

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**

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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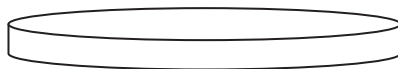
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**Pearson**

**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.

$$\text{mean diameter} = 35.2 \text{ mm} \pm 0.1 \text{ mm}$$

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

(1)

.....

.....

.....

- (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)

.....

.....

Mean thickness = ..... mm

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

(2)

.....

.....

.....

.....

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  $7860 \text{ kg m}^{-3}$ .

Determine whether the disc could be made from carbon steel.

(2)

(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)

- (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)



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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)

- (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)





- (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.

$d/\text{m}$	$I/\text{lux}$
0.10	800
0.15	350
0.25	130

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

(3)

(Total for Question 3 = 6 marks)



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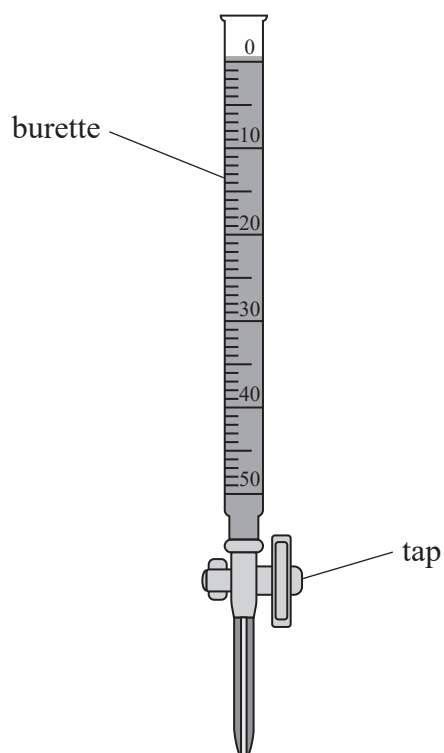
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- 4 A burette is filled with a liquid and allowed to empty by opening the tap. An investigation is carried out to determine a relationship between the volume of liquid remaining in the burette and the time taken for the liquid level to fall from the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



- (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)

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

$V / \text{cm}^3$	Mean $t / \text{s}$	
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)

$b =$  .....



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**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	$k = 1/4\pi\epsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
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	$F = Gm_1m_2/r^2$

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

