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Candidate surname	Other names
Centre Number	Candidate Number
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Pearson Edexcel International Advanced Level

Wednesday 15 October 2025

Afternoon (Time: 1 hour 30 minutes)	Paper reference	WPH12/01
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Physics

International Advanced Subsidiary/Advanced Level

UNIT 2: Waves and Electricity

<b>You must have:</b> Scientific calculator, ruler, protractor	Total Marks
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### 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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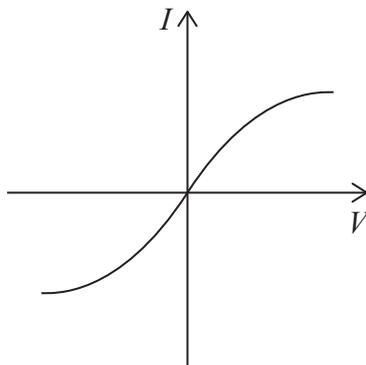


**SECTION A**

**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.

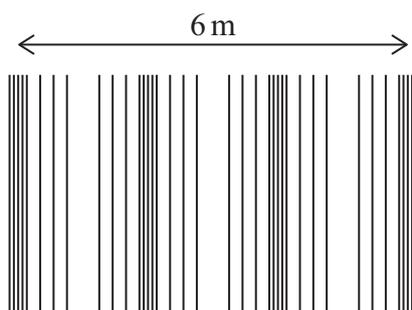


Which of the following components would give this graph?

- 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)**

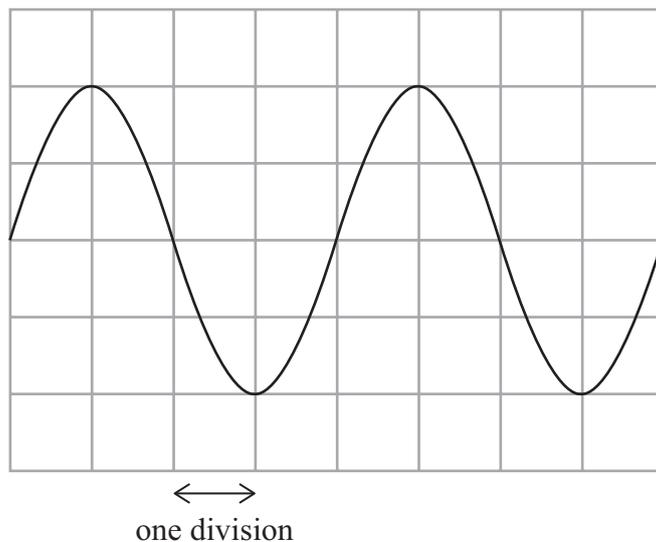


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3 The diagram shows the trace of a sound wave on an oscilloscope.



One horizontal division represents a time of 5 ms.

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

- A  $4 \times 0.005$
- B  $2 \times 0.005$
- C  $\frac{1}{2 \times 0.005}$
- D  $\frac{1}{4 \times 0.005}$

(Total for Question 3 = 1 mark)

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

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

- A  $\frac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 2 \times 10^7}$
- B  $\frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 2 \times 10^7}$
- C  $\frac{9.11 \times 10^{-31} \times 2 \times 10^7}{6.63 \times 10^{-34}}$
- D  $\frac{1.67 \times 10^{-27} \times 2 \times 10^7}{6.63 \times 10^{-34}}$

(Total for Question 4 = 1 mark)



- 5 Two points on a wave have a phase difference of  $25^\circ$ .

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

- A  $\frac{25 \times 2\pi}{360}$
- B  $\frac{25}{180}$
- C  $\frac{25 \times \pi}{360}$
- D  $\frac{25}{360}$

(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 =  $340 \text{ m s}^{-1}$

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  $\frac{340}{2 \times 4 \times 10^{-3}}$
- C  $340 \times 4 \times 10^{-3}$
- D  $\frac{340 \times 4 \times 10^{-3}}{2}$

(Total for Question 6 = 1 mark)

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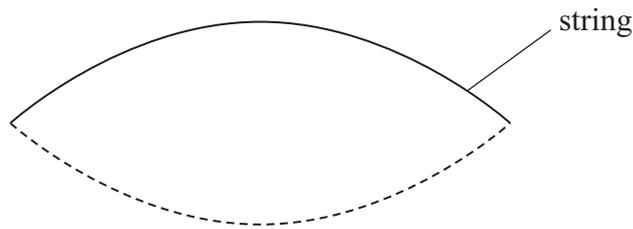


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- 7 A string vibrates between two fixed points. The diagram shows the stationary wave formed on the string when the string vibrates with frequency  $f$ .



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  $\frac{f}{\sqrt{2}}$
- B  $\sqrt{2} \times f$
- C  $\frac{f}{2}$
- 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  $1.0 \Omega$ .

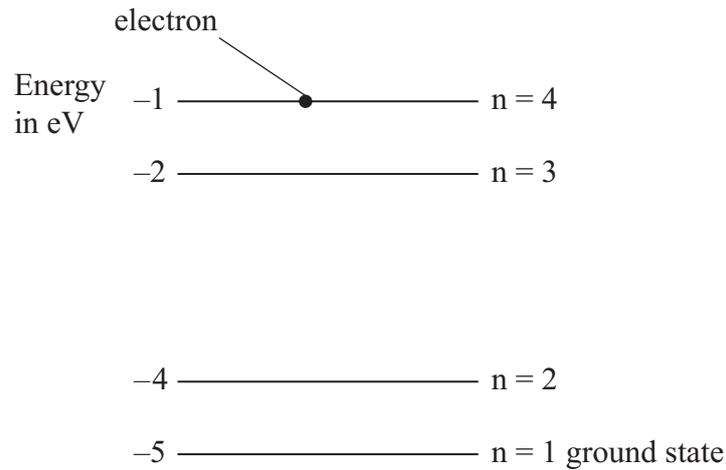
Which row of the table gives the e.m.f. and internal resistance of the battery?

	e.m.f./V	Internal resistance/ $\Omega$
<input type="checkbox"/> A	1.5	0.2
<input type="checkbox"/> B	1.5	5
<input type="checkbox"/> C	7.5	0.2
<input type="checkbox"/> D	7.5	5

(Total for Question 8 = 1 mark)



9 The diagram shows the energy levels in an atom.



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  $\frac{f}{8}$
- B  $\frac{f}{4}$
- C  $\frac{f}{2}$
- D  $\frac{3f}{4}$

(Total for Question 9 = 1 mark)

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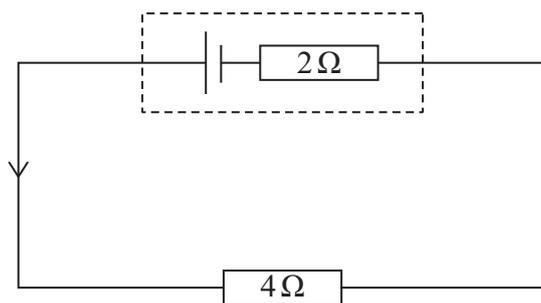
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10 The diagram shows a  $4\ \Omega$  resistor connected to a cell of e.m.f.  $12\ \text{V}$  and internal resistance  $2\ \Omega$ .



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

- A  $V = 12 \times \frac{2}{4}$
- B  $V = 12 \times \frac{6}{4}$
- C  $V = 12 \times \frac{4}{6}$
- D  $V = 12 \times \frac{2}{6}$

(Total for Question 10 = 1 mark)

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**TOTAL FOR SECTION A = 10 MARKS**

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**SECTION B**

**Answer ALL questions in the spaces provided.**

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

Calculate the drift velocity of the electrons in the wire.

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

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Drift velocity = .....

**(Total for Question 11 = 2 marks)**

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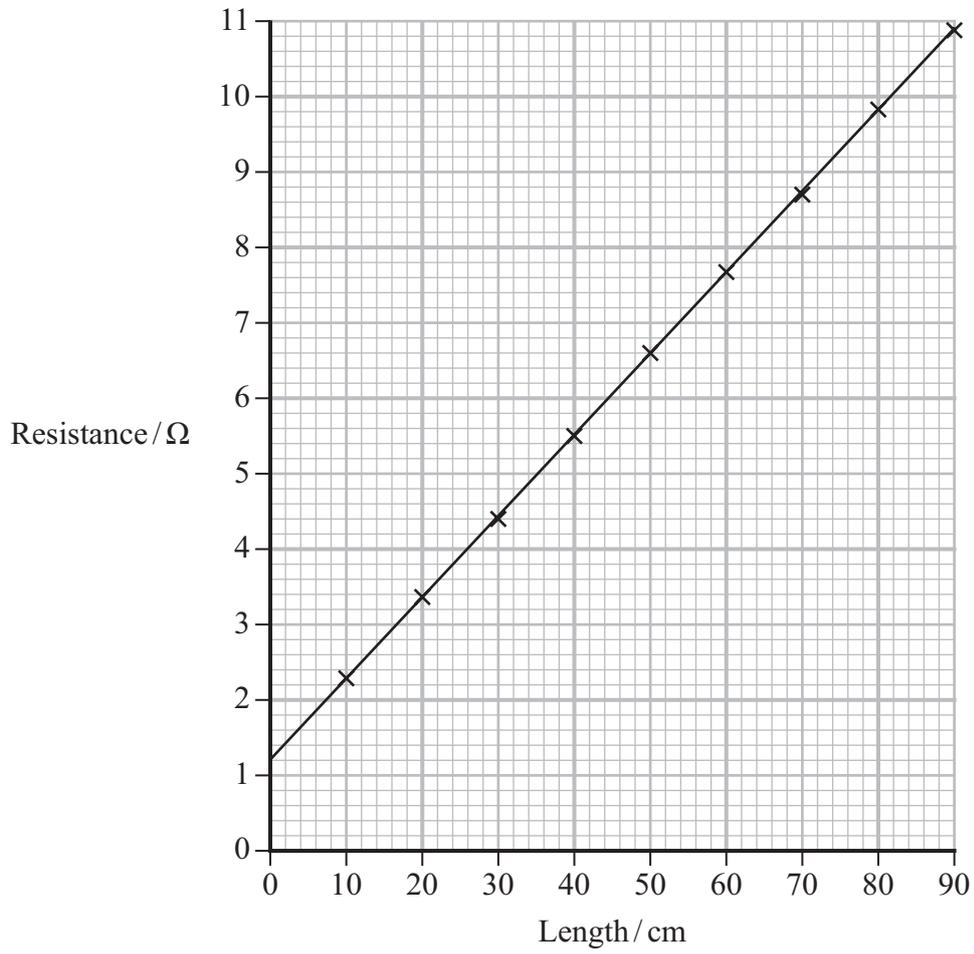
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- 13** A student determined the resistivity for a metal in the form of a wire.  
 The student measured the resistance for different lengths of the wire.  
 She plotted the graph shown.



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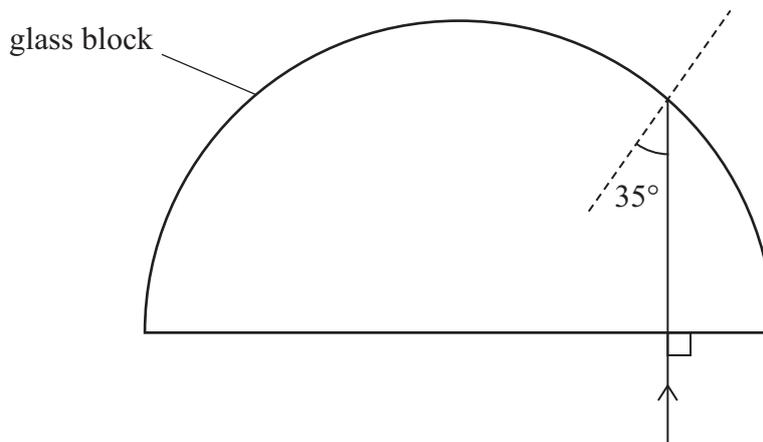
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14 A student used a semicircular glass block to investigate the refraction of light.

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



(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 = .....

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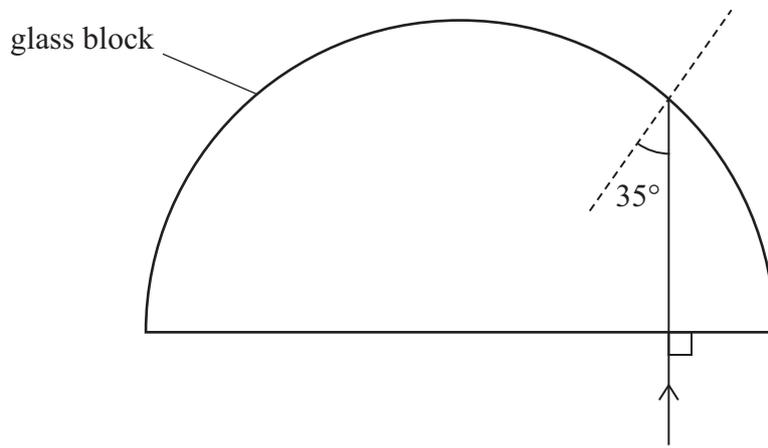
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(ii) Complete the diagram to show the path of the ray of light as it leaves the glass block.

(1)



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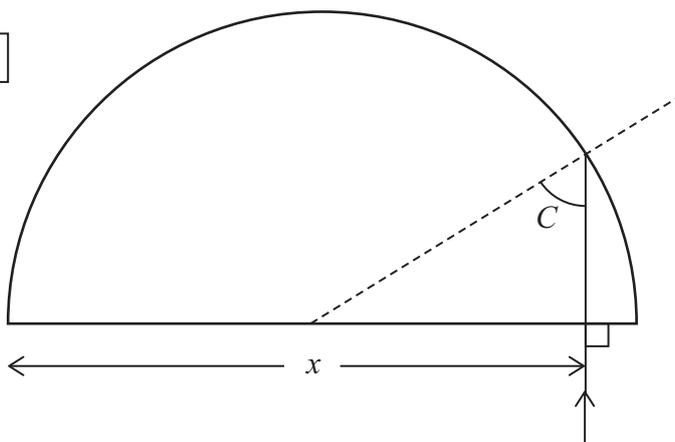
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(c) The student moved the glass block so that the ray of light was incident on the curved surface at the critical angle  $C$ , as shown below.

Not to scale



Determine the distance  $x$ .

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

(4)

Distance  $x$  = .....

**(Total for Question 14 = 8 marks)**



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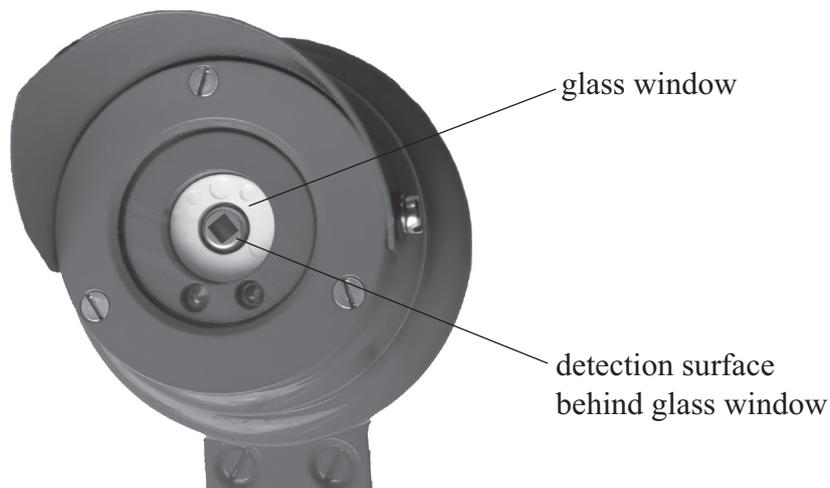
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15 The photograph shows a ‘flame detector’. The flame detector uses the photoelectric effect to detect ultraviolet radiation from fires.



(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  $5 \times 10^{-19}$  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  $8000 \text{ W m}^{-2}$  is incident on the detection surface.  
The detection surface has an area of  $0.020 \text{ m}^2$ .  
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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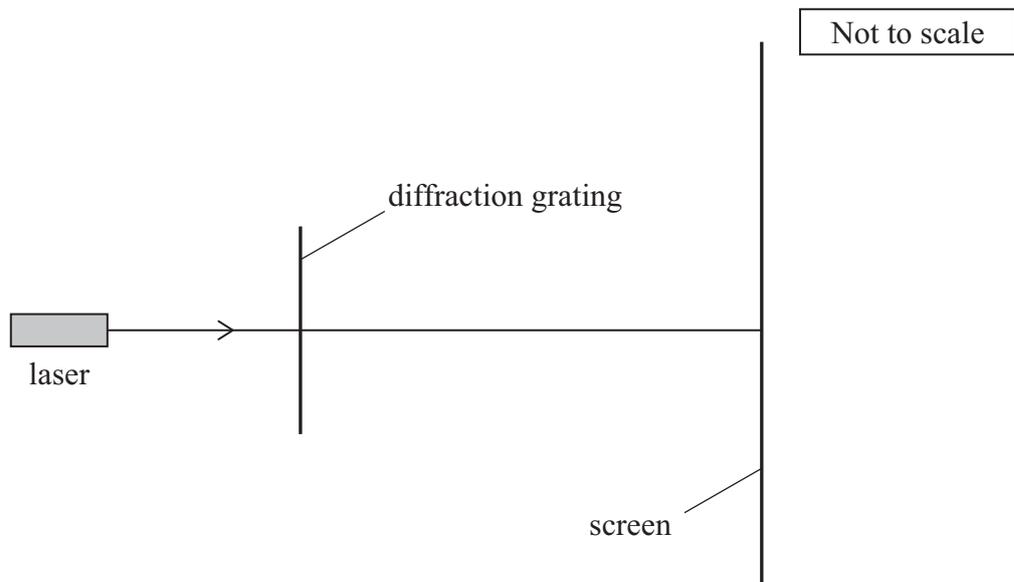
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16 A student directed light from a laser onto a diffraction grating, as shown.



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  $1.07 \times 10^{-6}$  m.

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

wavelength of laser light = 532 nm

(2)

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)

(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)

(Total for Question 16 = 12 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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**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

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

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

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

## Power

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

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

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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

$$\rho = \frac{m}{V}$$

Stokes' law

$$F = 6\pi\eta rv$$

Hooke's law

$$\Delta F = k\Delta x$$

Elastic strain energy

$$\Delta E_{\text{el}} = \frac{1}{2}F\Delta x$$

Young modulus

$$E = \frac{\sigma}{\varepsilon} \text{ where}$$

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

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

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**Unit 2***Waves*

Wave speed  $v = f\lambda$

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

Intensity of radiation  $I = \frac{P}{A}$

Refractive index  $n_1 \sin \theta_1 = n_2 \sin \theta_2$   
 $n = \frac{c}{v}$

Critical angle  $\sin C = \frac{1}{n}$

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

*Electricity*

Potential difference  $V = \frac{W}{Q}$

Resistance  $R = \frac{V}{I}$

Electrical power, energy  $P = VI$   
 $P = I^2R$   
 $P = \frac{V^2}{R}$   
 $W = VI t$

Resistivity  $R = \frac{\rho l}{A}$

Current  $I = \frac{\Delta Q}{\Delta t}$   
 $I = nqvA$

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

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

*Particle nature of light*

Photon model  $E = hf$

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

de Broglie wavelength  $\lambda = \frac{h}{p}$

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