Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3430U30-1

Z22-3430U30-1

MONDAY, 20 JUNE 2022 – MORNING

SCIENCE (Double Award)

Unit 3 – PHYSICS 1
FOUNDATION TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**17**	
3.	**5**	
4.	**9**	
5.	**9**	
6.	**15**	
Total	**60**	

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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 **4(a)**.

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

SI multipliers

Prefix	Multiplier
m	1×10^{-3}
k	1×10^{3}
M	1×10^{6}

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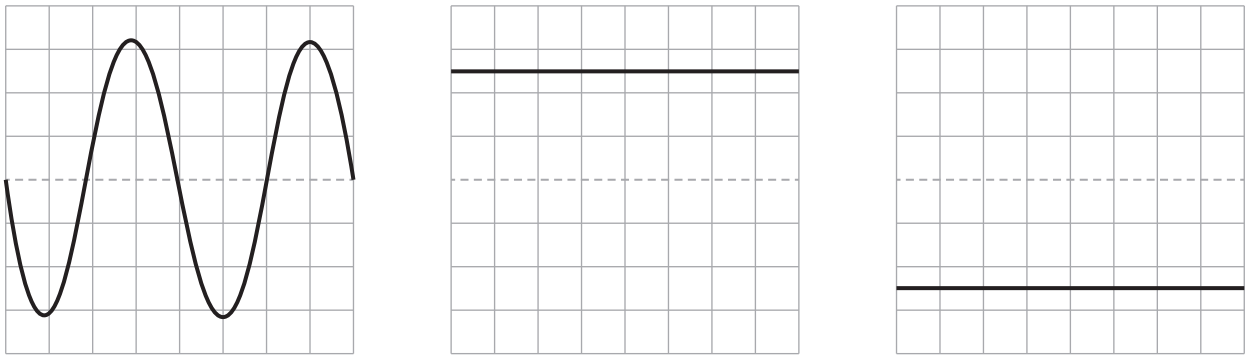
Answer **all** questions.

1. Domestic electricity in the UK is supplied to houses at a voltage of 230 V.
It is an alternating current (a.c.) supply.

(a) **Tick (✓)** the box below the diagram which shows the voltage from an a.c. supply. [1]



(b) (i) To use electricity safely in the home, some safety features are used.
Draw a line to match the safety feature in the list on the left with its action on the right. Each action should only be selected once. [3]

Safety feature	Action
Fuse	Quickly shuts off the supply if there is a difference between the live and neutral currents
Residual current circuit breaker (rccb)	Melts if there is too much current in the circuit
Earth wire	Quickly shuts off the supply if there is too much current in the circuit
Miniature circuit breaker (mcb)	Provides a low resistance path to Earth for current

(ii) One purpose of safety features is to prevent fires.
State **one** other purpose of safety features. [1]

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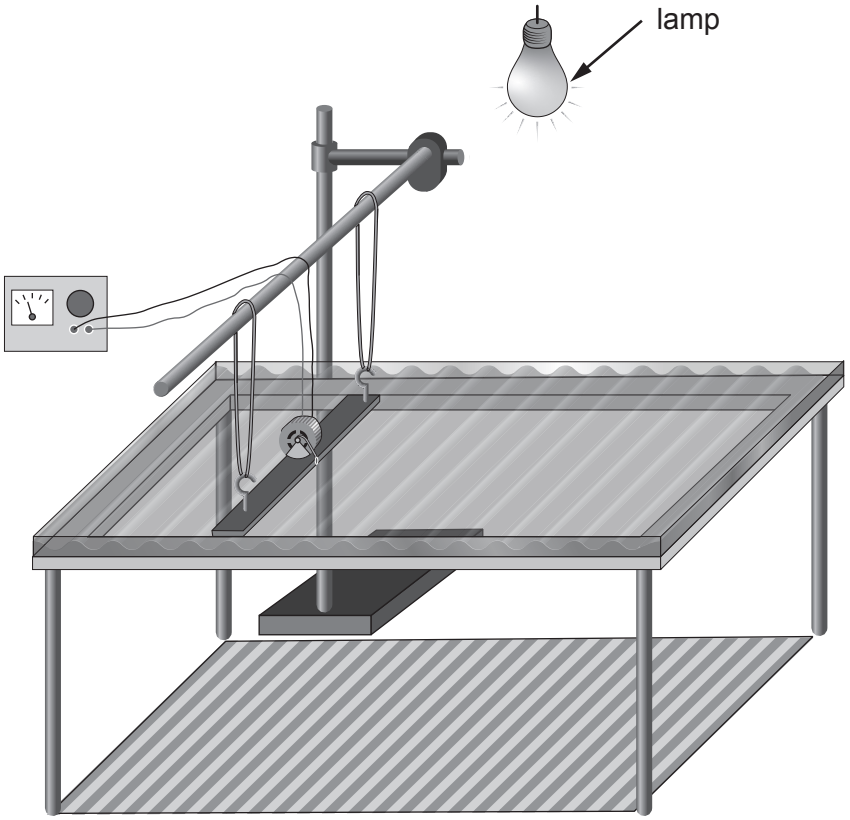
2. A teacher demonstrates waves using a ripple tank.
She changes the frequency of the waves produced and the class observes the effect on their wavelength.



Next, the class investigates the link between frequency and wavelength using a virtual ripple tank simulation.

The table below shows their results.

Frequency (Hz)	$\frac{1}{\text{frequency}}$ (s)	Wavelength (cm)
20.0	0.05	1.0
10.0	0.10	2.0
6.7	0.15	3.0
5.0	0.20	4.0
4.0	0.25	5.0

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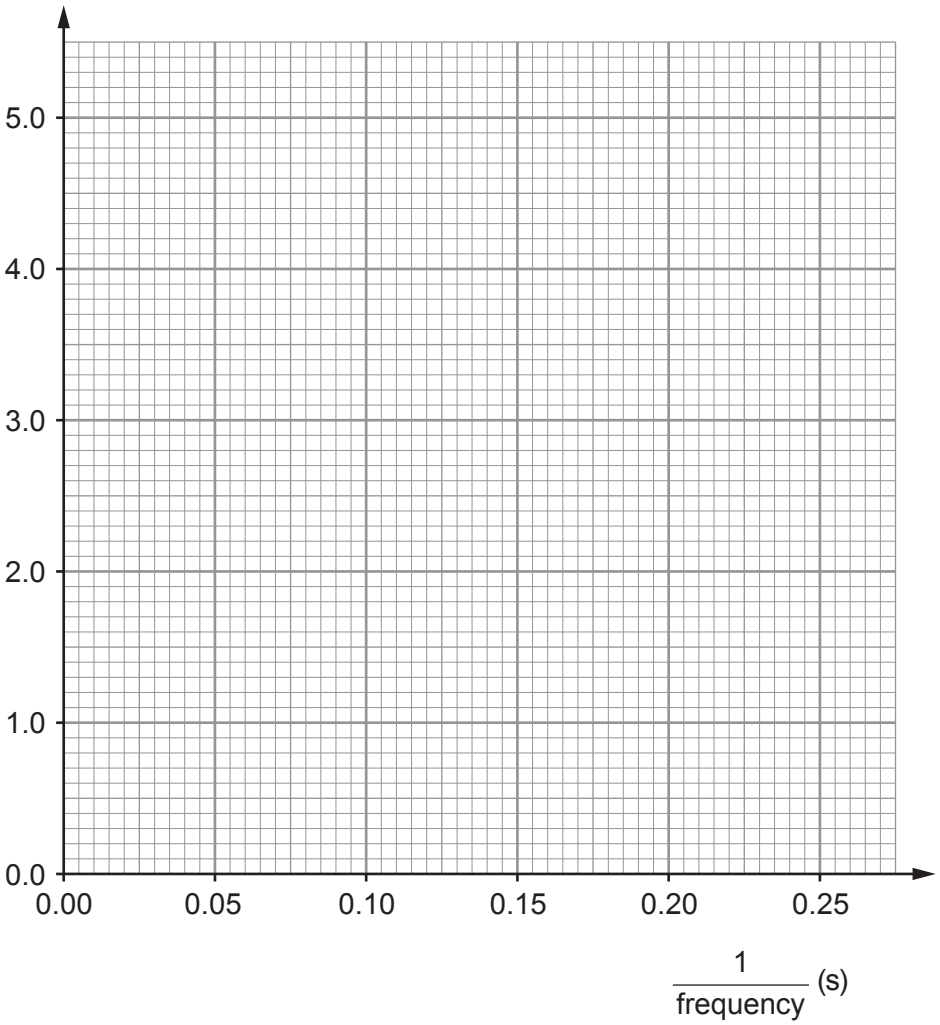
(a) (i) Plot the data on the grid below and draw a suitable straight line. [3]

Wavelength (cm)



(ii) **Complete** the following sentences by underlining the correct word or phrase in the brackets. [2]

I. As $\frac{1}{\text{frequency}}$ increases the wavelength **[increases / decreases / stays the same]**.

II. As frequency increases the wavelength **[increases / decreases / stays the same]**.

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(iii) I. Use data from the table to state the wavelength of the waves at a frequency of **10 Hz**. [1]

Wavelength = ... cm

II. Use the equation:

wave speed = frequency × wavelength

to determine the speed of the waves at a frequency of **10 Hz**. [2]

Speed = ... cm/s

(b) (i) Electromagnetic waves are used to communicate with satellites. Some satellites remain above the same point on the Earth to allow constant communication.

Complete the following sentences about communications satellites by underlining the correct word or phrase in the brackets. [4]

Electromagnetic waves are **(longitudinal / parallel / transverse)** waves.

TV signals are sent to satellites in **(geothermal / geosynchronous / geostationary)** orbits using **(microwaves / visible light / gamma rays)**.

These satellites orbit above the **(poles / equator / axis)** of the Earth.

(ii) A satellite orbits the Earth in a circular orbit, once every 24 hours. The radius of its orbit is 42 164 km.

I. Use the equation:

circumference of a circle = $2\pi r$ (where r = radius and π = 3.14)

to calculate the distance the satellite travels in one orbit. [1]

Distance = ... km

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II. Use the equation:

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

to calculate the speed of the satellite in km/h. [2]

Speed = ... km/h

(iii) Maddie suggests that the satellite orbits at the same speed as a point on the Earth's surface moves, so that it always stays above the same point on the Earth. Explain whether or not you agree. [2]

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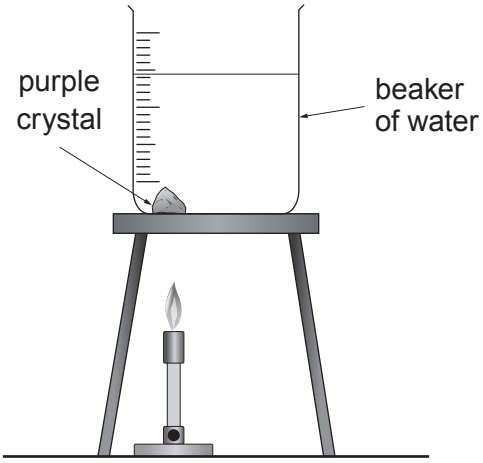
3. A group of students investigated different methods of heat transfer.

(a) First, they added a purple crystal to a beaker of water and heated it up as shown below.



(i) **Circle** the method of heat transfer that was being investigated.

conduction **convection** **radiation** [1]

(ii) I. State what the students observed. You may add to the diagram if you wish. [1]

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II. Give a reason for your answer to part I. [1]

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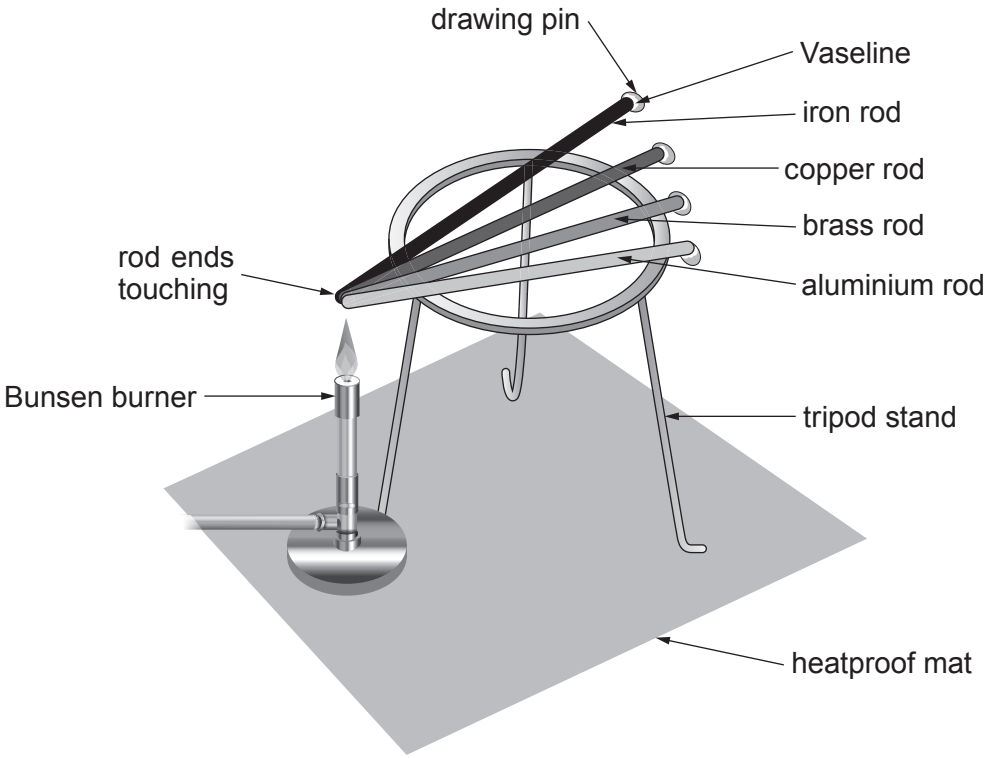
(b) In their next experiment the students placed 4 metal rods on a tripod.
The rods were identical except they were made from different metals.
They attached a drawing pin to the end of each rod with Vaseline.
They heated the other end of each of the rods and recorded the time for each pin to drop off.



The students recorded the following results:

Metal	Time for pin to drop off (s)
iron	46
copper	10
brass	23
aluminium	18

List the metals in order from best conductor to worst conductor. [2]

Best conductor .....

.....

.....

Worst conductor .....

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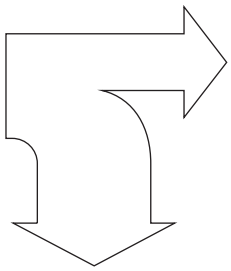
4. (a) Describe the advantages **and** disadvantages of generating electricity from:

coal **nuclear fuel** **wind** [6 QER]

(b) The Sankey diagram below shows the energy transfer for a coal-fired power station.

Input energy = 15.0 MWh



Energy to National Grid = 5.0 MWh

Wasted energy = ... MWh

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(i) **Complete** the diagram opposite to show the wasted energy. [1]

(ii) Use an equation from page 2 to calculate the % efficiency of the power station. [2]

% efficiency = ...

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Examiner only

5. A biogas generator converts cow dung into biogas which can be burned to generate electricity.

(a) A farmer buys 3 750 kWh of electricity per week from the National Grid.
He plans to buy a biogas generator which should reduce this to 750 kWh per week.

(i) Calculate how many units of electricity he would **save** per week. [1]

Units saved = ... kWh

(ii) Use the equation:

saving per week = units saved × cost per unit

to calculate the saving per week. One unit of electricity costs £0.20. [2]

Saving per week = £ .....

(iii) The biogas generator costs £150 000.

I. Use the equation:

$$\text{payback time} = \frac{\text{cost}}{\text{saving per week}}$$

to calculate the expected payback time in weeks. [1]

Payback time = ... weeks

II. Calculate the expected payback time in years. 1 year = 52 weeks. [1]

Payback time = ... years

Examiner only

(b) The farmer wants the biogas generator to produce at least 3000 kWh of electricity each week.
He collects 60 kg of dung from each cow per week.
1 kg of dung produces 0.095 kWh of electricity.

(i) Calculate how much electricity can be produced from each cow per week. [1]

Electricity produced = ... kWh

(ii) Calculate how many cows the farmer will need to produce the 3000 kWh required. [1]

Number of cows = ...

(c) The table below shows the heating effect different greenhouse gases have on the atmosphere by comparing the global warming potential (GWP) values. If the GWP is twice as big the gas will cause twice the heating effect.

Greenhouse gas	GWP
carbon dioxide	1
methane	25
nitrous oxide	298

If it is left outside, cow dung releases **methane** into the atmosphere. In a biogas generator the methane is captured and burned releasing a similar amount of **carbon dioxide** (CO_2) into the atmosphere instead.

Alun suggests that biogas generators are bad for the environment because they release CO_2 into the atmosphere.
Explain whether you agree. [2]

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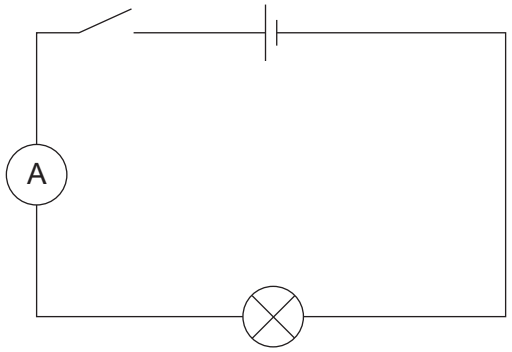
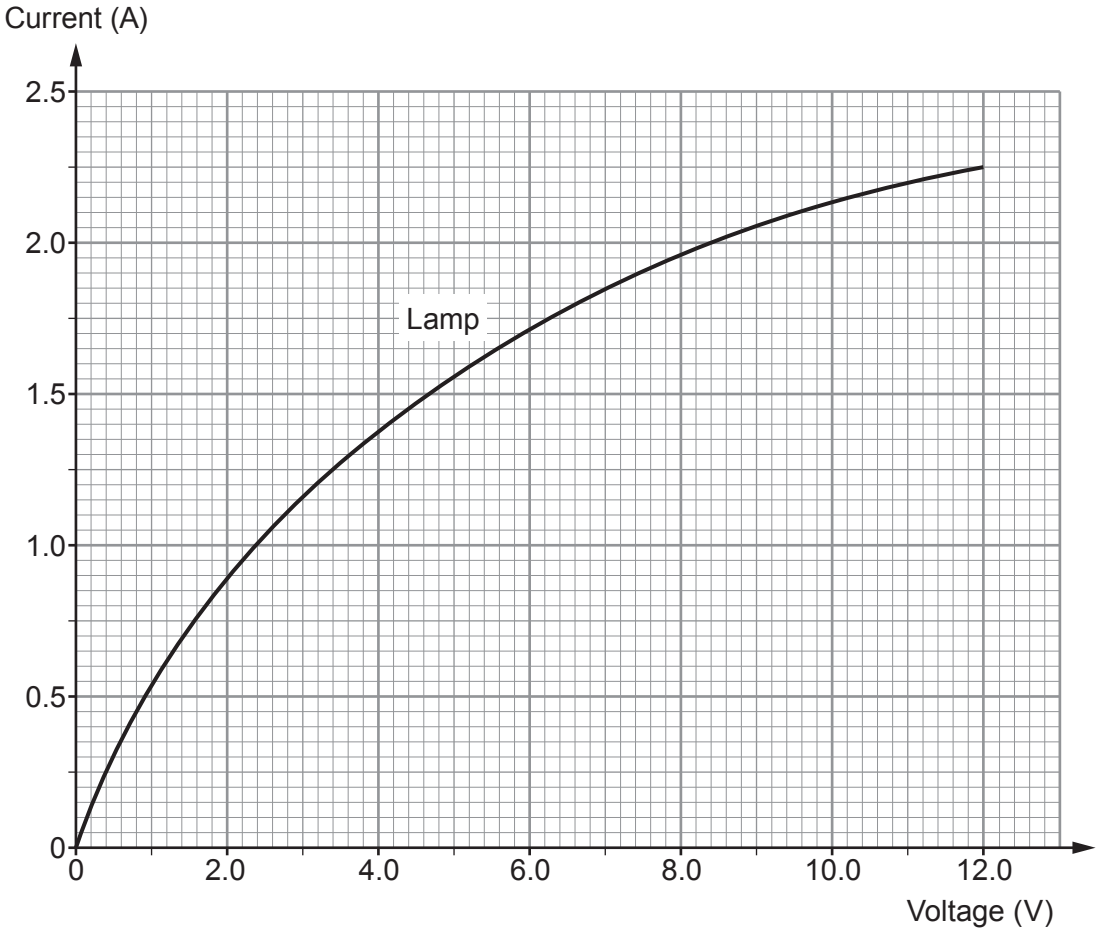
6. A group of pupils investigate the current-voltage (I-V) characteristics of different components.

(a) The first component they investigate is a lamp.
Part of the circuit used is shown below.
Add a variable resistor **and** voltmeter to the circuit diagram. [2]



(b) They draw a graph from their results for the **lamp**. It is shown below.



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(i) One student suggests that as the current through the lamp **doubles** the voltage **triples**.
Use pairs of data within the range 0.5 A to 2.0 A from the graph to explain whether you agree with the student. [3]

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(ii) Use the equation:

power = voltage × current

and information from the graph to calculate the **maximum** power produced by the lamp. [3]

Power = ... W

(c) The experiment is repeated with a 6 Ω resistor but the results are lost.

(i) Use the equation:

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

to calculate the current through the 6 Ω resistor at 12 V. [2]

Current = ... A

(ii) **Draw the line for this resistor** on the grid on the previous page. [1]

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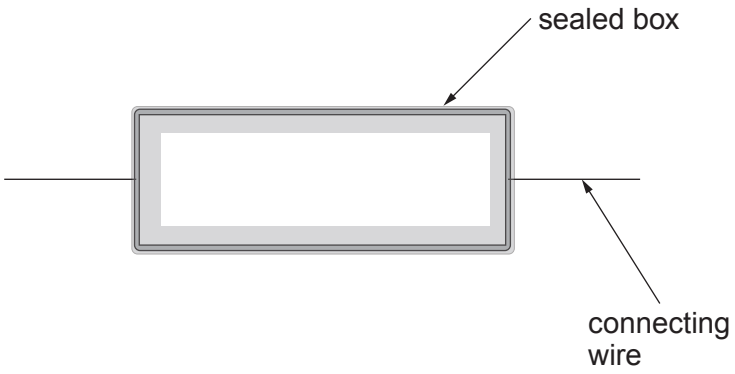
(d) The students are given a sealed box containing another component.



They are asked to confirm whether the hidden component is a diode.

(i) Describe how they would use the circuit shown in part (a) to confirm whether or not it is a diode. [3]

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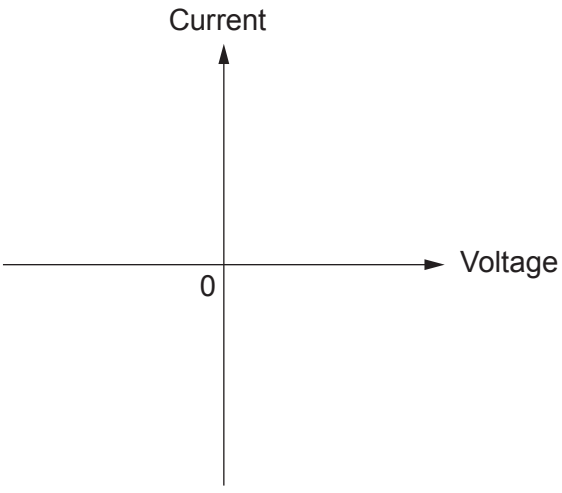
(ii) **Sketch** the I-V graph that you would expect to obtain for a diode on the grid below. [1]



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END OF PAPER

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