Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3430UC0-1

S24-3430UC0-1

MONDAY, 17 JUNE 2024 – 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.	**8**	
3.	**11**	
4.	**8**	
5.	**11**	
6.	**7**	
Total	**60**	

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01

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 **2**(a).

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 = $\dfrac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}} \times 100$	
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 = $\dfrac{\text{distance}}{\text{time}}$	

SI multipliers

Prefix	Symbol	Conversion factor	Multiplier
pico	p	divide by 1 000 000 000 000	1×10^{-12}
nano	n	divide by 1 000 000 000	1×10^{-9}
micro	μ	divide by 1 000 000	1×10^{-6}
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}
giga	G	multiply by 1 000 000 000	1×10^{9}
tera	T	multiply by 1 000 000 000 000	1×10^{12}

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Answer **all** questions.

1. Volac is a dairy food manufacturing company based in Felinfach in West Wales.
Volac use a combined heat and power biomass power station.
It produces some of the electricity and heat for the factory.
The biomass power station burns wood produced locally.
Data about the biomass power station is given below.

Cost to build the biomass power station = £38 million (£38 000 000) Estimated annual savings on energy bills = £3.75 million (£3 750 000)

(a) (i) Calculate the expected payback time for the biomass power station. [2]

payback time = ... years

(ii) State **one** reason why this payback time may change. [1]

....

(b) Seren states that burning wood produces CO_2 so it is harmful to the environment.
Explain whether you agree with Seren. [2]

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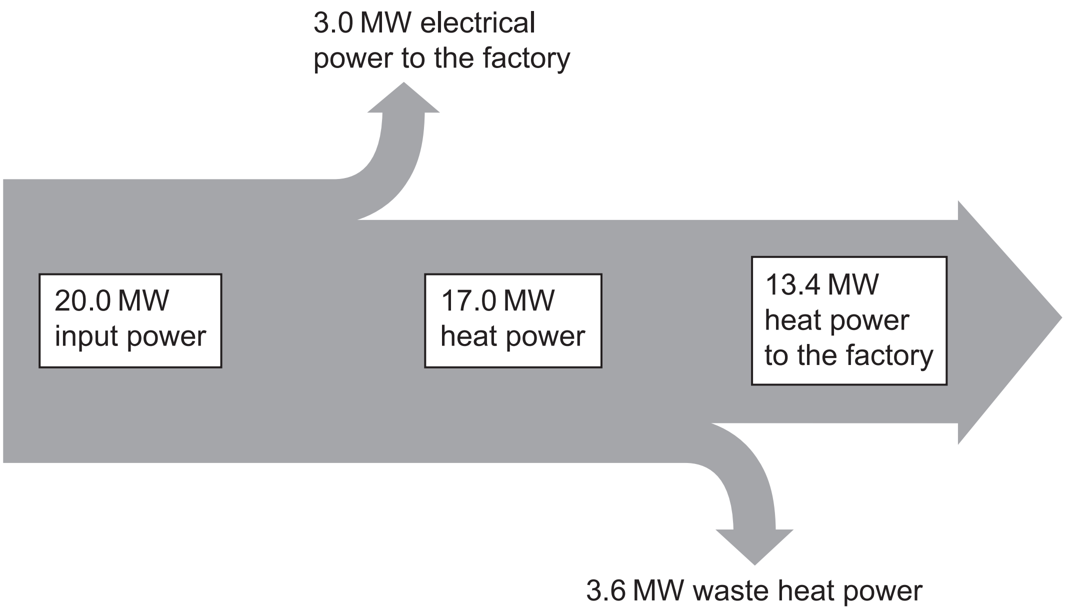
(c) A Sankey diagram for the biomass power station is shown below.



(i) Calculate the **total** useful output power from the biomass power station. [1]

useful output power .... MW

(ii) Evan states that the biomass power station is only 15% efficient.
Explain whether you agree. Include a calculation. [2]

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(d) (i) The input power to the biomass power station is 20.0 MW.
Use an equation from page 2 to calculate how much energy is transferred by burning wood in the power station every 60 minutes.
Give your answer in MJ. [3]

energy transferred every 60 minutes = ... MJ

(ii) Burning 1 tonne of the wood used in the biomass power station produces 2880 MJ of energy.
Calculate how many tonnes of wood the biomass power station burns every 60 minutes. [1]

mass of wood burned every 60 minutes = ... tonnes

(iii) The wood used in the biomass power station has a density of 500 kg/m^3.
Use the equation:

$$\text{volume} = \frac{\text{mass}}{\text{density}}$$

to determine the volume of wood burned every 60 minutes.
1 tonne = 1000 kg. [2]

volume of wood burned every 60 minutes = ... m^3

(iv) An average tree produces 5 m^3 of wood.
Calculate how many trees are burned every 60 minutes. [1]

number of trees burned every 60 minutes = ...

15

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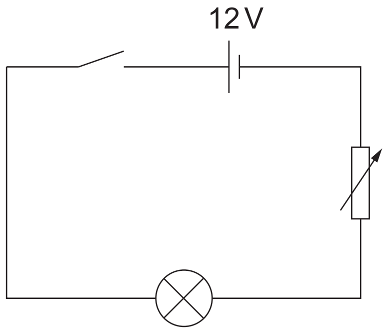
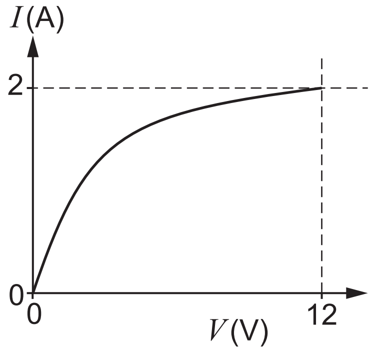
2. Students set up the following circuit to investigate how the current through a 12 V filament lamp varies with voltage.
Their results are shown on the graph.





(a) Explain how they use the circuit to produce the results shown.
Include in your answer:
- what additional components they need to add to the circuit
- how these components should be connected and what they are used for
- a method they can use to obtain several pairs of readings. [6 QER]

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(b) George states that the resistance of the lamp decreases as the voltage increases. Use the graph to explain whether you agree. [2]

....

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8

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Turn over.

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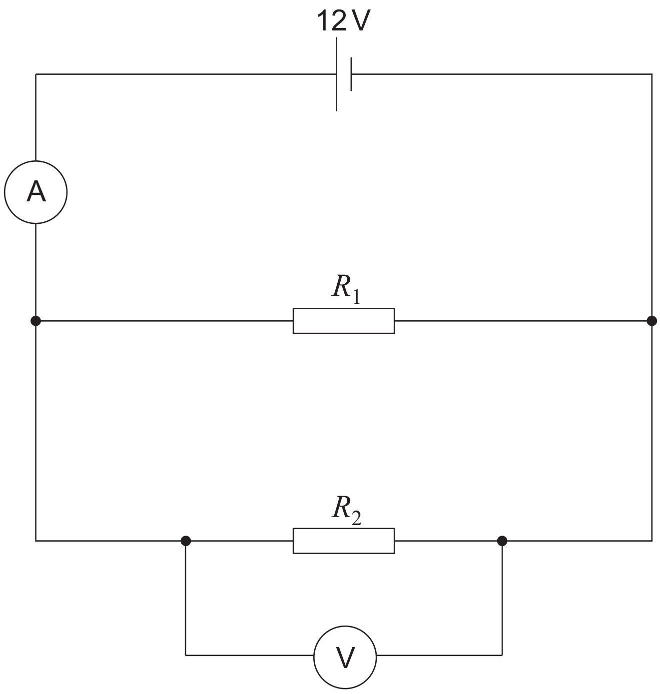
3. The circuit shown below contains two identical resistors connected in parallel. Each resistor has a resistance of 10 Ω.



(a) (i) Use the equation:

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2}$$

to calculate the total resistance of the circuit. [2]

total resistance = ... Ω

(ii) Use an equation from page 2 to calculate the current reading on the ammeter. [2]

current = ... A

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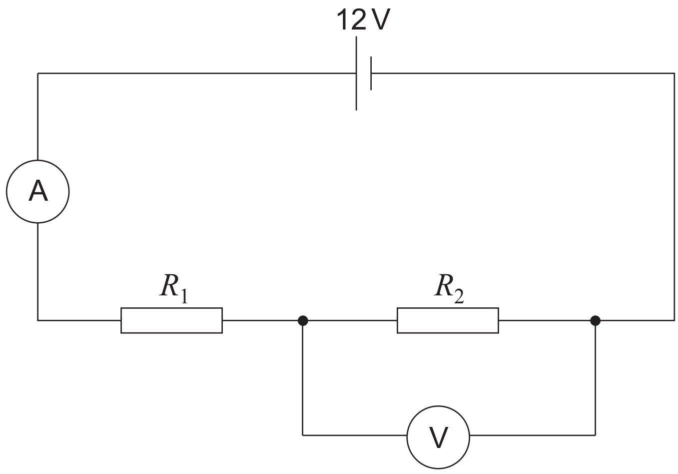
(iii) State the voltage across R_2. [1]

voltage = ... V

(iv) Calculate the current through R_2. [2]

current = ... A

(b) The same resistors are now connected in series.



State how the following values compare with the parallel circuit in part (a).

(i) The total resistance of the circuit. [1]

....

(ii) The current reading on the ammeter. [1]

....

(iii) I. The voltage across R_2. [1]

....

II. Give a reason for your answer. [1]

....

....

11

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4. An incomplete diagram of the electromagnetic (em) spectrum is shown below.

Region	Radio waves	Microwaves	Infra-red	Visible
Wavelength (m)	....	....	....	....

(a) The wavelength of a wave in each of the regions shown is given below.
Complete the table by using the wavelength values below. [2]

2×10^{-2} m $\quad$ 4×10^{2} m $\quad$ 5×10^{-7} m $\quad$ 3×10^{-5} m

(b) The ionising regions of the em spectrum are not included on the diagram.

(i) Name the missing regions. [1]

....

(ii) State what is meant by the term ionising radiation. [1]

....

....

(c) All waves in the em spectrum are transverse.
State **one** other property they have in common. [1]

....

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(d) Electromagnetic radiation is used in communications.
A and B are two points on the Earth's surface.
To send a signal from A to B, it can either be sent as a signal in a cable or as a signal via a satellite in geostationary orbit.

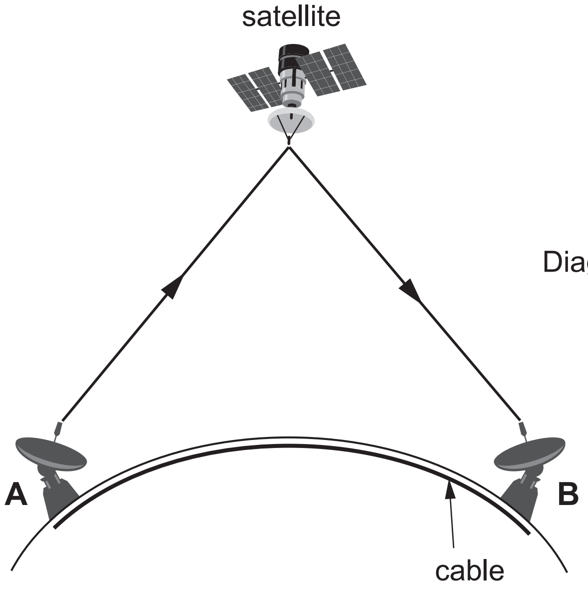

Diagram not drawn to scale

Information about both methods is given in the table below.

Speed of signal to satellite	3×10^8 m/s
Speed of signal in cable	2×10^8 m/s
Distance from A to B through the cable	6×10^6 m
Distance from A to B via the satellite	7.2×10^7 m

Owain states that it is better to send the signal by satellite as it travels faster so it will arrive in a shorter time.
Use data from the table to explain whether you agree. [3]

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8

Turn over.

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5. The table gives information about two kettles.

Kettle	Power (W)	Time to boil 0.5 litres of water (minutes)	Time to boil 0.5 litres of water (hours)
A	3000	2	0.033
B	2400	2.5	

(a) (i) Calculate the units used (kWh) by **kettle B** if it is used to boil 0.5 litres of water 6 times a day. [2]

units used = ... kWh

(ii) Kettle B is used 6 times a day.
Calculate the cost of using kettle B for **one week**. [2]
Cost of 1 unit = 34 p.

cost = ... p

(iii) James suggests that it would be cheaper to use kettle B because it has a lower power.
Sophia disagrees and suggests it would make no difference.
Explain who is correct. [2]
Space for calculation.

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Turn over.

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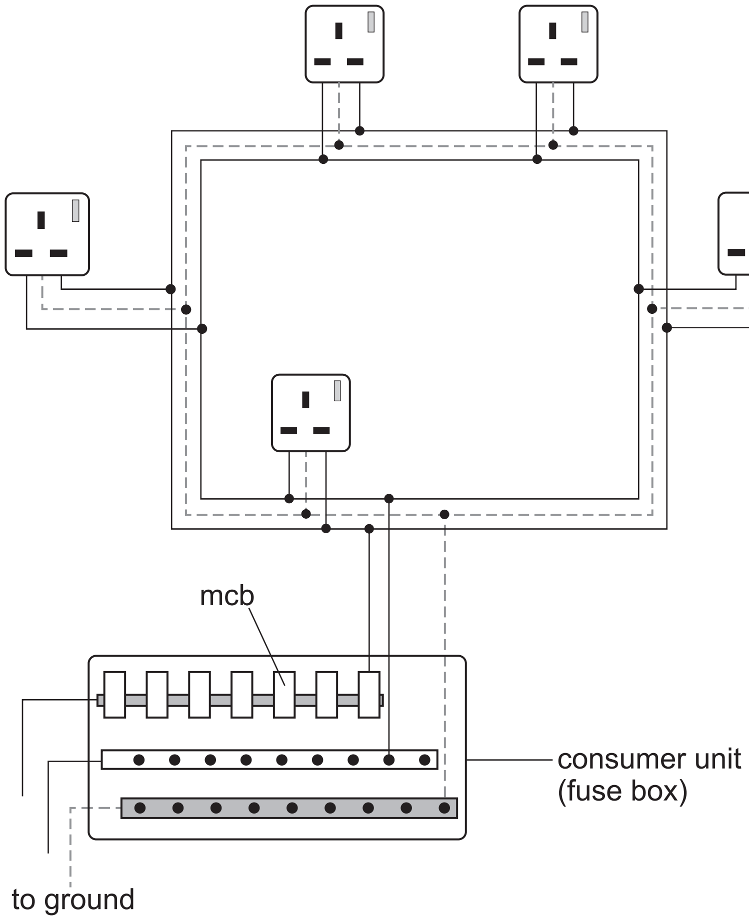
(b) Kettle B is connected into a ring main circuit.
A diagram of a ring main circuit is shown below.



(i) State **two** advantages of a ring main circuit. [2]

1. ....

2. ....

(ii) The ring main is protected by an mcb.
State **two** advantages of an mcb compared to a fuse. [2]

1. ....

2. ....

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(iii) The mcb has a rating of 32 A.
The maximum power that the ring main can supply is 7360 W.
The table shows some of the appliances that are used in a kitchen.

Appliance	Power (W)
kettle	2400
toaster	1200
microwave	800
washing machine	750
dishwasher	1500
iron	1100

Jack states that all these appliances can be connected to the ring main and used at the same time.
Determine whether Jack is correct.
Space for calculation. [1]

....

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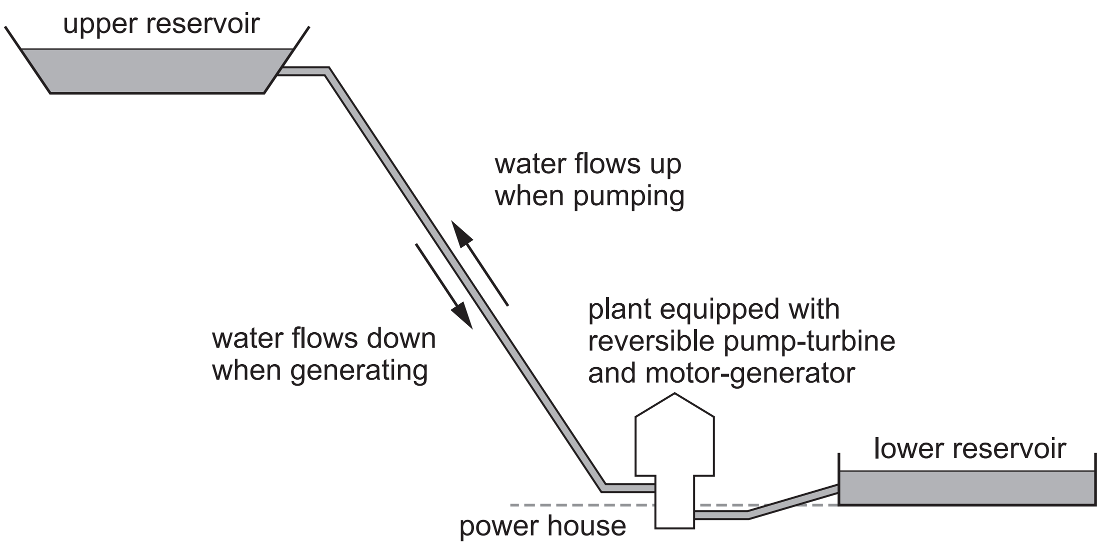
6. Dinorwig is a pumped storage hydroelectric power station in North Wales.
Water is stored in an upper reservoir to be released when electricity is required.
Water is then pumped back to the upper reservoir.



At full capacity Dinorwig produces 1800 MW of power for 6 hours.
This is transferred to the National Grid via a step-up transformer.

(a) (i) Explain why a step-up transformer is used. [2]

....

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(ii) Use an equation from page 2 to calculate the output current from the transformer at full capacity if the output voltage is 400 kV. [3]

output current = ... A

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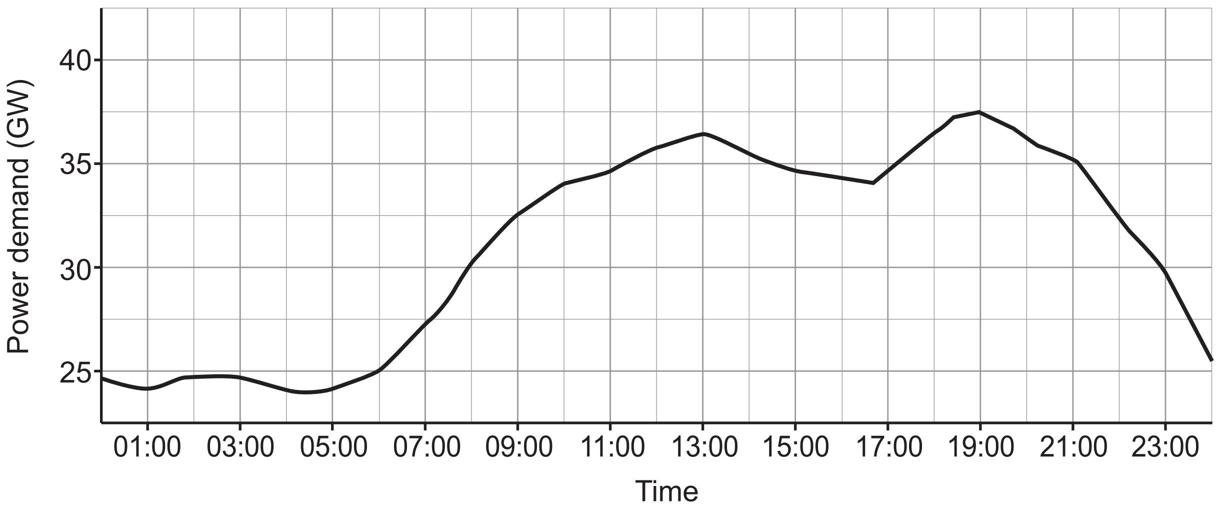
(b) The graph shows how power demand for electricity varied throughout the day for one day in March.



Use the graph to state between which times water will be pumped back to the upper reservoir.
Explain your answer. [2]

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....

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7

END OF PAPER

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