Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Friday 17 May 2019

Morning (Time: 1 hour 30 minutes) | Paper Reference **WPH02/01**

Physics

Advanced Subsidiary
Unit 2: Physics at Work

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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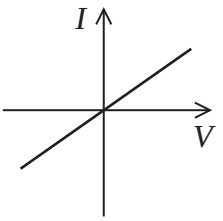
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SECTION A

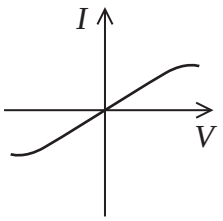
Answer ALL questions.

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 ☒.

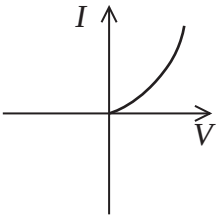
1 Which of the following graphs shows how current *I* varies with potential difference *V* for a negative temperature coefficient thermistor?



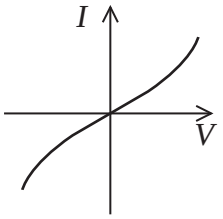
☒ **A**



☒ **B**



☒ **C**



☒ **D**

(Total for Question 1 = 1 mark)

2 Which of the following processes makes use of microwaves?

☒ **A** connecting a mobile phone network

☒ **B** imaging a broken bone within a human body

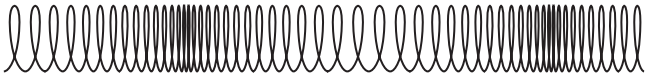
☒ **C** sterilising hospital equipment

☒ **D** testing a person's eyesight for short sight

(Total for Question 2 = 1 mark)

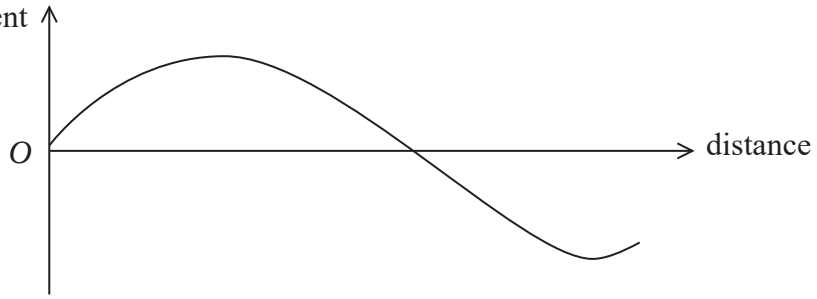
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3 The diagram shows waves passing along a section of a spring at a particular time.

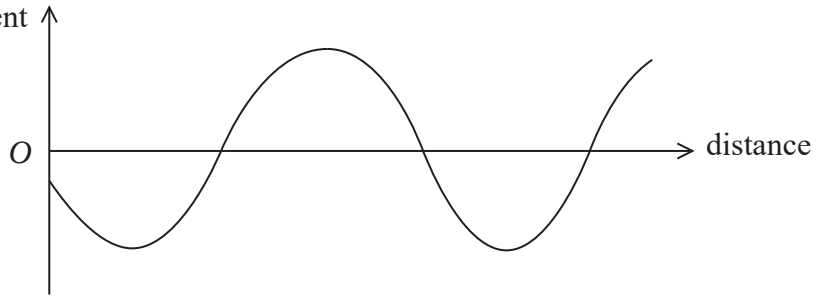


Which of the following graphs of displacement against distance along this section of the spring, at this particular time, is correct?

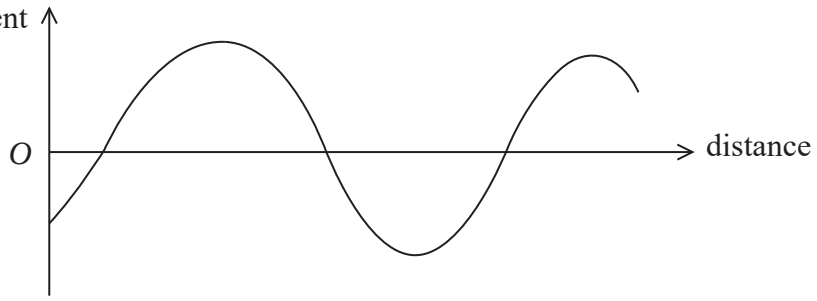
☒ **A**



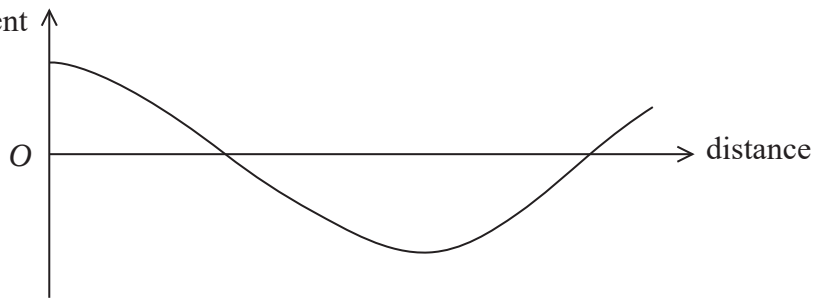
☒ **B**



☒ **C**



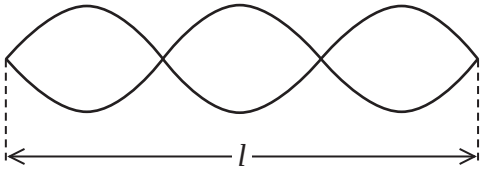
☒ **D**



(Total for Question 3 = 1 mark)

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4 A standing wave is set up on a string of length l as shown.



Which of the following gives the wavelength λ of the waves on the string?

☒ **A** $\lambda = \frac{l}{3}$

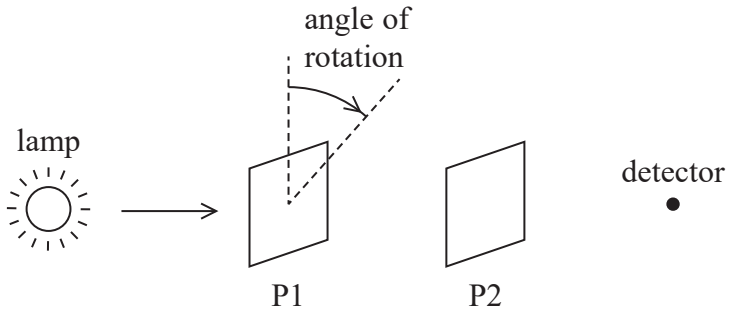
☒ **B** $\lambda = \frac{2l}{3}$

☒ **C** $\lambda = \frac{3l}{2}$

☒ **D** $\lambda = 3l$

(Total for Question 4 = 1 mark)

5 Light from a lamp passes through two polarising filters, P1 and P2, before reaching a detector. Each filter can be rotated through an angle as shown.



The filters initially have their planes of polarisation perpendicular to each other.

The intensity of light at the detector will be greatest if

☒ **A** P1 is rotated by 45° and P2 is rotated by 315° in the same direction.

☒ **B** P1 is rotated by 90° and P2 is rotated by 270° in the same direction.

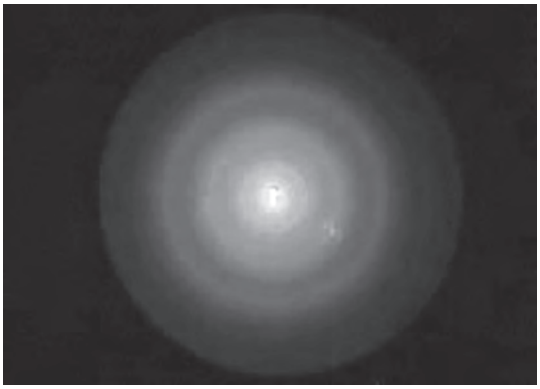
☒ **C** P1 is rotated by 45° and P2 is rotated by 270° in the same direction.

☒ **D** P1 is rotated by 90° and P2 is rotated by 315° in the same direction.

(Total for Question 5 = 1 mark)

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6 A beam of electrons is directed at a graphite crystal. After passing through the crystal, the beam is incident on a fluorescent screen where each incident electron produces light. The photograph shows the pattern observed on the screen.



Which of the following gives two properties of electrons which help to explain the production of this pattern?

☒ **A** diffraction and refraction

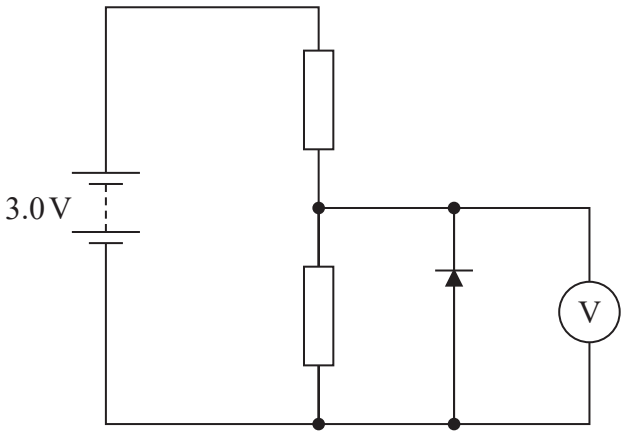
☒ **B** diffraction and superposition

☒ **C** polarisation and refraction

☒ **D** polarisation and superposition

(Total for Question 6 = 1 mark)

7 The following circuit contains two resistors of equal resistance and a diode.



What is the reading on the digital voltmeter?

☒ **A** 0 V

☒ **B** 0.7 V

☒ **C** 1.5 V

☒ **D** 3.0 V

(Total for Question 7 = 1 mark)

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8 A conductor of cross-sectional area A carries a current I. The speed of the charge carriers is v.

A second conductor, made of the same material, has a cross-sectional area $2A$ and carries a current $2I$.

What is the speed of the charge carriers in the second conductor?

☒ **A** $\frac{v}{4}$

☒ **B** v

☒ **C** $2v$

☒ **D** $4v$

(Total for Question 8 = 1 mark)

9 Which of the following are the base units for the Planck constant?

☒ **A** kg m s^{-2}

☒ **B** kg m^2 s^{-1}

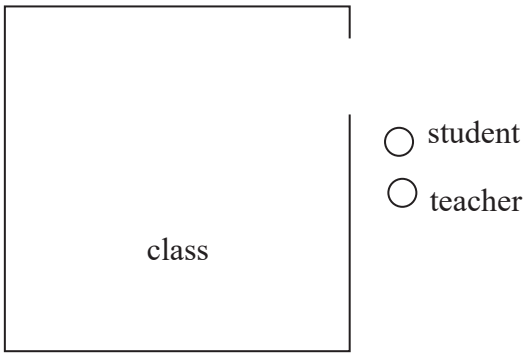
☒ **C** kg m^2 s^{-2}

☒ **D** kg m^2 s^{-3}

(Total for Question 9 = 1 mark)

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10 A teacher is talking to a student outside a classroom. Although they are out of sight from the rest of the class the door is left open. The rest of the class can hear the conversation between the teacher and the student clearly.



Which of the following properties of waves explains this?

☒ **A** diffraction

☒ **B** polarisation

☒ **C** refraction

☒ **D** superposition

(Total for Question 10 = 1 mark)

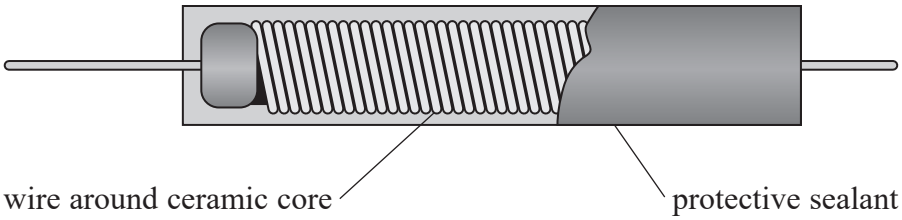
TOTAL FOR SECTION A = 10 MARKS

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SECTION B

Answer ALL questions in the spaces provided.

11 Wire wound resistors are made by coiling a length of wire around a ceramic core and then coating the arrangement in a protective sealant as shown.



(a) Show that the resistance of a 1.40 m length of nichrome wire of diameter 0.0500 mm is about 1100 Ω.

resistivity of nichrome = 1.50×10^{-6} Ω m

(3)

(b) A wire wound resistor is required with a value of resistance as close as possible to 1100 Ω. This can be achieved by using a nichrome wire with any value of diameter and then cutting the corresponding length of wire.

Explain how a greater accuracy of resistance value could be obtained using a different combination of length and diameter from those given in (a).

(2)

(Total for Question 11 = 5 marks)

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12 Einstein won a Nobel Prize for explaining the photoelectric effect using a photon model for light.

(a) State two observations of the photoelectric effect that can only be explained using the photon model for light.

(2)

(b) Ultraviolet (UV) light is shone onto a clean piece of zinc and photoelectrons are emitted.

Calculate the maximum velocity of the photoelectrons.

work function of zinc = 4.3 eV
wavelength of UV light = 1.2×10^{-7} m

(4)

Maximum velocity = ...

(Total for Question 12 = 6 marks)

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13 The efficiency of different types of solar panel used to generate electricity varies widely. A solar panel was connected to a resistor and placed in sunlight. The following data was collected:

radiation flux of sunlight = 800 W m^{-2}
potential difference across resistor = 29 V
current through resistor = 7.3 A
dimensions of solar panel = 1.6 m × 0.95 m

(a) Calculate the efficiency of the solar panel when transferring light energy to electrical energy in this resistor.

(4)

Efficiency = ...

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(b) The solar panel was disconnected from the resistor.
A digital voltmeter was connected across the solar panel and the e.m.f. was measured as 55 V.

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

(1)

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(ii) Calculate the internal resistance of the solar panel.

(3)

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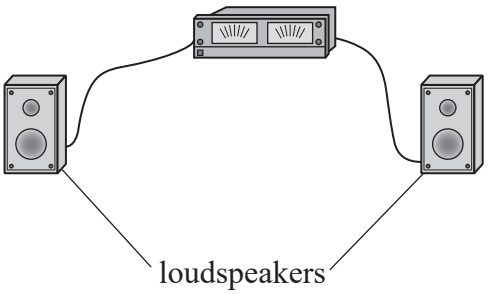
Internal resistance = ...

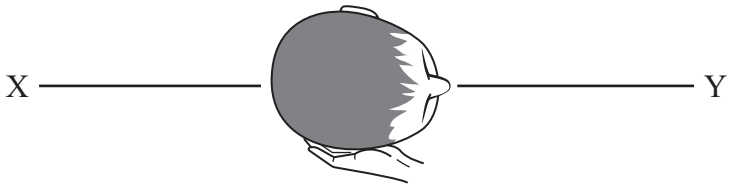
(Total for Question 13 = 8 marks)

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14 A student was setting up audio equipment in a large hall. He positioned two identical loudspeakers a few metres apart and played a note of frequency 300 Hz through the loudspeakers.

When the 300 Hz note was playing the student noticed that the loudness varied at different positions within the hall. The student covered one ear and walked along a line XY, a few metres away from the loudspeakers, as shown.





As the student walked from X to Y he heard alternate areas of loud and quiet sound.

*(a) Explain this observation.

(6)

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(b) The loudspeakers were then connected to separate sources, which were both set to approximately the same frequency. The student stood in a fixed position. He noticed that sometimes there were louder sounds and then quieter sounds.

Explain this observation.

(2)

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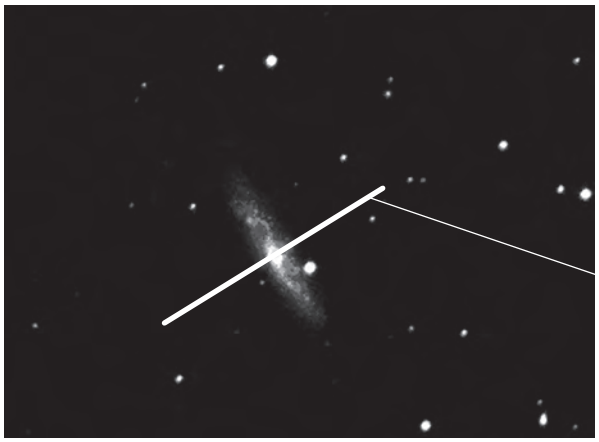
(Total for Question 14 = 8 marks)

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15 The photograph shows a typical side-on view of a galaxy. The galaxy is rotating around an axis through its centre.



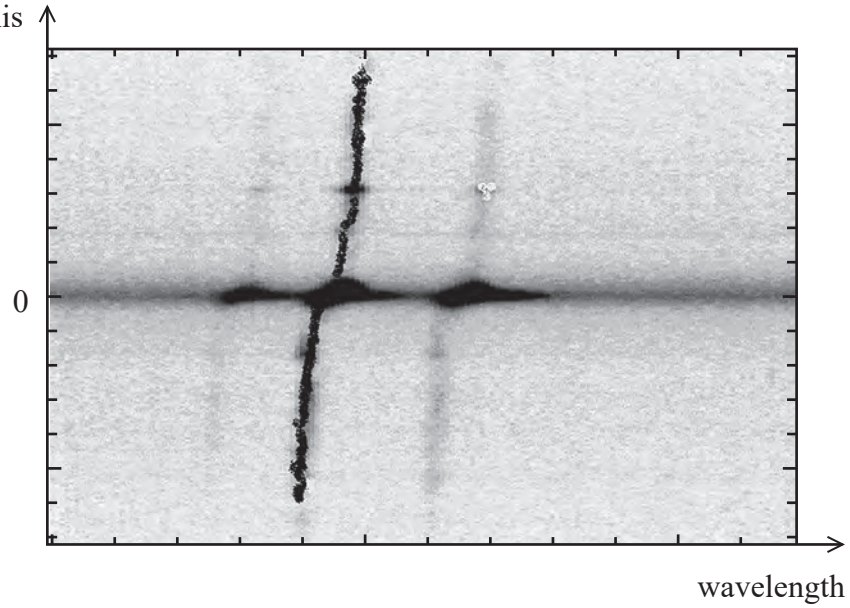
The light observed from the galaxy includes an atomic line spectrum for hydrogen.

*(a) Explain how an atomic line spectrum is formed.

(5)

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(b) It was found that the wavelength of one line of the spectrum depended on the distance of the source of light from the axis of rotation of the galaxy. The photograph below shows how the distance from the axis affects the wavelength of this line.



Explain why the wavelength corresponding to the top of the line is greater than the wavelength corresponding to the bottom of the line.

(3)

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(Total for Question 15 = 8 marks)

(images taken from http://spiff.rit.edu/classes/phys301/lectures/doppler/doppler.html#rotgal)

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16 Driverless cars are fitted with sensors to "map out" their surroundings so that they can navigate. A transducer on the car emits a pulse of laser light. The laser light is reflected from nearby objects and is received by the transducer.

(a) State the factors that determine the fraction of the laser light which is reflected from a nearby object and received by the transducer.

(3)

(b) The duration of the pulse of laser light is 5.0 ns.

Determine whether this allows objects as close as 1.0 m from the car to be detected.

(3)

(c) Ultrasound would also be reflected from the objects around the car.
However, ultrasound travels at a much slower speed than laser light.

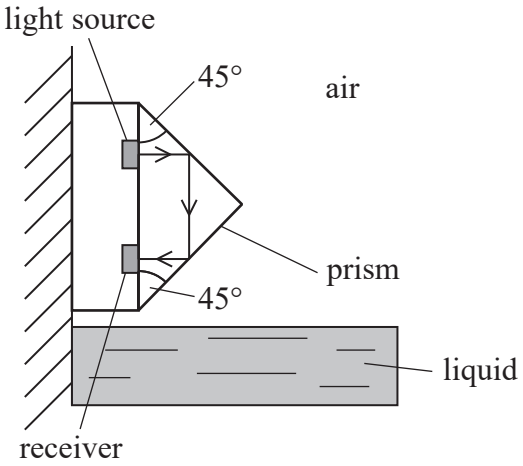
Suggest why the laser light could not be replaced with ultrasound in a driverless car.

(2)

(Total for Question 16 = 8 marks)

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17 A liquid level sensor uses a plastic prism, a light source and a receiver.



When the liquid is below the level of the prism the light totally internally reflects to the receiver as shown.

(a) Describe the conditions required for total internal reflection.

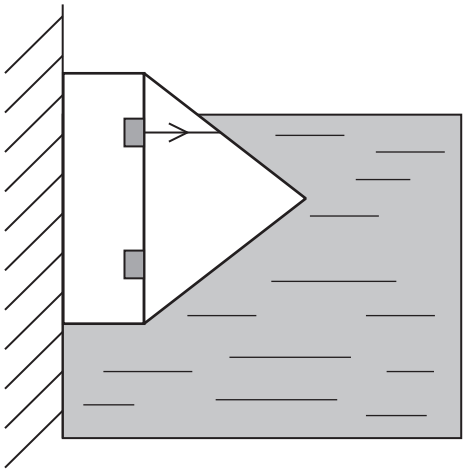
(2)

(b) The critical angle for light travelling from plastic to air is 42°.
Explain why the light reaches the receiver.

(3)

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(c) When the liquid surrounds most of the prism the light does not reach the receiver.



(i) Calculate the critical angle for light travelling from the plastic prism into the liquid.

velocity of light in plastic = 2.0×10^8 m s^{-1}
velocity of light in liquid = 2.3×10^8 m s^{-1}

(3)

Critical angle = ...

(ii) Sketch the path of the ray of light at the plastic-liquid interface on the diagram above.

(2)

(d) A storage tank may be used to store waste water for a house. Such a tank is usually located underground. If the storage tank becomes full, waste water can leak into the surrounding ground and pollute drinking water.

Suggest how the liquid level sensor could help prevent this problem.

(2)

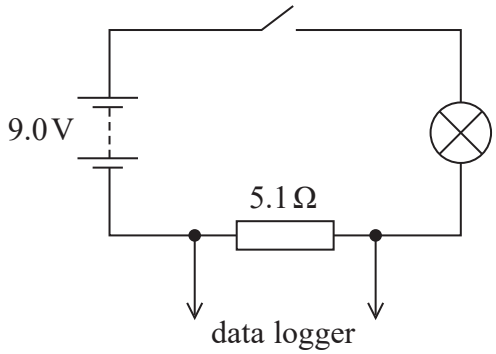
(Total for Question 17 = 12 marks)

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18 The following circuit was used to investigate how the current through a filament lamp varied with time, from the moment the switch was closed.

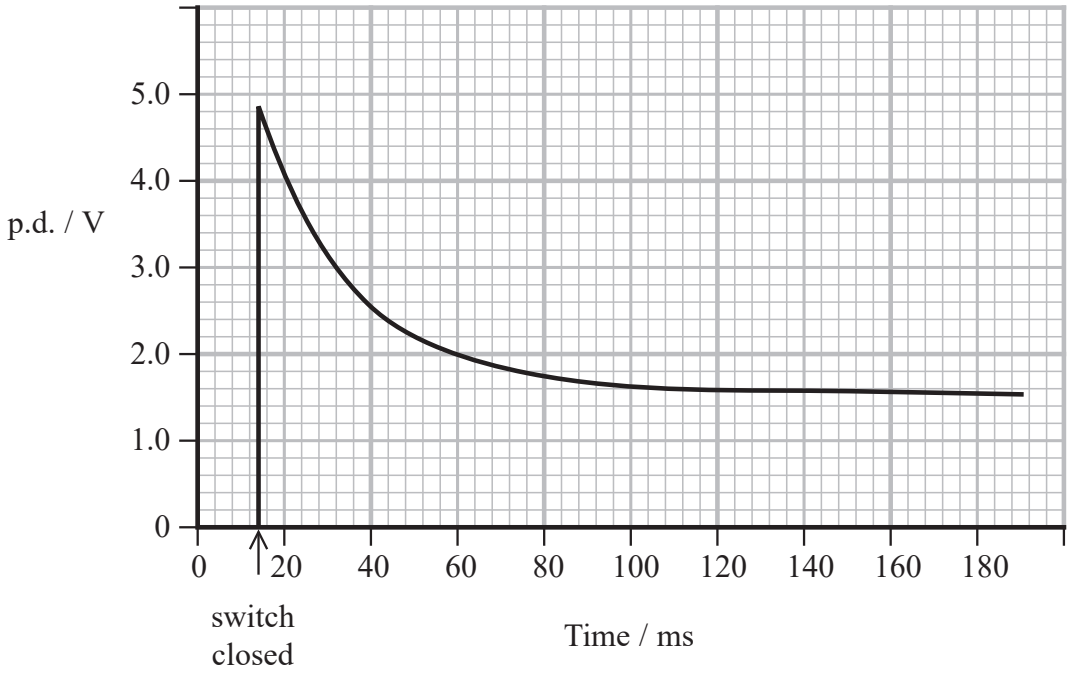


(a) Explain how an increase in temperature affects the resistance of a filament lamp.

(4)

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(b) The graph below shows the variation of potential difference (p.d.) across the 5.1 Ω resistor with time. The time at which the switch was closed is marked with an arrow.



(i) Explain why the shape of this graph also represents the variation of current through the filament lamp.

(2)

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(ii) Calculate the resistance of the filament lamp at the moment the switch is closed.

(3)

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Resistance = ...

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(iii) Calculate the rate of transfer of energy by the 5.1 Ω resistor immediately after the switch is closed.

(2)

Rate of transfer of energy = ...

(iv) Explain why it is reasonable to assume that this filament lamp reached a constant temperature after 180 ms.

(2)

(v) Explain why a data logger was used for this investigation.

(2)

(Total for Question 18 = 15 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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\%\ \text{efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100$
	$\%\ \text{efficiency} = \dfrac{\text{useful power output}}{\text{total power input}} \times 100$
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	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

Quantum physics

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

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