

Write your name here

Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Physics

Advanced

Unit 6: Experimental Physics

Monday 1 February 2016 – Morning

Time: 1 hour 20 minutes

Paper Reference

WPH06/01

You must have:

Ruler

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 40.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- 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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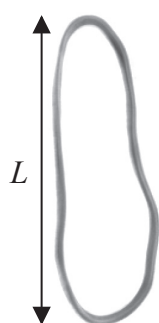
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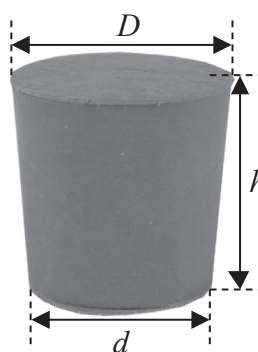
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Answer ALL questions in the spaces provided.

- 1 A student investigates the properties of a rubber band and a rubber bung to determine whether they are made from the same type of rubber.



Rubber band



Rubber bung

- (a) The volume V_1 of the band is given by

$$V_1 = 2Lwt$$

where w is the width of the band and t is the thickness and L is the length shown in the diagram.

- (i) The student uses a metre rule to measure L which is approximately 10 cm.
Explain why a metre rule is suitable for this measurement.

(2)

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- (ii) She uses a micrometer screw gauge to measure w and t and records the following readings with negligible uncertainties.

L/cm	w/mm	t/mm
10.0	9.33	1.03

Use these measurements to calculate V_1 in cm^3 .

(2)

$$V_1 = \dots\dots\dots \text{cm}^3$$

- (b) The volume V_2 of the bung is given by

$$V_2 = \frac{\pi h}{12} (D^2 + d^2 + Dd)$$

where D , d and h are the dimensions shown on the diagram.
The student uses callipers to take measurements of the bung.

- (i) Describe how h should be measured.

(2)



- (ii) She records values for the diameters with negligible uncertainty.

$$D = 3.45 \text{ cm}$$

$$d = 3.06 \text{ cm}$$

She records the following values for h

h/cm	3.51	3.49	3.53
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Use these measurements to calculate V_2 in cm^3 .

(2)

$$V_2 = \dots\dots\dots \text{cm}^3$$

- (iii) Estimate the percentage uncertainty in V_2 .

(1)

Percentage uncertainty = ...



- (c) The student uses a top pan balance to record the following readings with negligible uncertainty.

mass of band = 2.23 g mass of bung = 44.48 g

Calculate the densities of the band and the bung.

(3)

Density of band = ...

Density of bung = ...

- (d) The percentage uncertainty in the density of the band is 4%.

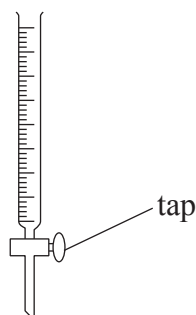
Use this value and your results to comment on the suggestion that both the band and the bung are made from the same type of rubber.

(2)

(Total for Question 1 = 14 marks)



- 2 A burette is a transparent tube that can contain a liquid. It has a tap at the bottom to allow the liquid to flow out. The volume V of liquid remaining in the burette is measured using a scale on the side of the tube.



It is suggested that V decreases exponentially with time as shown by the equation

$$V = V_0 e^{-\frac{t}{b}}$$

where V_0 is the initial volume, t is the time since the tap was opened and b is a constant.

- (a) Write a plan for an experiment to determine a value for b using a graphical method and a burette where $V_0 = 100 \text{ cm}^3$.

Your plan should include

- (i) a description of how you would measure V and t and **two** precautions you would take to make your readings as accurate as possible,

(4)

- (ii) one source of uncertainty in the measurements,

(1)

- (iii) the graph you would plot and how you would use the graph to determine b .

(2)

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- (b) The temperature of the liquid in the burette is increased. This reduces the viscosity of the liquid.

Explain the effect of this on the value of b in the equation.

(2)

(Total for Question 2 = 9 marks)



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3 A student carried out an experiment to measure how the resistance of a thermistor decreases as the temperature increases.

- (a) Draw a diagram of the apparatus that could be used to carry out this experiment in a school laboratory.

(3)

- (b) The following readings were recorded.

$T/^{\circ}\text{C}$	$R/\text{k}\Omega$
14	8.16
30	4.03
45	2.29
61	1.32
83	0.65

- (i) Suggest why it would be a good idea to take extra readings in the range 14°C to 45°C .

(1)

- (ii) Suggest how the range of readings could have been increased.

(1)

(Total for Question 3 = 5 marks)



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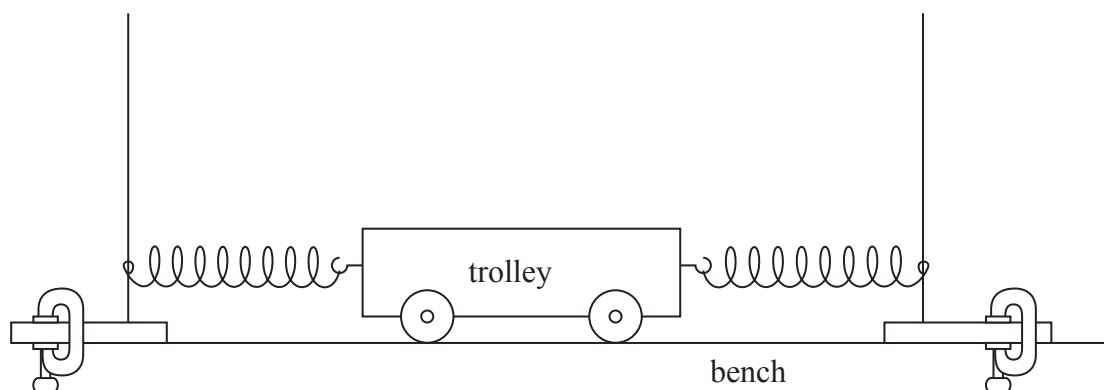
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- 4 A trolley is attached to two fixed points by springs as shown.



When pulled to one side and released, the trolley oscillates with simple harmonic motion. The periodic time T of this oscillation is measured. Masses m are placed on the trolley and the new periodic times are measured. The results are shown in the table.

m/kg	T/s	
0	1.59	
0.5	1.94	
1.0	2.19	
1.5	2.47	
2.0	2.66	

- (a) The relationship between T and m is

$$T^2 = \frac{4\pi^2 m}{k} + \frac{4\pi^2 M}{k}$$

where k is the stiffness of the arrangement of the springs and M is the mass of the trolley.

- (i) Draw a graph of T^2 against m on the grid opposite. Use the extra column in the table for your processed data.

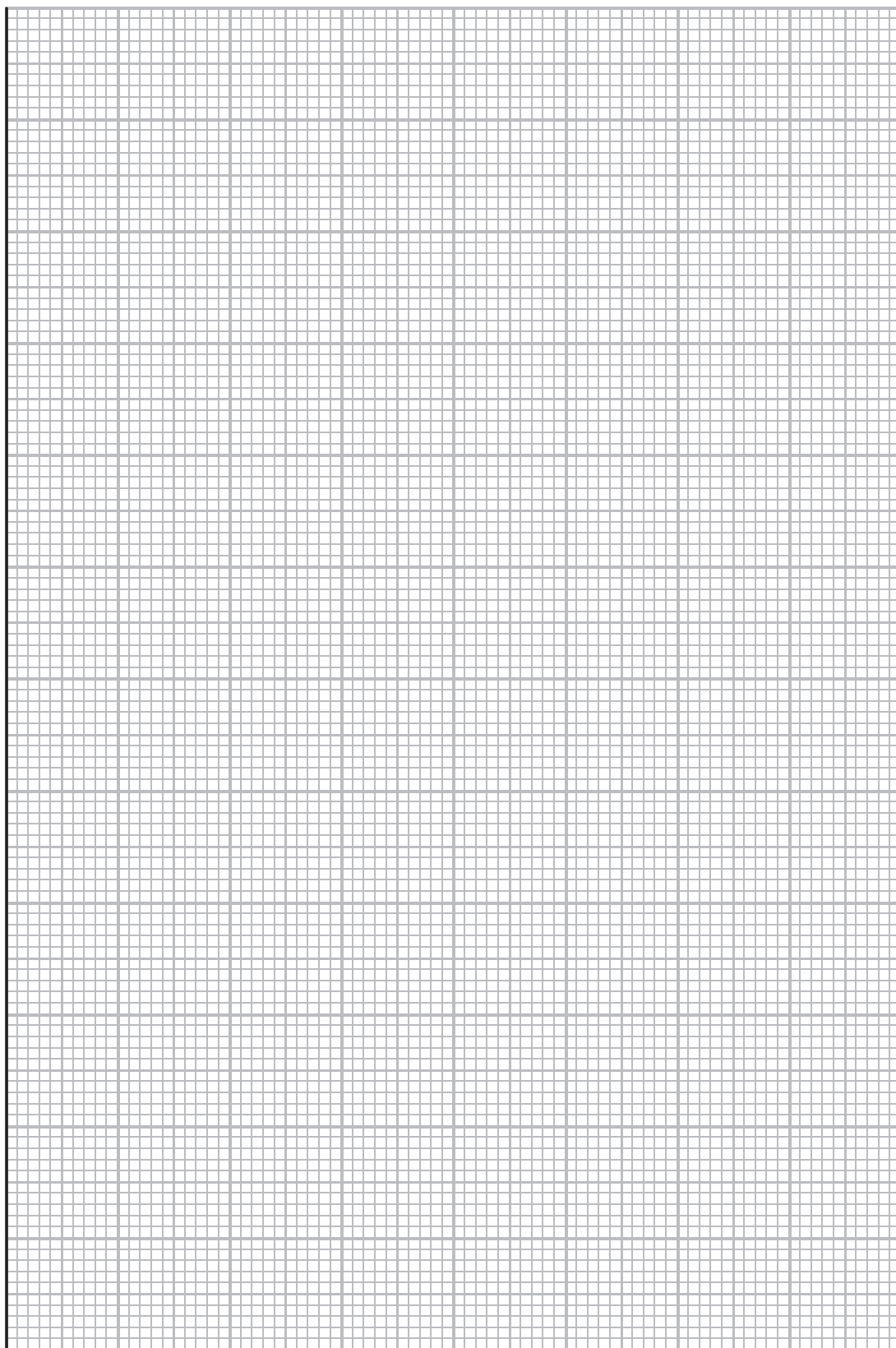
(4)



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Question 4 continues on the next page



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(ii) Use your graph to determine a value for k .

(3)

$k =$

(iii) Use your graph to determine a value for M .

(3)

$M =$

(b) The mass of the trolley is measured using a balance and recorded as 1.05 kg.
Comment on the accuracy of your answer for (a)(iii).

(2)

(Total for Question 4 = 12 marks)

TOTAL FOR PAPER = 40 MARKS



List of data, formulae and relationships

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$	
Coulomb's law constant	$k = 1/4\pi\epsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
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 constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to Earth's surface)
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$	
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	
Proton mass	$m_p = 1.67 \times 10^{-27} \text{ kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27} \text{ kg}$	

Unit 1

Mechanics

Kinematic equations of motion	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
Forces	$\Sigma F = ma$ $g = F/m$ $W = mg$
Work and energy	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{\text{grav}} = mg\Delta h$

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	$E = \sigma/\epsilon$ where Stress $\sigma = F/A$ Strain $\epsilon = \Delta x/x$
Elastic strain energy	$E_{\text{el}} = \frac{1}{2}F\Delta x$



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

$$hf = \phi + \frac{1}{2}mv_{\max}^2$$



Unit 4*Mechanics*

Momentum

$$p = mv$$

Kinetic energy of a
non-relativistic particle

$$E_k = p^2/2m$$

Motion in a circle

$$v = \omega r$$

$$T = 2\pi/\omega$$

$$F = ma = mv^2/r$$

$$a = v^2/r$$

$$a = r\omega^2$$

Fields

Coulomb's law

$$F = kQ_1Q_2/r^2 \text{ where } k = 1/4\pi\epsilon_0$$

Electric field

$$E = F/Q$$

$$E = kQ/r^2$$

$$E = V/d$$

Capacitance

$$C = Q/V$$

Energy stored in capacitor

$$W = \frac{1}{2}QV$$

Capacitor discharge

$$Q = Q_0 e^{-t/RC}$$

In a magnetic field

$$F = BIl \sin \theta$$

$$F = Bqv \sin \theta$$

$$r = p/BQ$$

Faraday's and Lenz's Laws

$$\epsilon = -d(N\phi)/dt$$

Particle physics

Mass-energy

$$\Delta E = c^2 \Delta m$$

de Broglie wavelength

$$\lambda = h/p$$



Unit 5*Energy and matter*

Heating	$\Delta E = mc\Delta\theta$
Molecular kinetic theory	$\frac{1}{2}m\langle c^2 \rangle = \frac{3}{2}kT$
Ideal gas equation	$pV = NkT$

Nuclear Physics

Radioactive decay	$dN/dt = -\lambda N$
	$\lambda = \ln 2/t_{1/2}$
	$N = N_0 e^{-\lambda t}$

Mechanics

Simple harmonic motion	$a = -\omega^2 x$ $a = -A\omega^2 \cos \omega t$ $v = -A\omega \sin \omega t$ $x = A \cos \omega t$ $T = 1/f = 2\pi/\omega$
Gravitational force	$F = Gm_1 m_2 / r^2$

Observing the universe

Radiant energy flux	$F = L/4\pi d^2$
Stefan-Boltzmann law	$L = \sigma T^4 A$ $L = 4\pi r^2 \sigma T^4$
Wien's Law	$\lambda_{\max} T = 2.898 \times 10^{-3} \text{ m K}$
Redshift of electromagnetic radiation	$z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$
Cosmological expansion	$v = H_0 d$

