Pearson Edexcel International Advanced Level

Wednesday 15 October 2025

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WPH12/01**

Physics
International Advanced Subsidiary/Advanced Level
UNIT 2: Waves and Electricity

You must have:
Scientific calculator, ruler, protractor

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name,
  centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need*.
- **Show all your working out** in calculations and **include units** where appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question*.
- In the question marked with an **asterisk (*)**, marks will be awarded for your ability
  to structure your answer logically, showing how the points that you make are
  related or follow on from each other where appropriate.
- The list of data, formulae and relationships is printed at the end of this booklet.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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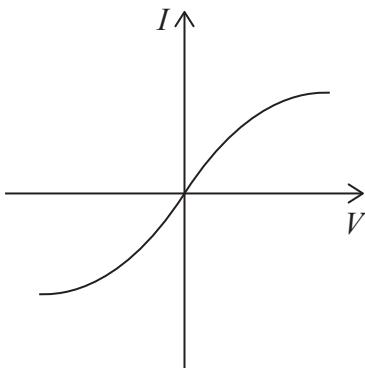
Pearson

Answer ALL questions.

For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ⊠. If you change your mind, put a line through the box ⊠ and then mark your new answer with a cross ⊠.

1   The graph shows how current I varies with potential difference V for an electrical component.
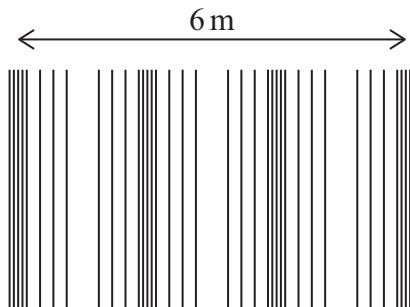
Which of the following components would give this graph?

☒   **A**   diode

☒   **B**   filament bulb

☒   **C**   resistor

☒   **D**   thermistor

(Total for Question 1 = 1 mark)

2   The diagram represents a longitudinal wave.
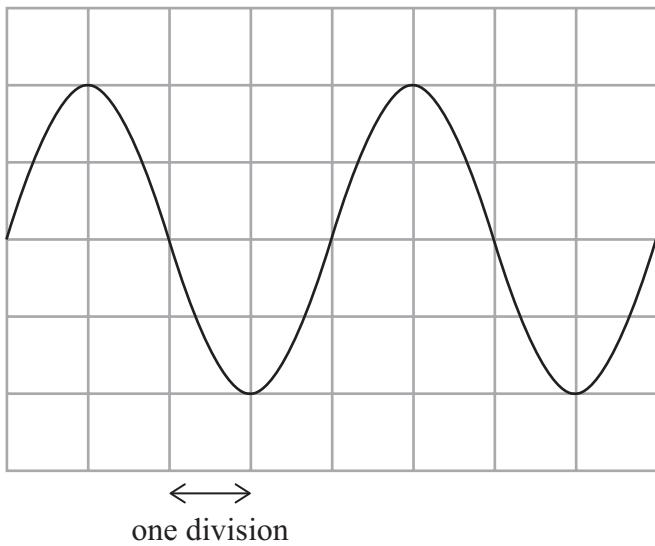
Which of the following is the wavelength of the wave?

☒   **A**   2 m

☒   **B**   3 m

☒   **C**   4 m

☒   **D**   6 m

(Total for Question 2 = 1 mark)

3 The diagram shows the trace of a sound wave on an oscilloscope.

one division

One horizontal division represents a time of 5 ms.

Which of the following expressions gives the frequency of the sound wave in Hz?

☒ **A** 4×0.005

☒ **B** 2×0.005

☒ **C** $\dfrac{1}{2 \times 0.005}$

☒ **D** $\dfrac{1}{4 \times 0.005}$

(Total for Question 3 = 1 mark)

4 An electron has a velocity of $2 \times 10^{7}\,\text{m s}^{-1}$.

Which of the following expressions gives the de Broglie wavelength of the electron in metres?

☒ **A** $\dfrac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 2 \times 10^{7}}$

☒ **B** $\dfrac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 2 \times 10^{7}}$

☒ **C** $\dfrac{9.11 \times 10^{-31} \times 2 \times 10^{7}}{6.63 \times 10^{-34}}$

☒ **D** $\dfrac{1.67 \times 10^{-27} \times 2 \times 10^{7}}{6.63 \times 10^{-34}}$

(Total for Question 4 = 1 mark)

5 Two points on a wave have a phase difference of 25°.

Which of the following expressions gives the phase difference in radians?

☒ **A** $\dfrac{25 \times 2\pi}{360}$

☒ **B** $\dfrac{25}{180}$

☒ **C** $\dfrac{25 \times \pi}{360}$

☒ **D** $\dfrac{25}{360}$

(Total for Question 5 = 1 mark)

6 A bat is an animal that locates objects using a pulse-echo technique. A bat emits a pulse of sound waves that travel to an object. The bat detects the reflected pulse 4 ms later.

speed of sound = 340 m s^{-1}

Which of the following expressions gives the distance, in metres, between the bat and the object?

☒ **A** $2 \times 340 \times 4 \times 10^{-3}$

☒ **B** $\dfrac{340}{2 \times 4 \times 10^{-3}}$
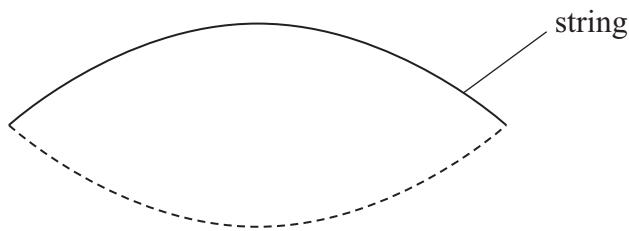
☒ **C** $340 \times 4 \times 10^{-3}$

☒ **D** $\dfrac{340 \times 4 \times 10^{-3}}{2}$

(Total for Question 6 = 1 mark)

7   A string vibrates between two fixed points. The diagram shows the stationary wave formed on the string when the string vibrates with frequency f.

string

The tension in the string is doubled. The frequency of vibration is adjusted until the same shape of standing wave forms on the string.

Which of the following expressions gives the frequency f of the new standing wave?

☒   A $\dfrac{f}{\sqrt{2}}$

☒   B $\sqrt{2} \times f$

☒   C $\dfrac{f}{2}$

☒   D $2 \times f$

(Total for Question 7 = 1 mark)

8   A student connects 5 identical 1.5 V cells in parallel to form a battery.
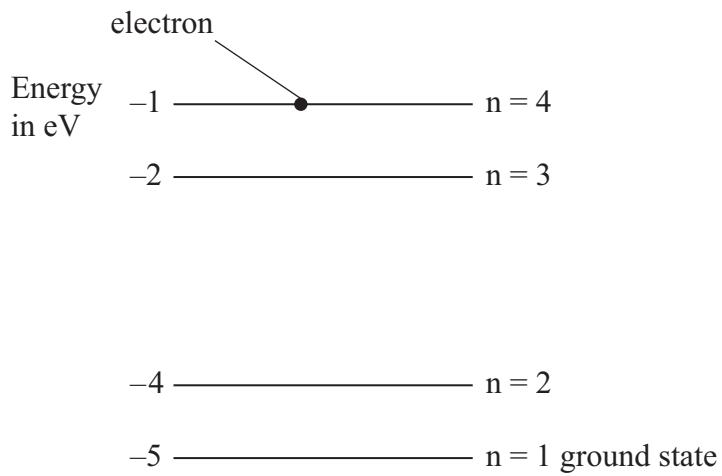
Each cell has an internal resistance of $1.0\,\Omega$.

Which row of the table gives the e.m.f. and internal resistance of the battery?

	e.m.f./V	Internal resistance/Ω
☒ A	1.5	0.2
☒ B	1.5	5
☒ C	7.5	0.2
☒ D	7.5	5

(Total for Question 8 = 1 mark)

9 The diagram shows the energy levels in an atom.

electron

Energy in eV

−1 ———————•——————— n = 4

−2 —————————————— n = 3

−4 —————————————— n = 2

−5 —————————————— n = 1 ground state

When the electron moves from n = 4 to the ground state, a photon of frequency f is emitted.
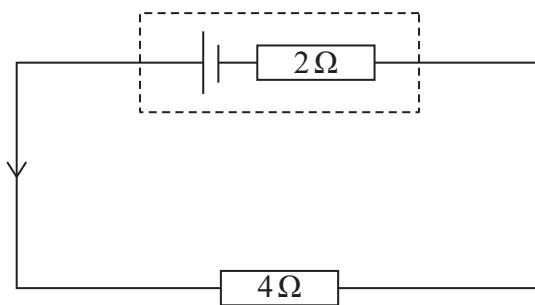
Which of the following photon frequencies could **not** be emitted by this atom?

☒ **A** $\dfrac{f}{8}$

☒ **B** $\dfrac{f}{4}$

☒ **C** $\dfrac{f}{2}$

☒ **D** $\dfrac{3f}{4}$

(Total for Question 9 = 1 mark)

10 The diagram shows a 4 Ω resistor connected to a cell of e.m.f. 12 V and internal resistance 2 Ω.

Which of the following expressions gives the potential difference V across the internal resistance of the cell?

☒ **A** $V = 12 \times \dfrac{2}{4}$

☒ **B** $V = 12 \times \dfrac{6}{4}$

☒ **C** $V = 12 \times \dfrac{4}{6}$

☒ **D** $V = 12 \times \dfrac{2}{6}$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

Answer ALL questions in the spaces provided.

11 A wire of cross-sectional area $2.8 \times 10^{-6}\,\mathrm{m^2}$ is connected in a circuit. There is a current of 2.5 A in the wire.

Calculate the drift velocity of the electrons in the wire.

number of charge carriers per unit volume $= 8.5 \times 10^{28}\,\mathrm{m^{-3}}$

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Drift velocity = ...

(Total for Question 11 = 2 marks)

12 A coffee machine is connected across a 230 V power supply. The heating element in the coffee machine has a resistance of 18 Ω.

(a) The coffee machine takes 38 s to heat enough water to make one cup of coffee.

Calculate the energy transferred by the heating element in 38 s.

(3)

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Energy transferred = ...

(b) Explain why the resistance of the heating element increases as its temperature increases.

(3)

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(Total for Question 12 = 6 marks)
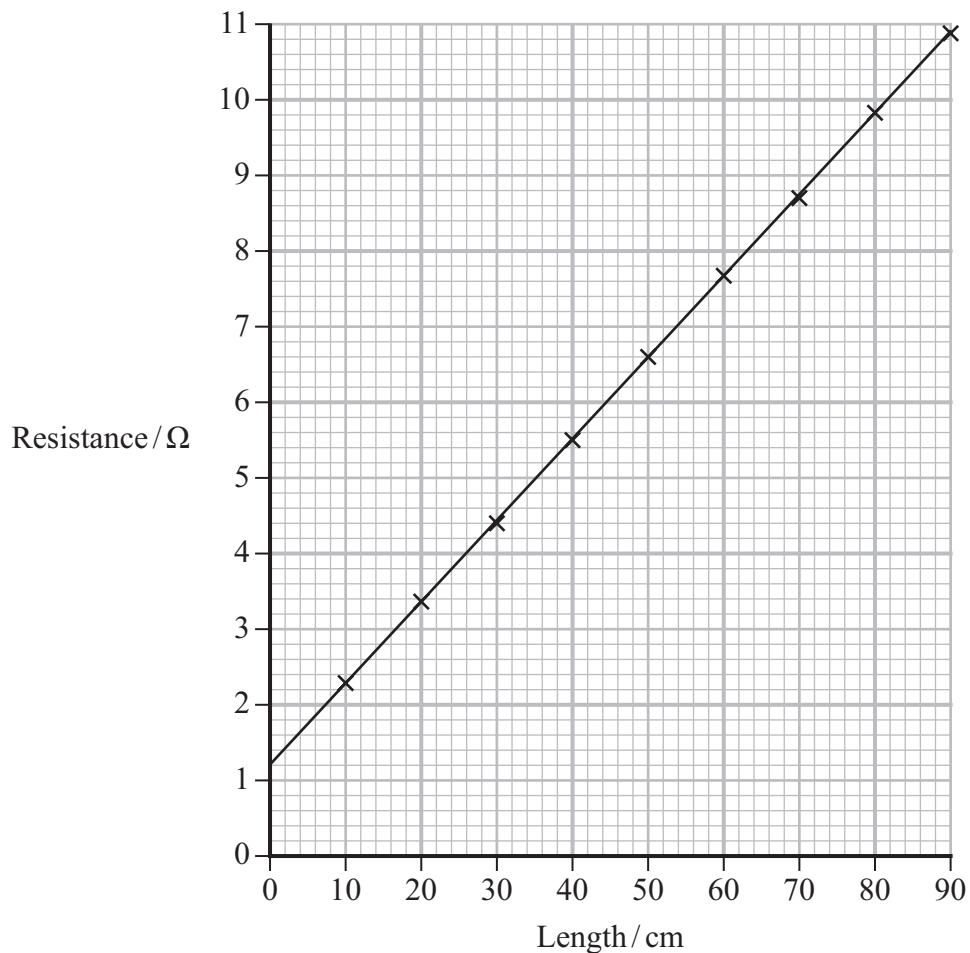
13 A student determined the resistivity for a metal in the form of a wire.

The student measured the resistance for different lengths of the wire.

She plotted the graph shown.

Length/cm

The table shows the resistivity of some metals.

Metal	Resistivity/$\Omega\,m$
constantan	4.90×10^{-7}
nichrome	1.07×10^{-6}
copper	1.55×10^{-8}

Deduce which of these metals the wire was made from.
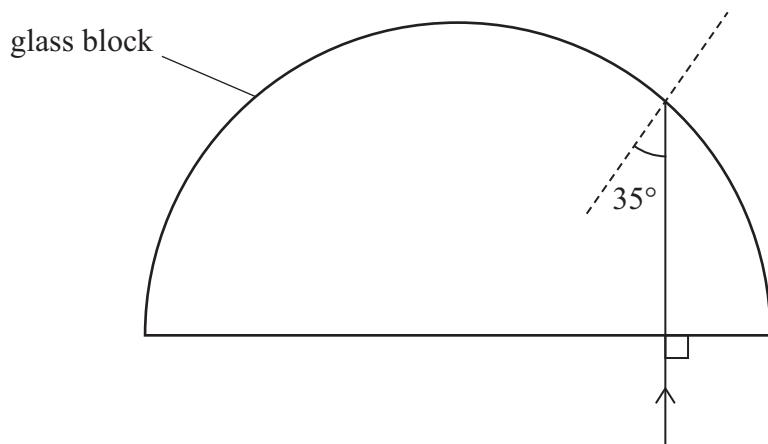
diameter of wire = 0.24 mm

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(Total for Question 13 = 5 marks)

14 A student used a semicircular glass block to investigate the refraction of light.

He directed a ray of light onto the glass block, as shown.

glass block

35°

(a) State why the ray of light does not refract as it enters the glass block.

(1)

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(b) The glass has a refractive index of 1.5

(i) The ray of light is refracted at the curved surface of the block.

Calculate the angle of refraction.
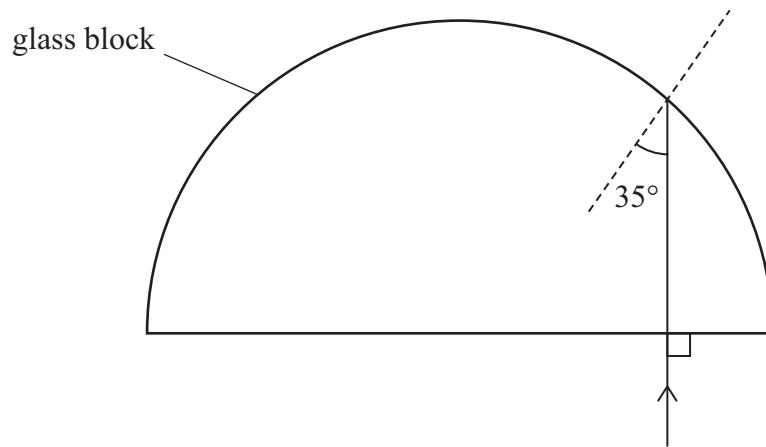
(2)

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Angle of refraction = ...
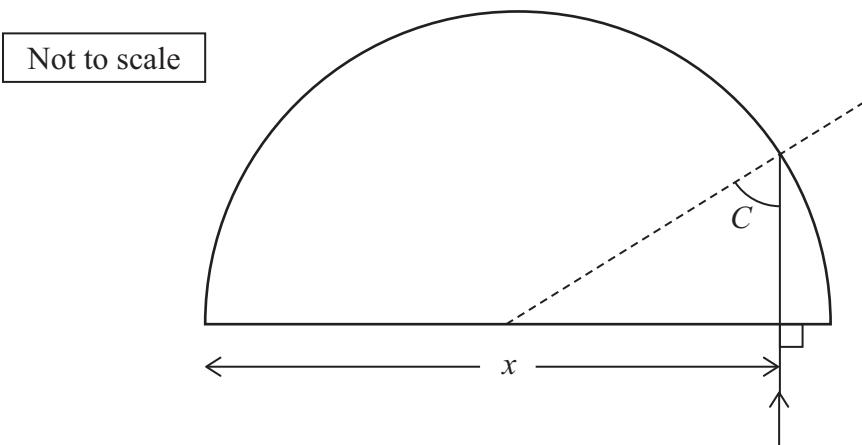
(ii) Complete the diagram to show the path of the ray of light as it leaves the glass block.

(1)

glass block

35°

P 7 8 8 3 2 A 0 1 3 2 8

(c) The student moved the glass block so that the ray of light was incident on the curved surface at the critical angle C, as shown below.

Not to scale

Determine the distance x.

refractive index of glass = 1.5
radius of glass block = 45 mm

(4)

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Distance x = ...

(Total for Question 14 = 8 marks)
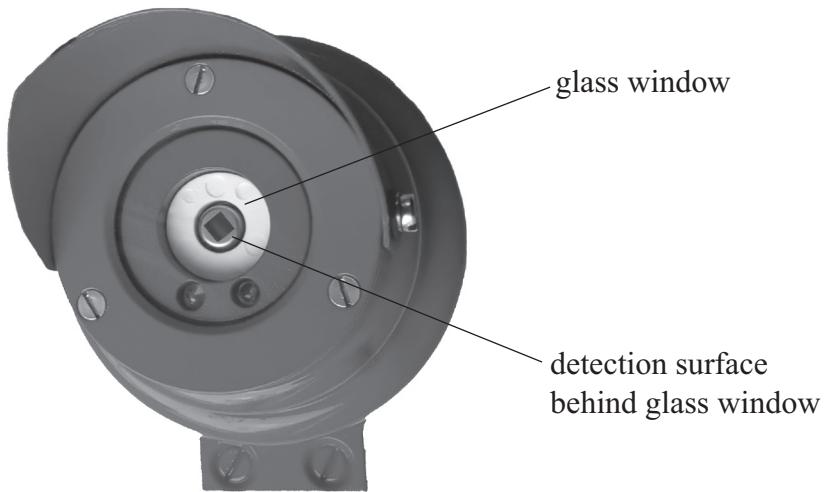
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P7 8 8 3 2 A 0 1 5 2 8

15 The photograph shows a 'flame detector'. The flame detector uses the photoelectric effect to detect ultraviolet radiation from fires.

glass window

detection surface
behind glass window

(Source: © Fisenko Evgeny/Shutterstock)

(a) Explain how electrons are released in the photoelectric effect.

(4)

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(b) A fire emits photons of ultraviolet radiation with a wavelength of 380 nm.

(i) Show that the energy of each photon is about 5×10^{-19} J.

(3)

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(ii) Calculate the maximum kinetic energy of the released electrons in eV.

work function of metal = 2.2 eV

(3)

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Maximum kinetic energy = ... eV

(iii) Ultraviolet radiation with an intensity of 8000 W m^{-2} is incident on the detection surface.

The detection surface has an area of 0.020 m^2.

Determine the number of photons incident on the detection surface each second.

(3)

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Number of photons = ...

(c) The detection surface is part of an electrical circuit. The released electrons cause a current in this circuit.

The intensity of ultraviolet radiation incident on the detection surface increases.

Explain how this will affect the current in the circuit.

(3)

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(Total for Question 15 = 16 marks)

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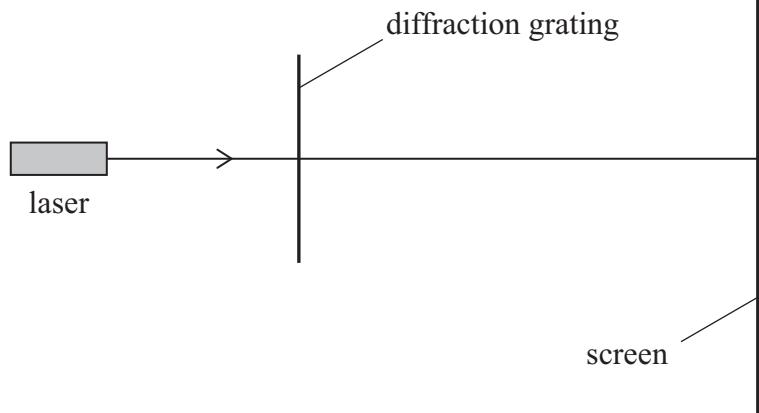
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16 A student directed light from a laser onto a diffraction grating, as shown.

Not to scale

diffraction grating

laser

screen

A series of bright dots was formed on the screen.

(a) (i) The light from the laser is coherent.

State what is meant by coherent light.

(1)

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(ii) Explain why a series of bright dots was formed on the screen.

(3)

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(b) The diffraction grating has a grating spacing d of 1.07×10^{-6} m.

   (i) Calculate the angle between the central maximum and the first order maximum.

   wavelength of laser light = 532 nm

   (2)

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   Angle = ...

   (ii) The student observed first and second order maxima.

   Explain why it is **not** possible for a third order maximum to be produced.

   (3)

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(c) The student replaced the laser with a lamp that produced a narrow beam of white light.

   Describe the pattern that formed on the screen.

   (3)

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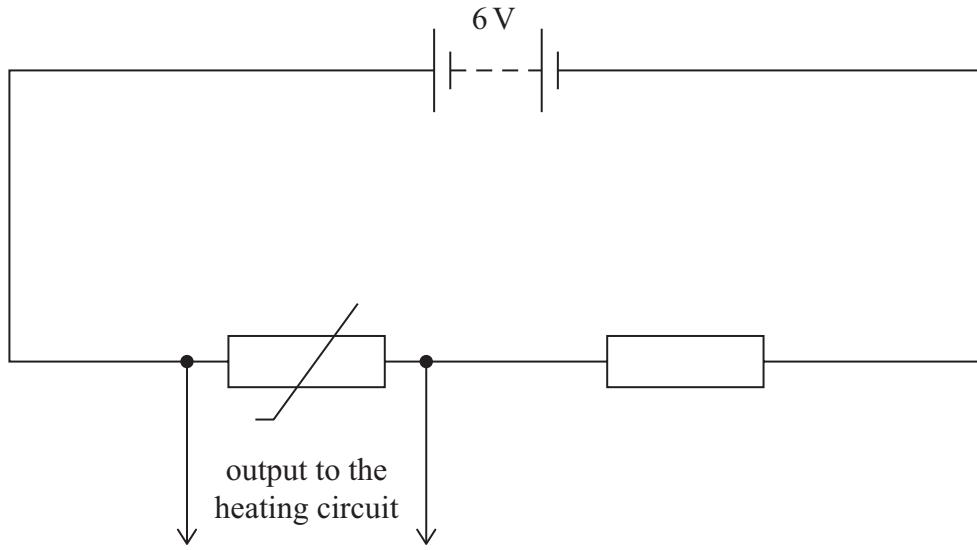
   (Total for Question 16 = 12 marks)

P 7 8 8 3 2 A 0 2 1 2 8

17 Water in a water bath is heated using an electric heater. The heating circuit is switched on and off by the control circuit shown.

The cell has negligible internal resistance.

The thermistor is placed in the water. When the potential difference (p.d.) across the thermistor is above a certain value, the heating circuit is switched on.

*(a) Explain how increasing the temperature of the water affects the p.d. across the thermistor.

You should refer to conduction electrons in your answer.

(6)

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(b) The heater will switch off when the p.d. across the thermistor is 0.90 V.

The water temperature should reach 65 °C.

The resistance of the thermistor at 65 °C is 56 Ω.

The resistance of the fixed resistor is 300 Ω.

Deduce whether the heater will switch off when the water temperature reaches 65 °C.

(5)

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(Total for Question 17 = 11 marks)

18 A student directs unpolarised light through a polarising filter.

(a) After passing through the polarising filter, the light is plane polarised.

(i) Explain the difference between unpolarised light and plane polarised light.

(3)

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(ii) The student rotates the polarising filter.
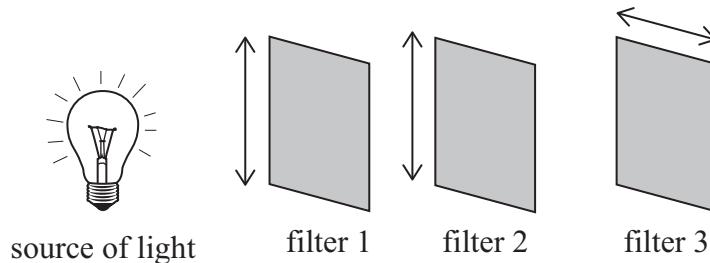
Explain why rotating the polarising filter will **not** change the intensity of the light that passes through the filter.

(2)

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P 7 8 8 3 2 A 0 2 4 2 8

(b) The student arranges three polarising filters in different orientations.

The arrows in the diagram show the initial orientation of the plane of polarisation of each filter.

source of light   filter 1   filter 2   filter 3

The student rotates filter 2 by 45°. The intensity of light that passes through filter 3 changes.

Explain how rotating filter 2 by 45° from its initial orientation affects the intensity of light passing through filter 3.

(5)

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(Total for Question 18 = 10 marks)

**TOTAL FOR SECTION B = 70 MARKS
TOTAL FOR PAPER = 80 MARKS**

P 7 8 8 3 2 A 0 2 5 2 8

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to Earth's surface)
Electron charge	$e = -1.60 \times 10^{-19} \text{ C}$	
Electron mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$	
Electronvolt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to Earth's surface)
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8} \text{ m s}^{-1}$	

Unit 1

Mechanics

Kinematic equations of motion

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_{grav} = mg\Delta h$$

Power

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

Efficiency

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Materials

Density $\qquad\qquad\qquad\qquad \rho = \dfrac{m}{V}$

Stokes' law $\qquad\qquad\qquad F = 6\pi\eta rv$

Hooke's law $\qquad\qquad\qquad \Delta F = k\Delta x$

Elastic strain energy $\qquad\quad \Delta E_{el} = \dfrac{1}{2}F\Delta x$

Young modulus $\qquad\qquad E = \dfrac{\sigma}{\varepsilon}$ where

$$\text{Stress } \sigma = \frac{F}{A}$$

$$\text{Strain } \varepsilon = \frac{\Delta x}{x}$$

Unit 2

Waves

Wave speed $\qquad\qquad v = f\lambda$

Speed of a transverse wave
on a string $\qquad\qquad v = \sqrt{\dfrac{T}{\mu}}$

Intensity of radiation $\qquad\qquad I = \dfrac{P}{A}$

Refractive index $\qquad\qquad n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\qquad\qquad\qquad\qquad\qquad n = \dfrac{c}{v}$

Critical angle $\qquad\qquad \sin C = \dfrac{1}{n}$

Diffraction grating $\qquad\qquad n\lambda = d\sin\theta$

Electricity

Potential difference $\qquad\qquad V = \dfrac{W}{Q}$

Resistance $\qquad\qquad R = \dfrac{V}{I}$

Electrical power, energy $\qquad\qquad P = VI$

$\qquad\qquad\qquad\qquad\qquad P = I^2R$

$\qquad\qquad\qquad\qquad\qquad P = \dfrac{V^2}{R}$

$\qquad\qquad\qquad\qquad\qquad W = VIt$

Resistivity $\qquad\qquad R = \dfrac{\rho l}{A}$

Current $\qquad\qquad I = \dfrac{\Delta Q}{\Delta t}$

$\qquad\qquad\qquad\qquad\qquad I = nqvA$

Resistors in series $\qquad\qquad R = R_1 + R_2 + R_3$

Resistors in parallel $\qquad\qquad \dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

Particle nature of light

Photon model $\qquad\qquad E = hf$

Einstein's photoelectric
equation $\qquad\qquad hf = \phi + \dfrac{1}{2}mv_{max}^2$

de Broglie wavelength $\qquad\qquad \lambda = \dfrac{h}{p}$