Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Thursday 9 June 2016 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6PH02/01

You must have:
Ruler, protractor

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.
- Keep an eye on the time.
- 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 used for detecting security markings on property?

☒ **A** infrared

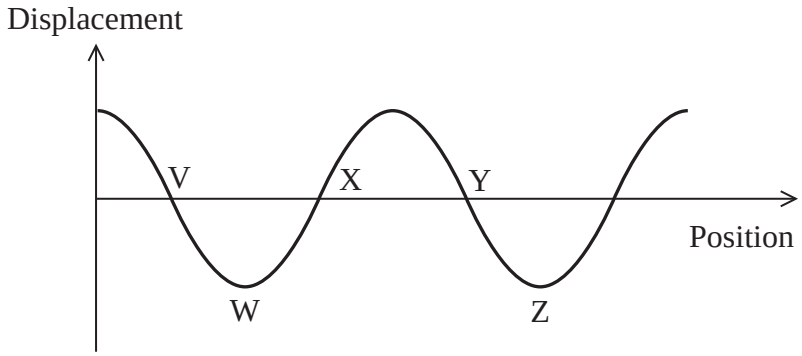
☒ **B** radio

☒ **C** ultrasound

☒ **D** ultraviolet

(Total for Question 1 = 1 mark)

2 The graph shows displacement against position for the particles in a sound wave at a particular instant.



Which of the following could show the positions of a pair of particles moving in the same direction at that instant?

☒ **A** V and W

☒ **B** V and Y

☒ **C** W and Z

☒ **D** X and Y

(Total for Question 2 = 1 mark)

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3 Which of the following SI units is equivalent to the volt?

☒ **A** ampere per ohm

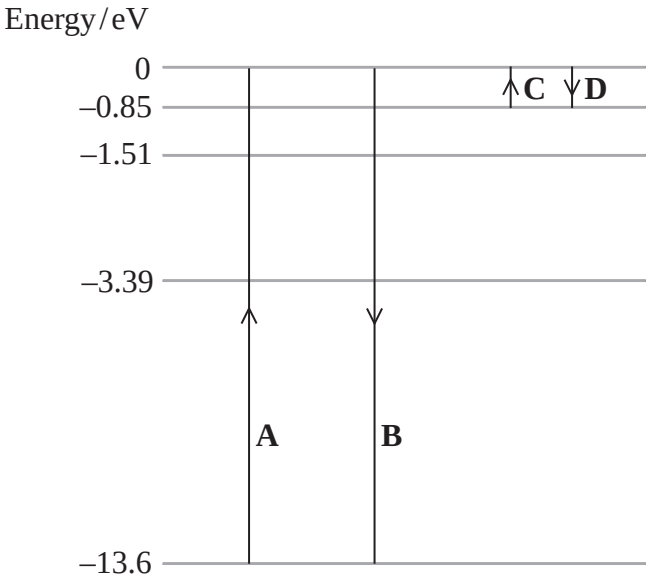
☒ **B** coulomb per second

☒ **C** joule per coulomb

☒ **D** joule per second

(Total for Question 3 = 1 mark)

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



Which arrowed line, A, B, C or D, shows the transition of an electron that corresponds to the absorption of light with the shortest wavelength?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 4 = 1 mark)

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5 A potential difference of 600 mV is applied across a circuit component.
What is the energy transferred when a charge of 2 C flows through the component?

☒ **A** 1200 J

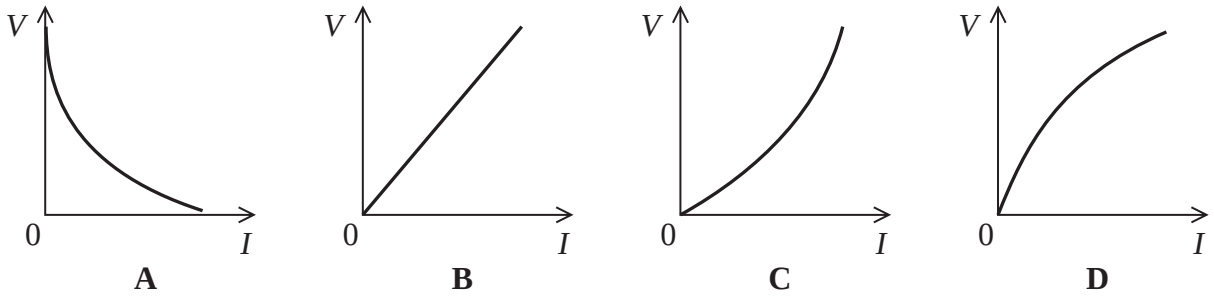
☒ **B** 300 J

☒ **C** 1.33 J

☒ **D** 1.2 J

(Total for Question 5 = 1 mark)

6 Which of the following graphs of potential difference *V* against current *I* correctly shows the behaviour of a filament lamp?



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 6 = 1 mark)

7 A rechargeable cell carries the marking 150 milliamp hours.
What charge does this correspond to?

☒ **A** 9 C

☒ **B** 540 C

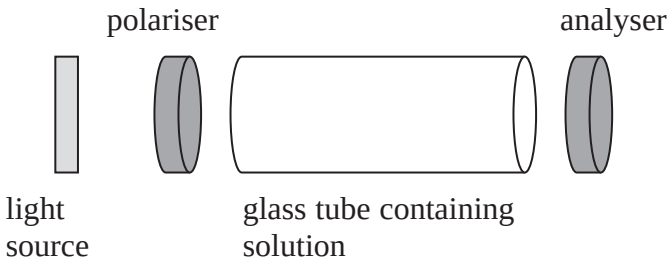
☒ **C** 9000 C

☒ **D** 540 000 C

(Total for Question 7 = 1 mark)

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8 Polarimeters are used to measure the degree of rotation of the plane of polarisation by solutions.
The diagram represents the parts of a polarimeter. The polariser and analyser are both polarising filters.



An experiment led to the conclusion that the solution had rotated the plane of polarisation of the light by 35°.

Which of the following rotations of the plane of polarisation could also have been a correct conclusion?

☒ **A** 55°

☒ **B** 125°

☒ **C** 215°

☒ **D** 305°

(Total for Question 8 = 1 mark)

9 Which of the following terms corresponds to the time taken for a complete wave to pass a point?

☒ **A** frequency

☒ **B** period

☒ **C** wavelength

☒ **D** wave speed

(Total for Question 9 = 1 mark)

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10 A sample of material has charge carrier density n and cross-sectional area A. When the current through the sample is I the drift velocity is v.

Another sample of the same material has double the cross-sectional area and the current through it is $2I$. What is the drift velocity?

☒ **A** $v / 2$

☒ **B** v

☒ **C** $2v$

☒ **D** $4v$

(Total for Question 10 = 1 mark)

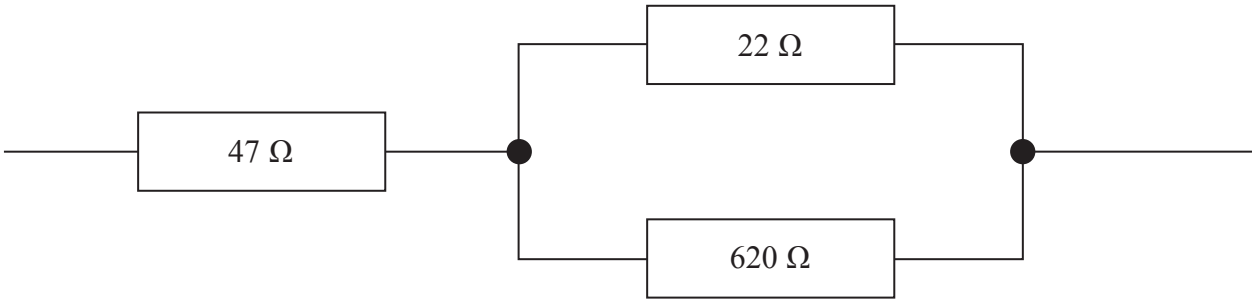
TOTAL FOR SECTION A = 10 MARKS

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SECTION B

Answer ALL questions in the spaces provided.

11 The circuit shows a combination of three resistors.



Calculate the total resistance of this combination.

(3)

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Total resistance = ...

(Total for Question 11 = 3 marks)

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*12 An experiment investigating the nature of electrons involves firing a beam of electrons through a thin sheet of crystalline material towards a fluorescent screen.

Explain what the results of this experiment demonstrate about the nature of electrons.

(3)

(Total for Question 12 = 3 marks)

13 Bees have eyes that can detect polarised light. This ability helps them to navigate because scattering of sunlight by particles in the air causes polarisation of the light. When the Sun is low in the sky, light scattered at an angle 90° relative to the position of the Sun is strongly vertically polarised.

Explain what is meant by vertically polarised.

(3)

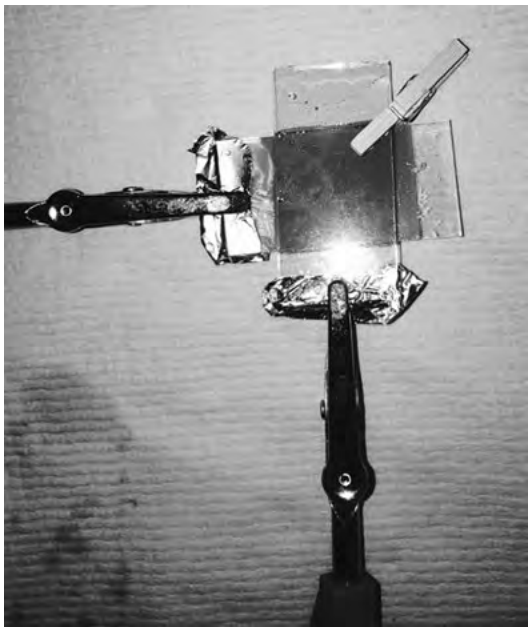
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14 Many plants obtain energy from sunlight using a green pigment called chlorophyll. Other plant pigments can also absorb sunlight, for example the red pigment in raspberries. The photograph shows a solar cell that uses a pigment from raspberries to absorb light in order to generate an e.m.f.



When measured with a high resistance voltmeter, the e.m.f. is found to be 400 mV. When the solar cell is connected across a 4700 Ω resistor, the potential difference across the resistor is 18 mV.

(a) Calculate the internal resistance of the solar cell.

(3)

Internal resistance = ...

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(b) The absorbing area of the solar cell is 3.9×10^{-4} m^2 and the radiation flux is 1.5 mW m^{-2}. Calculate the efficiency of the solar cell in transferring energy from sunlight to the resistor.

(4)

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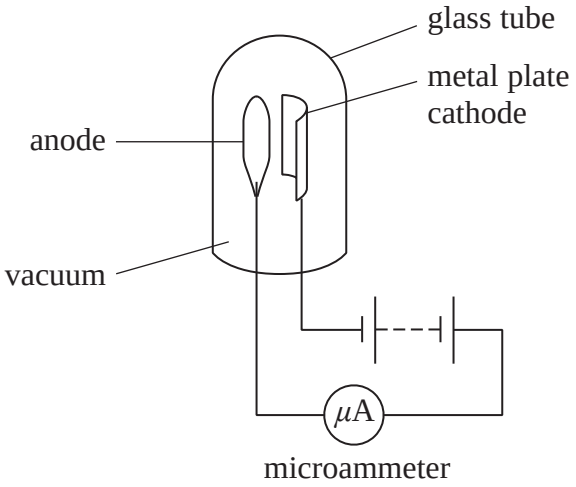
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Efficiency = ...

(Total for Question 14 = 7 marks)

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15 The diagram shows a phototube. One use of phototubes is in light meters to measure the intensity of light.



When light is incident on the cathode, the microammeter shows a current.

The following observations are made when varying the frequency and intensity of light incident on the phototube.

- There is only a current if the frequency of the incident light is greater than a certain value.
- The size of the current increases as the intensity of the incident light increases.

*(a) Explain these observations.

(5)

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(b) For a particular phototube the minimum frequency required for a current to be produced is 6.34×10^{14} Hz. The phototube is illuminated with light of frequency 7.52×10^{14} Hz.

Calculate the maximum kinetic energy of the released electrons in eV.

(3)

Maximum kinetic energy = ... eV

(Total for Question 15 = 8 marks)

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16 A student places a stick in a glass vase in front of a candle. The student then fills the vase with water.





When the vase is full of water, the stick appears to be broken and the candle appears distorted because of refraction.

(a) Explain how these effects are caused.

(3)

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(b) The refractive index of water is 1.33.
Calculate the speed of light in water.

(2)

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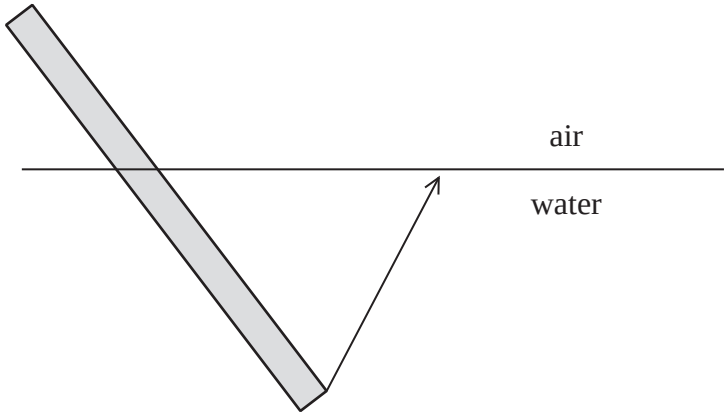
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Speed of light in water = ...

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(c) The diagram shows a light ray from part of the stick in the water.



(i) By measuring the angle of incidence of the light ray at the surface of the water, determine the angle of refraction in air.
refractive index of water = 1.33

(3)

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Angle of refraction = ...

(ii) Add to the diagram to show how that part of the stick appears to be in a different position.

(2)

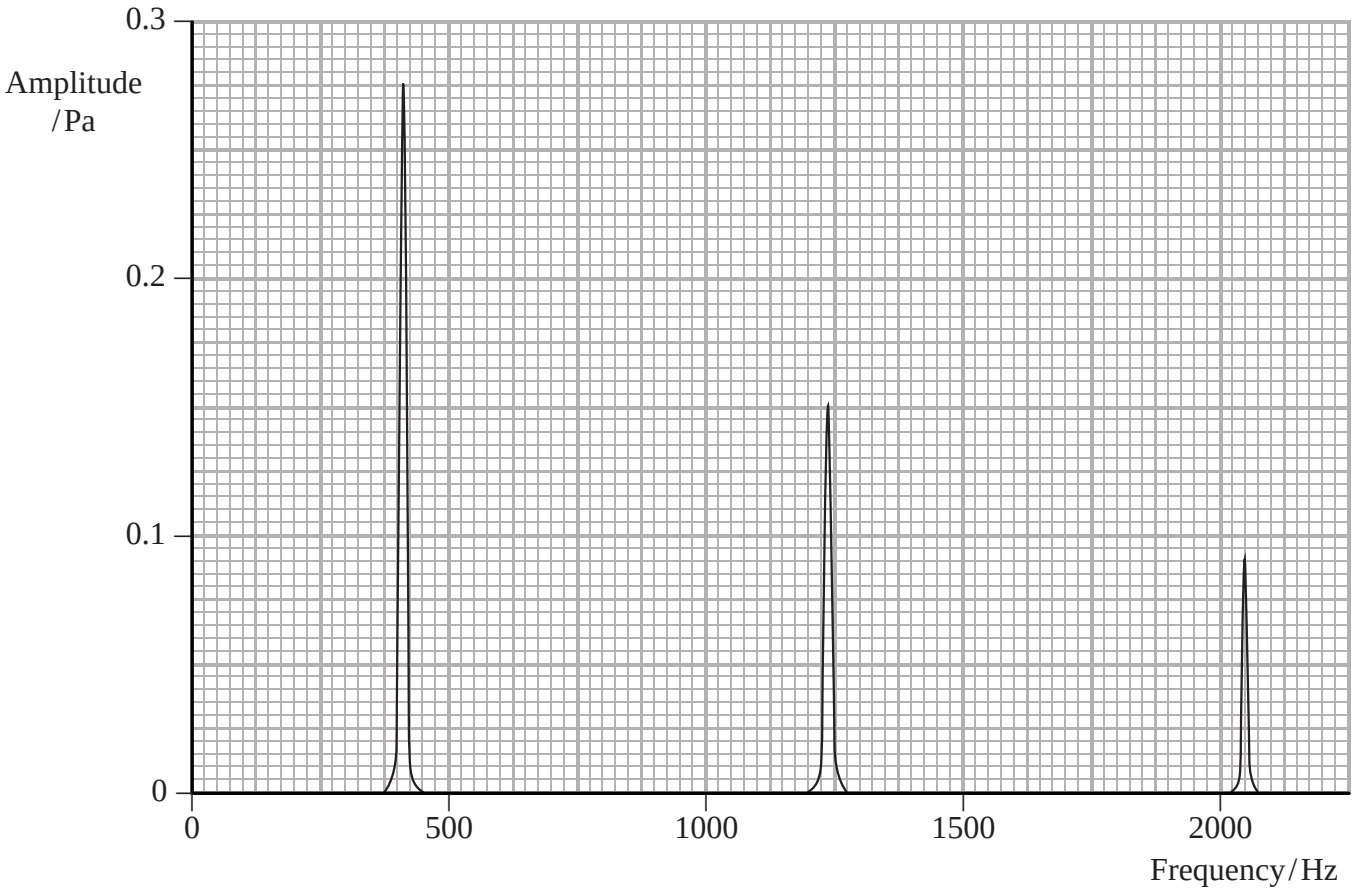
(Total for Question 16 = 10 marks)

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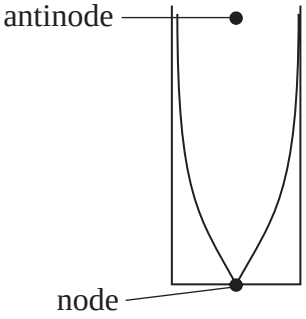
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17 A sound is created by blowing across the top of a tube which is open at one end.
The sound is recorded and displayed on a graph of amplitude against frequency.



Several frequencies of sound are observed. Each frequency corresponds to a different standing wave in the tube. The loudest, at 410 Hz, is the fundamental frequency. The higher frequencies observed are known as overtones.

(a) The diagram below shows the standing wave created at the fundamental frequency.
The positions of a node and an antinode are shown.



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(i) Explain how this standing wave is formed.

(3)

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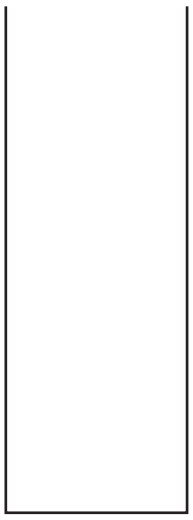
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(ii) Add to the diagram below to show the standing wave pattern for an overtone and state its frequency.

(3)



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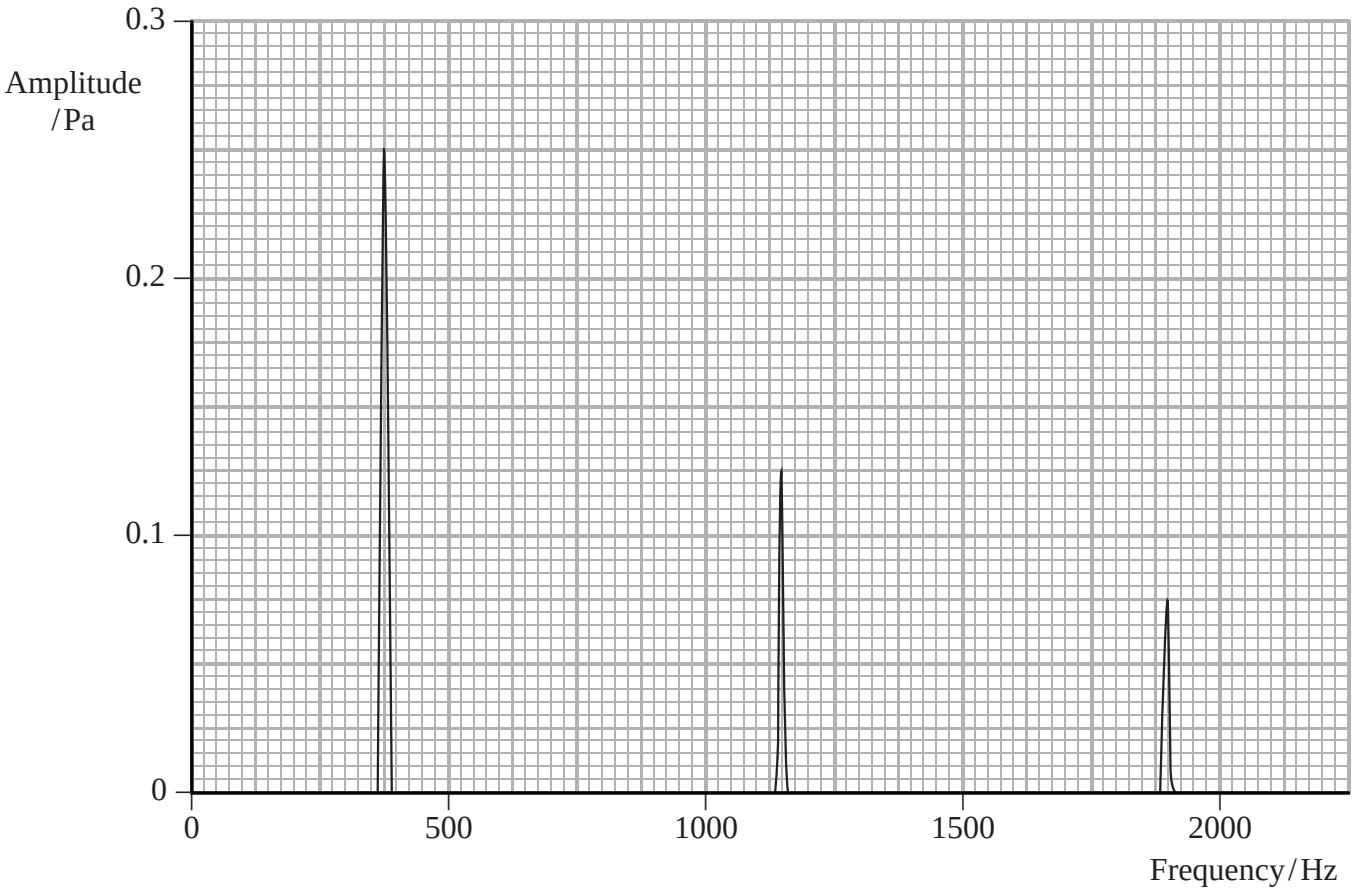
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Frequency = ...

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(b) Carbon dioxide is poured into the tube and the sound of the standing waves for the tube is recorded again. The frequencies seen are lower than with air.



Determine a value for the speed of sound in carbon dioxide.
length of tube = 20.3 cm

(4)

Speed of sound in carbon dioxide = ...

(Total for Question 17 = 10 marks)

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18 A student carries out an investigation to determine how the resistance of a metal varies with temperature.
A resistor is made from a coil of wire. The resistor is placed in a beaker of hot water as shown in the photograph. The resistance is measured for different temperatures of the water as it cools.



(a) (i) Explain two precautions the student should take to ensure that her results are accurate.

(2)

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(ii) The student used a thermometer and ohmmeter.

State why it would have been better to use a temperature sensor and resistance sensor attached to a data logger.

(1)

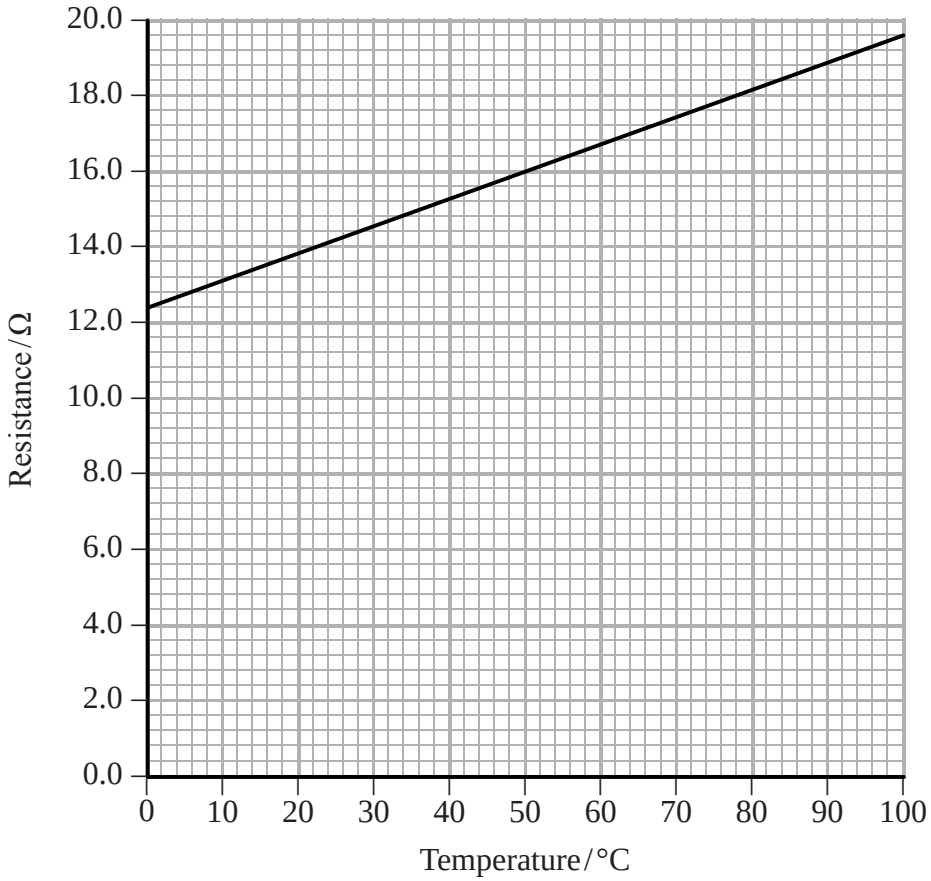
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(b) The results of the investigation are shown in the graph.



(i) The graph shows that resistance is **not** directly proportional to temperature in °C. State how the graph shows this.

(1)

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(ii) Explain the graph in terms of the structure of the metal.

(4)

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(c) The resistance of the coil of wire is 12.4 Ω at 0 °C.
Calculate the length of wire in the coil.
resistivity of the metal = 9.71×10^{-8} Ω m
diameter of wire = 8.13×10^{-5} m

(3)

Length = ...

(d) The resistor from the investigation is placed in series with a fixed resistor of resistance 24 Ω. A potential difference of 12 V is applied across the two resistors in series.

Using information from the graph in (b), determine the temperature for which the potential difference across the resistor from the investigation will be 4.5 V.

(3)

Temperature = ...

(Total for Question 18 = 14 marks)

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19 Bats emit pulses of ultrasound to find the positions of objects using echolocation.

(a) The time between a bat emitting a pulse towards a building and the echo being detected is 0.045 s.
Calculate the distance from the bat to the building.
speed of sound in air = 340 m s^{-1}

(3)

Distance = ...

(b) When a bat is closer to its prey the following changes take place:

- the ultrasound emitted by the bat becomes higher in frequency;
- the pulses become shorter in duration;
- the pulses are separated by a shorter time interval.

Explain why these changes are made.

(6)

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(c) Some bats can detect changes in frequency between the emitted pulse and the echo.

Suggest how this helps the bats in hunting their prey.

(3)

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(Total for Question 19 = 12 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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