Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Tuesday 13 January 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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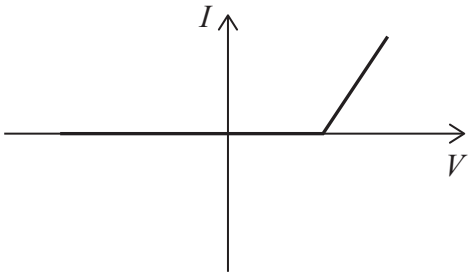
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SECTION A

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 component is represented by this graph?

☒ **A** diode

☒ **B** filament lamp

☒ **C** ohmic conductor

☒ **D** thermistor

(Total for Question 1 = 1 mark)

2 A phone is connected to a charger. The current in the charger is 5 mA.

Which of the following gives the charge in coulombs entering the phone in 8 minutes?

☒ **A** $\frac{5 \times 10^{-3}}{480}$

☒ **B** $\frac{5 \times 10^{-3}}{8}$

☒ **C** $5 \times 10^{-3} \times 480$

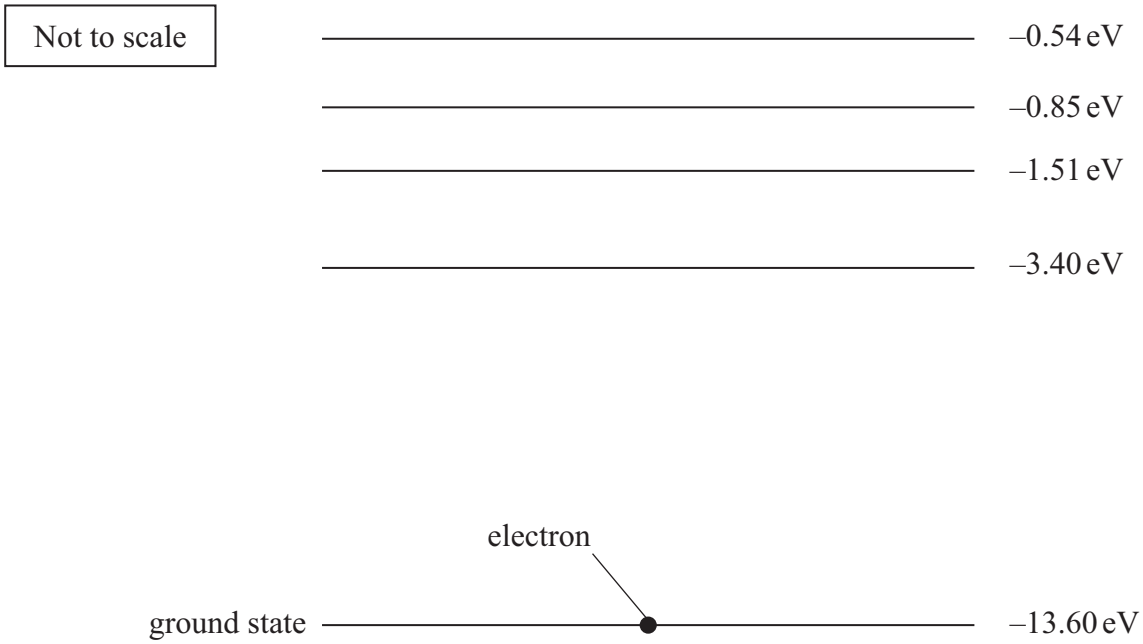
☒ **D** $5 \times 10^{-3} \times 8$

(Total for Question 2 = 1 mark)

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3 The diagram shows some of the energy levels of a hydrogen atom.



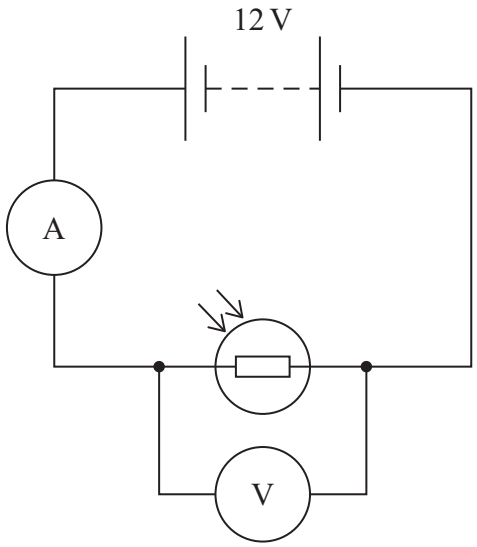
An electron in the ground state absorbs a photon.

Which of the following could **not** be the energy of the photon?

- ☒ **A** 9.8 eV
- ☒ **B** 10.2 eV
- ☒ **C** 12.09 eV
- ☒ **D** 12.75 eV

(Total for Question 3 = 1 mark)

4 A light dependent resistor (LDR) is connected in a circuit, as shown.



The internal resistance of the battery is negligible.

The light intensity incident on the LDR increases.

Which row of the table describes what happens to the readings on the voltmeter and the ammeter?

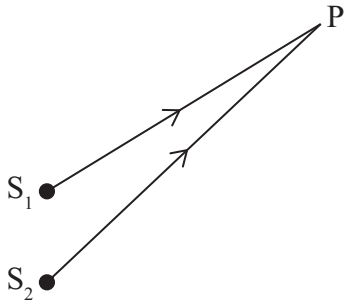
		Voltmeter reading	Ammeter reading
☒	**A**	decreases	decreases
☒	**B**	stays the same	increases
☒	**C**	stays the same	decreases
☒	**D**	increases	increases

(Total for Question 4 = 1 mark)

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5 Light from two sources, S_1 and S_2, is in phase.
The light has wavelength λ and meets at point P, as shown.



The path difference for the light is $\frac{\lambda}{4}$.

Which of the following is the phase difference, in radians, at P?

☒ **A** 2π

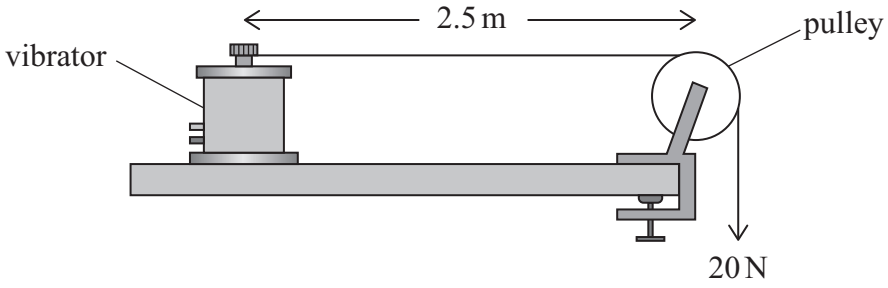
☒ **B** π

☒ **C** $\frac{\pi}{2}$

☒ **D** $\frac{\pi}{4}$

(Total for Question 5 = 1 mark)

6 A student investigated stationary waves on a string, using the apparatus shown.



The vibrating length of the string has a mass of 0.005 kg and a length of 2.5 m.

Which of the following gives the speed of a transverse wave on this string in $m\,s^{-1}$?

☒ **A** $\sqrt{\frac{20}{2.5}}$

☒ **B** $\sqrt{\frac{20 \times 2.5}{0.005}}$

☒ **C** $\sqrt{\frac{20 \times 0.005}{2.5}}$

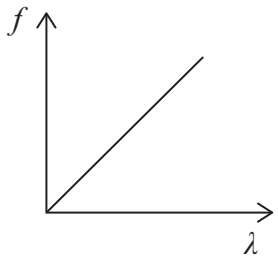
☒ **D** $\sqrt{\frac{20}{0.005}}$

(Total for Question 6 = 1 mark)

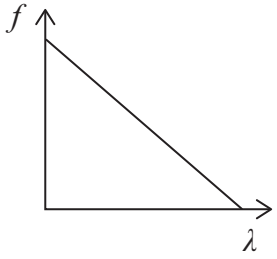
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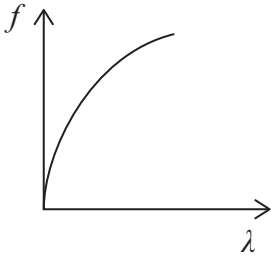
7 Which of the following graphs represents the relationship between the frequency f and wavelength λ of photons?



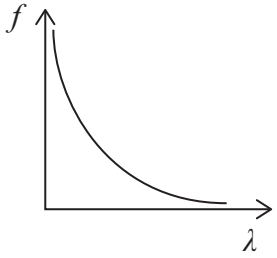
☒ **A**



☒ **B**



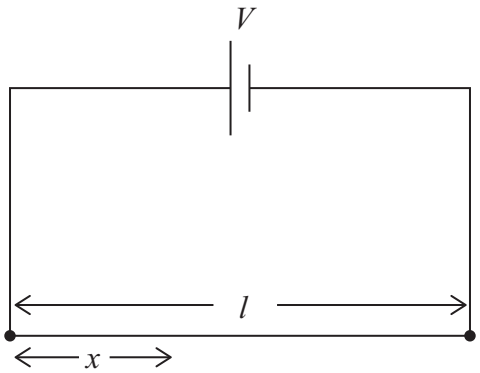
☒ **C**



☒ **D**

(Total for Question 7 = 1 mark)

8 The circuit diagram shows a potential difference V applied across the ends of a uniform wire of length l.



Which of the following gives the potential difference across length x of the wire?

☒ **A** $V \times \frac{l}{x}$

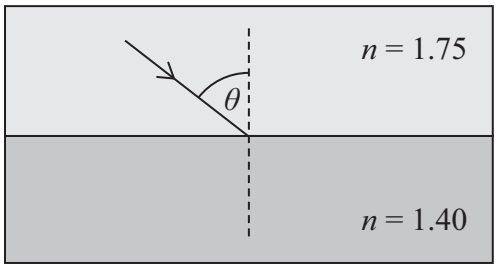
☒ **B** $V \times \frac{x}{l}$

☒ **C** $\frac{V}{x \times l}$

☒ **D** $V \times x \times l$

(Total for Question 8 = 1 mark)

9 A ray of light is travelling through a material of refractive index 1.75. The ray is incident at the boundary with a material of refractive index 1.40, as shown.



Not to scale

Which of the following expressions gives the condition for total internal reflection?

☒ **A** $\theta > \sin^{-1}\left(\frac{1.40}{1.75}\right)$

☒ **B** $\theta > \sin^{-1}\left(\frac{1.75}{1.40}\right)$

☒ **C** $\theta < \sin^{-1}\left(\frac{1.40}{1.75}\right)$

☒ **D** $\theta < \sin^{-1}\left(\frac{1.75}{1.40}\right)$

(Total for Question 9 = 1 mark)

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

Which row of the table is correct?

	Pressure at rarefaction points	Displacement at compression points
☒ **A**	minimum	maximum
☒ **B**	maximum	zero
☒ **C**	maximum	maximum
☒ **D**	minimum	zero

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 There is a current of 1.25 A in a wire.

Calculate the drift velocity of the conduction electrons in the wire.

number of conduction electrons per $m^3 = 9.0 \times 10^{28}\,m^{-3}$
cross-sectional area of wire $= 2.7 \times 10^{-7}\,m^2$

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Drift velocity = ...

(Total for Question 11 = 2 marks)

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12 The filament in a lamp is a metal wire. A current in the filament causes heating.

Explain how the resistance of the filament changes as the temperature of the filament increases.

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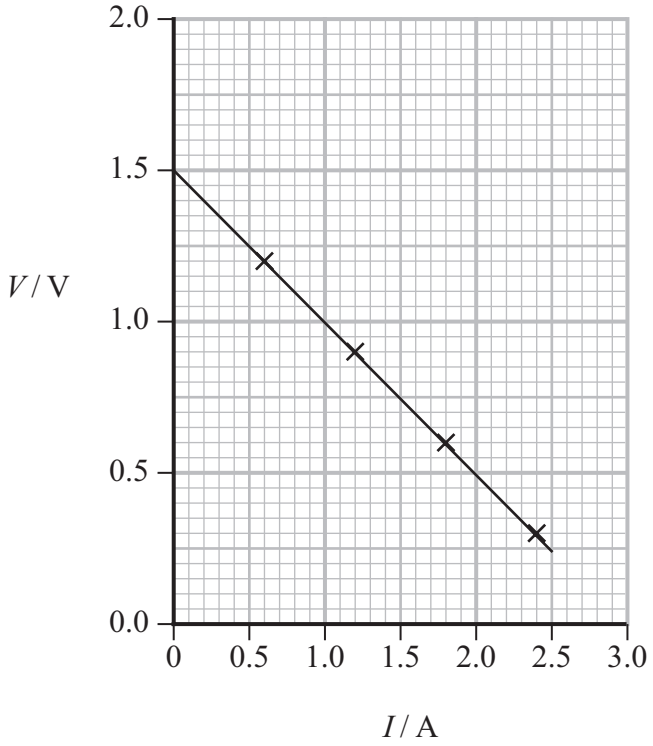
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(Total for Question 12 = 3 marks)

13 A student investigated how the potential difference V across a battery varied with current I in the battery.

The student plotted her results on a graph, as shown.



Determine the e.m.f. and internal resistance of the battery.

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e.m.f. = ...

Internal resistance = ...

(Total for Question 13 = 3 marks)

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14 An electron is accelerated from rest through a potential difference of 4.8 kV in a cathode ray tube.

(a) Show that the kinetic energy gained by the electron is about 7.7×10^{-16} J.

(2)

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(b) Calculate the de Broglie wavelength of the electron.

(3)

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de Broglie wavelength = ...

(Total for Question 14 = 5 marks)

15 The photograph shows a rear window heater in a car.



(Source: © narai chal/Shutterstock)

(a) (i) Each metal strip in the heater has a rectangular cross-section of width 1.64 mm and height 0.20 mm.

Show that the resistance of each metal strip is about 5 Ω.

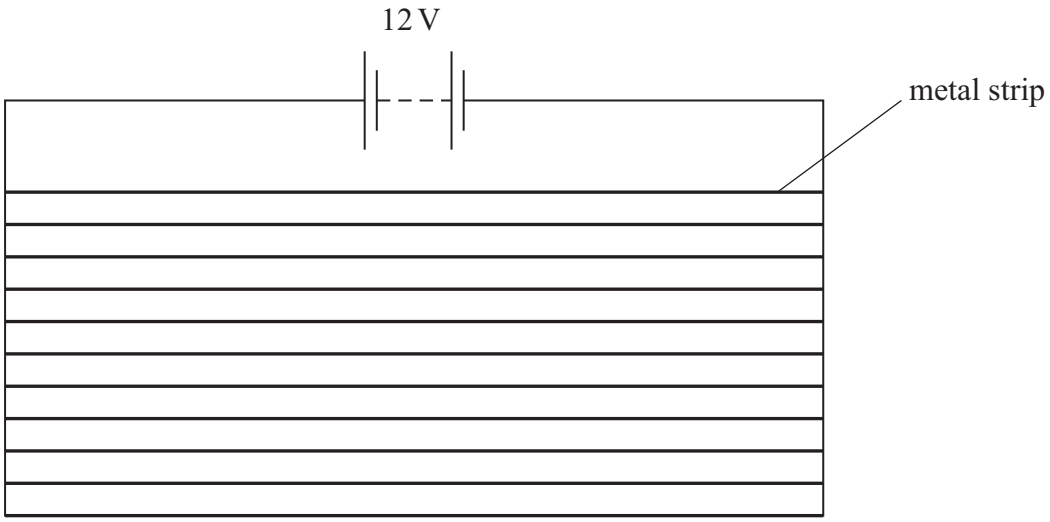
resistivity of metal in strip = 1.70×10^{-6} Ω m
length of metal strip = 0.95 m

(3)

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(ii) The heater has 11 identical metal strips connected in parallel, as shown.



Determine the total resistance of the metal strips.

(2)

Total resistance = ...

(iii) The potential difference across the heater is 12 V and the internal resistance is negligible.

Determine the current entering the heater.

(2)

Current = ...

(b) An alternative design is to connect the metal strips in series.

Explain why this would **not** result in the same power being dissipated by the heating circuit.

You do not need to include calculations in your answer.

(2)

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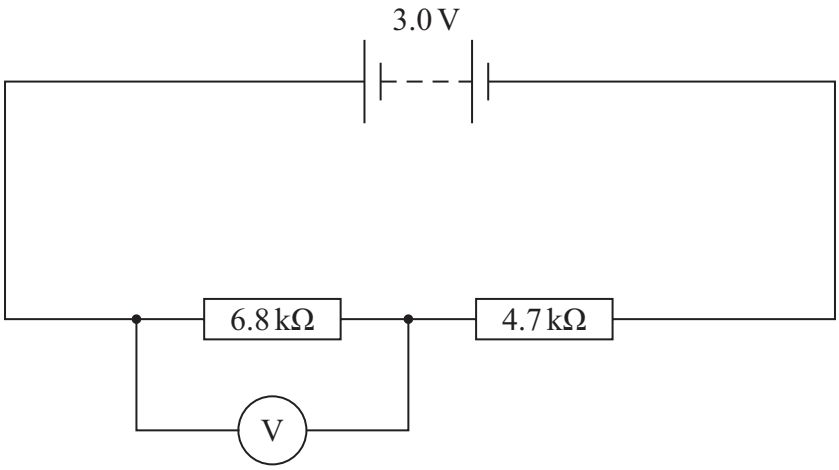
(Total for Question 15 = 9 marks)

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16 A student connects the circuit shown in the diagram.



(a) Determine the reading on the voltmeter.

(3)

Voltmeter reading = ...

(b) Determine the power dissipated by the circuit.

(2)

Power dissipated = ...

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(c) The student connects the battery to an ammeter and a motor.

There is a current of 2.5 A in the motor.

Calculate the energy transferred to the motor in 1.5 minutes.

(2)

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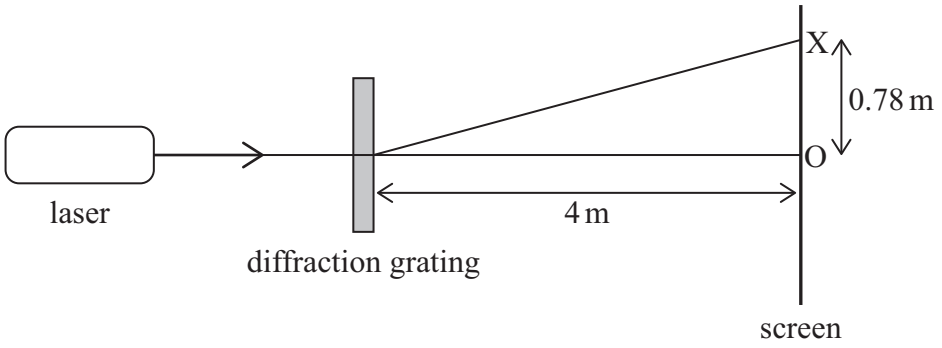
Energy transferred = ...

(Total for Question 16 = 7 marks)

17 A student directed light from a laser onto a diffraction grating.

The student saw a series of maxima on the screen.

The diagram shows the position of the central maximum at O and the first order maximum at X.



(a) Calculate the number of lines per mm on the diffraction grating.

wavelength of light from laser = 635 nm

(4)

Number of lines per mm = ...

(b) Explain why there is a maximum at X.

(3)

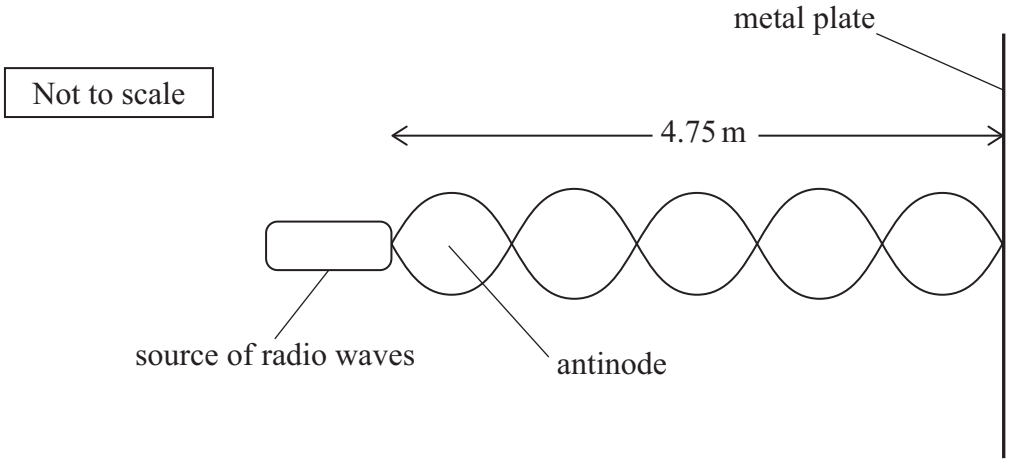
(Total for Question 17 = 7 marks)

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18 In 1886 Heinrich Hertz directed radio waves towards a metal plate. A standing wave with 5 antinodes was produced, as shown.



(a) Explain how the antinodes were formed.

(3)

(b) Determine a value for the speed of the radio waves in this experiment.

frequency of radio waves = 157 MHz

(3)

Speed of radio waves = ...

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(c) A teacher demonstrated the properties of radio waves. He used an aerial to detect the radio waves.

Initially, the aerial was vertical, and a maximum intensity of radio waves was detected. The teacher rotated the aerial by 90° so that it was horizontal.

He observed that when the aerial was horizontal, the radio waves were **not** detected.

Explain this observation.

(2)

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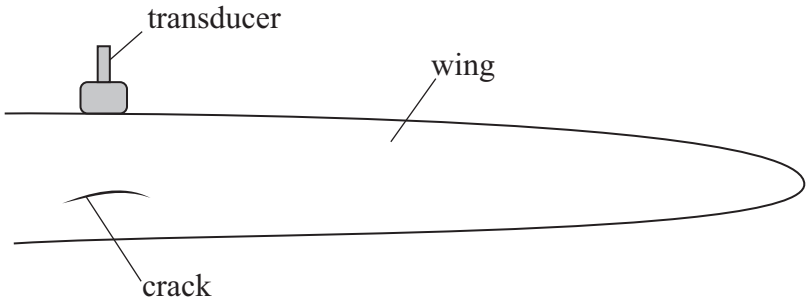
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(Total for Question 18 = 8 marks)

***19** Ultrasound can be used to detect cracks in the wing of an aeroplane, as shown.



A transducer that emits and receives ultrasound is used to scan the wing.

Explain how ultrasound can be used to determine the depth of a crack.

(Total for Question 19 = 6 marks)

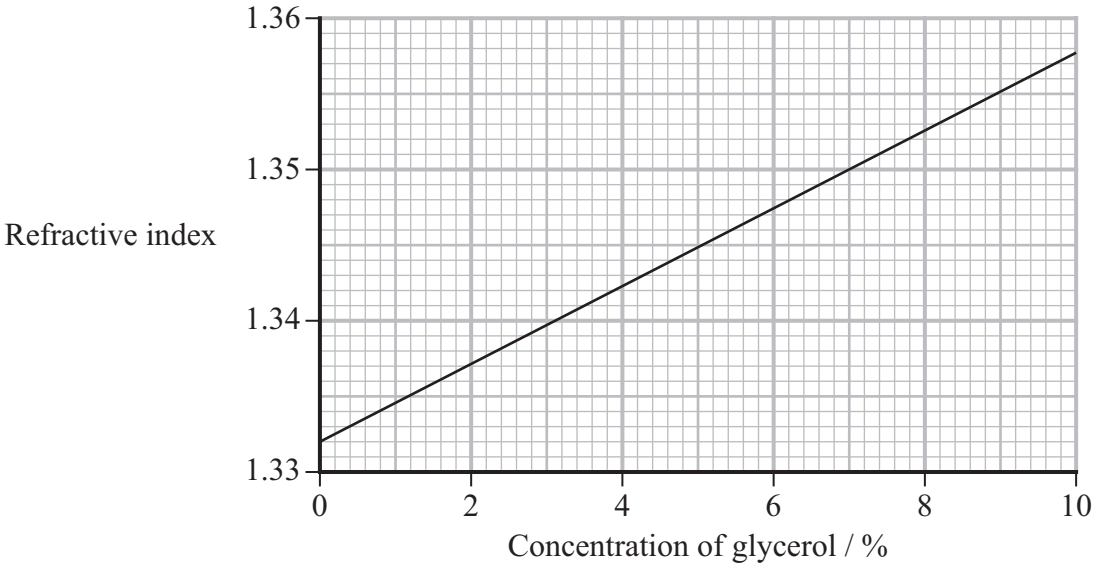
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20 A device called a refractometer can be used to determine the concentration of a solution of glycerol.

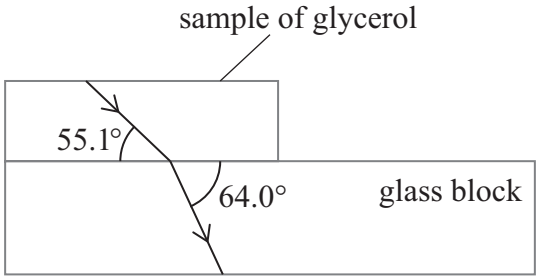
The graph shows the refractive index for different concentrations of glycerol.



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(a) In a refractometer, a ray of light is shone through a sample of glycerol and refracts at the surface of a glass block, as shown.



The refractive index of the glass block is 1.75

(i) Determine the speed of light in the glass block.

(2)

Speed of light = ...

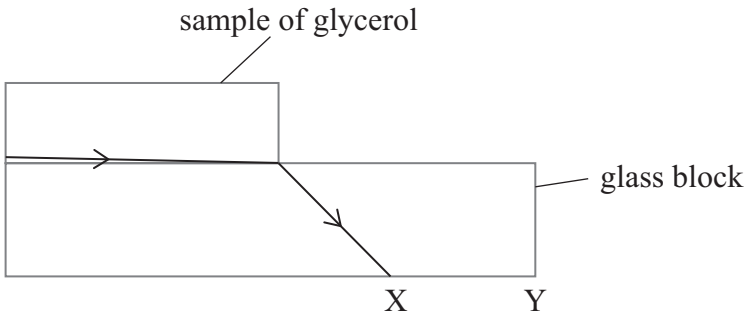
(ii) The table shows the concentration of different samples of glycerol.

Sample	Concentration / %
1	1.40
2	3.20
3	4.80

Deduce which sample is being tested in the refractometer.

(4)

(b) Light rays can be directed through the sample of glycerol at different angles of incidence. One ray of light is shown.



Explain why it is **not** possible for any light from the glycerol to reach the region between X and Y.

(2)

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(Total for Question 20 = 8 marks)

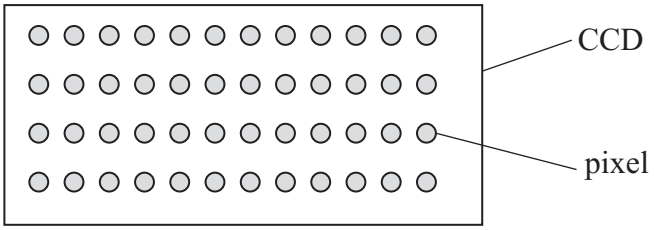
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21 A camera detects light using a charge-coupled device (CCD).

One CCD has an array of metal pixels, as shown. The pixels release electrons when exposed to ultraviolet (UV) light.



The pixels are exposed to UV light of wavelength 380 nm.

(a) (i) Show that the energy of a photon of this light is about 5.2×10^{-19} J.

(3)

(ii) The manufacturer states that about 80% of these photons incident on a pixel will cause the emission of an electron.

Deduce whether the manufacturer's statement is correct.

intensity of incident light = 1.1 μW m^{-2}
diameter of pixel = 1.2×10^{-5} m
number of electrons emitted by each pixel per second = 195

(5)

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(b) The threshold frequency of the metal in the pixels is equal to the frequency of green light.

The pixels were exposed to white light with the same intensity as the UV light. The UV light source was removed.

Explain how this changed the percentage of photons that released electrons.

(4)

(Total for Question 21 = 12 marks)

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

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81$ 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

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

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

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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 $F = 6\pi\eta r v$

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

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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