Write your name here

Surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | Candidate Number

Physics

Advanced
Unit 6: Experimental Physics

Thursday 25 January 2018 – 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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over

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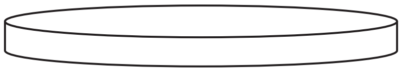
Pearson

Answer ALL questions in the spaces provided.

1 A student makes measurements to determine the density of steel. The student has a disc made from steel with a thickness of about 1 mm.



(a) The student uses vernier calipers to measure the diameter of the disc. He measures the diameter several times and calculates a mean.

mean diameter = 35.2 mm ± 0.1 mm

State why the student should take several measurements and calculate a mean.

(1)

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(b) He measures the thickness of the disc using a micrometer screw gauge and records the following values in mm.

1.58 1.52 1.55 1.54 1.56

(i) Calculate the mean thickness of the disc.

(1)

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....

Mean thickness = ... mm

(ii) Calculate the percentage uncertainty in the value of the mean thickness.

(2)

....

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....

Percentage uncertainty = ...

(c) (i) Calculate the mean value for the volume of the disc.

(2)

Mean value for volume of disc = ...

(ii) Calculate the percentage uncertainty in the mean value for the volume of the disc.

(3)

Percentage uncertainty = ...

(d) The student uses an electronic balance to measure the mass of the disc as 11.96 g with negligible uncertainty.

Calculate the density of the steel.

(2)

Density of steel = ...

(e) There are different types of steel. The density of carbon steel is 7860 kg m^{-3}.

Determine whether the disc could be made from carbon steel.

(2)

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(Total for Question 1 = 13 marks)

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2 A student is asked to determine a value for g using a simple pendulum. She is given the equation

$$T = 2\pi\sqrt{\frac{l}{g}}$$

where T is the period of oscillation of the pendulum and l is the length of the pendulum.

(a) The student uses a stopwatch with a precision of 0.01 s to time the oscillations.

State what is meant by precision.

(1)

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....

(b) Write a plan for an experiment to determine a value for g using a graphical method.

Your plan should include:

(i) a diagram of the apparatus, showing the length l to be measured,

(1)

(ii) one source of uncertainty in the measurement of T,

(1)

(iii) a description of how an accurate value for T can be determined,

(4)

(iv) the graph you would plot and how you would use the graph to determine g.

(2)

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(Total for Question 2 = 9 marks)

3 A student uses a light meter to investigate how the light intensity from a filament bulb varies with distance from the bulb.

(a) State a precaution that the student should take to make the measurement of light intensity as accurate as possible.

(1)

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(b) The student uses distances in the range 5 cm to 80 cm.

Explain, with the aid of a calculation, why a metre rule is a suitable instrument to measure the distance.

(2)

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(c) The student thinks that the light intensity I varies with distance d from the filament according to the equation

$$I = kd^{-2}$$

where k is a constant.

She measures d and records some corresponding values of I as shown in the table.

d / m	***I*** / lux
0.10	800
0.15	350
0.25	130

Explain whether these values are consistent with the equation. Your answer should include calculations.

(3)

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(Total for Question 3 = 6 marks)

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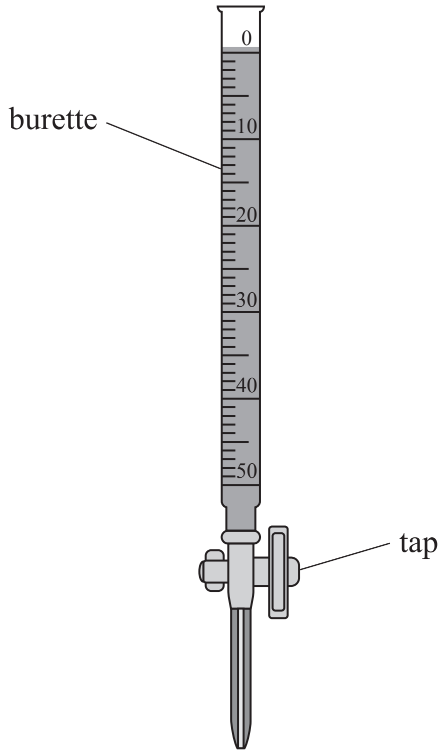
4 A burette is filled with a liquid and allowed to empty by opening the tap. An investigation is carried out to determine a relationship between the volume of liquid remaining in the burette and the time taken for the liquid level to fall from the zero mark.



(a) State the property of the liquid that determines the rate at which it flows.

(1)

....

(b) Suggest one advantage of opening the tap with the initial liquid level above the zero mark.

(1)

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P 5 1 9 4 6 A 0 1 1 2 0

(c) It is suggested that $V = V_0 e^{-bt}$ where V is the volume of liquid remaining at time t. V_0 and b are constants.

Explain why a graph of $\ln V$ against t should be a straight line.

(2)

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....

(d) The following data were obtained in the investigation.

V / cm^3	Mean t / s	
50.0	0.0	
45.0	4.4	
40.0	8.5	
35.0	13.1	
30.0	17.3	
25.0	23.3	

(i) Plot a graph on the grid opposite to show that the data is consistent with $V = V_0 e^{-bt}$

Use the extra column provided to show your processed data.

(5)

(ii) Determine a value for the constant b.

(3)

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b = ...

(Total for Question 4 = 12 marks)

TOTAL FOR PAPER = 40 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)
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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\% \text{ efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$
	$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{total power input}} \times 100$
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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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	$\mathrm{d}N/\mathrm{d}t = -\lambda N$
	$\lambda = \ln 2/t_{½}$
	$N = N_0 \mathrm{e}^{-\lambda t}$

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	$v = H_0 d$