Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3430UC0-1

S23-3430UC0-1

MONDAY, 19 JUNE 2023 – AFTERNOON

SCIENCE (Double Award)
Unit 3 – PHYSICS 1

HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**6**	
3.	**3**	
4.	**9**	
5.	**8**	
6.	**6**	
7.	**12**	
8.	**7**	
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 **6**.

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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 = $\dfrac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}}$ × 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}
terra	T	multiply by 1 000 000 000 000	1×10^{12}

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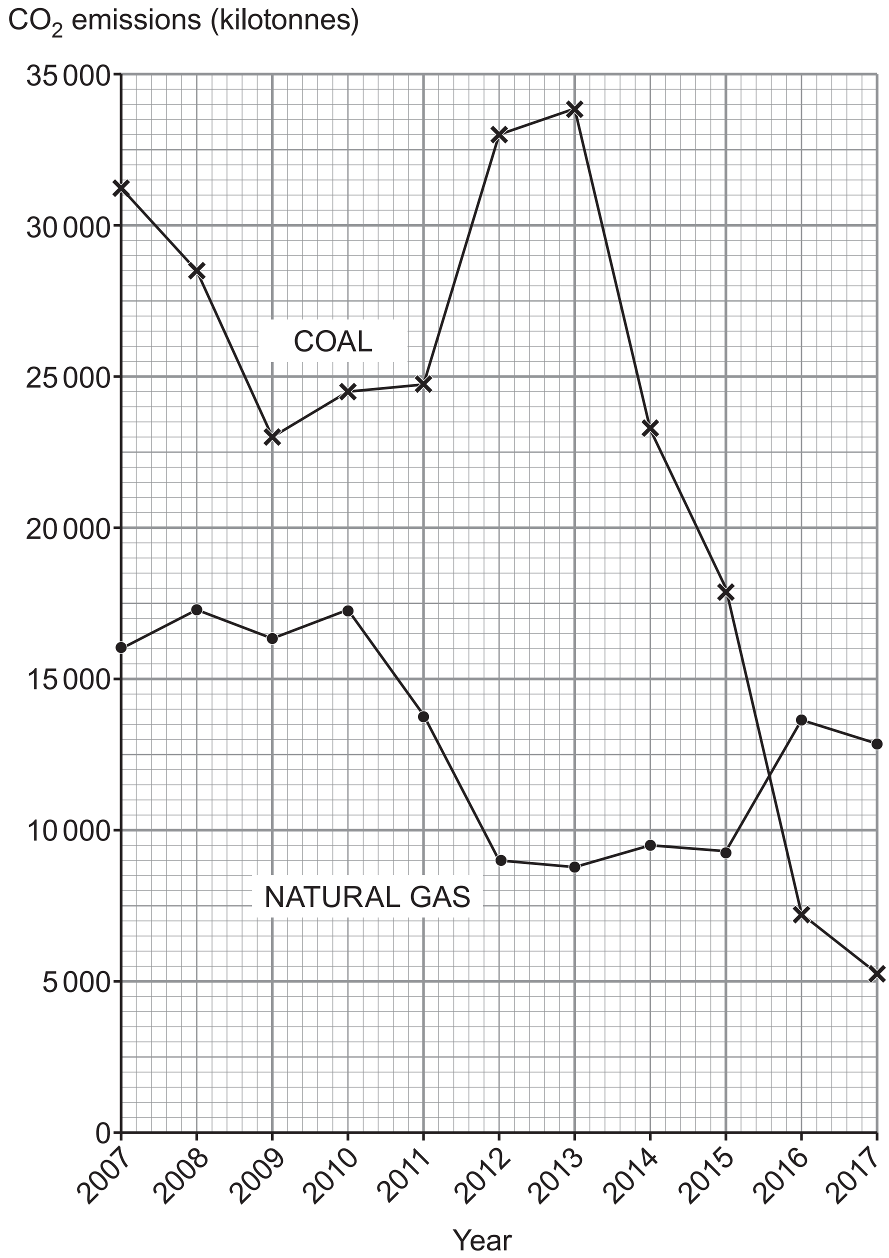
Answer **all** questions.

1. The UK government wants to reduce the CO_2 emissions from power stations.

The graphs below show the CO_2 emissions from coal and natural gas power stations between the years 2007 and 2017.



Examiner only

(a) Look at the data for **2012**. Calculate the difference in the emissions of CO_2 from coal and natural gas. [2]

difference = ... kilotonnes of CO_2

(b) Between the years 2014 and 2015, the emission of CO_2 from coal fell by 5500 kilotonnes.

State between which other years the emission of CO_2 from coal fell **at the same rate**. [1]

Years .... and ....

(c) State **two** benefits of reducing CO_2 in the atmosphere. [2]

1. ....

2. ....

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(d) (i) Nuclear power stations provide up to 20% of the present UK demand for electricity.

Gas provides up to 50%.

One student, Seren, says that a graph for the CO_2 emissions from nuclear power stations would be the same shape as for gas but always lower.

Explain whether you agree with Seren. [2]

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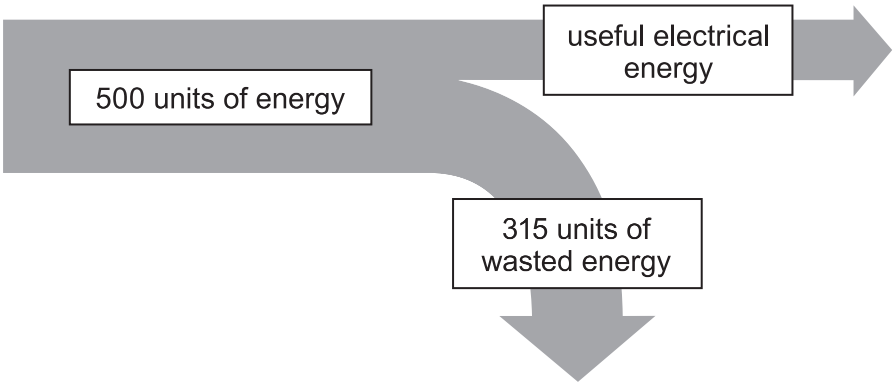
Examiner only

(ii) The Sankey diagram shows the energy input and output for a power station.



Seren looks at the diagram and calculates that the power station is 63% efficient.

Explain whether you agree with Seren. [2]

Space for calculation.

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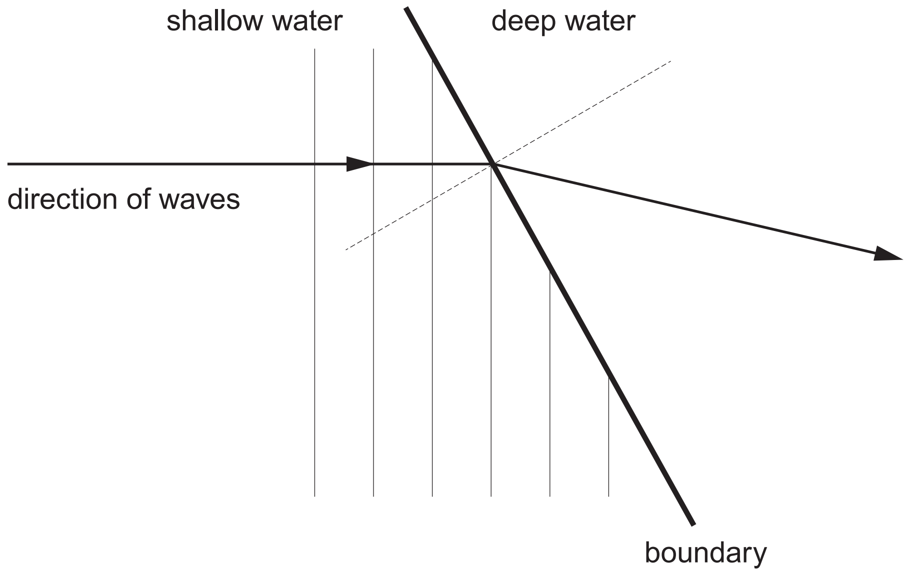
2. Students study refraction of waves in a ripple tank.

They set up the tank to show waves going from shallow water into deeper water.

The diagram shows a number of wavefronts approaching a boundary between shallow and deep water.

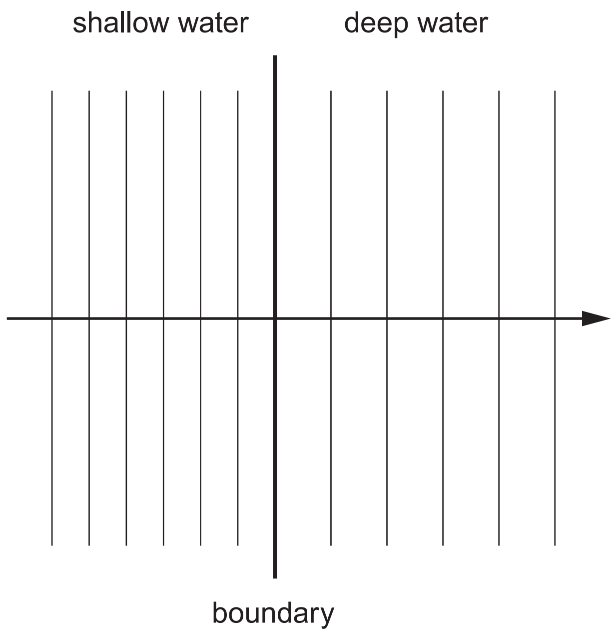
The first four wavefronts have reached the boundary.



(a) **Complete the diagram** to show the wavefronts in the deep water. [3]

Examiner only

(b) In a separate experiment, the wavefronts pass over the boundary in the way shown below.



Sam says that the speed of the waves is greater in deep water than shallow water.

Explain whether you agree with his statement. [3]

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3. A washing machine uses 0.54 kWh per wash cycle.

(a) A customer uses it for 200 wash cycles per year.

Use the equation:

$$\text{cost} = \text{units used (kWh)} \times \text{cost per unit}$$

to calculate the cost of using the washing machine **for 1 year in £**. [2]

The cost of a unit is £0.30.

cost = £ ....

(b) The wash cycle lasts for a time of 4 hours.

Use the information above and the equation:

$$\text{mean power (kW)} = \frac{\text{units used (kWh)}}{\text{time (h)}}$$

to calculate the mean power of the washing machine during one wash cycle. [1]

mean power = ... kW

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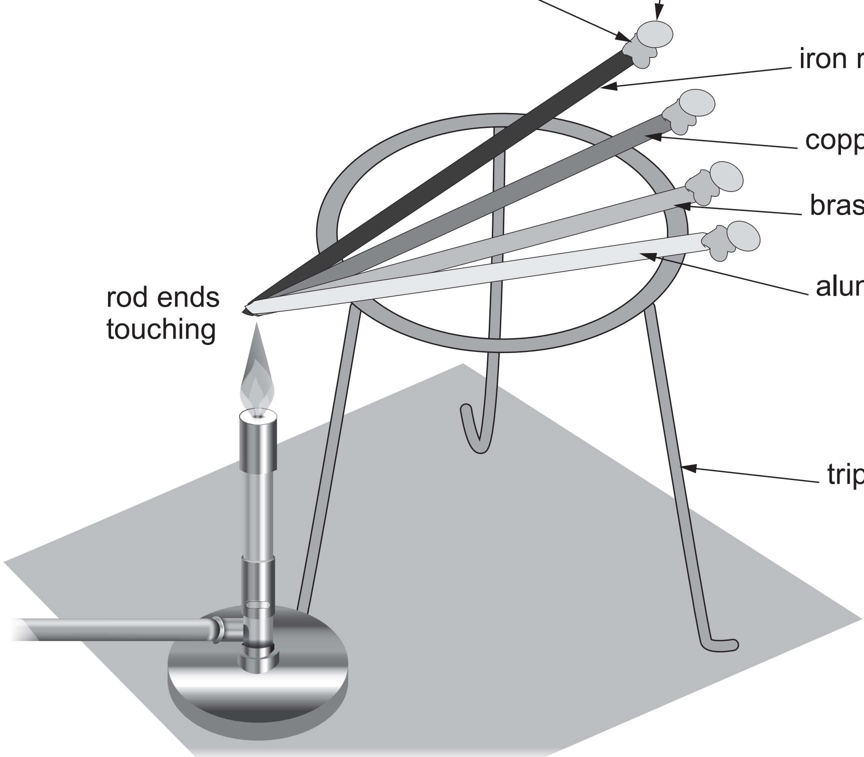
4. (a) (i) The apparatus shown can be used to compare how well different metals conduct heat.

Explain:
- how the apparatus is used
- how the results are used to show that copper is the best conductor. [3]



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(ii) Describe, in terms of the behaviour of **particles**, how heat energy is conducted through the metal rods. [2]

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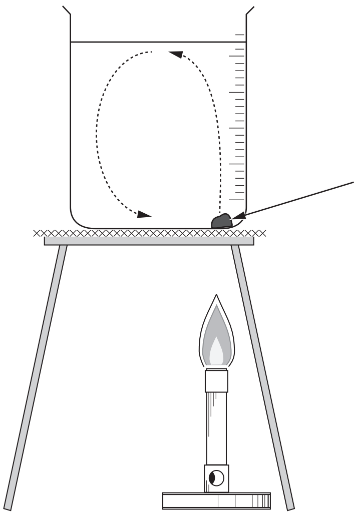
Examiner only

(b) A teacher demonstrates the process of convection in liquids.

Some purple crystals are placed in the bottom corner of a beaker that is filled with water.

The water is then heated and a current of coloured water is seen to move as shown in the diagram below.



(i) Explain why the coloured water moves in the way shown above. [2]

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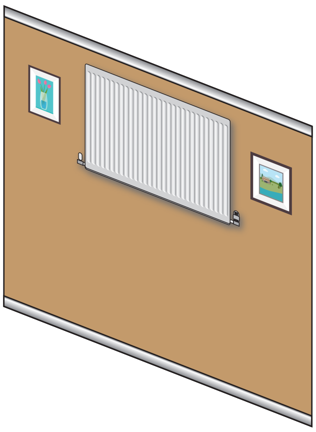
(ii) Explain why it is not suitable to put a hot radiator at the top of a wall to warm the room. [2]



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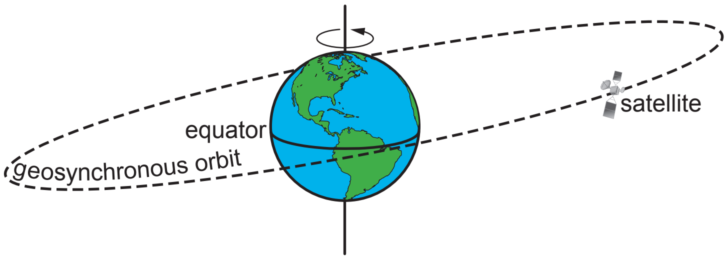
Examiner only

5. The diagram shows an example of a satellite in geosynchronous orbit around the Earth.



(a) State **one** way in which a geostationary orbit is different to the one shown above. [1]

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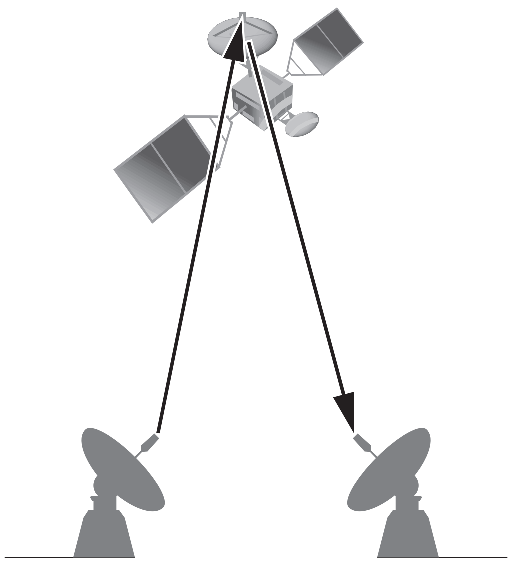
(b) The diagram shows a signal sent from one ground station to a satellite which is then received back at a second ground station.



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(i) Use the equation:

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

to calculate the time interval between a microwave signal being sent from Earth to one of the satellites 36 000 000 m away and it being received back again. [3]
(speed of light, $c = 3 \times 10^8$ m/s)

time = ... s

(ii) Microwaves travel at the speed of light and have a range of wavelengths between 0.002 m and 1 m.
Use an equation from page 2 to calculate the **maximum** frequency of microwave signals. [3]

maximum frequency = ... Hz

(iii) Name **one** type of electromagnetic radiation which has frequencies smaller than those of microwaves. [1]

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8

Examiner only

6. Describe how you would find the density of a small irregular-shaped rock.
You may assume that all the usual laboratory apparatus is available for you to use. [6 QER]

Include in your answer:
- the apparatus you would use
- a description of the method you would use to obtain results
- how the density would be calculated.

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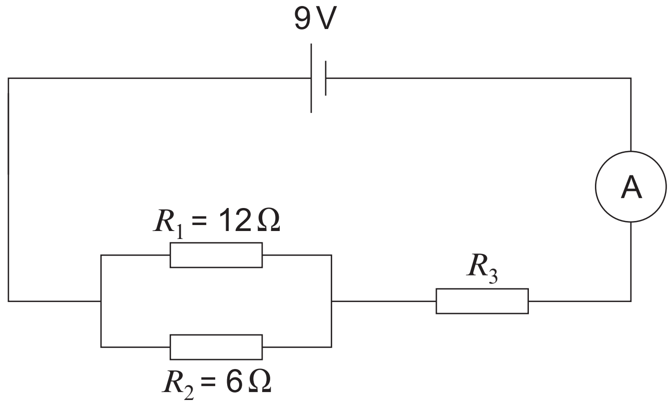
7. A group of students set up the following circuit.



(a) (i) Use the equation:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

to calculate the total resistance of resistors R_1 and R_2 in parallel. [3]

total resistance of R_1 and R_2 = ... Ω

(ii) The total resistance of the circuit is 6 Ω.

Use an equation from page 2 to calculate the resistance of resistor R_3. [1]

resistance of R_3 = ... Ω

(iii) Use an equation from page 2 to calculate the current through the ammeter. [2]

current = ... A

Examiner only

(iv) Calculate the voltage across the resistor R_3. [3]

voltage across R_3 = ... V

(b) One of the students, Katrina, connects a different circuit, without R_1 and R_2.

The circuit only contains R_3 in series with the battery.

She correctly calculates that the current from the battery would be 4.5 A.

She **claims** that the new circuit would transfer 45 J of energy in 10 s.

By using equations from page 2, explain whether her claim is correct. [3]

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8. Germany is building the world's first system in which wind turbines are combined with a hydroelectric pumped storage system.

(a) State the main disadvantage of relying on energy from wind turbines. [1]

....

(b) When the output from the wind farm is not required by the German National Grid, the energy from the wind is used to pump water from a low level to a higher level.

The water at the higher level can then be used to generate electricity when required, just as in a conventional hydroelectric pumped storage system.

When generating, the power output from the hydroelectric pumped storage system is 16 MW.

The mean power used by homes in Germany was 0.43 kW in 2017 (which was the lowest on record up to that time).

(i) Suggest a possible reason why the 0.43 kW figure is lower than for any previous year. [1]

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Examiner only

(ii) Calculate the number of homes in Germany in 2017, that could be supplied using the power from the hydroelectric pumped storage system. [3]

number of homes = ...

(c) The wind turbines have a maximum power output of 13.6 MW.

They provide energy to the water when slowly pumping it to a higher level.

When needed, the hydroelectric pumped storage system can quickly generate electricity.

Scientists state it is possible to get a greater **power** from the hydroelectric pumped storage system (16 MW) than the power supplied to it by the wind turbines.

By considering the equation:

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

explain why the claim is true. [2]

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END OF PAPER

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Examiner only

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