Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3430UC0-1

Z22-3430UC0-1

MONDAY, 20 JUNE 2022 – MORNING

SCIENCE (Double Award)

Unit 3 – PHYSICS 1
HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**15**	
2.	**13**	
3.	**6**	
4.	**7**	
5.	**6**	
6.	**13**	
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 pages 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 **5**.

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Equations

current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
total resistance in a series circuit	$R = R_1 + R_2$
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 = $\frac{\text{energy (or power) usefully transferred}}{\text{total energy (or power) supplied}}$ × 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
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}

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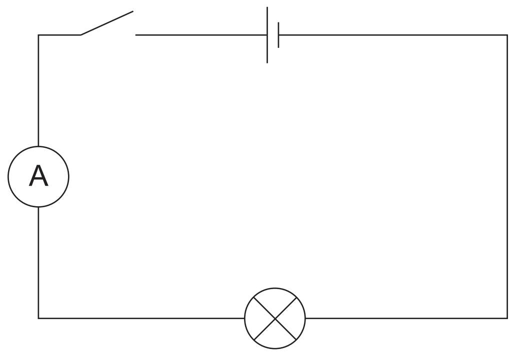
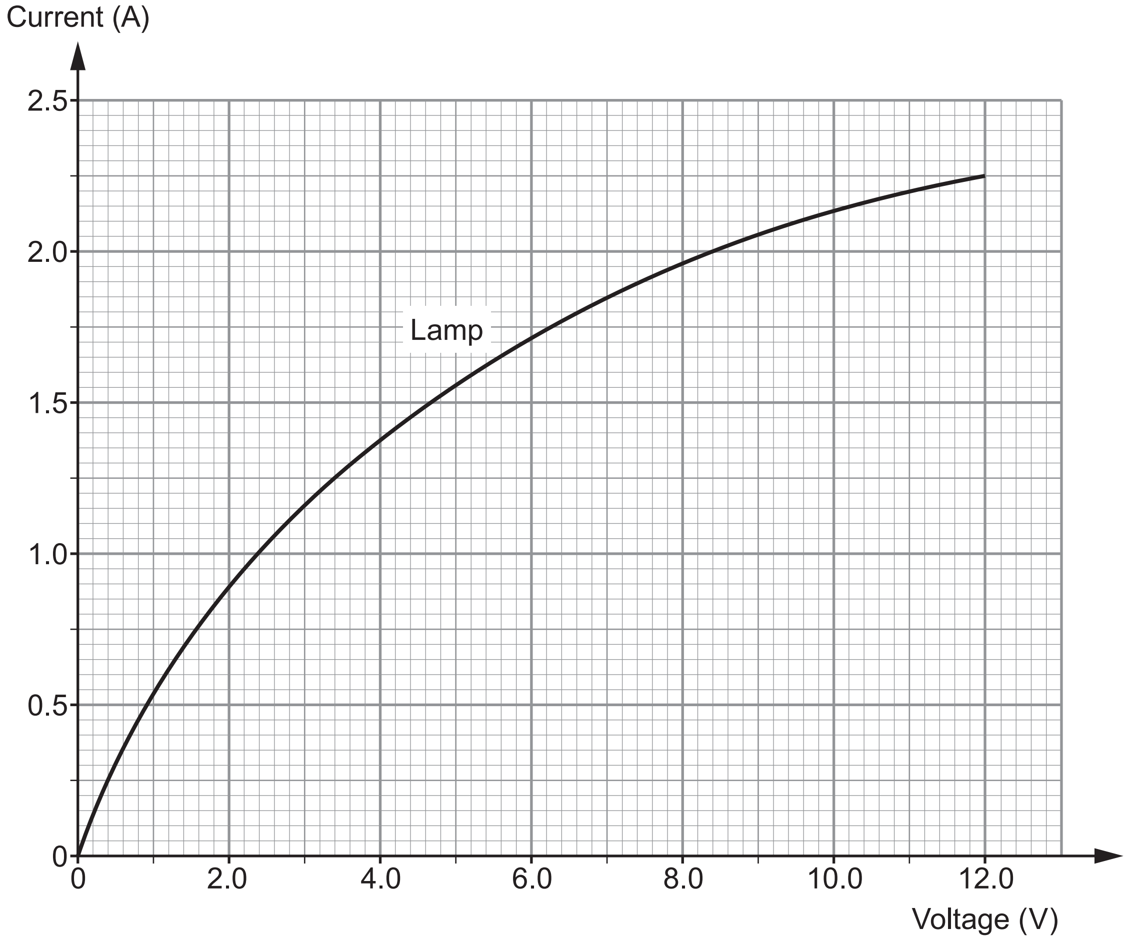
Answer **all** questions.

1. 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]

....

....

(ii) Use the equation:

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

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

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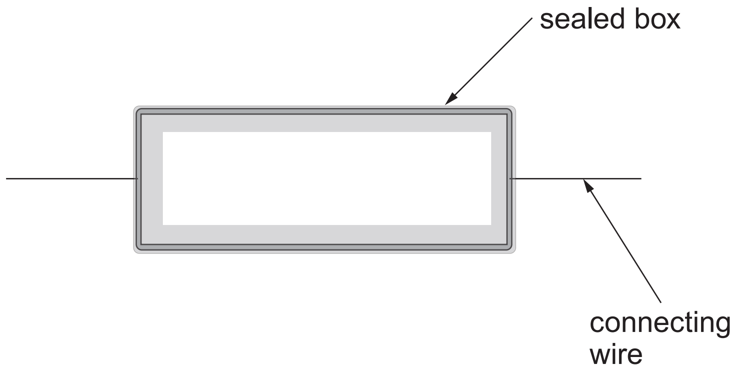
(d) The students are given a sealed box containing another component.



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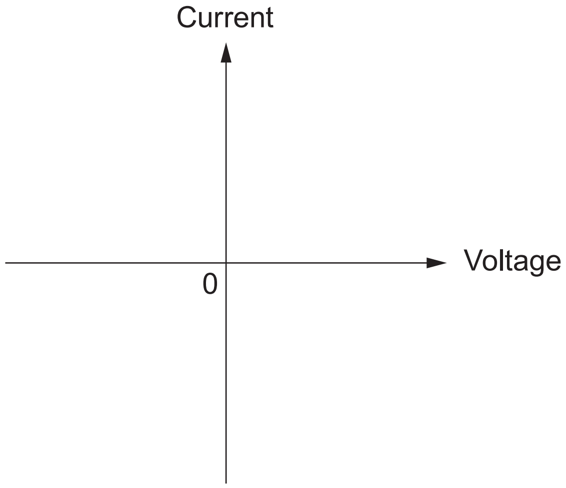
(ii) **Sketch** the I-V graph that you would expect to obtain for a diode on the grid below. [1]



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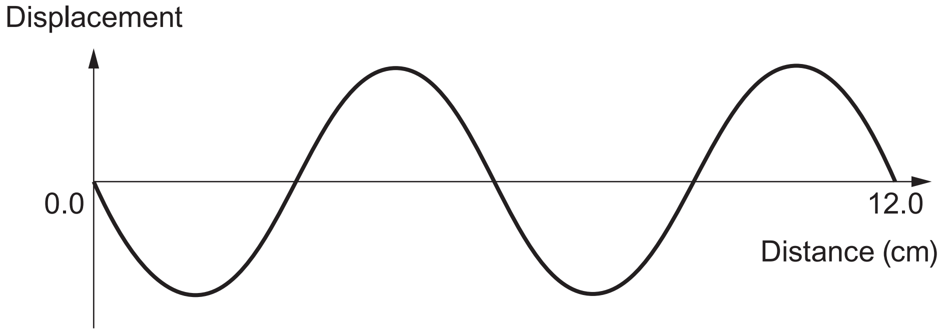
2. Microwaves travel through space at a speed of 3×10^8 m/s and are one part of the electromagnetic spectrum.

(a) The diagram represents microwaves produced at a certain frequency.



(i) Use the information in the diagram to calculate the wavelength of these microwaves. [1]

Wavelength = ... cm

(ii) Use your answer above and the equation:

wave speed = wavelength × frequency

to calculate the frequency of these microwaves. [3]

Frequency = ... Hz

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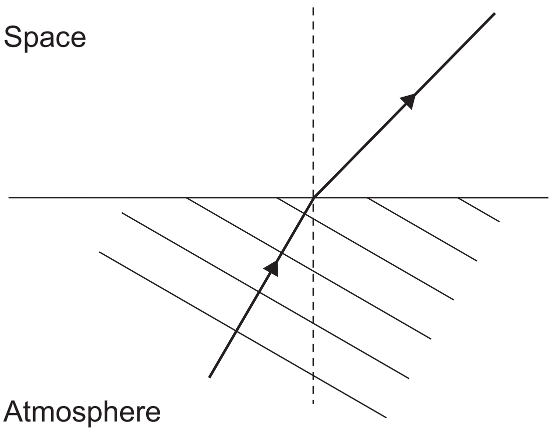
(b) Microwaves are refracted as they travel from the atmosphere into space.



Complete the diagram to show the refracted wavefronts in space. [3]

(c) Geostationary artificial satellites are used to send microwave signals around the world.

(i) Explain why a satellite in a geostationary orbit above the equator appears to stay in a fixed place above the surface of the Earth even though both the satellite and the Earth are constantly moving. [2]

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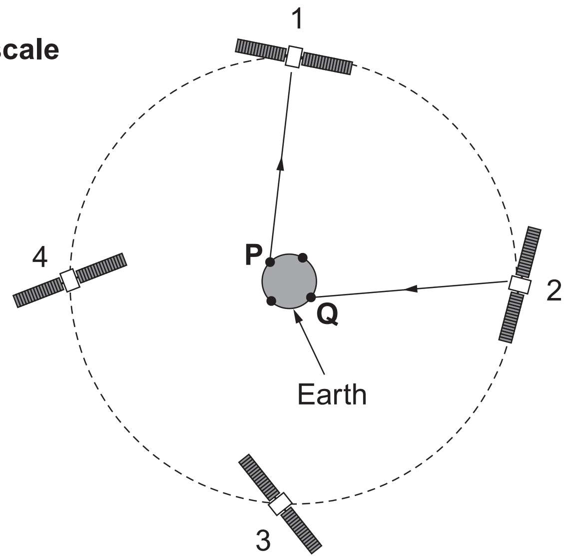
(ii) The diagram shows 4 satellites in geostationary orbit around the Earth.
A signal is to be sent from Earth station **P** to **Q** using the satellites 1 and 2.
The first and last parts of the path are shown.

Diagram not to scale



Use an equation from page 2 to calculate the time taken for the signal to travel from **P** to **Q**.
The height of a geostationary satellite above the Earth is 3.6×10^7 m. [3]
(Speed of light, $c = 3 \times 10^8$ m/s)

Time = ... s

(iii) It was suggested that if the signal had been sent in the opposite direction from **Q** to **P** via satellites **3** and **4** then it would have arrived quicker.
Explain whether you agree with this suggestion. [1]

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3. A ring main is used to connect sockets to the fuse box.
The cables include live, neutral and Earth wires.
The fuse box includes miniature circuit breakers (mcb) and residual current circuit breakers (rccb).

(a) Describe the function of each of the following wires. [3]

live:

....

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neutral:

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Earth:

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....

(b) Explain the differences between an mcb and an rccb. [3]

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6

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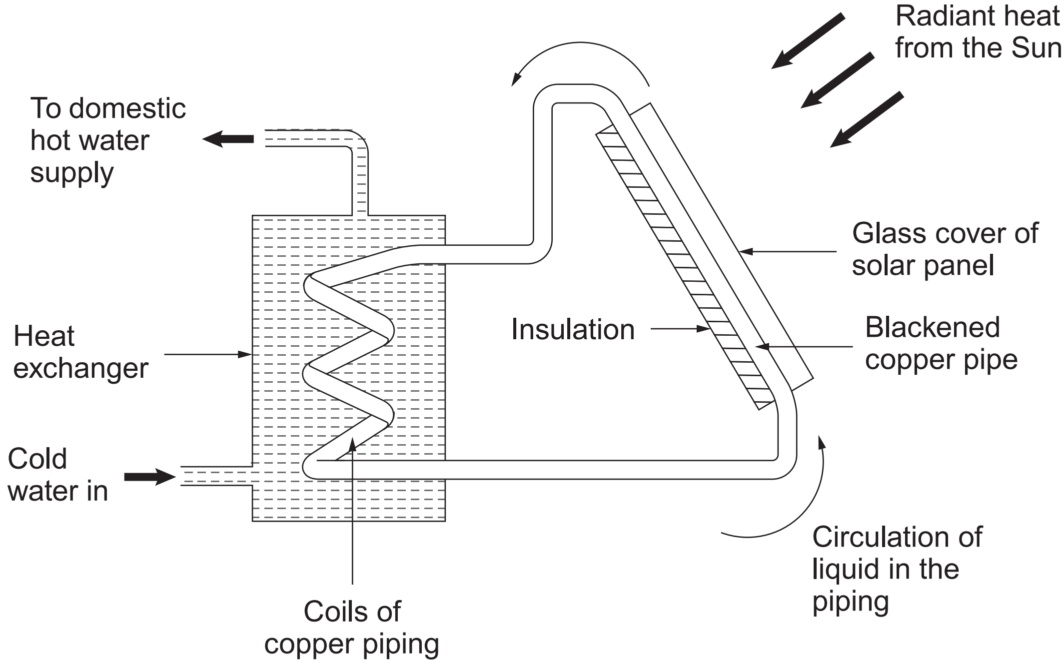
4. The diagram shows a solar heating panel that is installed on a roof. The liquid in the solar panel becomes heated by radiation from the Sun. The heated liquid passes through coils of copper piping inside a heat exchanger resulting in water heating up.



(a) Explain, **in terms of particles**, how heat energy conducts through the walls of the copper piping in the heat exchanger. [3]

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(b) Explain why the liquid in the solar panel circulates in the direction shown. [2]

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(c) In good sunlight, each square metre of the solar panel receives 960 J of energy per second from the Sun. Only $\frac{1}{3}$ of this energy is used to heat the liquid.

Calculate the amount of energy given to the liquid per second if the panel has an area of 2 m^2. [2]

Energy given to the liquid per second = ... J

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5. Describe the processes involved in generating electricity in a gas fired power station **and** explain how this electricity is supplied to consumers efficiently and safely through the National Grid. [6 QER]

6

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6. A dairy farm was using 15 000 kWh of electricity every month from the National Grid.
The cost of electricity to the farm was 20 p per unit.
The farmer decided to spend £152 400 on a biogas generator which uses cow dung to generate electricity.
When working at maximum output, it was expected to reduce his demand on the National Grid to only 3 000 kWh a month.

(a) (i) Use an equation from page 2 to calculate the expected monthly savings **in £**. [3]

Savings = £ ....

(ii) Calculate the payback time for the biogas generator. [1]

Payback time = ... months

(b) The biogas generator needs to produce 144 000 kWh of electricity per year.
The farmer owns 150 cows.
Each cow produces 200 kg of dung per week, but the farmer is only able to collect 60 kg of this.
Each 1 kg of dung produces 0.05 m^3 of methane gas.
Each 1 m^3 of methane gas input to the generator has an energy value of 5.3 kWh.
Each 1 m^3 of methane gas when burned produces an output of 1.9 kWh of electricity.

(i) Use the information above and an equation from page 2 to calculate the % efficiency of using methane gas to produce electricity. [2]

% efficiency = ...

Examiner only

(ii) The farmer thinks that there will be enough cow dung to produce the required amount of electricity (144 000 kWh).
Use the information opposite to explain whether the farmer is correct.
Show all your workings in the space below. (1 year = 52 weeks) [5]

(c) When cow dung decomposes it produces methane gas.
When methane gas burns, it produces the greenhouse gases carbon dioxide and water vapour.
An online article contains this information about methane:

"While carbon dioxide is said to be the major contributor to the greenhouse effect, methane is roughly 30 times more effective as a heat-trapping gas."

Explain whether collecting cow dung to use in a biogas generator benefits efforts to reduce human impact on the greenhouse effect. [2]

13

END OF PAPER

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