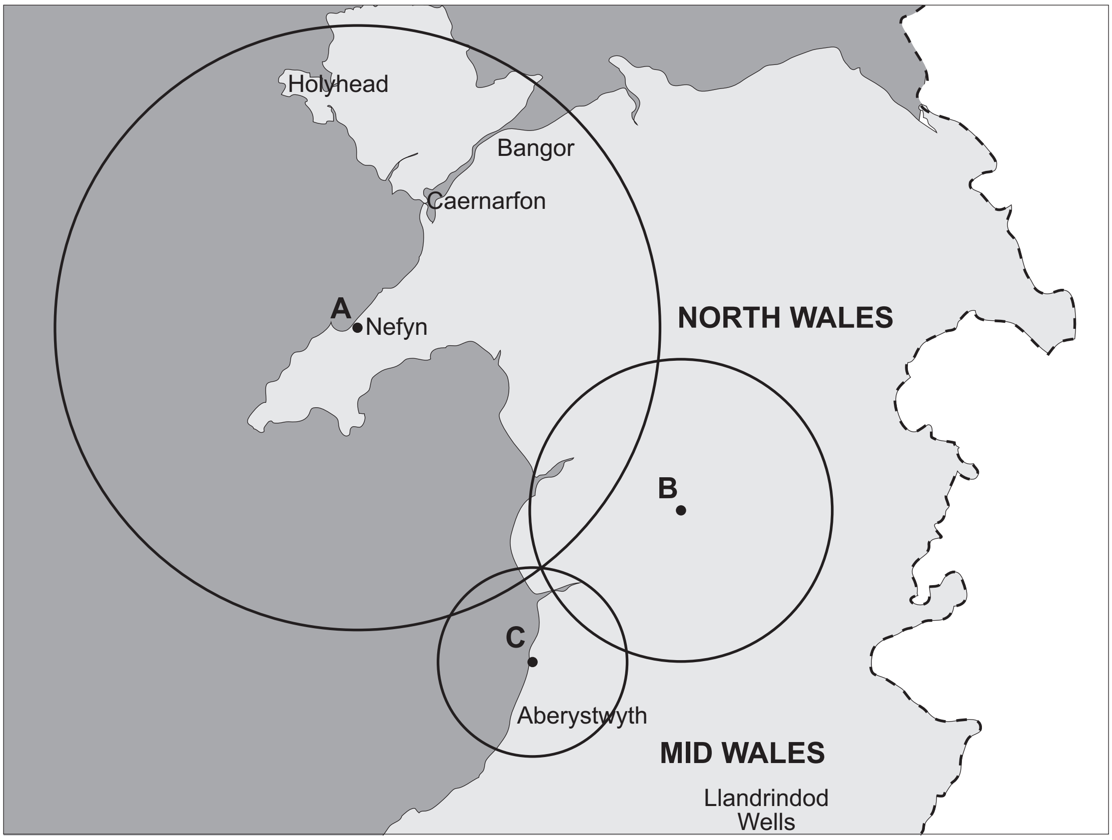
**7.** The waves from an earthquake can be monitored by seismological stations located on the surface of the Earth.




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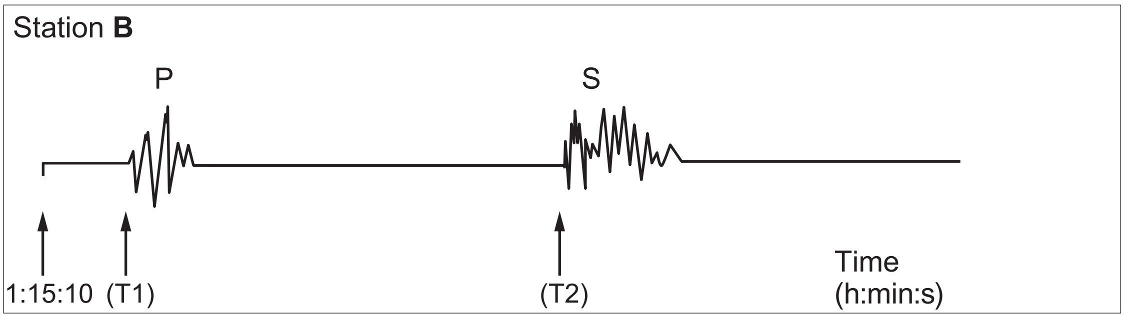
*(c)* The diameter of the circle around station A **is double** the diameter of the circle around station B.

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.

| |
|---|
| |
| 8 |

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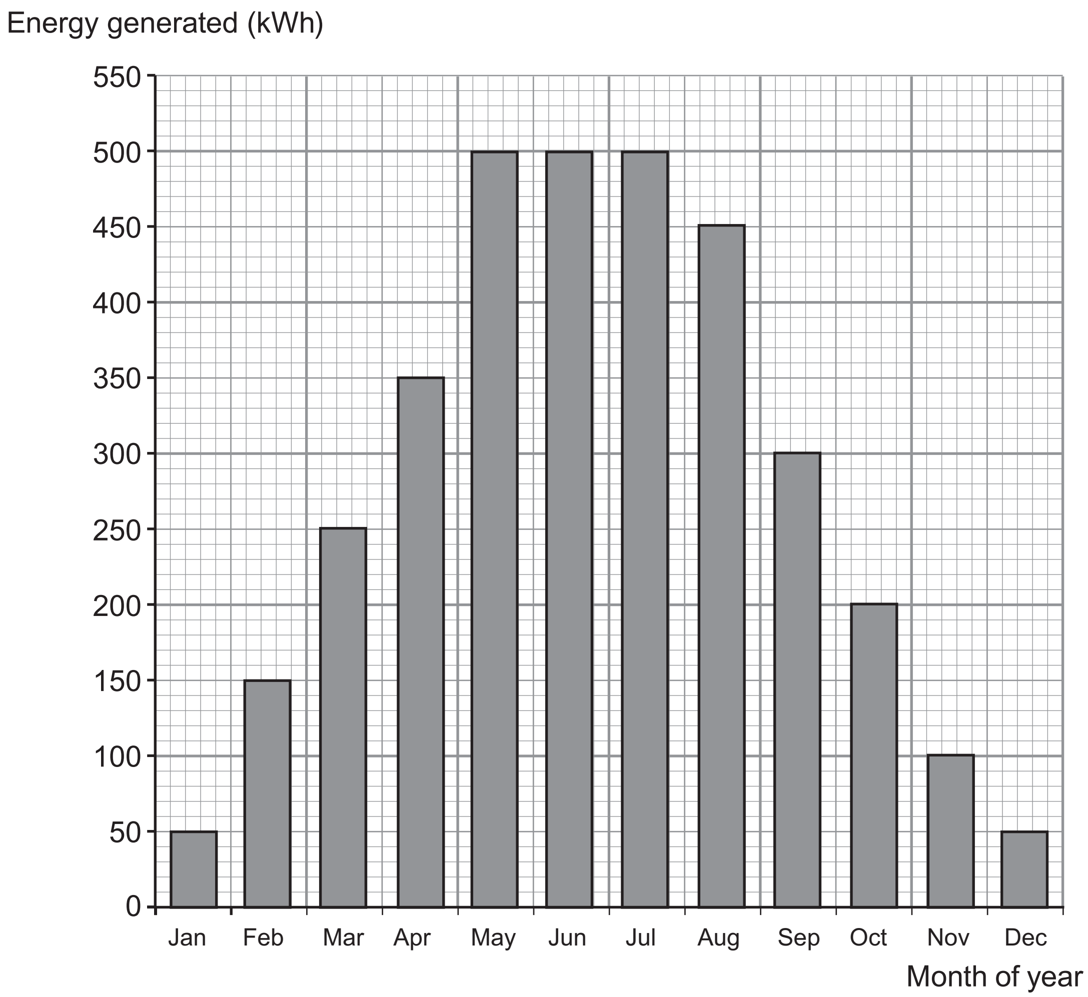
**8.** A family from Wales researched photovoltaic (PV) cells before they bought some. They were told by the manufacturer that they could expect the PV cells to generate 3 400 kWh of electricity per year. **Figure 1** shows the energy generated in kWh from PV cells in a typical year in Wales. This was 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 3 400 kWh annually. [2]

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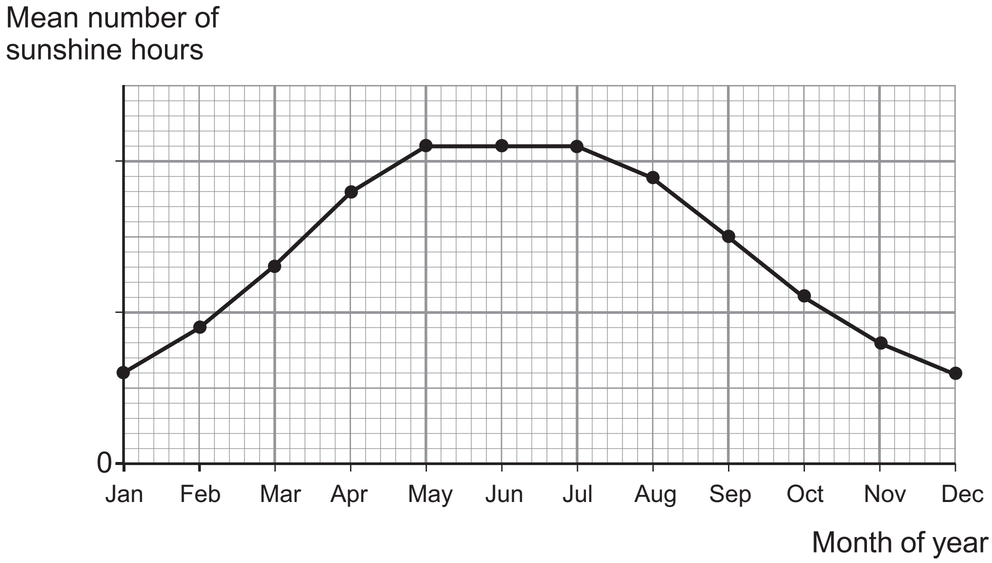
*(b)* Sunshine data for Wales over the last 30 years was obtained from the Welsh MET weather office. **Figure 2** shows the mean number of sunshine hours for each month in Wales.

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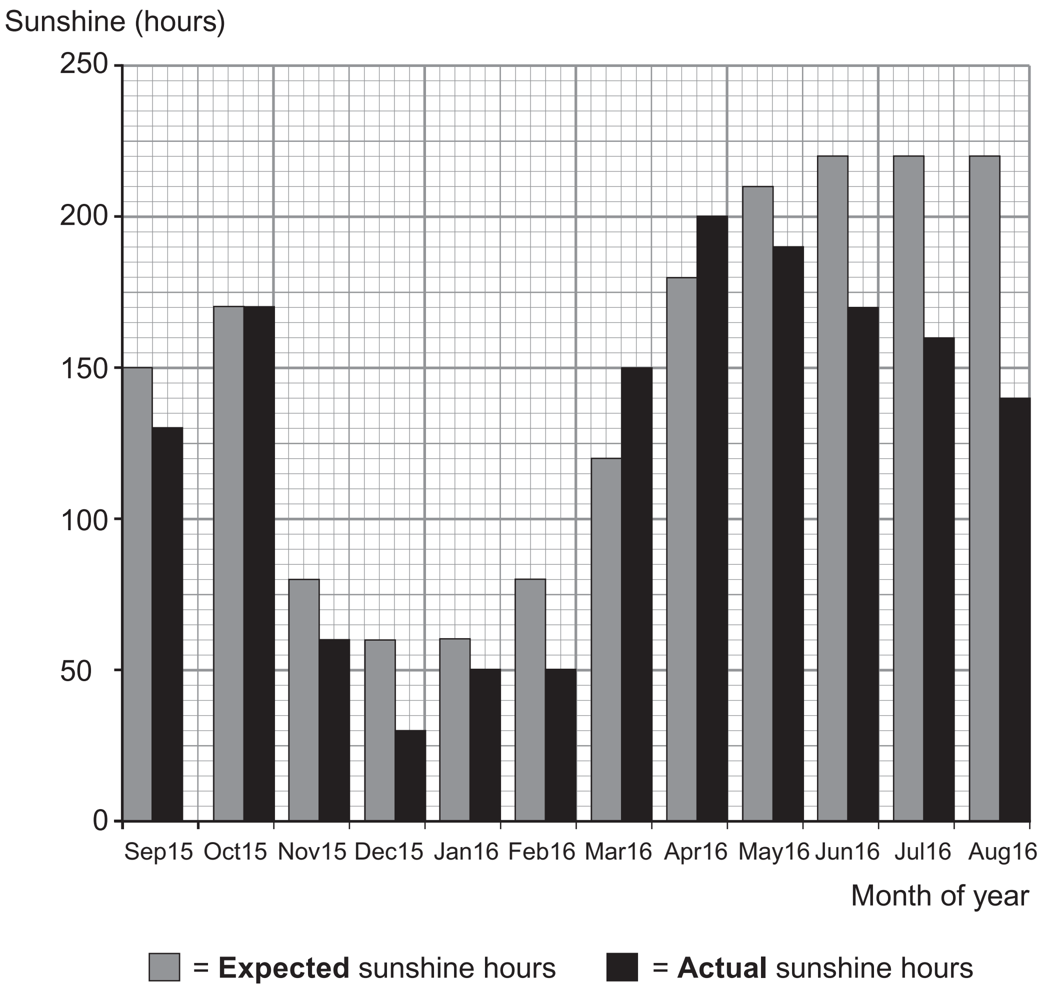
*(c)* In September 2015 the family had PV cells installed on their south facing roof. They collected 12 months of actual data from their PV cells. **Figure 3** compares the **expected** sunshine hours with **actual** sunshine hours. The **expected** sunshine hours data were obtained from local weather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