Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S25-3420U10-1

3420U10-1

MONDAY, 16 JUNE 2025 – MORNING

PHYSICS – Unit 1:
Electricity, Energy and Waves
FOUNDATION TIER

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**9**	
3.	**6**	
4.	**11**	
5.	**6**	
6.	**6**	
7.	**6**	
8.	**11**	
9.	**11**	
10.	**9**	
Total	**80**	

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ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

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. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

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

The assessment of the quality of extended response (QER) will take place in question **6**.

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 = $\frac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}} \times 100$	
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 = $\frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
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 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	Symbol	Conversion factor	Multiplier
milli	m	divide by 1000	1×10^{-3}
centi	c	divide by 100	1×10^{-2}
kilo	k	multiply by 1000	1×10^{3}
mega	M	multiply by 1 000 000	1×10^{6}

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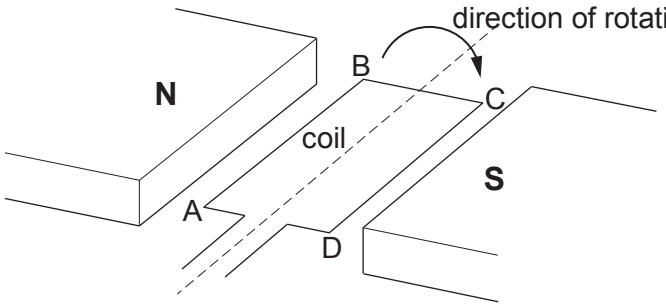
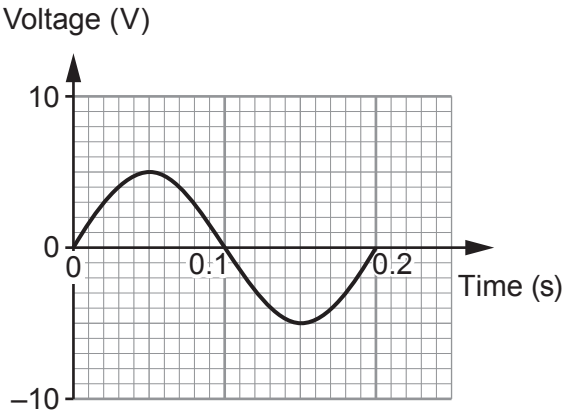
Answer **all** questions.

1. Electromagnetic induction takes place in generators and transformers.
The diagram shows a simple generator of electricity.



The coil spins at a steady speed in the direction shown.
The voltage produced is shown in Graph **A**.

Graph **A**



(a) (i) Write down the maximum voltage produced. ..... V [1]

(ii) Tomos says the coil spins once in 0.1 seconds.

Complete the following sentence by underlining the correct answers in the brackets. [1]

I (**agree** / **disagree**) with Tomos because the coil spins once in (**0.1** / **0.2**) seconds.

(b) Circle the direction of the current in the coil when it is in the position shown in the diagram. [1]

A to B / **C to B** / **D to C**

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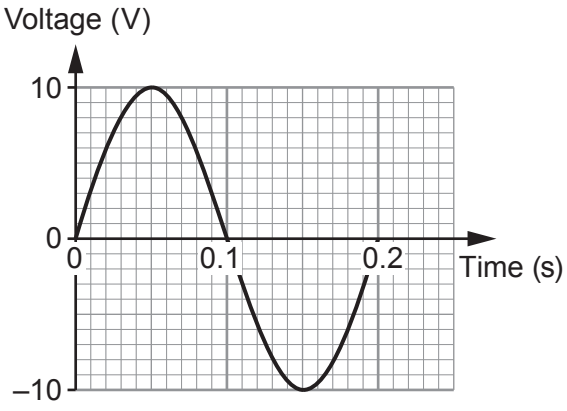
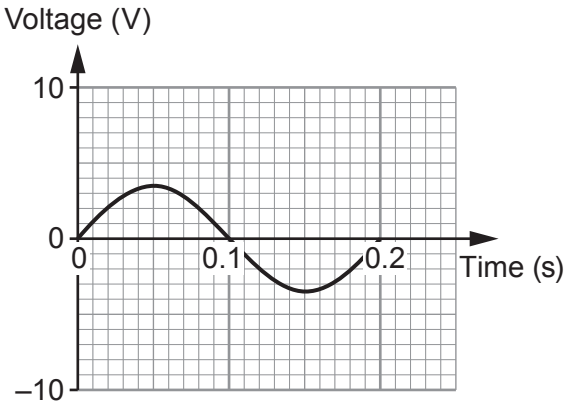
(c) The following graphs show the voltages produced after making changes to the coil.

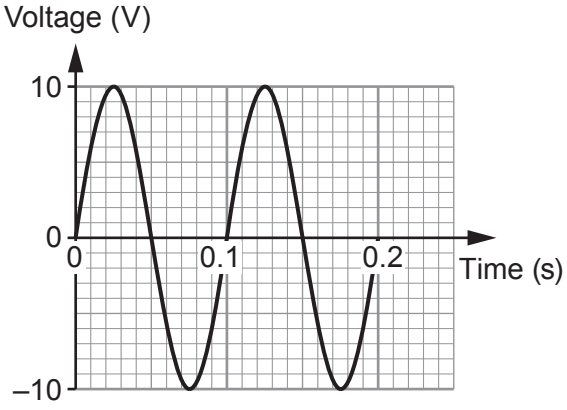
Graph **B**



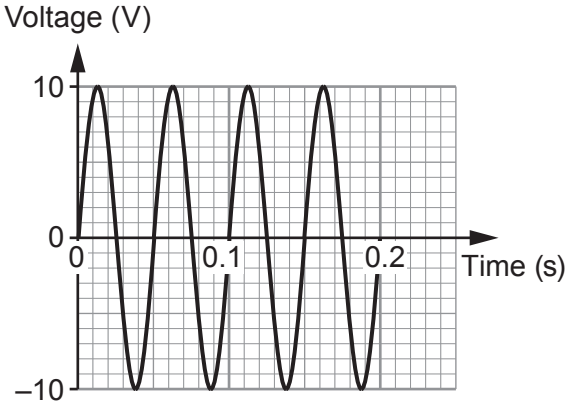
Graph **C**



Graph **D**



Graph **E**



(i) State which graph, **B**, **C**, **D** or **E**, would be produced if the number of turns of wire on the coil were doubled. [1]

.....

(ii) State which graph, **B**, **C**, **D** or **E**, would be produced by the original coil if it were spun twice as fast. [1]

.....

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Turn over.

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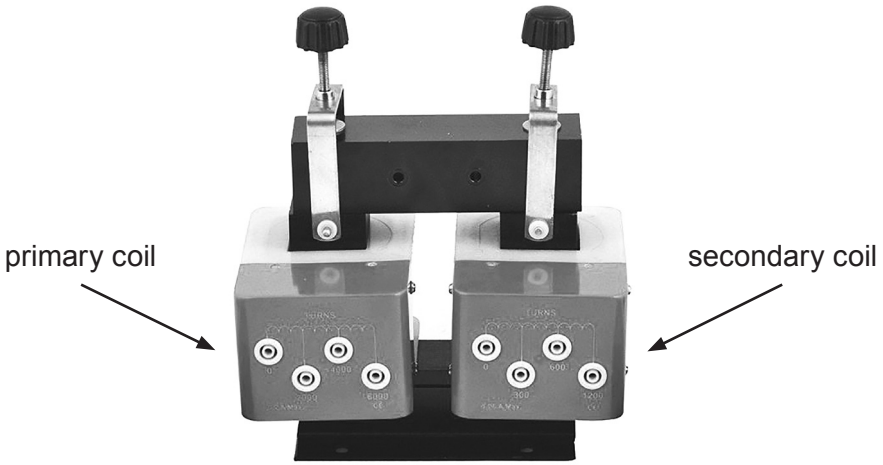
2. The diagram shows apparatus that can be used to investigate transformers.



(a) Underline the words in brackets to correctly complete the sentences about how a transformer works. [3]

A transformer works because (**an alternating** / **a direct** / **a constant**) current in the primary coil produces a changing (**magnetic** / **electric** / **gravitational**) field in the (**iron** / **copper** / **aluminium**) core. This induces an alternating voltage across the secondary coil.

(b) A **200-turn** coil is used as the primary coil and remains in place throughout the investigation.

(i) The secondary coils available to fit the transformer have the following number of turns.

100	200	400	800	1 200

They are used to investigate how the number of turns in the secondary coil affects the output voltage.

I. State which of the above coils would be used so the output voltage is smaller than the input voltage. [1]

..... turns

II. State which of the above coils would be used to give the maximum output voltage. [1]

..... turns

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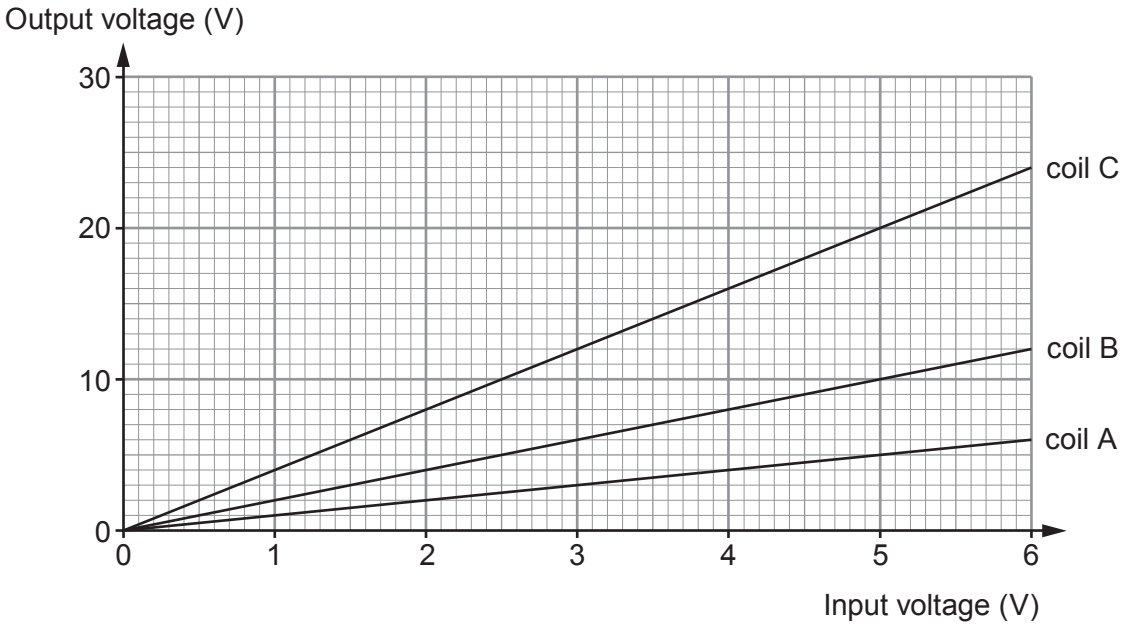
(ii) Different secondary coils (A, B and C) are used.
The results are shown on the graph below.



I. Complete the following sentence by underlining the correct words or phrases in the brackets.

As the input voltage increases, the output voltage
(**increases** / **decreases** / **stays the same**) at
(**an increasing** / **a decreasing** / **a constant**) rate. [2]

II. A 10 V lamp needs a 10 V supply to operate at normal brightness.
State which secondary coil, A, B or C, would be used to operate a 10 V lamp at normal brightness from a 5 V input voltage. [1]

.....

III. State which secondary coil, A, B or C, has an output which is always double the input voltage. [1]

.....

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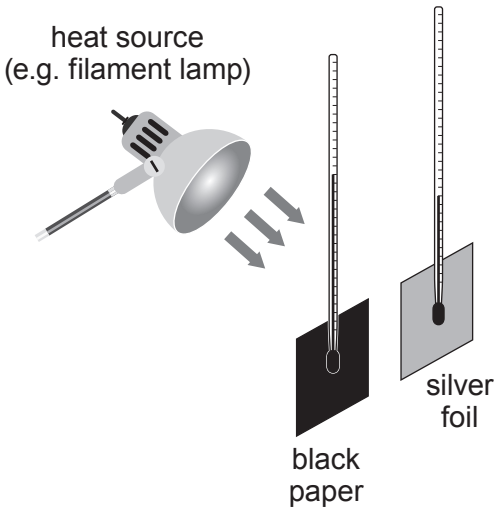
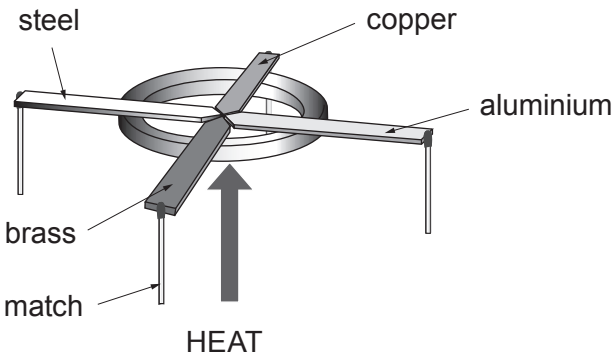
3. The diagrams show three experiments (A, B and C) used to demonstrate methods of heat transfer.

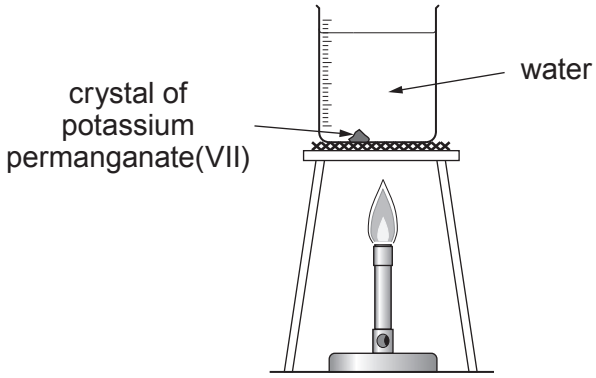
Experiment A



Experiment B



Experiment C



(a) (i) State which experiment **A**, **B** or **C** demonstrates convection. ..... [1]

(ii) State which experiment **A**, **B** or **C** demonstrates radiation. ..... [1]

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(b) (i) In experiment **B**, the time for the match to drop off each metal is measured. The results are shown in Table **1**.

Table **1**

Metal	Time taken to drop off (s)
aluminium	13
brass	18
copper	15
steel	20

Use the results to arrange the 4 metals in order starting with the best conductor. [1]

best .....

.....

.....

worst .....

(ii) Table 2 shows the thermal conductivity of metals. The larger the number the better the conductor.

Table **2**

Metal	Thermal conductivity (units)
aluminium	205
brass	109
copper	385
steel	50

Explain whether the results from experiment **B** in Table **1** agree with the data in Table **2**. [2]

.....

.....

.....

(c) Complete the following sentence.

Heat energy transfers along the metal rods in experiment **B** because the end of each rod in the middle of the ring is ..... than the end that holds the match. [1]

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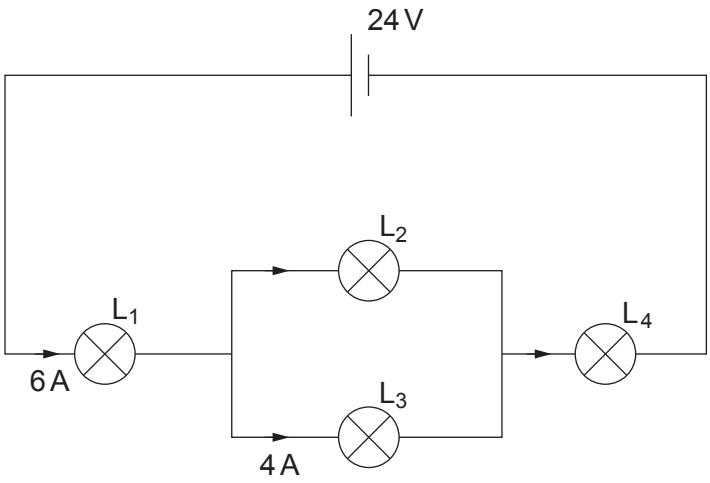
4. This question is about lamps connected in a circuit.

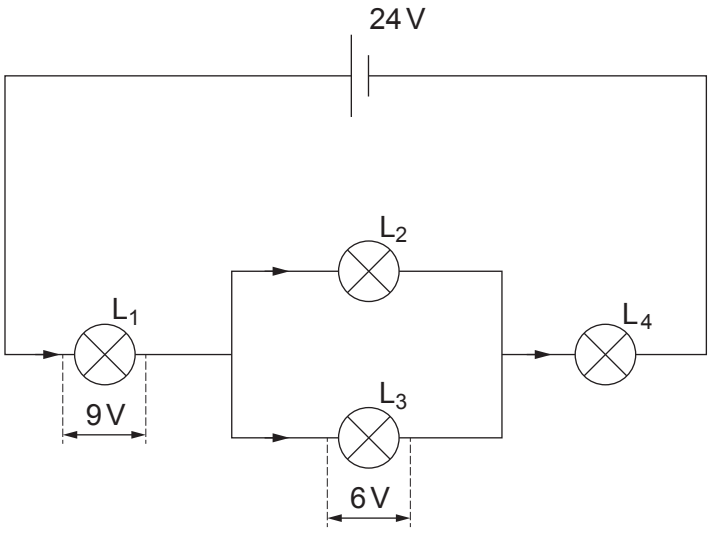
(a) The diagram shows the current in lamps L_1 and L_3.



State the currents in lamps L_2 and L_4. [2]

L_2 = ... A L_4 = ... A

(b) The diagram is the same circuit as above but it shows the voltages across lamps L_1, L_3 and the battery.



State the **voltages** across lamps L_2 and L_4. [2]

L_2 = ... V L_4 = ... V

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(c) Use information from both circuit diagrams and the equation: [3]

$$\text{power} = \text{voltage} \times \text{current}$$

to calculate the power of lamp L_1.
Give the unit for power.

power = ...

unit = ...

(d) (i) Use information from both circuit diagrams and the equation:

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

to calculate the resistance of lamp L_1. [2]

resistance = ... Ω

(ii) Owain says that setting up the circuit without lamp L_1 will not affect the current through the battery.
Explain whether you agree. [2]

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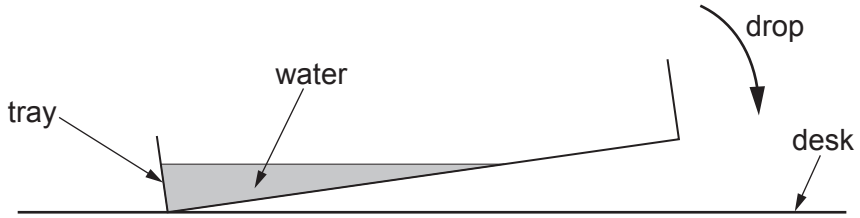
Examiner only

5. An experiment to determine how the speed of water waves depends on depth is described below.



1. Measure the length of the tray and record the result.
2. Add water to the tray to give a depth of 0.5 cm.
3. Lift the end of the tray up a few cm and gently drop on the desk.
4. Start the stopwatch when the wave produced hits the end of the tray.
5. Record how long it takes the waves to travel 3 lengths of the tray.
6. Repeat steps 3–5 four more times.
7. Repeat steps 2–6, increasing the depth each time by 0.5 cm up to 3.0 cm.

(a) (i) Explain why step **5** helps to improve the accuracy of the experiment. [1]

.....

.....

(ii) Explain why step **6** helps to improve the accuracy of the experiment. [2]

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Examiner only

(b) The length of the tray is **40 cm**.
At one depth, the time for the wave to travel **3 lengths** is 2.4 s.

(i) Calculate the distance travelled by the wave in **3 lengths** of the tray. [1]

distance = ... cm

(ii) Use the equation:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

to calculate the speed of the water wave. [2]

speed = ... cm/s

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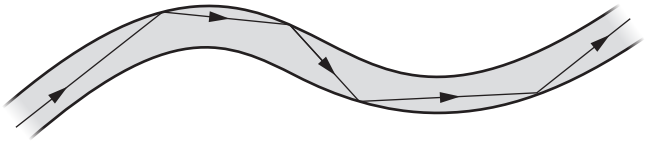
6. The diagram shows how light passes through an optical fibre.



Explain how optical fibres transmit information in this way **and** describe their advantages over satellites for long distance communication. [6 QER]

6

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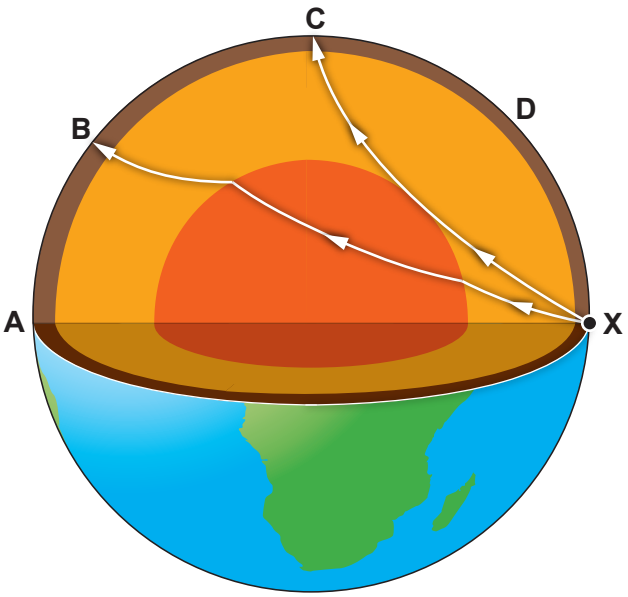
7. The diagram shows a cut away section of the Earth.

Four monitoring stations **A**, **B**, **C** and **D** are shown.
The path of earthquake (seismic) waves to **B** and **C** are shown spreading out from an earthquake at **X**.



(a) **Add lines with arrows** to the diagram to show the paths of the earthquake waves to **A** and **D**. [2]

(b) The type of earthquake waves detected at **A** and **B** are different from the ones arriving at **C** and **D**.

(i) Name the type of earthquake waves detected at **C** but not at **A**. [1]

.....

(ii) Geologists used seismic records to develop a model of the structure of the Earth. Describe what these seismic records tell us about the structure of the Earth. [3]

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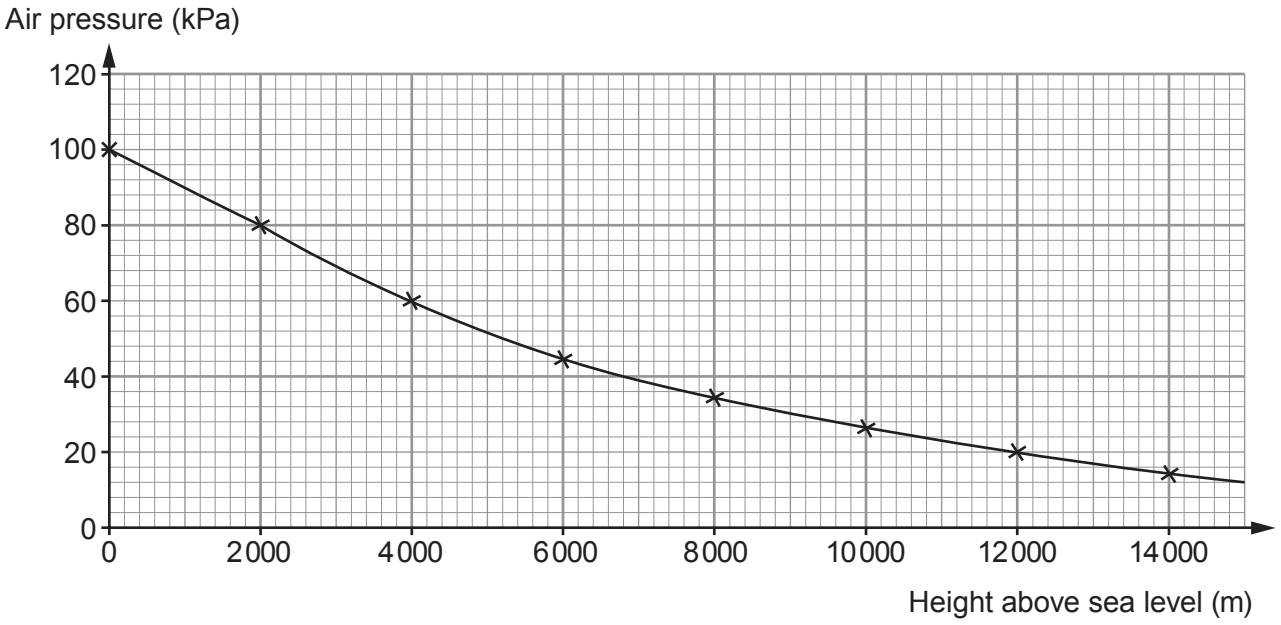
8. The graph below shows how air pressure varies with height above sea level.



(a) Passenger jets fly 12000 m above sea level.

(i) Use the graph to find the air pressure at this height. [1]

pressure = ... kPa

(ii) Calculate the difference in air pressure between the inside and outside of the jet. Assume the air pressure in the cabin of the jet is the same as the air pressure at sea level. [2]

pressure difference = ... kPa

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(b) A window in a passenger jet is shown below.

It is 0.40 m wide and 0.25 m high.

(i) Calculate the area of the window (assume it is a rectangle). [2]

area = ... m^2

(ii) Use the equation:

force = pressure difference × area

to calculate the force on the window due to the pressure difference when flying at a height of 12 000 m above sea level. [3]

force = ... N

Examiner only

(c) Information shown on a screen during the flight is given below.
Use the information below and in the graph to explain the change in air pressure with height in terms of molecules. [3]

Height above sea level = 12 000 m

Aircraft speed = 900 km / h

Temperature at sea level = 17 °C

Outside temperature = –55 °C

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TURN OVER FOR THE LAST TWO QUESTIONS

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9. In the UK, domestic electricity has a voltage of 230 V and a frequency of 50 Hz. It is an alternating current (a.c.) supply, rather than a direct current (d.c.) supply.

(a) State the difference between a.c. and d.c. [1]

.....

.....

(b) A science class investigates the cost and efficiency of different kettles. They collect and compare data for two different kettles.

	Kettle **X**	Kettle **Y**
Power	2200 W	2.4 kW
Time to boil (s)	90	90
Mass of water (kg)	0.6	0.6
Heat energy transferred to the water (J)	188 100	

(i) Not all of the heat energy transferred by the kettle is transferred to the water.

I. Use data from the table and an equation from page 2 to calculate the total electrical energy transferred by kettle **X** when it is boiled **once**. [2]

total electrical energy transferred by kettle **X** = ... J

II. Use data from the table, an equation from page 2 and your answer to part (i)I to determine the % efficiency of kettle **X**. [2]

% efficiency = ...

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(ii) The students compare the cost of using each of the kettles.
They estimate that each kettle will be boiled 10 times per day.

I. Calculate the time that each kettle is used per day in hours. [1]

time = ... hours

II. Use equations from page 2 to calculate the cost of using kettle **Y** per day if 1 unit of electricity costs 30 p. [3]

cost per day = ... p

(iii) It is suggested that kettle **X** will cost more to use per day, than kettle **Y**, when used for the same time.
Explain whether you agree with this suggestion. [2]

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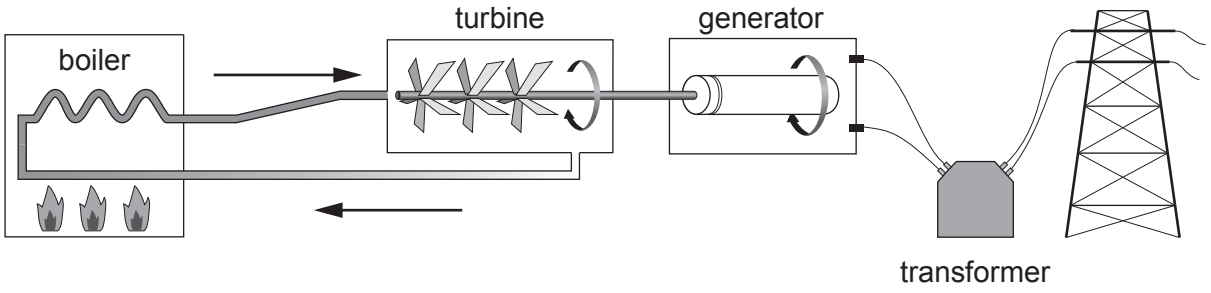
10. Drax power station is a fuel-burning power station.
In 1986, Drax was the largest power station in the UK.
It consisted of 6 coal-fired generators with a total capacity of about 4000 MW, powering millions of homes.
By 2018, Drax had converted four of the coal-fired generators to run on biomass, producing 70% of its electrical power through burning compressed wood pellets.

(a) The simplified diagram below shows a fuel-burning power station.



Describe the processes involved in producing electrical power from a fuel. [3]

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(b) Burning biomass does not produce sulfur dioxide.
State **and** explain another environmental advantage of burning biomass rather than coal. [2]

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Examiner only

(c) The demand for electricity depends on the weather.
In the winter, demand increases by 750 MW for every degree the temperature drops below 14 °C.
In the summer, demand increases by 350 MW for every degree rise over 20 °C, from a mean demand of 40 000 MW.

(i) Suggest why demand for electricity increases as the temperature increases above 20 °C in the summer. [1]

.....

.....

(ii) On one summer's day, the demand for electricity increased to 45 600 MW.
Chris suggests that the temperature must have risen to 30 °C, but Ella states that it must be 36 °C.
Determine who is correct. [3]
Space for calculations.

.....

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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