Write your name here

Surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | Candidate Number

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.

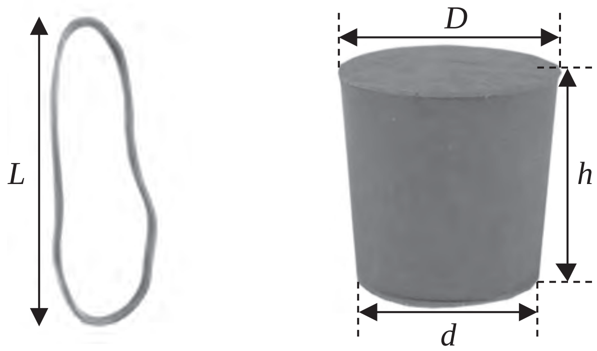
Turn over ▶

6/6/6/6/3/

PEARSON

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)

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V_1 = ... cm^3

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

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

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)

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

$D = 3.45\,\text{cm}$ $\qquad$ $d = 3.06\,\text{cm}$

She records the following values for h

h/cm	3.51	3.49	3.53

Use these measurements to calculate V_2 in cm^3.

(2)

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V_2 = ... cm^3

(iii) Estimate the percentage uncertainty in V_2.

(1)

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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 = ...

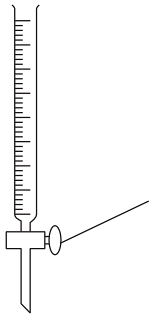
(d) The percentage uncertainty in the density of the band is 4%.

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)

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*/°C**	***R*/kΩ**
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)

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

(1)

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(Total for Question 3 = 5 marks)

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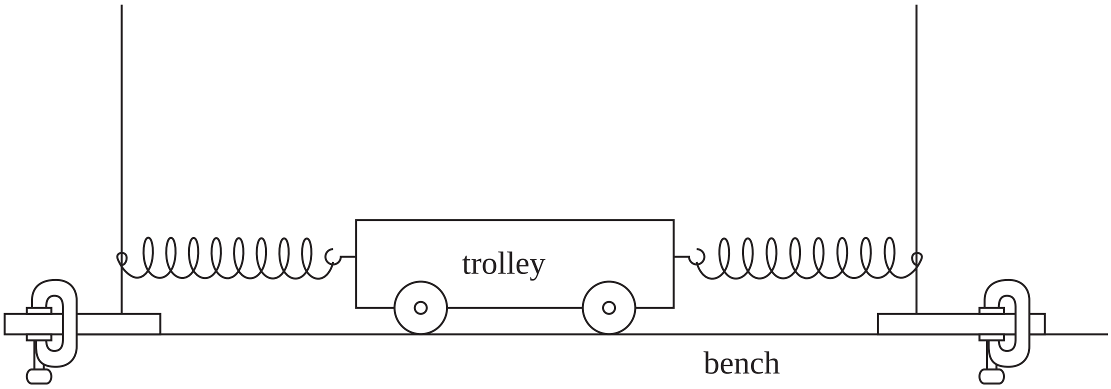
4 A trolley is attached to two fixed points by springs as shown.



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

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

(3)

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k = ...

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

(3)

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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)

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(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	$k = 1/4\pi\varepsilon_0$ $= 8.99 \times 10^{9}\ \text{N m}^2\ \text{C}^{-2}$	
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	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$	
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	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{grav} = mg\Delta h$

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	$E_{el} = \frac{1}{2}F\Delta x$

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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\% \text{ efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100$
	$\% \text{ efficiency} = \dfrac{\text{useful power output}}{\text{total power input}} \times 100$
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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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	$F = kQ_1Q_2/r^2$ where $k = 1/4\pi\varepsilon_0$
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	$\varepsilon = -d(N\phi)/dt$

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	$\mathrm{d}N/\mathrm{d}t = -\lambda N$
	$\lambda = \ln 2/t_{\frac{1}{2}}$
	$N = N_0 e^{-\lambda t}$

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	$F = Gm_1m_2/r^2$

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	$\lambda_{max}T = 2.898 \times 10^{-3}$ m K
Redshift of electromagnetic radiation	$z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$
Cosmological expansion	$v = H_0 d$