Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Physics

Advanced
Unit 6: Experimental Physics

Thursday 19 May 2016 – Afternoon
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 ▶

P46655A

©2016 Pearson Education Ltd.

6/6/3/1/

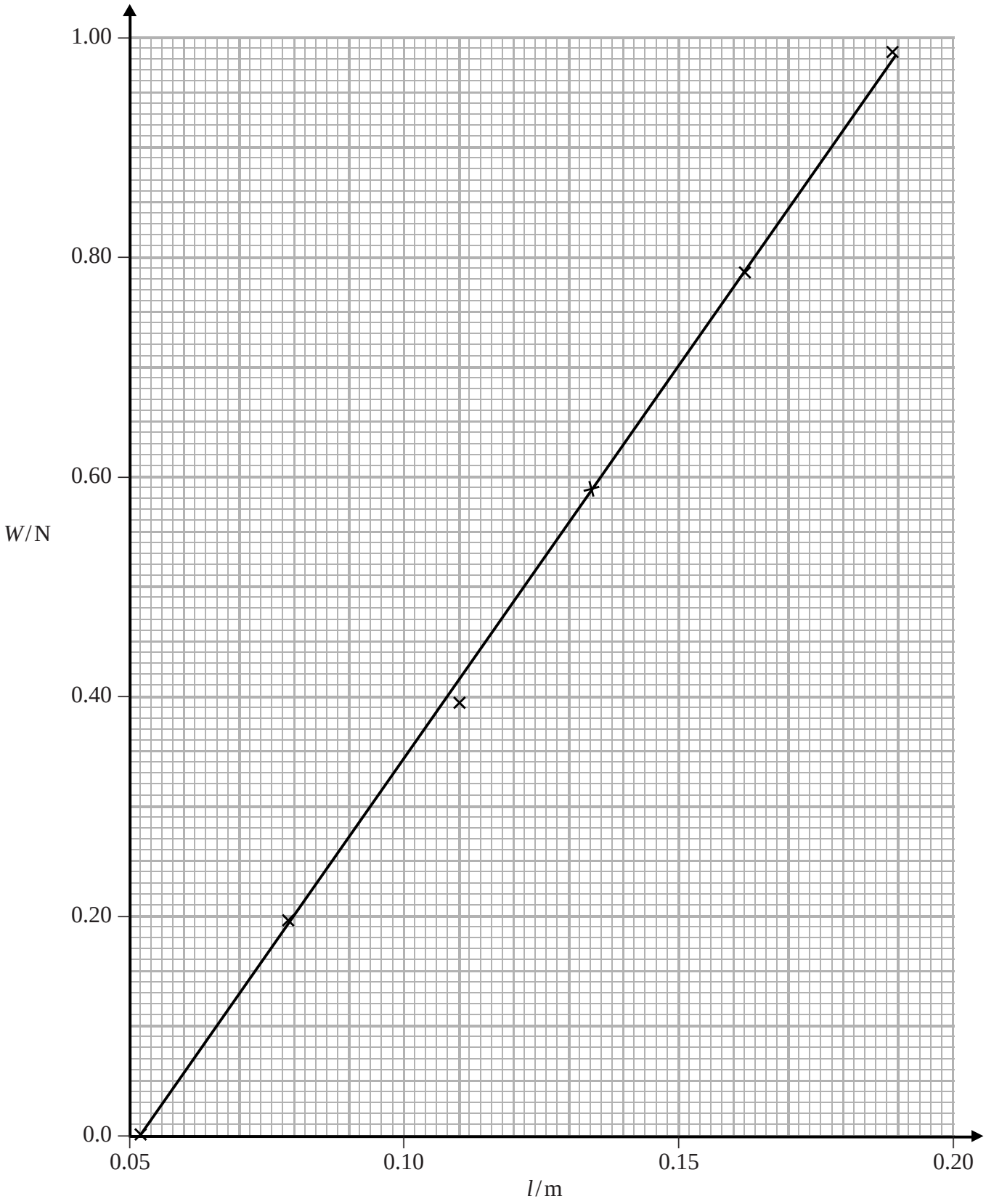
P 4 6 6 5 5 A 0 1 1 6

PEARSON

Answer ALL questions in the spaces provided.

1 A student measured the length l_0 of a spring. She suspended different weights W from the spring and measured the new length l each time.

She drew a graph of W against l. She measured the gradient of the line of best fit as 7.14 Nm^{-1}.



DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(a) She measured l_0 using a metre rule and recorded l_0 = 5.2 cm.
Explain why a metre rule is a suitable instrument to make this measurement.

(2)

.....

.....

.....

.....

(b) (i) The student suspended a piece of modelling clay from the spring. She recorded the new length of the spring as l = 14.3 cm.

Determine the weight W_1 of the clay.

(1)

.....

.....

W_1 = ...

(ii) The student estimated the uncertainty in l as 2 mm. Use this uncertainty and the graph to estimate the uncertainty in your value for W_1.

(2)

.....

.....

.....

.....

Uncertainty = ...

(iii) Calculate the percentage uncertainty in your value for W_1.

(1)

.....

.....

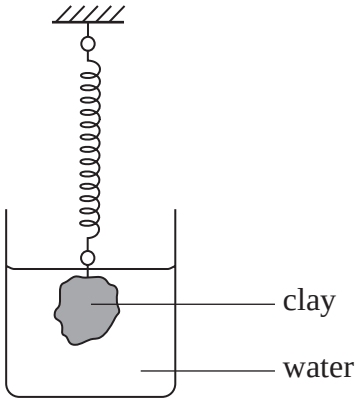
Percentage uncertainty = ...

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c) The student immersed the clay in water as shown in the diagram. The upthrust of the water on the clay reduced the force of the clay on the spring to a new value W_2 and so l was also reduced.



(i) On the diagram draw and label the three forces acting on the clay.

(1)

(ii) When the clay was immersed the student recorded l = 9.1 cm.

Determine W_2.

(1)

.....

.....

W_2 = ...

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(d) The ratio $\frac{\text{Density of clay}}{\text{Density of water}} = \frac{W_1}{W_1 - W_2}$

density of water = 1000 kg m^{-3}

Calculate a value for the density of clay.

(2)

.....

.....

.....

Density of clay = ...

(e) The manufacturer's value for the density of this clay is 1680 kg m^{-3}.

Comment on the accuracy of your result.

(3)

.....

.....

.....

.....

.....

.....

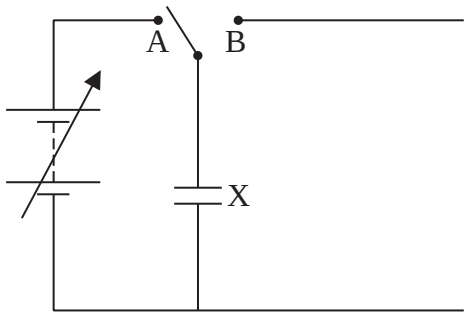
(Total for Question 1 = 13 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

2 Part of an electric circuit is shown.



When the switch is connected to terminal A the capacitor X is connected to the variable power supply.

(a) (i) Add a second capacitor Y to the circuit so that it is connected in parallel with X when the switch is moved to B.

(1)

(ii) Add a voltmeter so that the potential difference (p.d.) across X can be measured when the switch is in either position.

(1)

(b) The capacitance of X is C_X. If C_X is known, this circuit can be used to determine the capacitance C_Y of capacitor Y using the equation

$$V_2 = \frac{C_X}{C_Y}(V_1 - V_2)$$

where

- V_1 is the p.d. across X when it is connected to the power supply
- V_2 is the p.d. across X when Y is connected in parallel with it.

Write a plan for an experiment using this circuit and a graphical method to determine C_Y.

Your plan should include

(i) the readings you would take

(2)

(ii) the graph you would plot and how you would use the graph to determine C_Y

(2)

(iii) how you would ensure the capacitors would not be damaged during the experiment

(1)

(iv) a precaution you would take to ensure the results are accurate.

(1)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

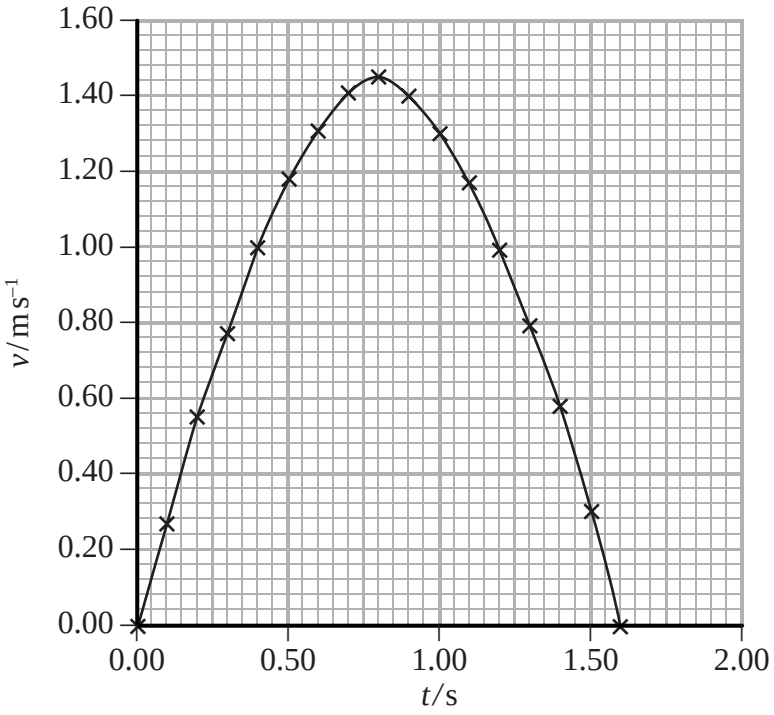
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(Total for Question 2 = 8 marks)

3 A pendulum is made using a heavy mass suspended on a length of string. The pendulum was suspended from a high ceiling. The pendulum was pulled to one side to a maximum displacement and released.

The velocity v of the mass and the corresponding time t were recorded using a sensor and a data logger. Readings were recorded from the instant the pendulum was released.

The readings were plotted on the graph shown.



(a) (i) Determine the time period T of the pendulum.

(1)

.....

T = ...

(ii) State the value for t when the pendulum is at the centre of the oscillation.

(1)

t = ...

(iii) Explain why the graph has a horizontal tangent at t = 0.80 s.

(2)

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) (i) Draw a tangent to the graph at $t = 0.40$ s and use it to calculate the acceleration at this point.

(2)

.....

.....

Acceleration = ...

(ii) State the next time the mass had the same magnitude of acceleration as in (b)(i).

(1)

t = ...

(c) State **one** advantage of using a data logger.

(1)

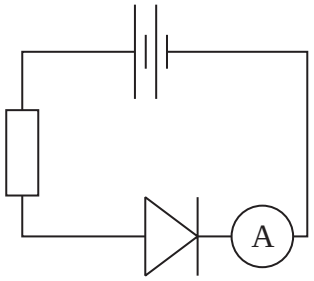
.....

.....

(Total for Question 3 = 8 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

4 The diode connected in the circuit shown will allow a current to flow.



For a constant potential difference, the current I and the temperature T of the diode are related by

$$I = I_0 e^{-\frac{p}{T}}$$

where I_0 and p are constants and T is measured in kelvin.

(a) Explain why a graph of ln I against $1/T$ should produce a straight line.

(2)

.....

.....

.....

.....

(b) A student carried out an experiment using this circuit. He recorded I and the temperature θ of the diode for different values of θ measured in °C. The results are shown in the table.

θ/°C	I/mA			
0	1.2			
20	3.0			
40	6.0			
60	12.5			
80	22.6			
100	41.7			

(i) Draw on the grid opposite a graph of ln I against $1/T$. Use the columns in the table for your processed data.

(4)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

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

(2)

.....

.....

.....

.....

p = ...

(iii) Theory suggests that the electron charge e is given by $e = \frac{kp}{V}$

where k is the Boltzmann constant and V = 0.32 V.

Calculate a value for e.

(1)

.....

.....

.....

e = ...

(iv) Comment on the accuracy of the result.

(2)

.....

.....

.....

.....

.....

(Total for Question 4 = 11 marks)

TOTAL FOR PAPER = 40 MARKS

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

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

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

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	$Q = Q_0e^{-t/RC}$
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	$\lambda = h/p$

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

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

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	$v = H_0 d$

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA