Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Wednesday 13 May 2026

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

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

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 Which of the following is the SI base unit for charge?

☒ **A** ampere

☒ **B** ampere second

☒ **C** coulomb

☒ **D** coulomb per second

(Total for Question 1 = 1 mark)

2 The resistance of a negative temperature coefficient thermistor depends upon its temperature.

The resistance R and the charge carrier density n change as the temperature increases.

Which row in the table gives the changes as the temperature increases?

		R	***n***
☒	**A**	decreases	decreases
☒	**B**	decreases	increases
☒	**C**	increases	decreases
☒	**D**	increases	increases

(Total for Question 2 = 1 mark)

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3 A sound wave is travelling through air. The displacement of air molecules creates compressions and rarefactions.

Which row of the table is correct for a compression when compared with a rarefaction?

	Pressure	Density of air
☒ **A**	higher	lower
☒ **B**	lower	higher
☒ **C**	higher	higher
☒ **D**	lower	lower

(Total for Question 3 = 1 mark)

4 Two waves, from the same source, travel different paths before superposing at a point X.

At X the waves have a phase difference of 180°.

Which of the following describes the resultant displacement of the waves at X?

☒ **A** The displacement will be a minimum due to destructive interference.

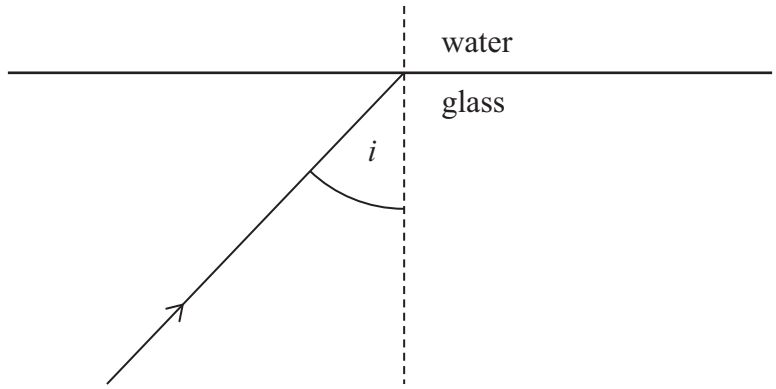
☒ **B** The displacement will be a maximum due to constructive interference.

☒ **C** The displacement will be a minimum due to constructive interference.

☒ **D** The displacement will be a maximum due to destructive interference.

(Total for Question 4 = 1 mark)

5 Light is directed to a boundary between glass and water. The light meets the boundary at an angle *i* to the normal, as shown.



Which row of the table explains why total internal reflection occurs at the boundary?

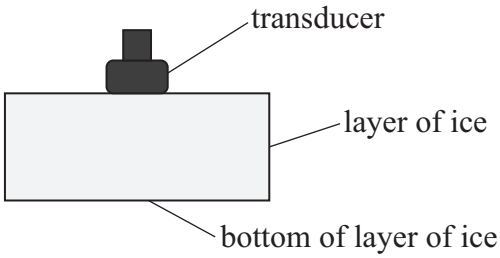
		Angle of incidence, *i*	Refractive index of glass
☒	**A**	greater than critical angle	greater than refractive index of water
☒	**B**	less than critical angle	greater than refractive index of water
☒	**C**	greater than critical angle	less than refractive index of water
☒	**D**	less than critical angle	less than refractive index of water

(Total for Question 5 = 1 mark)

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6 A transducer is placed on a layer of ice, as shown. The transducer emits pulses of ultrasound which reflect from the bottom of the layer of ice.



The time for a pulse to return is 0.005 s.

The speed of sound in ice is 4000 m s^{-1}.

Which of the following gives the thickness of the layer of ice in metres?

☒ **A** 4000×0.005

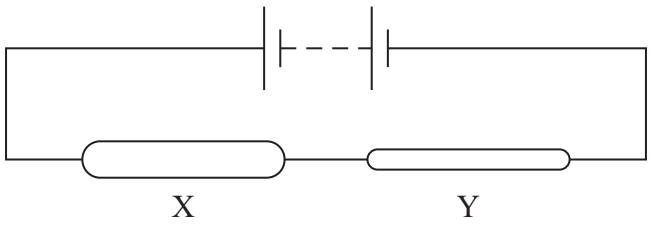
☒ **B** $2 \times 4000 \times 0.005$

☒ **C** $\dfrac{0.005}{2 \times 4000}$

☒ **D** $\dfrac{4000 \times 0.005}{2}$

(Total for Question 6 = 1 mark)

7 Two nichrome wires of the same length are connected in a circuit, as shown.



The diameter of wire X is twice the diameter of wire Y.

The drift velocity of the electrons in wire X is v_X.
The drift velocity of the electrons in wire Y is v_Y.

Which of the following gives the value of $\frac{v_X}{v_Y}$?

☒ **A** $\frac{1}{4}$

☒ **B** $\frac{1}{2}$

☒ **C** 2

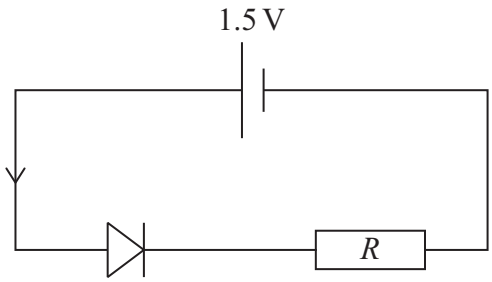
☒ **D** 4

(Total for Question 7 = 1 mark)

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8 A diode is connected in series with a resistor of resistance R and a cell of negligible internal resistance.



When the potential difference across the diode is 0.7 V, the current through the diode is 1.8×10^{-2} A.

Which of the following expressions gives the value of R in Ω?

☒ **A** $\dfrac{0.7}{1.8 \times 10^{-2}}$

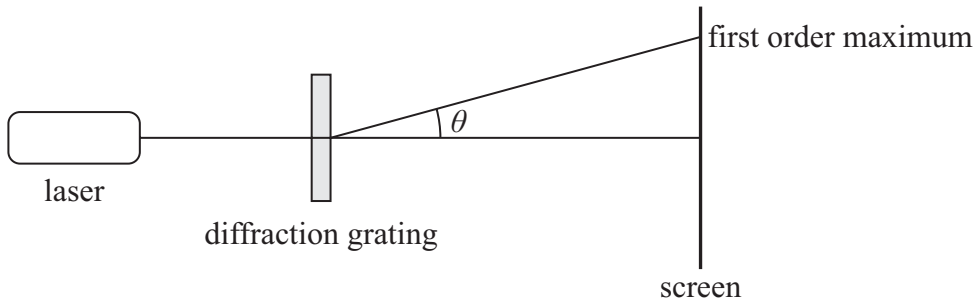
☒ **B** $\dfrac{1.5}{1.8 \times 10^{-2}}$

☒ **C** $\dfrac{1.5 - 0.7}{1.8 \times 10^{-2}}$

☒ **D** $\dfrac{1.8 \times 10^{-2}}{0.7}$

(Total for Question 8 = 1 mark)

9 A student directs a laser beam towards a diffraction grating, as shown.



The laser light has a wavelength of 6.0×10^{-7} m.
The diffraction grating has 4.0×10^{5} lines per metre.

Which of the following expressions gives the value of θ?

☒ **A** $\sin^{-1}\left(\frac{6.0 \times 10^{-7}}{4.0 \times 10^{5}}\right)$

☒ **B** $\sin^{-1}\left(\frac{4.0 \times 10^{5}}{6.0 \times 10^{-7}}\right)$

☒ **C** $\sin^{-1}(6.0 \times 10^{-7} \times 4.0 \times 10^{5})$

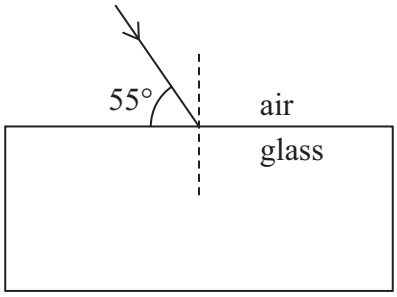
☒ **D** $\sin^{-1}\left(\frac{1}{6.0 \times 10^{-7} \times 4.0 \times 10^{5}}\right)$

(Total for Question 9 = 1 mark)

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10 A ray of light is incident on a glass block, as shown.



The speed of light in the glass block is $2.00 \times 10^8\,\text{m s}^{-1}$.

Which of the following expressions gives the angle of refraction?

☒ **A** $\sin^{-1}(\frac{2}{3}\ \sin 35°)$

☒ **B** $\sin^{-1}(\frac{2}{3}\ \sin 55°)$

☒ **C** $\sin^{-1}(\frac{3}{2}\ \sin 35°)$

☒ **D** $\sin^{-1}(\frac{3}{2}\ \sin 55°)$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 A heating element in an electric kettle has a resistance of 18 Ω.

The current in the heating element is 13 A.

Calculate the power dissipated in the heating element.

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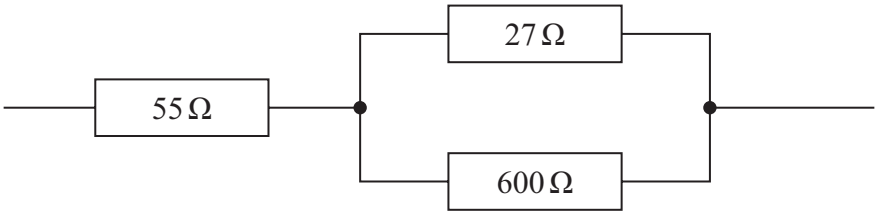
Power dissipated = ...

(Total for Question 11 = 2 marks)

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12 A combination of three resistors is shown.



Calculate the total resistance of this combination.

(3)

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Total resistance = ...

(Total for Question 12 = 3 marks)

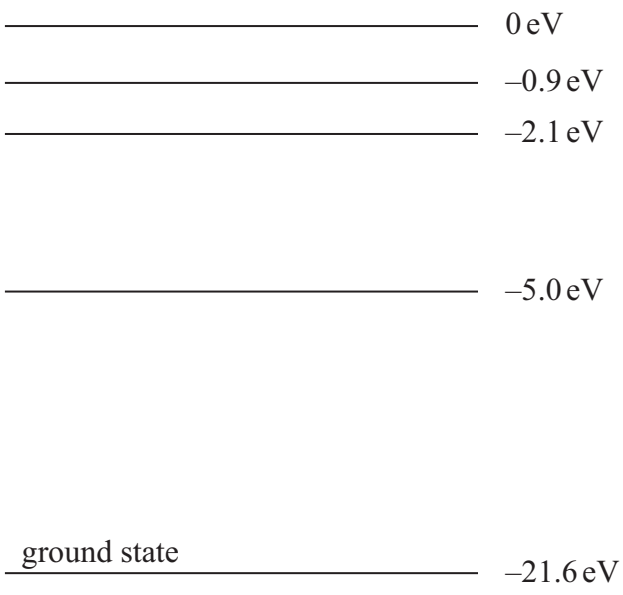
13 In a neon lamp, free electrons collide with neon atoms.

The neon atoms absorb energy, causing electrons in these atoms to move to higher energy levels. These electrons then return to lower energy levels, resulting in the emission of photons.

(a) Explain why only certain frequencies of radiation are emitted as a result of this process.

(3)

(b) The diagram shows some of the energy levels in a neon atom.



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(i) An electron in the ground state is excited to the –2.1 eV level.

Calculate the wavelength of the photon emitted when this electron returns to the ground state.

(4)

Wavelength = ...

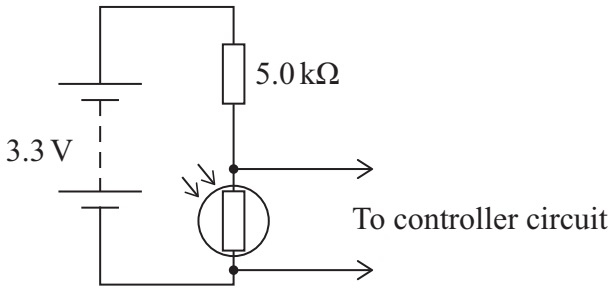
(ii) A photon with a photon energy of 20.0 eV is incident on this atom.
An electron in the ground state is not excited and remains at the ground state.

Explain this observation.

(2)

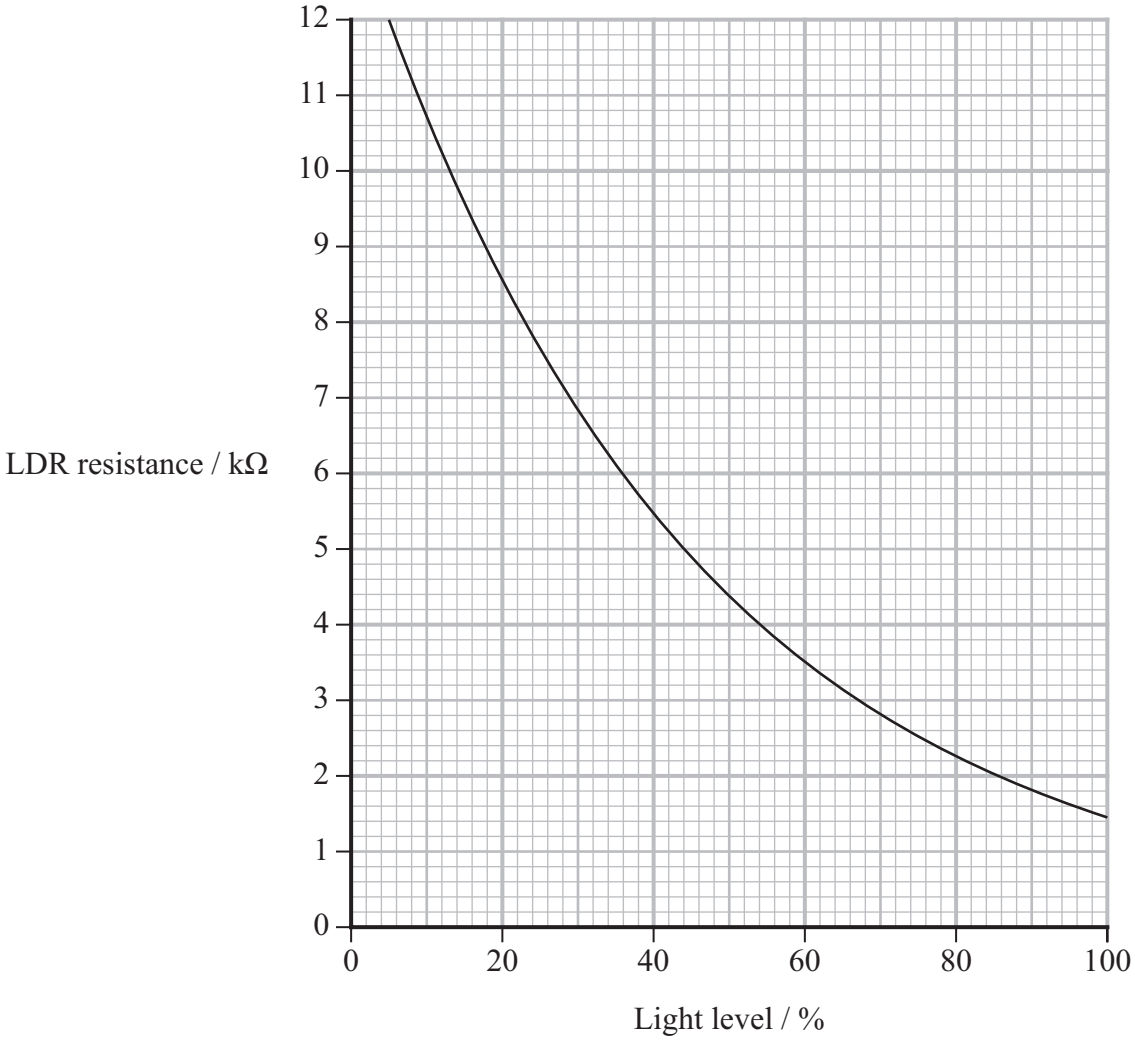
(Total for Question 13 = 9 marks)

14 A smartphone uses a sensing circuit to adjust its screen brightness. The sensing circuit contains a fixed resistor and a light-dependent resistor (LDR), as shown.



The sensing circuit supplies a potential difference (p.d.) to operate a controller circuit that adjusts the screen brightness.

The resistance of the LDR varies with light level, as shown on the graph. A light level of 100% corresponds to bright sunlight.



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(a) The screen brightness is reduced when the p.d. across the LDR falls below 1.0 V.

The light level incident on the screen is 90%.

Deduce whether the screen brightness will have been reduced.

(5)

(b) Explain why the resistance of the LDR decreases as light level increases.

(2)

(Total for Question 14 = 7 marks)

15 A car battery has an electromotive force (e.m.f.) of 12 V and an internal resistance of 0.05 Ω.

(a) State what is meant by e.m.f.

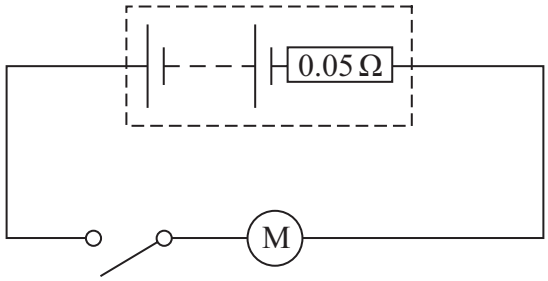
(1)

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(b) The circuit diagram shows the car battery connected to the starter motor of a car.

The starter motor has a very small resistance, as it needs a large current to work.



(i) The starter motor has a resistance of 93 mΩ.

Determine the terminal potential difference across the battery when the switch is closed.

(4)

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Terminal potential difference = ...

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(ii) After a few years, the battery will have a greater internal resistance.

Explain why this could prevent the starter motor from working.

(3)

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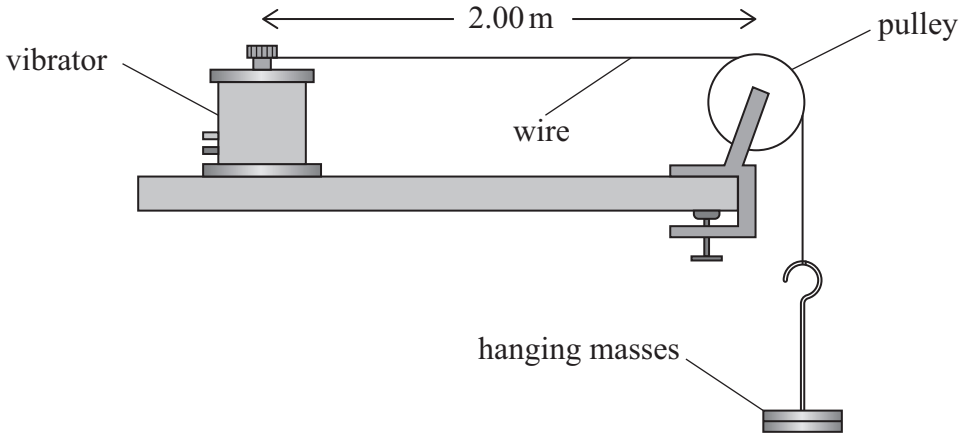
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(Total for Question 15 = 8 marks)

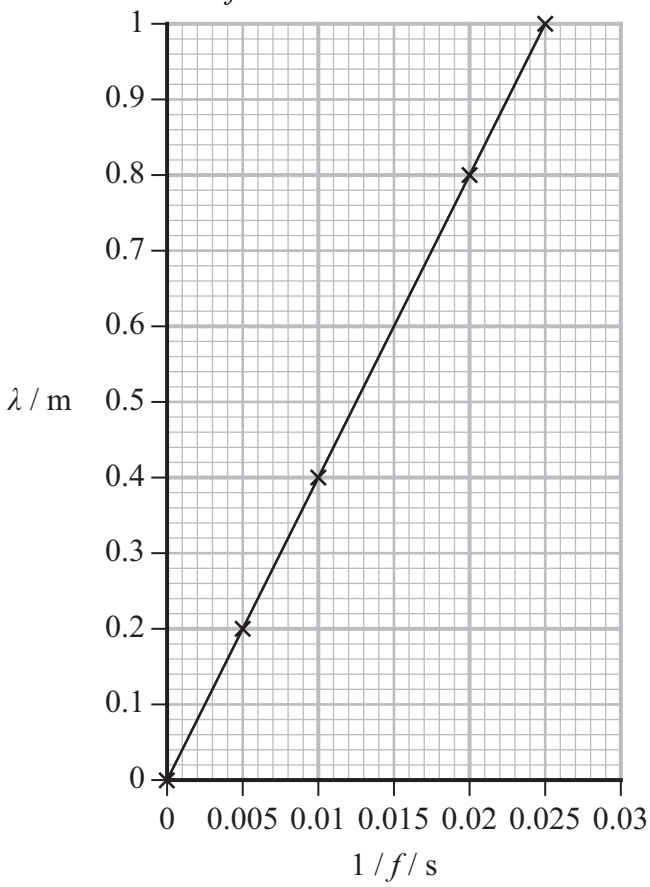
16 A student investigated stationary waves on a wire, using the apparatus shown.



A mass was hung from the wire and the frequency f was adjusted until a stationary wave was formed. The student determined the wavelength λ of the stationary wave.

The frequency was increased and different stationary wave patterns were observed.

The student plotted a graph of λ against $\frac{1}{f}$ as shown.



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(a) λ is related to f by the expression

$$\lambda = \frac{1}{f}\sqrt{\frac{T}{\mu}}$$

where T is the tension in the wire and μ is the mass per unit length of the wire.

(i) Show that this expression is correct.

(2)

(ii) Explain why the graph is a straight line through the origin.

(2)

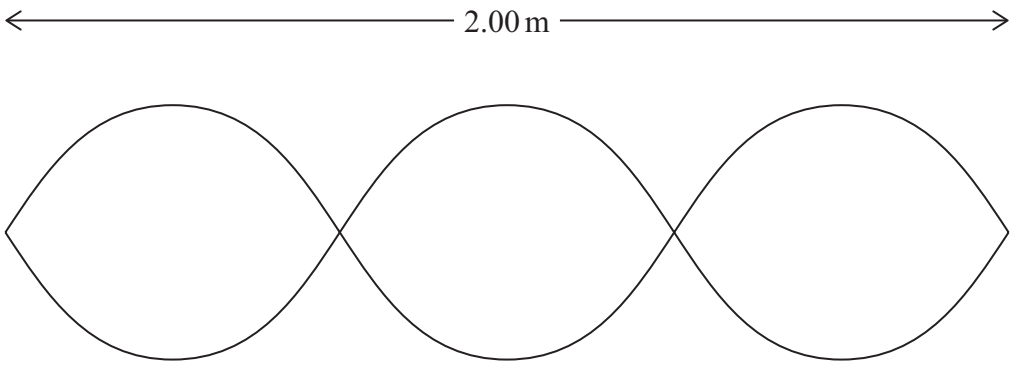
(iii) Show that the mass per unit length of the wire is about $1.2 \times 10^{-3}\,\text{kg}\,\text{m}^{-1}$.

mass hung from wire = 200 g

(4)

(b) The student changed the mass and repeated the experiment at a frequency of 45 Hz.

The following stationary wave pattern was formed on the wire.



Calculate the tension, T, in the string.

$\mu = 1.2 \times 10^{-3}\,\text{kg m}^{-1}$

(4)

Tension = ...

(Total for Question 16 = 12 marks)

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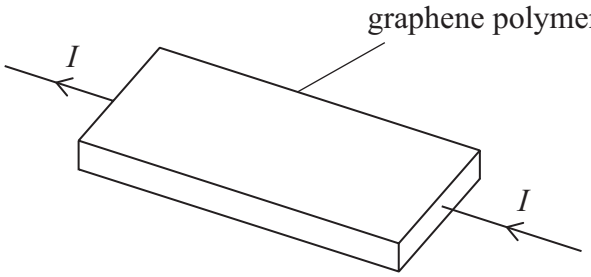
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17 Graphene polymer is a flexible conducting material used in sensors that can be worn on the body.

A strip of graphene polymer has a length of 15 cm, a width of 2.5 cm and a thickness of 1.1×10^{-7} m.

The strip is connected to a cell with negligible internal resistance.

There is a current I in the strip, as shown.



(a) Determine the resistivity of this graphene polymer.

e.m.f. of cell = 1.5 V
I = 0.12 A

(4)

Resistivity = ...

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(b) A strip of graphene polymer is used in a sensor worn on the body. When the person moves, the strip of graphene polymer is stretched along its length.

A student suggests that doubling the length of the strip of graphene polymer would double the resistance.

Deduce whether this suggestion is correct.

(3)

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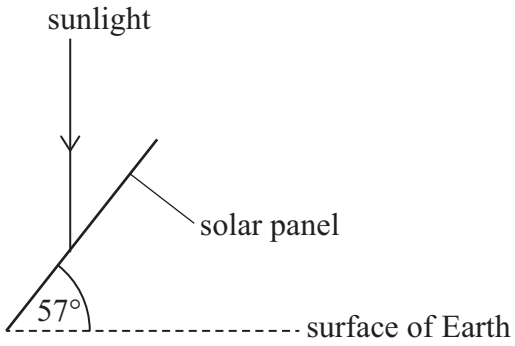
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(Total for Question 17 = 7 marks)

18 When sunlight is incident on the surface of a solar panel, an e.m.f. is produced.

(a) (i) At the surface of the Earth, the maximum intensity of solar radiation is $1100\,Wm^{-2}$.

A solar panel, at the surface of the Earth, is placed at an angle of 57° to the horizontal, as shown.



Show that the power output of this solar panel is about 260 W.

efficiency of solar panel = 20%
area of solar panel = $2.2\,m^2$

(4)

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(ii) A nuclear power station has an annual energy output of 2.53×10^{16} J.

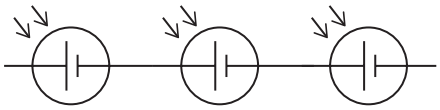
It is suggested that 15 million solar panels would be needed to generate the same amount of energy as this nuclear power station in one year.

Evaluate the validity of this suggestion.

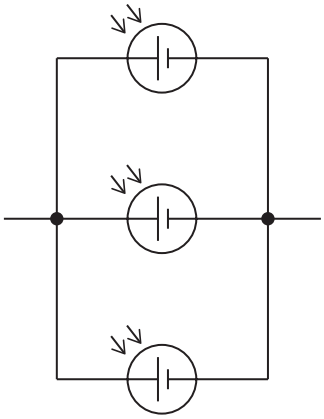
Assume that the solar panels generate 260 W of electrical power for 5 hours per day.

(3)

*(b) A solar panel is a combination of solar cells. The solar cells can be connected in series or in parallel, as shown.



Series combination



Parallel combination

The intensity of light incident on each combination is the same.

Explain how both combinations of solar cells produce the same power output and state an advantage for each combination.

(6)

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(Total for Question 18 = 13 marks)

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19 Photons with energy 10.9 eV are incident on the surface of a metal plate.

Electrons are released from the metal surface due to the photoelectric effect.

(a) (i) Show that the electrons released from the surface have a maximum velocity of about $1.5 \times 10^{6}\,\text{m s}^{-1}$.

work function of metal = $6.80 \times 10^{-19}\,\text{J}$

(4)

(ii) Calculate the de Broglie wavelength of an electron moving at $1.5 \times 10^{6}\,\text{m s}^{-1}$.

(2)

de Broglie wavelength = ...

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

Explain why.

(3)

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(Total for Question 19 = 9 marks)

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

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List of data, formulae and relationships

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

Stokes' law $F = 6\pi\eta r v$

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

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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	$P = VI$
	$P = I^2R$
	$P = \frac{V^2}{R}$
	$W = VIt$
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	$hf = \phi + \frac{1}{2}mv^2_{max}$
de Broglie wavelength	$\lambda = \frac{h}{p}$

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