Write your name here

| Surname | Other names |
|---|---|
| | |

**Edexcel GCE**

Centre Number | Candidate Number

# Physics

## Advanced
## Unit 6B: Experimental Physics
## International Alternative to Internal Assessment

Tuesday 17 January 2012 – Afternoon
**Time: 1 hour 20 minutes**

Paper Reference
**6PH08/01**

**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* ▶

P39852A

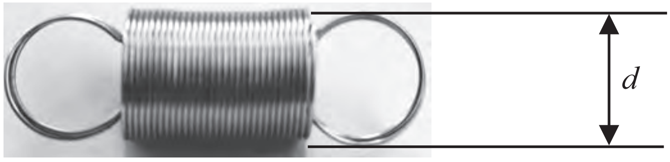
6/6/6/6/

P 3 9 8 5 2 A 0 1 1 6

PEARSON

**Answer ALL questions.**

**1** The spring shown below is made up of loops of wire. There are two extra loops on each end.




A student wants to determine the total length of wire used to make the spring.

She only has digital callipers.

She decides to find the length of wire, *l*, in each loop and multiply this by the total number of loops.

The length of wire, *l*, is given by $l = \pi d$ where *d* is the diameter of each loop.

(a) She obtains the following values for *d*.

| | | | | | |
|---|---|---|---|---|---|
| *d*/mm | 15.52 | 15.56 | 15.48 | 15.55 | 15.47 |

(i) Use these values to calculate a mean value for *d*.

**(1)**

..............................................................................................................................................

..............................................................................................................................................

(ii) Hence calculate a value for *l*.

**(1)**

..............................................................................................................................................

..............................................................................................................................................

(iii) Estimate the percentage uncertainty in your value for *l*.

**(1)**

..............................................................................................................................................

..............................................................................................................................................

(b) There are 30.5 loops in the main part of the spring. At both ends of the spring there are 2 extra loops. These loops are the same size as the main ones.

(i) Calculate the total length of wire in the spring.

**(1)**

...............................................................................................................................................

...............................................................................................................................................

...............................................................................................................................................

(ii) The student forgets the 2 extra loops at both ends.

Estimate the percentage uncertainty in her value for the total length of wire caused by this error.

**(1)**

...............................................................................................................................................

...............................................................................................................................................

(c) She now wants to measure the diameter of the wire that makes the spring.

Describe how you would do this as accurately as possible.

**(2)**

...............................................................................................................................................

...............................................................................................................................................

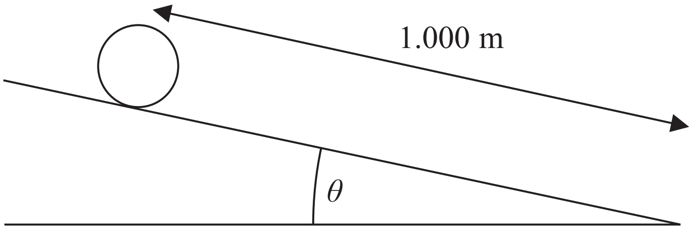
...............................................................................................................................................

...............................................................................................................................................

**(Total for Question 1 = 7 marks)**

**2** A student measures the acceleration of a drinks can as it rolls down a ramp. He wants to use this acceleration to find a value for $g$.

(a) The ramp makes an angle $\theta$ with the bench as shown.




(i) Describe an accurate method to determine the angle $\theta$. You may add to the diagram if you wish.

**(2)**

........................................................................................................................................................................................................

........................................................................................................................................................................................................

........................................................................................................................................................................................................

(ii) Explain why your method gives good precision.

**(2)**

........................................................................................................................................................................................................

........................................................................................................................................................................................................

........................................................................................................................................................................................................

(b) To find the acceleration he measures the time $t$ it takes for the can to roll a distance $s$ down the ramp.

(i) He uses a metre rule to mark a distance $s = 1.000$ m on the ramp. Estimate the percentage uncertainty in this measurement.

**(1)**

........................................................................................................................................................................................................

........................................................................................................................................................................................................

(ii) He uses a stopwatch to measure $t$.

State **one** technique he can use to reduce the uncertainty in this measurement.

**(1)**

........................................................................................................................................................................................................

........................................................................................................................................................................................................

........................................................................................................................................................................................................

(c) The student determines the mean value for $t$ as 1.20 s with an uncertainty of 0.10 s.

He assumes the acceleration $a$ is given by $a = 2s/t^2$.

(i) Use his value to calculate the acceleration of the can.

**(1)**

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

(ii) Estimate the overall percentage uncertainty in his value for the acceleration.

**(2)**

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

(d) The student assumes that the acceleration of the can is given by $a = g \sin\theta$.

(i) Use this equation to calculate a value for $g$ when $\theta = 10.0°$.

**(1)**

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

(ii) Calculate the percentage difference between this value for $g$ and the accepted value for $g$.

**(1)**

..............................................................................................................................................

..............................................................................................................................................

(iii) Explain whether your answers in (c)(ii) and (d)(ii) support the assumption that $a = g \sin\theta$.

**(1)**

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

**(Total for Question 2 = 12 marks)**

**3** A student wants to determine the specific heat capacity of aluminium. She heats a block of aluminium by supplying electrical energy to a heater that is inserted into the block as shown.

(a) Draw the electrical circuit she should use.

**(1)**

(b) She writes the following plan

> Measure the temperature of the block at the start
>
> Turn on the electric current
>
> Determine the energy flowing for a certain time
>
> Turn off the current and measure the temperature
>
> This will give me the specific heat capacity if I divide the total energy by the mass and the temperature rise

Write an improved plan that includes details of the method to be used and any precautions needed to produce an accurate value for the specific heat capacity of aluminium.

**(6)**

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

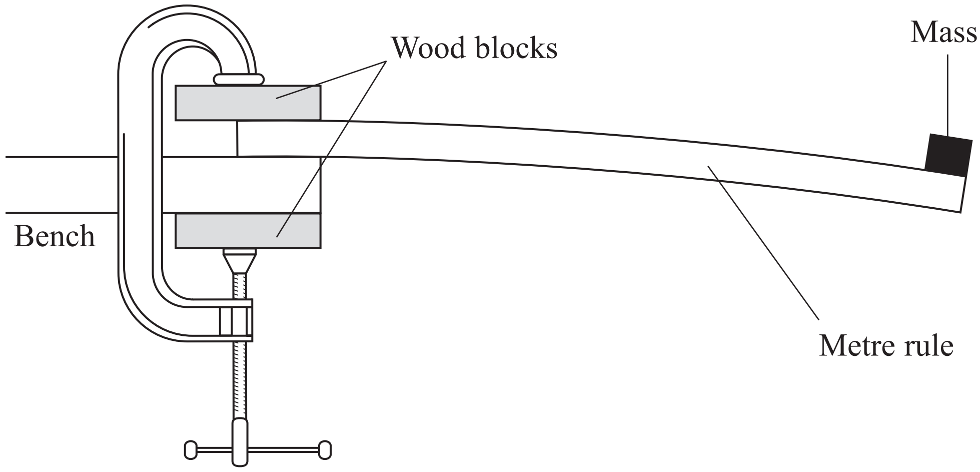
..................................................................................................................................................

..................................................................................................................................................

**(Total for Question 3 = 7 marks)**

BLANK PAGE

**4** A metre rule is clamped to the bench and a mass is attached to the end as shown. The arrangement is called a cantilever.




When pulled down a short distance and released, the cantilever will oscillate. The period of oscillation *T* will depend on the distance *d* of the mass from the clamped end, providing the mass on the end is kept constant.

(a) (i) Add to the diagram to show how you would measure the distance *d*.

**(1)**

(ii) Describe how you would use a stopclock to determine an accurate value for *T*.

**(2)**

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

(b) The stopclock has a precision of 0.01 s.

(i) State what is meant by this.

**(1)**

..............................................................................................................................................

(ii) State why this is a suitable instrument for this measurement.

**(1)**

..............................................................................................................................................

..............................................................................................................................................

(c) It is suggested that $T = p\,d^q$ where $p$ and q are constants.

(i) Explain why a graph of $\ln T$ against $\ln d$ should be a straight line.

**(1)**

.......................................................................................................................................

.......................................................................................................................................

(ii) State how you would use your graph to obtain a value for q.

**(1)**

.......................................................................................................................................

.......................................................................................................................................

(d) The following data were obtained in such an experiment.

| ***d*/cm** | **Mean *T*/s** | | |
|---|---|---|---|
| 87.7 | 7.23 | | |
| 82.7 | 6.49 | | |
| 77.7 | 5.85 | | |
| 72.7 | 5.26 | | |
| 67.7 | 4.66 | | |
| 62.7 | 4.16 | | |

(i) Plot a graph on the grid opposite to show that these data are consistent with $T = p\,d^q$.

Use the columns provided to show your processed data.

**(4)**

(ii) Use your graph to find a value for q.

**(2)**

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

(iii) Comment on the validity of your value.

**(1)**

.......................................................................................................................................

.......................................................................................................................................

**(Total for Question 4 = 14 marks)**

**TOTAL FOR PAPER = 40 MARKS**

## List of data, formulae and relationships

| | | |
|---|---|---|
| Acceleration of free fall | $g = 9.81\ \mathrm{m\ s^{-2}}$ | (close to Earth's surface) |
| Boltzmann constant | $k = 1.38 \times 10^{-23}\ \mathrm{J\ K^{-1}}$ | |
| Coulomb's law constant | $k = 1/4\pi\varepsilon_0$ | |
| | $= 8.99 \times 10^{9}\ \mathrm{N\ m^2\ C^{-2}}$ | |
| Electron charge | $e = -1.60 \times 10^{-19}\ \mathrm{C}$ | |
| Electron mass | $m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$ | |
| Electronvolt | $1\ \mathrm{eV} = 1.60 \times 10^{-19}\ \mathrm{J}$ | |
| Gravitational constant | $G = 6.67 \times 10^{-11}\ \mathrm{N\ m^2\ kg^{-2}}$ | |
| Gravitational field strength | $g = 9.81\ \mathrm{N\ kg^{-1}}$ | (close to Earth's surface) |
| Permittivity of free space | $\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\ m^{-1}}$ | |
| Planck constant | $h = 6.63 \times 10^{-34}\ \mathrm{J\ s}$ | |
| Proton mass | $m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$ | |
| Speed of light in a vacuum | $c = 3.00 \times 10^{8}\ \mathrm{m\ s^{-1}}$ | |
| Stefan-Boltzmann constant | $\sigma = 5.67 \times 10^{-8}\ \mathrm{W\ m^{-2}\ K^{-4}}$ | |
| Unified atomic mass unit | $u = 1.66 \times 10^{-27}\ \mathrm{kg}$ | |

***Unit 1***

*Mechanics*

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

*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<br>Stress $\sigma = F/A$<br>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 | $P = VI$<br>$P = I^2R$<br>$P = V^2/R$<br>$W = VIt$ |
| | $\%\ \text{efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100$ |
| | $\%\ \text{efficiency} = \dfrac{\text{useful power output}}{\text{total power input}} \times 100$ |
| Resistivity | $R = \rho l/A$ |
| Current | $I = \Delta Q/\Delta t$<br>$I = nqvA$ |
| 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 | $hf = \phi + \frac{1}{2}mv^2_{max}$ |

**Unit 4**

*Mechanics*

| | |
|---|---|
| Momentum | $p = mv$ |
| Kinetic energy of a non-relativistic particle | $E_k = p^2/2m$ |
| Motion in a circle | $v = \omega r$<br>$T = 2\pi/\omega$<br>$F = ma = mv^2/r$<br>$a = v^2/r$<br>$a = r\omega^2$ |

*Fields*

| | |
|---|---|
| Coulomb's law | $F = kQ_1Q_2/r^2$ where $k = 1/4\pi\varepsilon_0$ |
| Electric field | $E = F/Q$<br>$E = kQ/r^2$<br>$E = V/d$ |
| 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 | $F = BIl \sin\theta$<br>$F = Bqv \sin\theta$<br>$r = p/BQ$ |
| 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 | $\mathrm{d}N/\mathrm{d}t = -\lambda N$ |
| | $\lambda = \ln 2/t_{½}$ |
| | $N = N_0 e^{-\lambda t}$ |

*Mechanics*

| | |
|---|---|
| Simple harmonic motion | $a = -\omega^2 x$<br>$a = -A\omega^2 \cos \omega t$<br>$v = -A\omega \sin \omega t$<br>$x = A \cos \omega t$<br>$T = 1/f = 2\pi/\omega$ |
| Gravitational force | $F = Gm_1m_2/r^2$ |

*Observing the universe*

| | |
|---|---|
| Radiant energy flux | $F = L/4\pi d^2$ |
| Stefan-Boltzmann law | $L = \sigma T^4 A$<br>$L = 4\pi r^2 \sigma T^4$ |
| 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 | $v = H_0 d$ |

**BLANK PAGE**