Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

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

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 ▶

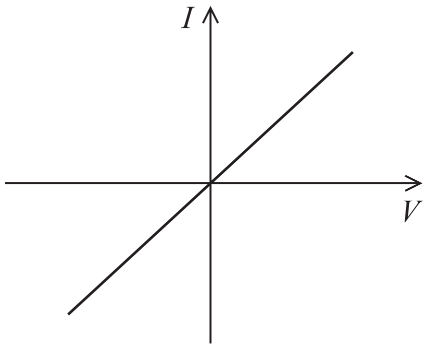
Pearson

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 component is represented by the graph?

☐ **A** diode

☐ **B** filament lamp

☐ **C** resistor at constant temperature

☐ **D** thermistor

(Total for Question 1 = 1 mark)

2 Monochromatic light travels through air and enters a glass block.

Which of the following quantities does **not** change as light enters the glass block?

☐ **A** amplitude

☐ **B** frequency

☐ **C** speed

☐ **D** wavelength

(Total for Question 2 = 1 mark)

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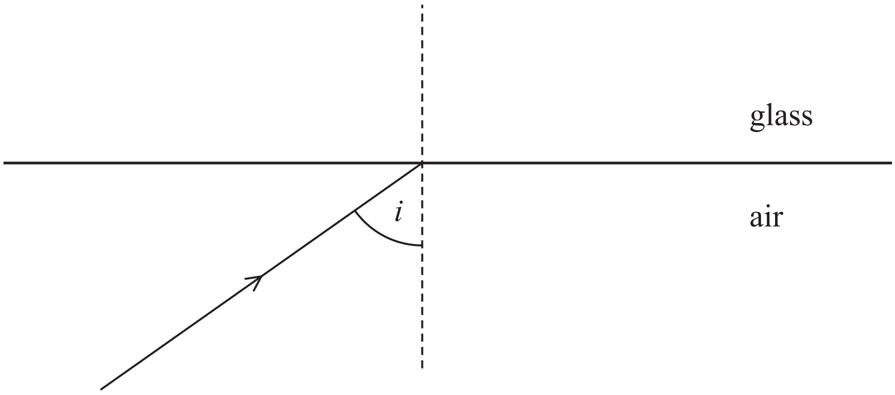
3 A ray of light approaches a boundary between air and glass, as shown.

The angle of incidence is i.



Which of the following statements about total internal reflection (TIR) is correct for the ray of light at this boundary?

☒ **A** TIR cannot take place.

☒ **B** TIR takes place if i is equal to the critical angle.

☒ **C** TIR takes place if i is greater than the critical angle.

☒ **D** TIR takes place if i is less than the critical angle.

(Total for Question 3 = 1 mark)

4 The equation $n\lambda = d\sin\theta$ can be used to determine the wavelength of laser light that has passed through a diffraction grating.

Which of the following is represented by d in the equation?

☒ **A** distance between adjacent lines on the diffraction grating

☒ **B** distance between the diffraction grating and the screen

☒ **C** number of lines per metre on the diffraction grating

☒ **D** order of the maximum observed on the screen

(Total for Question 4 = 1 mark)

5 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 6.0 ms later.

speed of sound = $340\,\text{m s}^{-1}$

Which of the following gives the distance, in metres, of the object from the bat?

☒ **A** 340×3.0

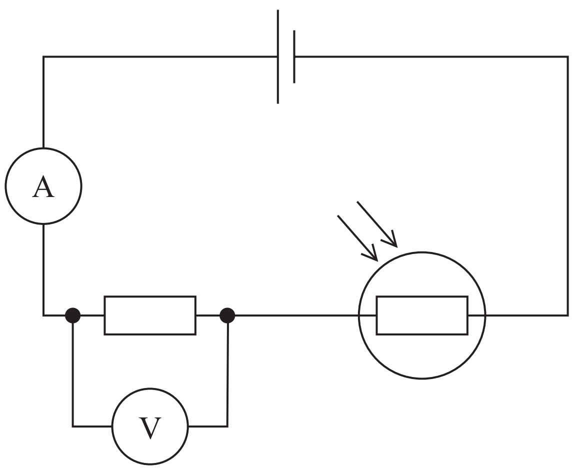
☒ **B** 340×6.0

☒ **C** 340×0.0030

☒ **D** 340×0.0060

(Total for Question 5 = 1 mark)

6 A light dependent resistor is connected in a circuit, as shown.



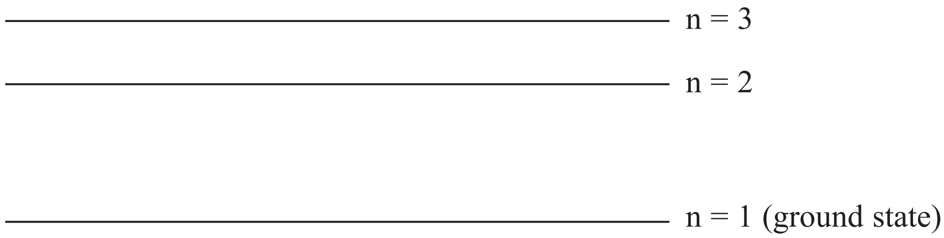
The intensity of light incident on the light dependent resistor decreases.

Which row of the table is correct?

		Ammeter reading	**Voltmeter reading**
☒	**A**	decreases	decreases
☒	**B**	increases	increases
☒	**C**	decreases	increases
☒	**D**	increases	decreases

(Total for Question 6 = 1 mark)

7 The diagram shows some of the energy levels in an atom.



Electrons in this atom are excited from the ground state to the energy level n = 3.

How many different frequencies of radiation can be emitted from this atom as electrons return to the ground state?

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(Total for Question 7 = 1 mark)

8 When longitudinal waves pass through a material, compressions and rarefactions are formed.

Which of the following statements is correct?

☒ **A** Compressions are points where the displacement of particles is a maximum.

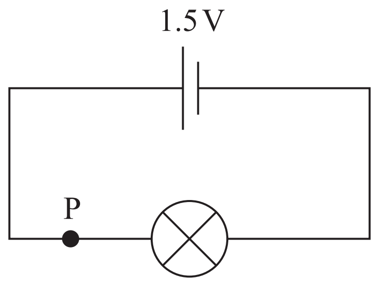
☒ **B** Compressions are points where the pressure is a minimum.

☒ **C** Rarefactions are points where the displacement of particles is a minimum.

☒ **D** Rarefactions are points where the pressure is a minimum.

(Total for Question 8 = 1 mark)

9 A lamp is connected in the circuit as shown. The cell has negligible internal resistance.



In 30 seconds, the charge passing point P is 0.4 C.

Which of the following gives the energy, in joules, transferred by the cell during this time?

☒ **A** $1.5 \times 0.4 \times 30$

☒ **B** 1.5×0.4

☒ **C** $\dfrac{1.5 \times 0.4}{30}$

☒ **D** $\dfrac{1.5}{0.4 \times 30}$

(Total for Question 9 = 1 mark)

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10 Which of the following is **not** a correct statement about stationary waves?

☒ **A** All points between two adjacent nodes are in phase.

☒ **B** Antinodes are points of maximum amplitude.

☒ **C** The distance between adjacent nodes is equal to one wavelength.

☒ **D** The net energy transfer along a stationary wave is zero.

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

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SECTION B

Answer ALL questions in the spaces provided.

11 A particle travelling at a speed of $9.89 \times 10^5 \, m \, s^{-1}$ has a de Broglie wavelength of $7.37 \times 10^{-10} \, m$.

Deduce whether this particle has a mass equal to the electron mass.

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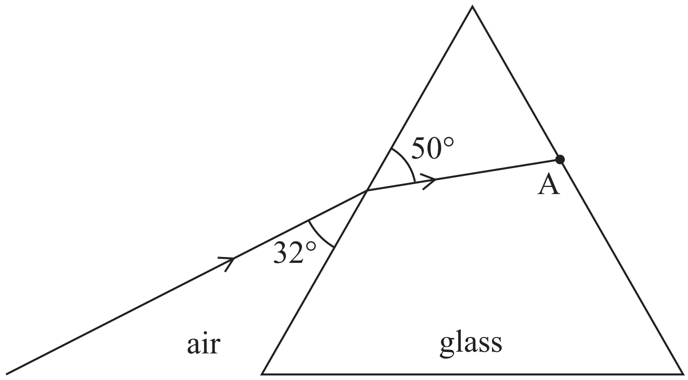
(Total for Question 11 = 3 marks)

12 In an experiment to determine the refractive index of glass, a student directed a ray of light towards a glass prism.

The ray of light is shown before and after entering the prism.



(a) (i) Determine the refractive index of the glass.

(3)

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Refractive index of glass = ...

(ii) Draw, on the diagram, the ray of light as it emerges from the prism at A.

No further calculations are required.

(1)

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(b) A different prism is made of glass with a refractive index of 1.63

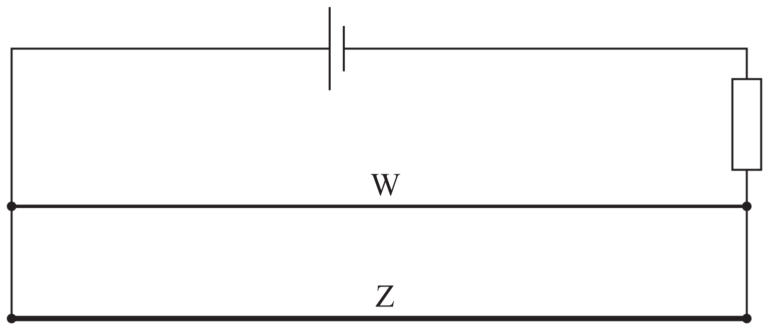
Calculate the speed of light in this glass.

(2)

Speed of light in glass = ...

(Total for Question 12 = 6 marks)

13 Equal lengths of two copper wires, W and Z, are connected in parallel in a circuit as shown.



Wire Z has twice the diameter of wire W.

(a) Explain why the drift velocity of the charge carriers is the same value in wires W and Z.

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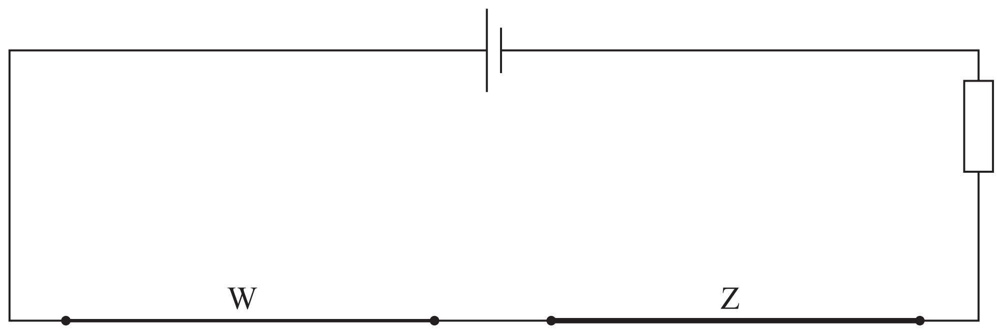
(b) Wires W and Z are now connected in series as shown.



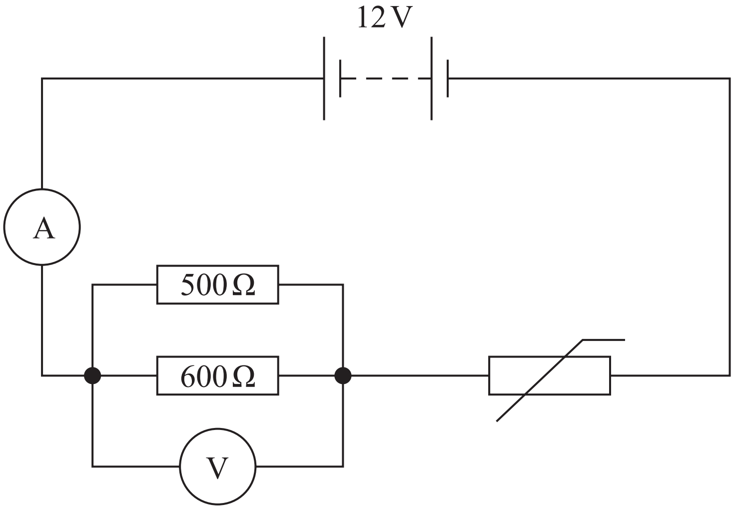
Complete the table by placing a cross in the correct box for each quantity.

(4)

Quantity	Same value for W and Z	Larger value in W	Larger value in Z
Current in the wires			
Resistance of the wires			
Potential difference across the wires			
Drift velocity of the charge carriers in the wires			

(Total for Question 13 = 8 marks)

14 A student set up the circuit shown to investigate the properties of a negative temperature coefficient thermistor.



The power supply has negligible internal resistance.

(a) (i) Show that the voltmeter reading was about 6 V.

ammeter reading = 23 mA

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(ii) Calculate the power dissipated by the thermistor.

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Power = ...

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(b) The student decreases the temperature of the thermistor.

Explain the effect of decreasing the temperature of the thermistor on the ammeter and voltmeter readings.

(4)

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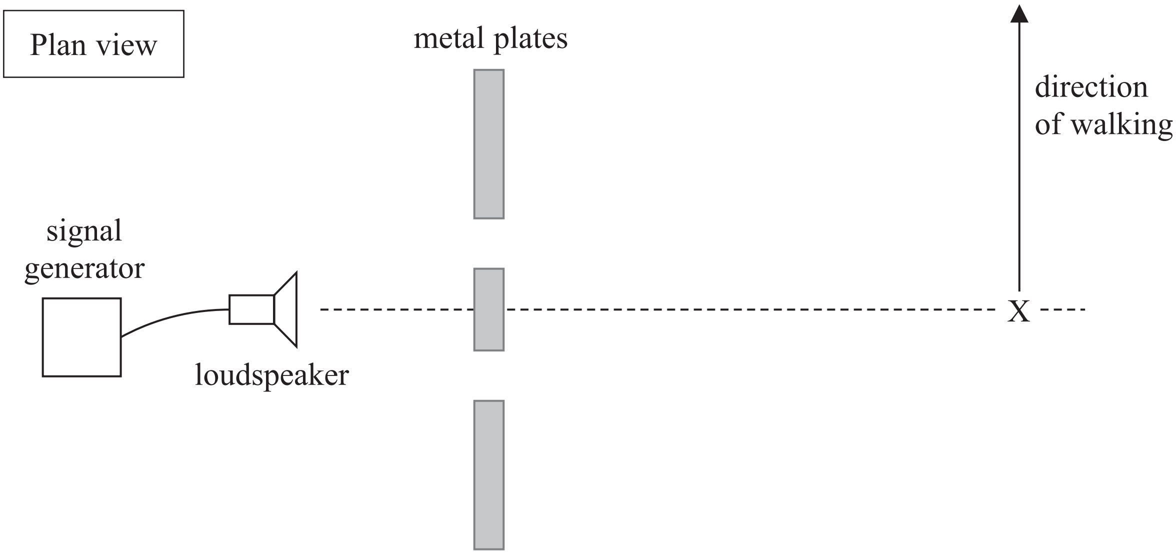
(Total for Question 14 = 10 marks)

15 A student connected a signal generator to a loudspeaker. The student arranged metal plates in front of the loudspeaker, as shown. The student left gaps between the metal plates.

Sound waves from the loudspeaker passed through the gaps. The gaps were approximately the same size as the wavelength of the sound waves.



The student stood at point X and heard a loud sound. The student walked in a straight line in the direction of the arrow. As her position changed, the sound became quieter until she heard no sound.

*(a) Explain why the sound became quieter until there was no sound.

Your explanation should refer to interference.

(6)

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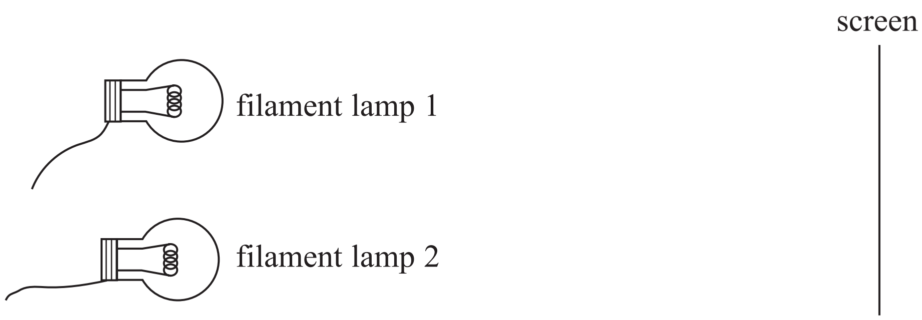
(b) Interference can be demonstrated using visible light.

A student connects two filament lamps to the same power supply. A screen is placed at a distance from the lamps, as shown.



Explain why it is **not** possible to create a consistent interference pattern on the screen using this arrangement.

(2)

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(Total for Question 15 = 8 marks)

16 An irrigation system uses a pump to move water from a lower level to a higher level. The electricity for the pump is generated using a panel of solar cells.

(a) The panel of solar cells is 1.20 m long and 0.80 m wide. To pump water from the lower level to the higher level the pump needs a minimum power of 140 W.

(i) Calculate the minimum efficiency of the panel of solar cells that will operate the pump.

intensity of sunlight on solar cells = $1040\,\text{W}\,\text{m}^{-2}$

(4)

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Minimum efficiency = ...

(ii) Suggest **two** reasons why the value calculated in (i) is the minimum efficiency that will operate the pump.

(2)

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(b) Light from the Sun arriving at the solar cells is unpolarised.

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

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(ii) Describe how a student can demonstrate that light from the Sun is unpolarised.

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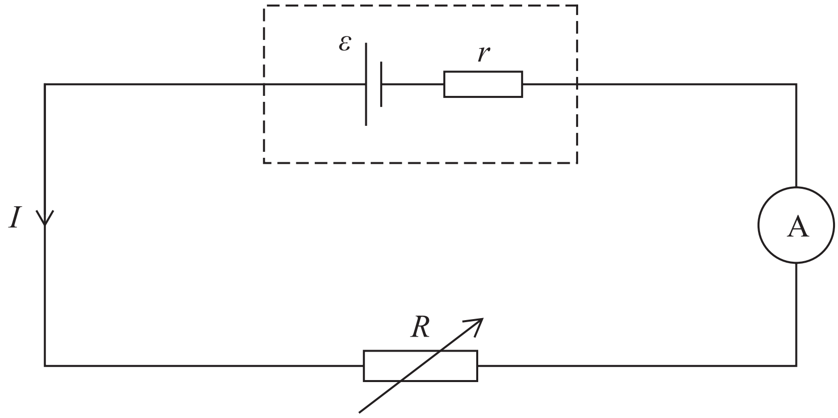
(Total for Question 16 = 11 marks)

17 A student set up the circuit shown to determine the e.m.f. ε and internal resistance r of a cell.

I is the current in the circuit and R is the resistance of the variable resistor.



(a) Show that, for this circuit, $R = \frac{\varepsilon}{I} - r$

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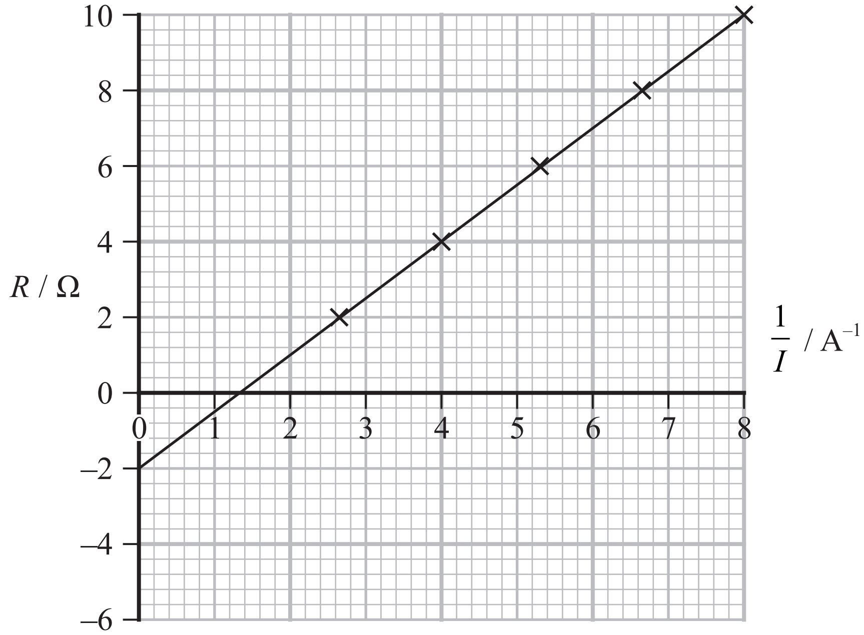
(b) The student varied R and measured corresponding values of I.

The student then plotted a graph of R against $\frac{1}{I}$, as shown.



Determine values of ε and r for the cell.

(3)

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ε = ...

r = ...

(c) The student suggested that the power dissipated by the internal resistance r decreases as R increases.

Comment on the student's suggestion.

No further calculations are required.

(3)

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(d) The student added a second, identical cell in series with the first cell and repeated the experiment.

Add a line to the graph to show the result of this experiment.

(3)

(Total for Question 17 = 11 marks)

18 (a) In an experiment to demonstrate the photoelectric effect, ultraviolet light is incident on a metal plate.

(i) Photoelectrons are released from the plate with a maximum speed of $3.51 \times 10^5\,m\,s^{-1}$.

Calculate the energy of these photoelectrons in eV.

(3)

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Energy = ... eV

(ii) The table shows typical values of work function for four different metals.

Metal	**Work function / 10^{-19} J**
Magnesium	5.89
Aluminium	6.53
Zinc	6.88
Iron	7.20

The ultraviolet light used in the experiment had a wavelength of 310 nm.

Deduce which of the metals was most likely to have been used as the metal plate.

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(b) Photoelectrons are only emitted from a given metal surface if the frequency of the incident radiation is above a particular value.

Explain why.

(4)

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(c) A student makes the following statement.

'It does not matter what the value of the work function is for a particular metal. Photoelectrons can always be released if the intensity of the incident light is high enough.'

Criticise the student's statement.

(2)

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(Total for Question 18 = 13 marks)

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

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

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

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

P 7 1 8 6 5 A 0 2 2 2 4

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

Young modulus $E = \frac{\sigma}{\varepsilon}$ where

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

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

Unit 2

Waves

Wave speed	$v = f\lambda$
Speed of a transverse wave on a string	$v = \sqrt{\dfrac{T}{\mu}}$
Intensity of radiation	$I = \dfrac{P}{A}$
Refractive index	$n_1 \sin\theta_1 = n_2 \sin\theta_2$
	$n = \dfrac{c}{v}$
Critical angle	$\sin C = \dfrac{1}{n}$
Diffraction grating	$n\lambda = d\sin\theta$

Electricity

Potential difference	$V = \dfrac{W}{Q}$
Resistance	$R = \dfrac{V}{I}$
Electrical power, energy	$P = VI$
	$P = I^2R$
	$P = \dfrac{V^2}{R}$
	$W = VIt$
Resistivity	$R = \dfrac{\rho l}{A}$
Current	$I = \dfrac{\Delta Q}{\Delta t}$
	$I = nqvA$
Resistors in series	$R = R_1 + R_2 + R_3$
Resistors in parallel	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

Particle nature of light

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2}mv^2_{max}$
de Broglie wavelength	$\lambda = \dfrac{h}{p}$