Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS

B420U20-1

S25-B420U20-1

WEDNESDAY, 21 MAY 2025 – AFTERNOON

PHYSICS – AS component 2
Electricity and Light

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**11**	
3.	**13**	
4.	**8**	
5.	**11**	
6.	**11**	
7.	**12**	
Total	**75**	

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ADDITIONAL MATERIALS

In addition to this paper, you will require a calculator and a **Data Booklet**.

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 total number of marks available for this paper is 75.

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

You are reminded to show all working. Credit is given for correct working even when the final answer is incorrect.

The assessment of the quality of extended response (QER) will take place in **3**(a).

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Answer **all** questions.

1. (a) (i) Explain what is meant by a progressive wave. [2]

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(ii) Progressive waves can be transverse or longitudinal. Explain the difference between these two types of waves. [2]

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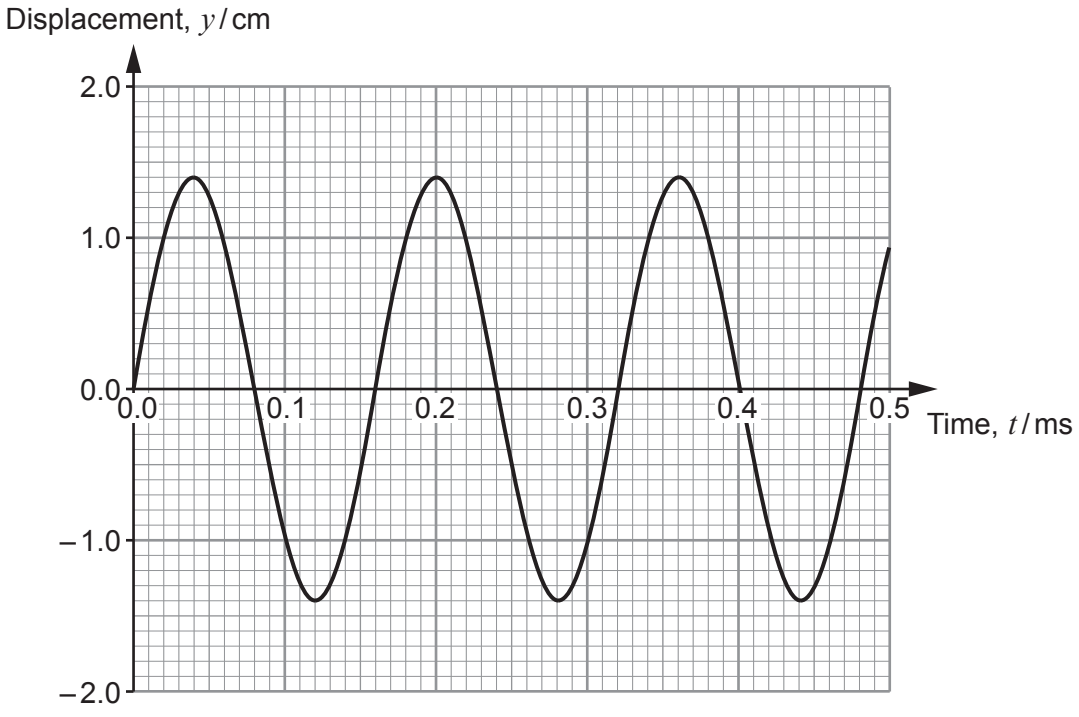
(b) The following graph shows displacement against time for a wave.



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(i) Calculate the frequency of the wave. [2]

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(ii) **Sketch, on the grid opposite,** a wave that has half the amplitude and a phase difference of 90° compared to the original wave. [3]

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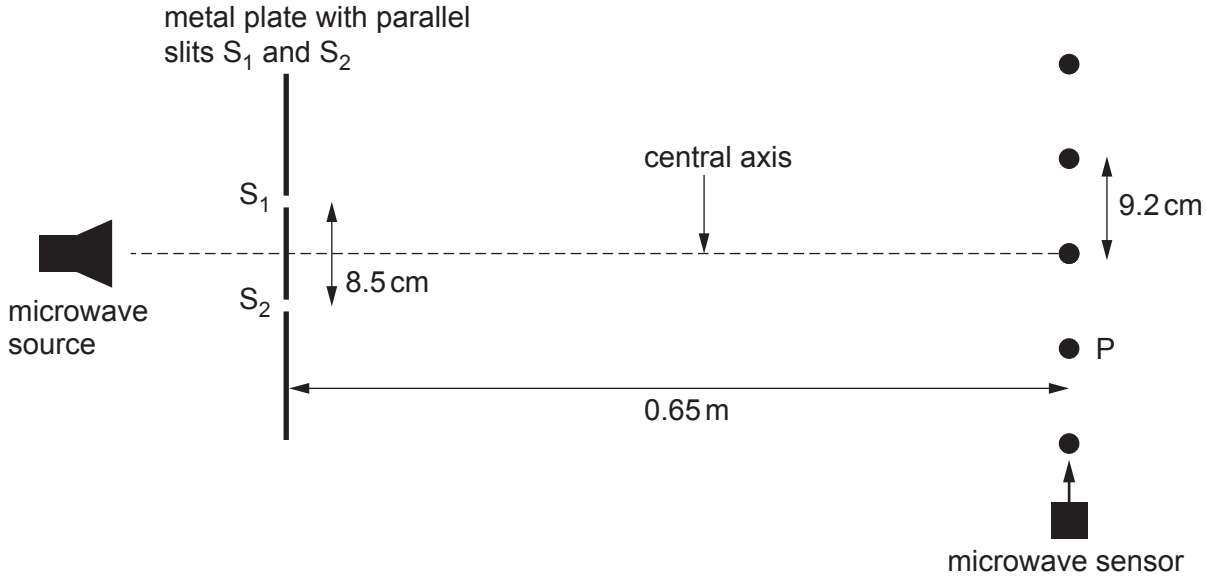
2. In the experimental set-up shown in the diagram below, a microwave sensor is moved slowly in a straight line at right angles to the central axis. Successive maxima of microwave intensity are found at points marked by dots.



(a) (i) Explain how diffraction **and** interference lead to a variation in intensity. [2]

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(ii) The slits S_1 and S_2 act as sources that are in phase with each other. Explain how the diagram confirms that S_1 and S_2 are in phase. [2]

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(b) (i) Explain the phase relationship between waves from S_1 and S_2 when they arrive at **point P**. [2]

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(ii) A physics textbook states that the wavelength of microwaves is in the range 1 mm to 30 cm. Evaluate whether this is consistent with the values in the diagram. [3]

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(c) Microwaves are used in multiwavelength astronomy.

(i) Explain what is meant by multiwavelength astronomy. [1]

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(ii) Explain why multiwavelength observations are useful in modern astronomy. [1]

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3. (a) Ada investigates the variation of resistance with temperature over the range 0 °C to 100 °C for a copper wire. Describe the apparatus and how Ada would use it to obtain accurate results in the investigation. Also, describe the expected relationship of resistance with temperature. [6 QER]

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(b) An aluminium wire with a cross-sectional area of $2.0 \times 10^{-7}\,m^2$ carries a current of 1.4 A. Each aluminium atom contributes three free electrons, and there are 6.0×10^{28} atoms per m^3 of aluminium.
Calculate the mean drift velocity of the free electrons in the wire. [3]

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(c) Superconductivity is an effect shown by several metals.

(i) State what is meant by superconductivity. [1]

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(ii) State **one** example of an application of a superconductor. Give an advantage **and** a disadvantage of using a superconductor instead of a conventional conductor, such as aluminium. [3]

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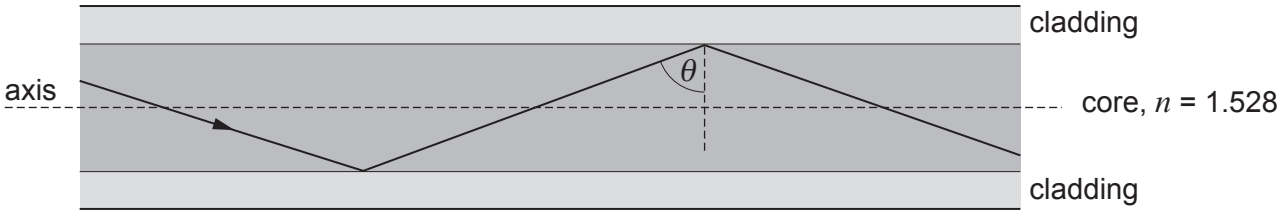
4. The diagram shows a path that light can take along a multimode optical fibre. The core of the optical fibre has a refractive index of 1.528.



(a) Calculate the refractive index of the cladding if the smallest angle, θ, at which total internal reflection can occur is 79°. [2]

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(b) The length of the optical fibre is 2.0 km.

(i) Calculate the time taken for light to travel straight along the axis of the fibre from one end to the other. [3]

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(ii) Thomas states that the light takes a greater amount of time to travel along the zigzag path (when θ = 79°) than along the axis. Thomas claims that this causes problems for sending data through the fibre. Using a suitable calculation, evaluate whether Thomas is correct. [3]

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5. (a) 'The pd measured between two points in an electrical circuit is 1.6 V.' Explain what is meant by this statement. [2]

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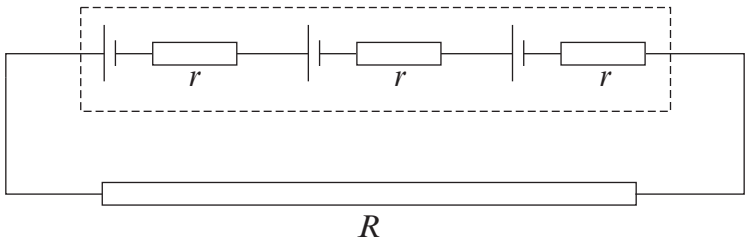
(b) (i) In an electrical toy, **three** cells, each of emf 1.6 V and internal resistance, r, are connected in series across the external circuit. The external circuit can be modelled as a resistance, R, as shown in the circuit diagram. The pd across the external circuit is measured to be 4.2 V, and the current is 0.40 A. Show clearly that the internal resistance of each cell is 0.50 Ω. [3]



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(ii) Calculate the current in the circuit if one of the cells is connected the wrong way round. [3]

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(c) A different toy uses cells of the same type as in part (a). The external circuit of the toy requires a current of 0.44 A and a pd of 6.9 V. Determine the number of cells required to operate the toy. [3]

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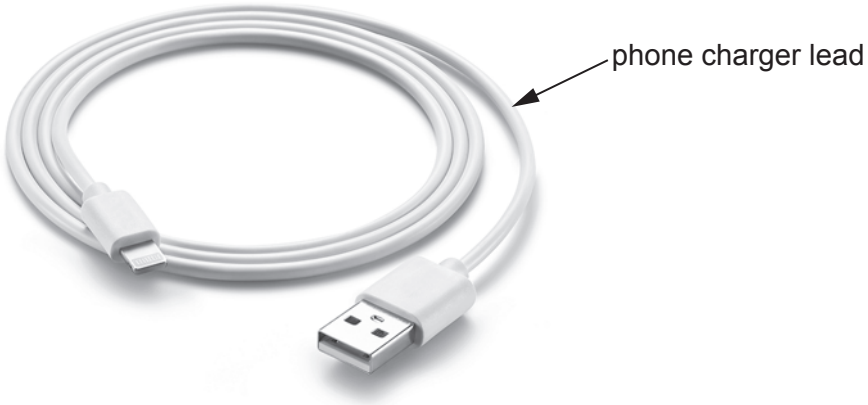
6. A laboratory technician analyses a metal wire from inside the lead of a mobile phone charger.



(a) (i) Using digital calipers, the technician measures the diameter of the wire to be 1.23 mm. The resolution of the calipers is $\pm$ 0.01 mm. Calculate the cross-sectional area of the wire and its **percentage** uncertainty. [3]

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(ii) The technician believes that the wire could be made of copper based on the following data.

- The resistance across the ends of the wire is $0.038\,\Omega \pm 5\%$.
- The length of the wire is $2.500 \pm 0.001\,\text{m}$.
- The resistivity of copper is $1.7 \times 10^{-8}\,\Omega\,\text{m}$.

Evaluate whether the technician is correct. [6]

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(b) A mobile phone company used to change the type of connector for use on its charging cables every five years. Following new regulations, all mobile phone companies must now use the same connector type. Discuss the implications of the new regulations. [2]

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7. The light power output of a green light laser of wavelength 550 nm is 2.5 mW.

(a) (i) Calculate the number of photons emitted per second by the laser. [3]

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(ii) Explain why the number of photons per second will be less if a laser with the same power output is used that emits blue light. [2]

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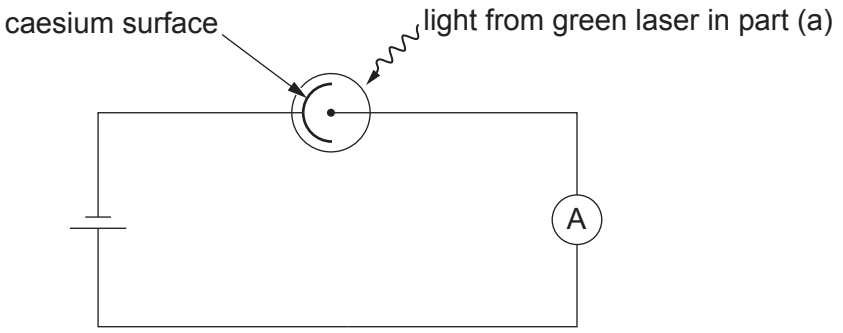
(b) A vacuum photocell containing a caesium surface is connected in the circuit shown. Light from the green laser in part (a) falls on the surface of caesium metal.



(i) The ammeter reading is 4.8×10^{-8} A. Calculate the number of electrons emitted per second by the caesium surface. State any assumptions you make. [3]

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(ii) Joanna states that the probability of an individual photon causing the emission of an electron is very low if light from the green laser in part (a) is used. Evaluate whether Joanna is correct. [1]

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(iii) Explain how the circuit needs to be changed to measure the stopping potential, V_s, of the emitted electrons from the caesium surface. [3]

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END OF PAPER

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