



PHYSICS
STANDARD LEVEL
PAPER 3

SPECIMEN PAPER

1 hour

Candidate session number

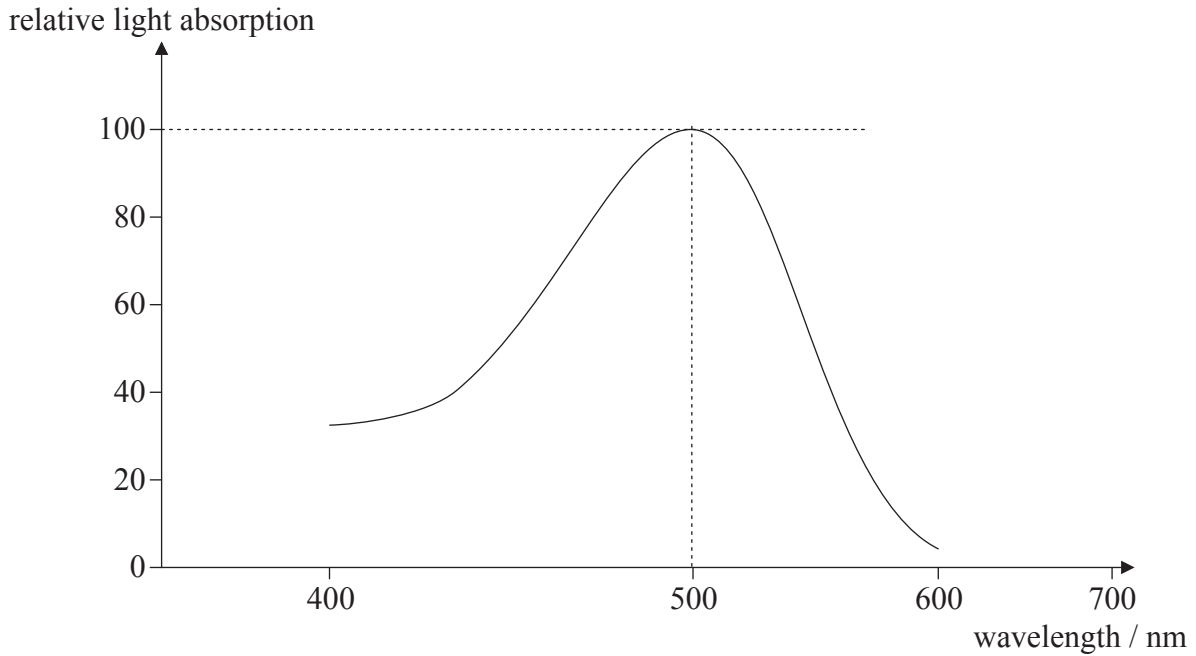
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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet.

Option A — Sight and wave phenomena

A1. The graph below shows the overall relative light absorption curve for the light-sensitive cells involved in scotopic vision. The relative light absorption is expressed as a percentage of the maximum.



(a) State the name of the cells involved in **scotopic** vision. [1]

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(b) (i) On the axes above, sketch a relative light absorption curve for a cell involved in **photopic** vision. [2]

(ii) State the colour to which the cell is most sensitive. [1]

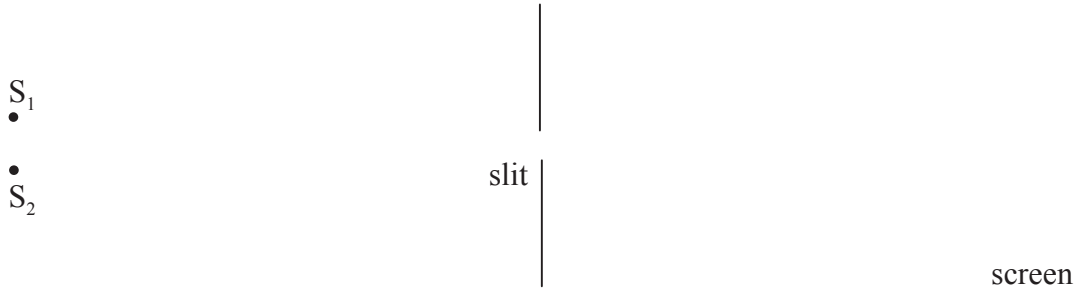
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(c) Outline how colour blindness may arise from defects in the retina's light sensitive cells. [3]

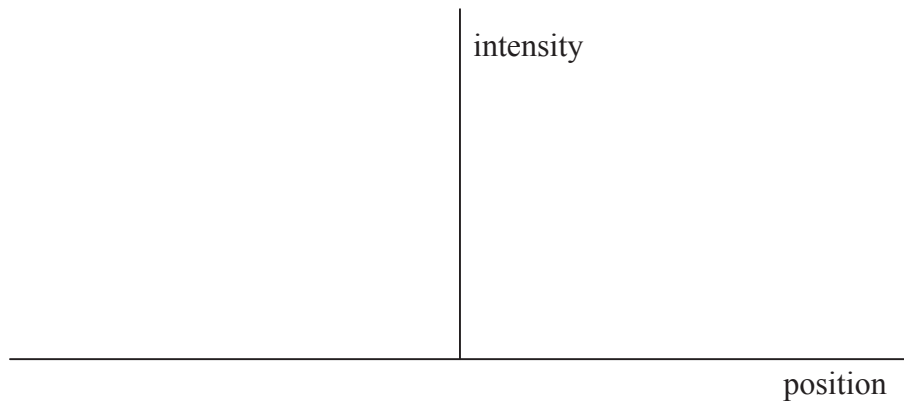
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A2. This question is about the Rayleigh criterion.

- (a) Light from two monochromatic distant point sources, S_1 and S_2 , is incident on a narrow slit. After passing through the slit, the light is incident on a screen.



On the axes below, draw the intensity distribution of the diffracted light on the screen from each source when the images of S_1 and S_2 are just resolved according to the Rayleigh criterion. [3]



- (b) A woman views an approaching car at night. The apertures of her eyes are each of diameter 3.0 mm. The headlamps of the car are separated by a distance of 1.2 m and emit light of wavelength 400 nm.

Calculate the distance of the car from the woman at which the images of the two headlamps are just resolved. [3]

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A3. This question is about polarization.

(a) State what is meant by polarized light. [1]

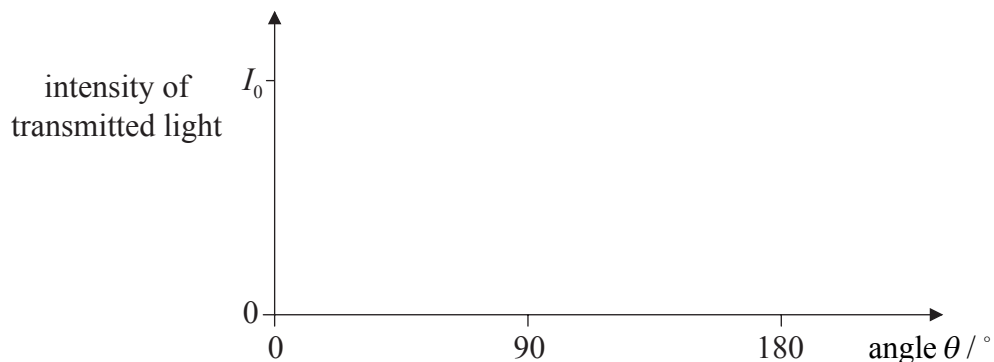
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(b) Polarized light of intensity I_0 is incident on an analyser. The transmission axis of the analyser makes an angle θ with the direction of the electric field of the light.

(i) Calculate, in terms of I_0 , the intensity of light transmitted through the analyser when $\theta = 60^\circ$. [1]

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(ii) On the axes below, sketch a graph to show the variation with angle θ of the intensity of the transmitted light. [2]



(c) Outline how polarizing sunglasses reduce glare from a reflecting surface. [3]

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Option B — Quantum physics and nuclear physics

B1. This question is about wave-particle duality.

- (a) Describe the de Broglie hypothesis. [2]

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- (b) An electron is accelerated from rest through a potential difference of 1250 V. Determine the associated de Broglie wavelength of the accelerated electron. [4]

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B2. This question is about line spectra.

- (a) Light is emitted from a gas discharge tube. Outline briefly how the visible line spectrum of this light may be obtained. [2]

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(Question B2 continued)

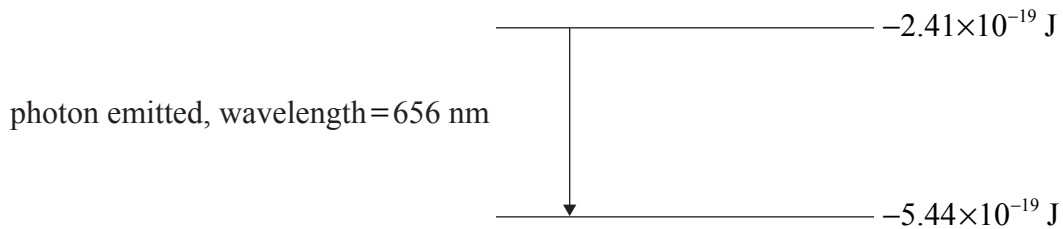
- (b) The table below gives information relating to three of the wavelengths in the line spectrum of atomic hydrogen.

Wavelength / $\times 10^{-9}$ m	Photon energy / $\times 10^{-19}$ J
1880	1.06
656	3.03
486	4.09

Deduce that the photon energy for the wavelength of 486×10^{-9} m is 4.09×10^{-19} J. [2]

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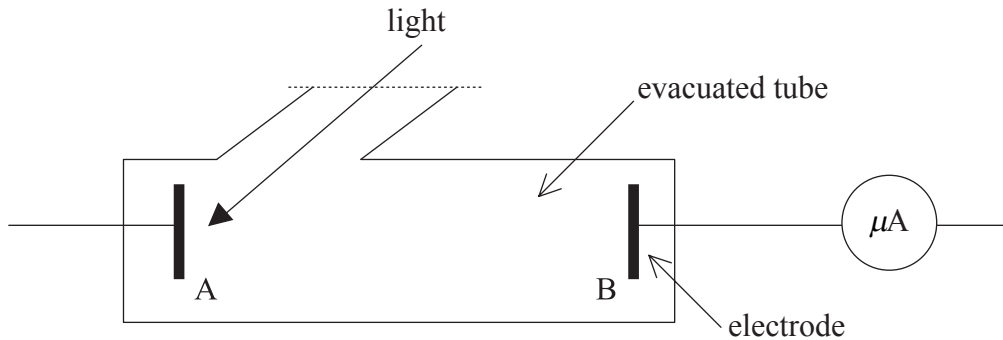
- (c) The diagram below shows two of the energy levels of the hydrogen atom, using data from the table above. An electron transition between these levels is also shown.



- (i) On the diagram above, construct the other energy level needed to produce the energy changes shown in the table above. [1]
- (ii) Draw labelled arrows to represent the energy changes for the two other wavelengths shown in the table above. [1]

B3. This question is about the photoelectric effect.

In an experiment to investigate the photoelectric effect, light of frequency f is incident on the metal surface A shown in the diagram below. A potential difference is applied between A and electrode B. The photoelectric current is measured by the microammeter. (*Note: the complete electrical circuit is not shown.*)



- (a) Indicate on the diagram the polarity of A and of B. [1]

- (b) The frequency f of the light is reduced and it is found that there is a frequency f_0 , the threshold frequency, below which the microammeter does not indicate a current. Explain how Einstein's photoelectric theory accounts for this observation. [4]

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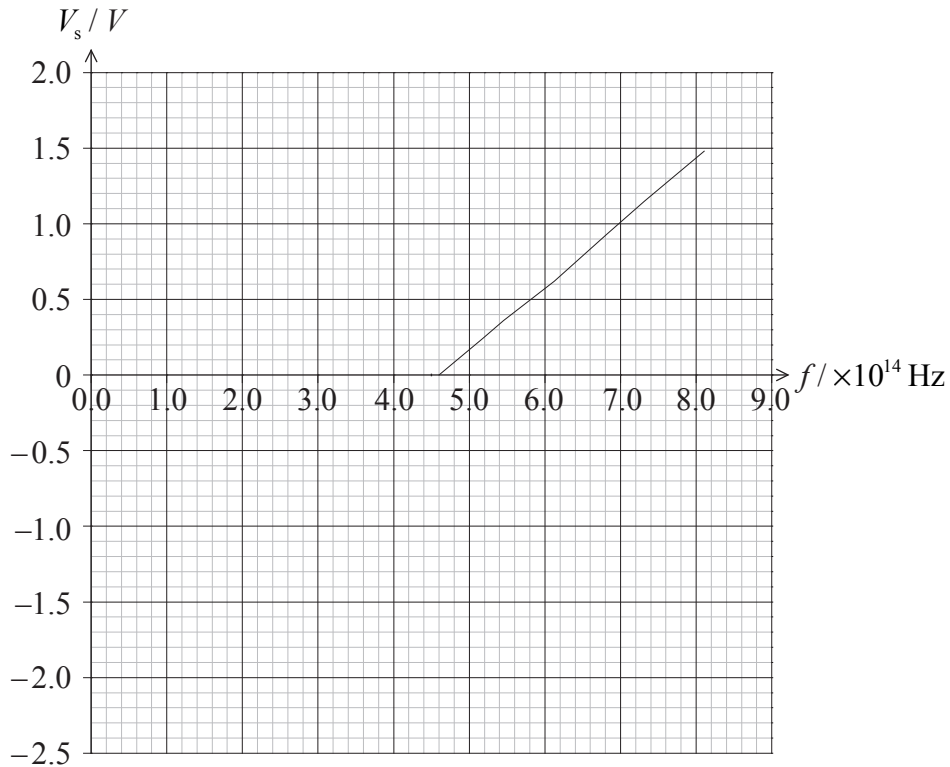
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(Question B3 continued)

- (c) The potential difference between A and B is now reversed. For a particular frequency of the light, the potential difference is changed until there is zero current in the circuit. The graph below shows the variation of frequency f of the light with the potential difference, V_s , for zero current.



Explaining your working, use the graph to determine the

- (i) threshold frequency. [1]

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- (ii) work function, in eV, of the metal. [2]

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