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Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Monday 31 October 2016 – Morning
Time: 1 hour 30 minutes

Paper Reference
WPH02/01

You do not need any other materials

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **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.*

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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

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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P 5 0 7 0 8 A 0 1 2 8

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 A voltmeter is used to measure the potential difference of a cell which is being used to light a bulb.

Choose the row that correctly describes the voltmeter's connection and resistance.

	Connected in	Resistance
☒ **A**	series with the cell	very low
☒ **B**	series with the cell	very high
☒ **C**	parallel with the cell	very low
☒ **D**	parallel with the cell	very high

(Total for Question 1 = 1 mark)

2 A current I flows through a wire of cross-sectional area A. The drift velocity of the charge carriers is v_x.

The wire is replaced by one of the same material but with cross-sectional area $\frac{A}{2}$ and the circuit is adjusted to keep the current unchanged. The drift velocity is now v_y.

The ratio $v_x : v_y$ is

☒ **A** 1 : 1

☒ **B** 1 : 2

☒ **C** 2 : 1

☒ **D** 1 : 4

(Total for Question 2 = 1 mark)

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3 A wave has a wavelength of 24 cm. Two points on the wave are $\frac{\pi}{2}$ radians out of phase.

The distance between these two points could be

☒ **A** 3 cm

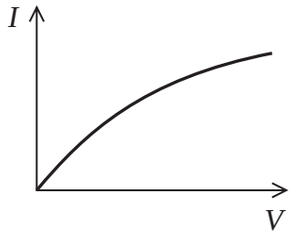
☒ **B** 12 cm

☒ **C** 30 cm

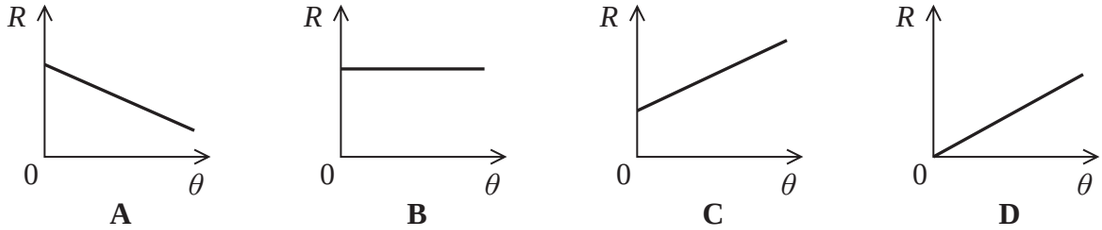
☒ **D** 36 cm

(Total for Question 3 = 1 mark)

4 The graph shows the current-voltage characteristic for a filament lamp.



Choose the graph that best shows how the resistance R of the lamp changes with temperature θ in °C.



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 4 = 1 mark)

5 The SI unit for charge may be expressed as

☒ **A** A Ω

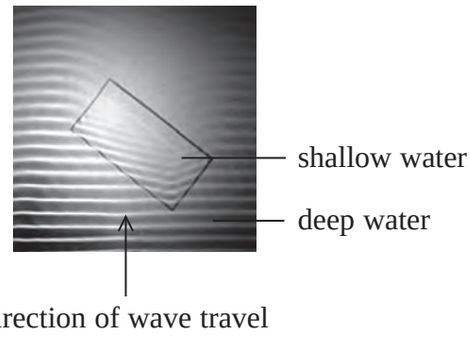
☒ **B** A s^{-1}

☒ **C** J V^{-1}

☒ **D** V Ω^{-1}

(Total for Question 5 = 1 mark)

6 The photograph shows water waves in a ripple tank, as they travel from deep water to shallow water.



It is observed that the waves are closer together as they move through the shallow water. This is because the waves in the shallow water

☒ **A** travel more slowly.

☒ **B** travel more quickly.

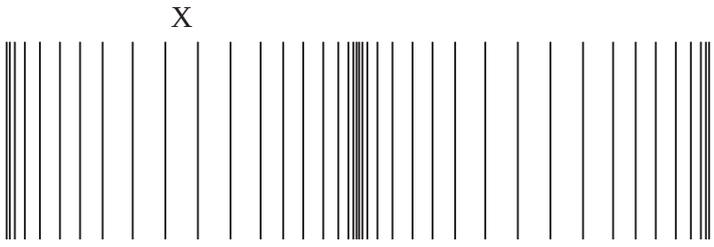
☒ **C** have a lower frequency.

☒ **D** have a higher frequency.

(Total for Question 6 = 1 mark)

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7 A sound wave has a time period *T*. The diagram shows the positions at time *t* of air layers which have been displaced by the passage of the wave. At this time there is a rarefaction at position X.



At time $t + \Delta t$ there is a compression at position X.

Δt may be equal to

☒ **A** $\frac{T}{4}$

☒ **B** $\frac{T}{2}$

☒ **C** $\frac{3T}{4}$

☒ **D** T

(Total for Question 7 = 1 mark)

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8 A source of sound is moving at a constant speed away from an observer.
Select the row of the table which correctly describes the amplitude and frequency of the sound heard by the observer compared to the emitted sound.

	Amplitude	Frequency
☒ **A**	smaller	smaller
☒ **B**	smaller	greater
☒ **C**	greater	smaller
☒ **D**	greater	greater

(Total for Question 8 = 1 mark)

9 Diffraction is the spreading of a wave after passing through a gap or around an obstacle.

Which of the following statements is correct?

☒ **A** Diffraction can be used to demonstrate the wave property of electrons.

☒ **B** Diffraction only occurs when the size of the gap is equal to the wavelength.

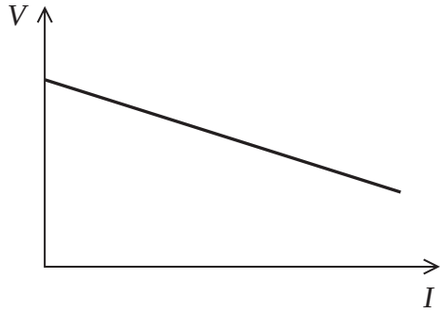
☒ **C** Microwaves show more significant diffraction around hills than radio waves.

☒ **D** Sound waves cannot be diffracted.

(Total for Question 9 = 1 mark)

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10 A student carries out an investigation to determine the e.m.f. $\mathcal{E}$ and internal resistance r of a cell. The potential difference V across the cell and the current I in the cell are measured as the load resistance is increased. The results are plotted on a graph.



Select the row of the table that correctly identifies how $\mathcal{E}$ and r are determined from the graph.

	$\mathcal{E}$ **determined from**	r **determined from**
☒ **A**	area under graph	$\frac{1}{\text{magnitude of gradient}}$
☒ **B**	y-intercept	$\frac{1}{\text{magnitude of gradient}}$
☒ **C**	area under graph	magnitude of gradient
☒ **D**	y-intercept	magnitude of gradient

(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 technician uses a length of constantan wire to make a resistor of resistance 6.0 Ω. The wire has a diameter of 0.23 mm.

Calculate the length of the wire.

resistivity of constantan = 4.9×10^{-7} Ω m

Length = ...

(Total for Question 11 = 3 marks)

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12 Polarising sunglasses are designed to reduce glare.

(a) State what is meant by polarised light.

(2)

(b) A student is viewing the screen of an electronic device through polarising sunglasses. When viewing the screen in landscape mode the screen looks bright. He gradually rotates the device through 90° into portrait mode. He notices that the screen becomes gradually darker until, in portrait mode, the screen is completely dark.

Explain these observations.

(4)

(Total for Question 12 = 6 marks)

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***13** A hydrogen discharge tube contains hydrogen gas at a low pressure.



A high potential difference is applied across the tube and a spectrometer can be used to produce a visible line spectrum, as shown below.



Explain how line spectra are formed.

(Total for Question 13 = 5 marks)

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14 During a demonstration ultraviolet radiation is shone onto a zinc plate. When the frequency of the radiation is greater than a certain value f_0 the zinc plate becomes positively charged.

(a) Explain why the zinc plate becomes positively charged when the frequency of the radiation is greater than f_0.

(3)

(b) Ultraviolet radiation of a frequency greater than f_0 is shone onto the zinc plate. The intensity of the radiation is increased and the magnitude of the positive charge on the plate increases at a greater rate.

Explain why.

(2)

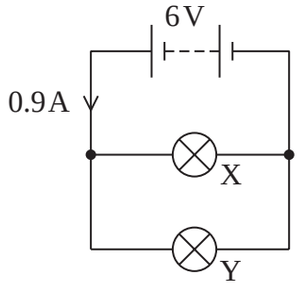
(c) Suggest a potential risk with performing this demonstration in a school laboratory.

(1)

(Total for Question 14 = 6 marks)

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15 The circuit shows how two bulbs, X and Y, may be connected in parallel with a 6 V battery.



The resistance of bulb X is R_X and the resistance of bulb Y is R_Y where

$$R_X = 2R_Y$$

(a) Calculate R_X and R_Y.

(3)

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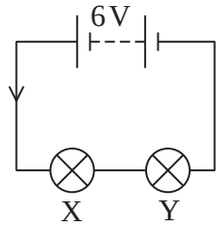
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R_X = ...

R_Y = ...

(b) X and Y may be connected in series as shown below.



Calculate the current in the series circuit if the resistances of the lamps are the same as in part (a).

(2)

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Current = ...

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(c) In the parallel circuit it is observed that one bulb is brighter than the other.
A student suggests "bulb X will be brighter because it has a higher resistance and so more energy is dissipated".

Explain why the student's suggestion is incorrect.

(2)

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(Total for Question 15 = 7 marks)

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16 Solar lights can be used to illuminate garden pathways during the night. The lights use solar cells that generate electricity during the day to charge a battery. At night the charged battery is used to power a bulb consisting of a light emitting diode (LED).



A solar cell is made up of a semiconductor that produces an electric current when light is incident on it.

(a) Radiation from the Sun is incident on a solar cell. In order for the solar cell to generate electricity photons with a minimum energy of 2.2 eV are required.

Calculate the maximum wavelength of light required.

(3)

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Maximum wavelength = ...

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(b) The solar cell has an efficiency of 25%. With the battery initially uncharged, the solar cell is illuminated for 8.0 hours with an average radiation flux of 1300 W m^{-2}. The following night the battery is used to operate the LED bulb.

Calculate the maximum time in hours for which the LED bulb can be operated.

power of LED bulb = 1.5 W
area of solar cell = 3.6×10^{-3} m^2

(4)

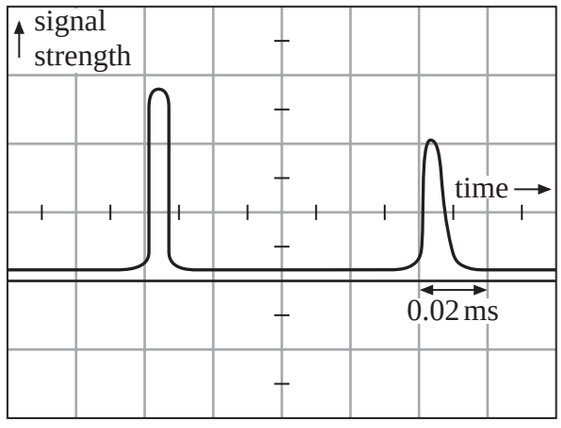
Maximum time = ... hours

(Total for Question 16 = 7 marks)

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17 Ultrasound may be used to scan organs of the body and to determine the speed of the blood.

(a) An ultrasound pulse is used to measure the size of the heart. Two reflected pulses are received at the ultrasound transducer, one from the front surface of the heart and one from the rear surface. An oscilloscope trace of these pulses is shown.



(i) Calculate the distance from the front surface of the heart to the rear surface of the heart.

speed of ultrasound in the heart = 1500 m s^{-1}

(3)

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Distance = ...

(ii) State two reasons why the amplitude of the second pulse is less than the amplitude of the first pulse.

(2)

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(b) Ultrasound can also be used to measure the speed of the blood using the Doppler effect.

State the measurements that need to be made to determine the speed of the blood.

(1)

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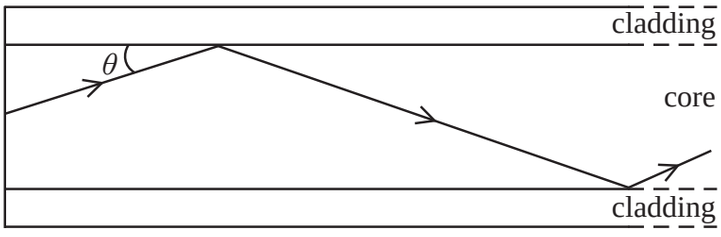
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(Total for Question 17 = 6 marks)

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18 Optical fibres are used in communication systems.

A typical fibre consists of a glass core surrounded by glass of a different refractive index as a cladding. The diagram shows a light ray being transmitted along the fibre.



(a) State why the refractive index of the cladding must be less than the refractive index of the core in an optical fibre.

(1)

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(b) Calculate the maximum value for the angle labelled θ to ensure maximum energy transfer of a light ray along the fibre.

refractive index for light travelling from core to cladding = 0.99

(3)

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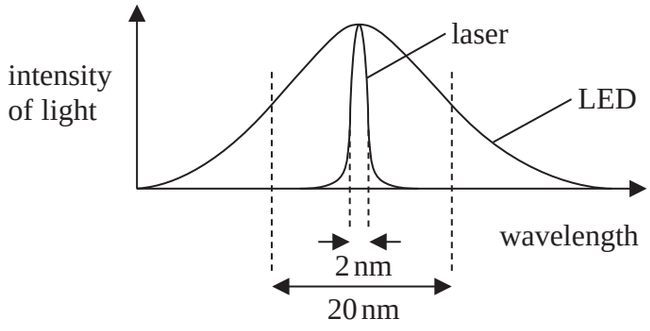
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θ = ...

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(c) A laser or a light emitting diode (LED) may both be used to produce pulses of light to transmit along the fibre. The graph shows the intensity of light over a range of wavelengths produced by a laser and by an LED.



Light of different wavelengths will travel at different speeds along the fibre.
Use the graph to compare lasers and LEDs as light sources for a communication system.

(3)

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(Total for Question 18 = 7 marks)

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19 A tuning fork is used to produce a sound of a single frequency. The tuning fork consists of two metal prongs joined at one end. When the fork is struck against a surface the prongs vibrate and a note is audible when the fork is held close to the ear.



(a) Explain how a sound wave travels through the air.

(3)

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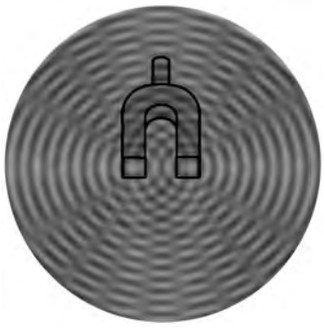
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(b) A student holds a vibrating tuning fork gently against the surface of a bowl of water. A pattern of waves on the water is observed.



*(i) Explain the pattern of waves observed.

(4)

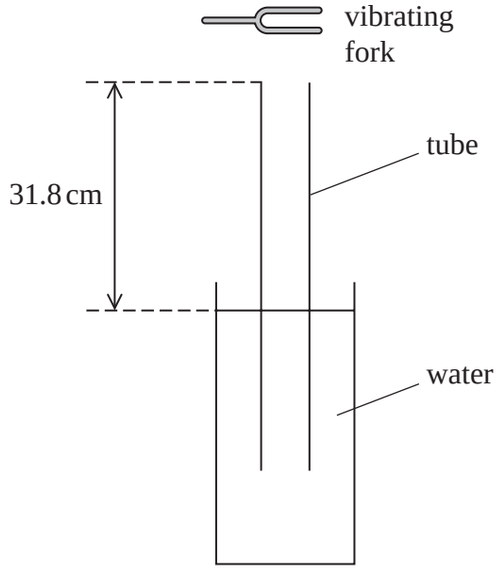
(ii) The demonstration is repeated with a different tuning fork. Its prongs are the same distance apart, but it produces a sound of a lower frequency.

State the difference that would be observed.

(1)

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(c) The frequency of the sound produced from a tuning fork can be determined using standing waves.
A tube, open at both ends, is held vertically and placed with one end in water as shown.



A vibrating fork is held above the other end and the tube is moved slowly upwards in the water. At a particular position the sound is loudest. When this occurs, there is one node and one antinode. The node is at the surface of the water and the antinode is at the top of the tube.

(i) The distance from the top of the tube to the surface of the water is measured to be 31.8 cm.

Determine a value for the frequency of the vibrations of the tuning fork.

speed of sound in air = 330 m s^{-1}

(3)

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Frequency = ...

(ii) Suggest why the calculated value for frequency in this procedure may be greater than the true value.

(1)

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(Total for Question 19 = 12 marks)

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20 A student is investigating how the resistance of a thermistor varies with temperature.
The student heats distilled water in a beaker and puts the thermistor in the hot water. She connects a multimeter directly across the thermistor and uses it to measure resistance.
She uses a thermometer to measure the temperature of the water.



The student records corresponding values of temperature and resistance as the water cools.

Temperature of water / °C	Resistance of thermistor / Ω
80.0	118
70.0	145
60.0	180
50.0	235
40.0	317
30.0	457
20.0	603

(a) (i) The student suggests that the resistance of the leads to the multimeter will cause an error in the results. She measures the total resistance of the leads to be 1.8 Ω.
Discuss her suggestion.

(2)

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(ii) State two advantages of using a data logger with suitable probes to measure the resistance and temperature.

(2)

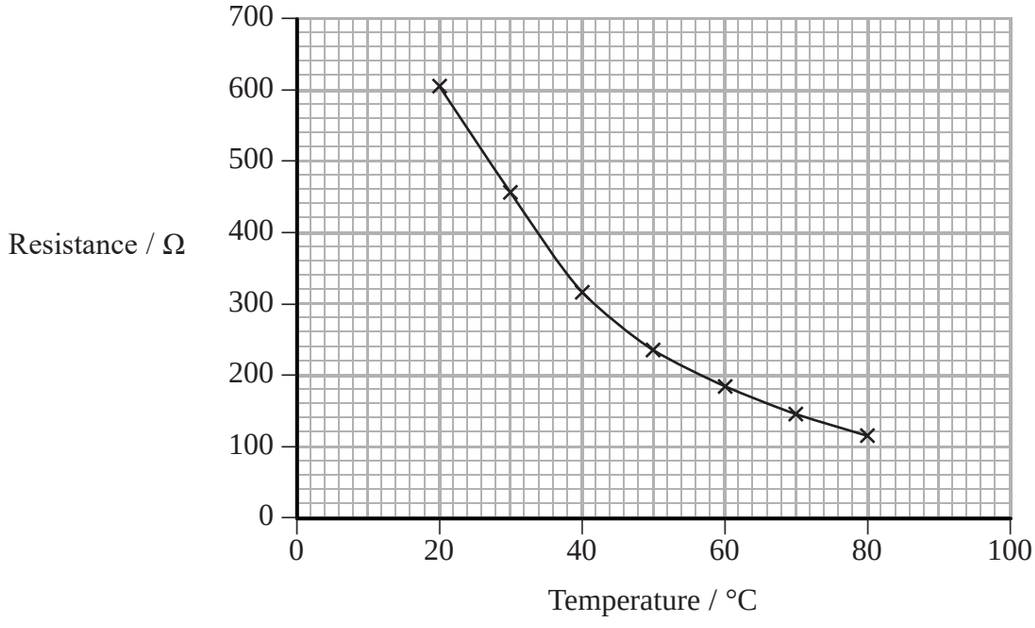
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(b) The student plots the results on a graph.



(i) Explain, in terms of charge carriers, why these results are obtained.

(3)

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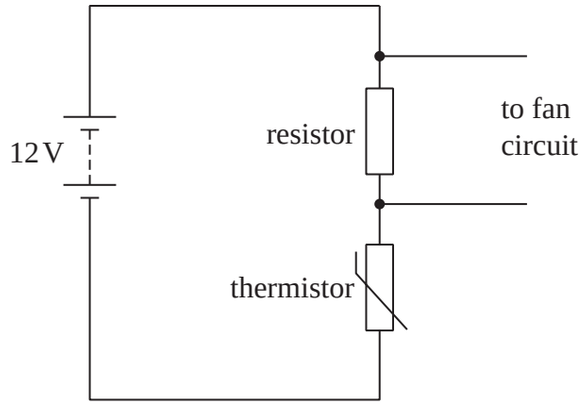
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(ii) The student designs the circuit shown, that uses this thermistor to switch on a fan when the temperature is above 24 °C. The fan switches on when the potential difference across the fan circuit is at least 4.5 V.



Calculate the resistance of the resistor.

(4)

Resistance of the resistor = ...

(Total for Question 20 = 11 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	$g = 9.81\ \text{m s}^{-2}$	(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

$$v = u + at$$
$$s = ut + \tfrac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$
$$g = F/m$$
$$W = mg$$

Work and energy

$$\Delta W = F\Delta s$$
$$E_k = \tfrac{1}{2}mv^2$$
$$\Delta E_{grav} = mg\Delta h$$

Materials

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

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

Density $\rho = m/V$

Pressure $p = F/A$

Young modulus $E = \sigma/\varepsilon$ where
Stress $\sigma = F/A$
Strain $\varepsilon = \Delta x/x$

Elastic strain energy $E_{el} = \tfrac{1}{2}F\Delta x$

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Unit 2

Waves

Wave speed	$v = f\lambda$
Refractive index	${}_1\mu_2 = \sin i / \sin r = v_1/v_2$

Electricity

Potential difference	$V = W/Q$
Resistance	$R = V/I$
Electrical power, energy and efficiency	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$

$$\% \text{ efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$$

$$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{total power input}} \times 100$$

Resistivity	$R = \rho l/A$
Current	$I = \Delta Q/\Delta t$ $I = nqvA$
Resistors in series	$R = R_1 + R_2 + R_3$
Resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Quantum physics

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2}mv^2_{max}$

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