Write your name here

| Surname | Other names |
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**Pearson Edexcel**
**International Advanced Level**

Centre Number | Candidate Number

# Physics
## Advanced
## Unit 6: Experimental Physics

Tuesday 15 May 2018 – 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.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

P51943A

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P 5 1 9 4 3 A 0 1 2 0

Pearson

**Answer ALL questions in the spaces provided.**

**1** A student has a sample of wire made of an unknown metal.

In order to identify the metal, she determines its resistivity.

(a) The student estimates that the diameter of the wire is approximately 0.5 mm.

She measures the diameter of the wire using a micrometer screw gauge.

(i) Explain why the micrometer screw gauge is an appropriate instrument for this measurement.

**(2)**

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(ii) Describe two techniques she should use to make this measurement as accurate as possible.

**(2)**

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(iii) She measures the diameter as 0.275 mm ± 0.003 mm.

Calculate the percentage uncertainty in the measurement of the diameter.

**(1)**

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Percentage uncertainty = ..............................................

(b) The student measures the length and resistance of the wire and obtains the following results.

length = 0.800 m ± 0.001 m

resistance = 6.48 Ω ± 0.03 Ω

(i) Calculate the resistivity of the metal.

**(2)**

Resistivity = ..............................

(ii) Calculate the percentage uncertainty in your value of resistivity.

**(3)**

Percentage uncertainty = ..............................

(c) The table lists the resistivity of some metals used in resistance wires.

| **Metal** | **Resistivity / Ω m** |
|---|---|
| constantan | $4.9 \times 10^{-7}$ |
| copper | $1.7 \times 10^{-8}$ |
| mild steel | $1.5 \times 10^{-7}$ |
| nichrome | $1.1 \times 10^{-6}$ |

Explain which metal the wire is most likely to be made from.

**(3)**

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**(Total for Question 1 = 13 marks)**

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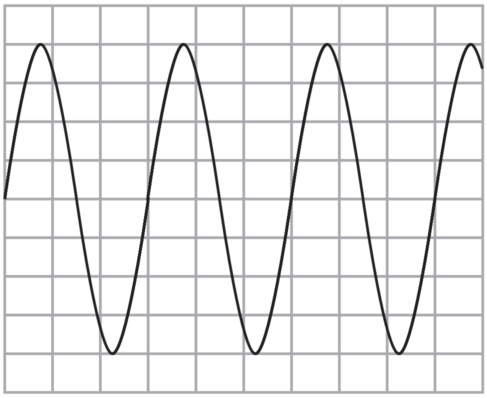
**2** (a) A student connects a variable frequency signal generator to an oscilloscope.

The oscilloscope displays how the output from the signal generator varies with time as shown.



On the horizontal scale of the oscilloscope screen, one division represents 50 ms.

Show that the frequency of the signal is about 6.7 Hz.

**(2)**

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(b) The student uses the variable frequency signal generator as a variable alternating current power supply and connects it to a coil of wire.

A coil of wire has a property known as impedance $Z$, which is given by

$$Z = \frac{V}{I}$$

where $V$ is the potential difference across the coil and $I$ is the alternating current through the coil.

$Z$ is thought to vary with the frequency $f$ of the alternating current as

$$Z^2 = 4\pi^2 L^2 f^2 + K^2$$

where $L$ and $K$ are constants.

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Write a plan for an investigation to verify the relationship $Z^2 = 4\pi^2 L^2 f^2 + K^2$ using a graphical method.

Your plan should include:

(i) any additional components required,

**(1)**

(ii) the measurements to be taken,

**(2)**

(iii) how the measurements will be used,

**(3)**

(iv) a sketch of the expected graph.

**(1)**

**(Total for Question 2 = 9 marks)**

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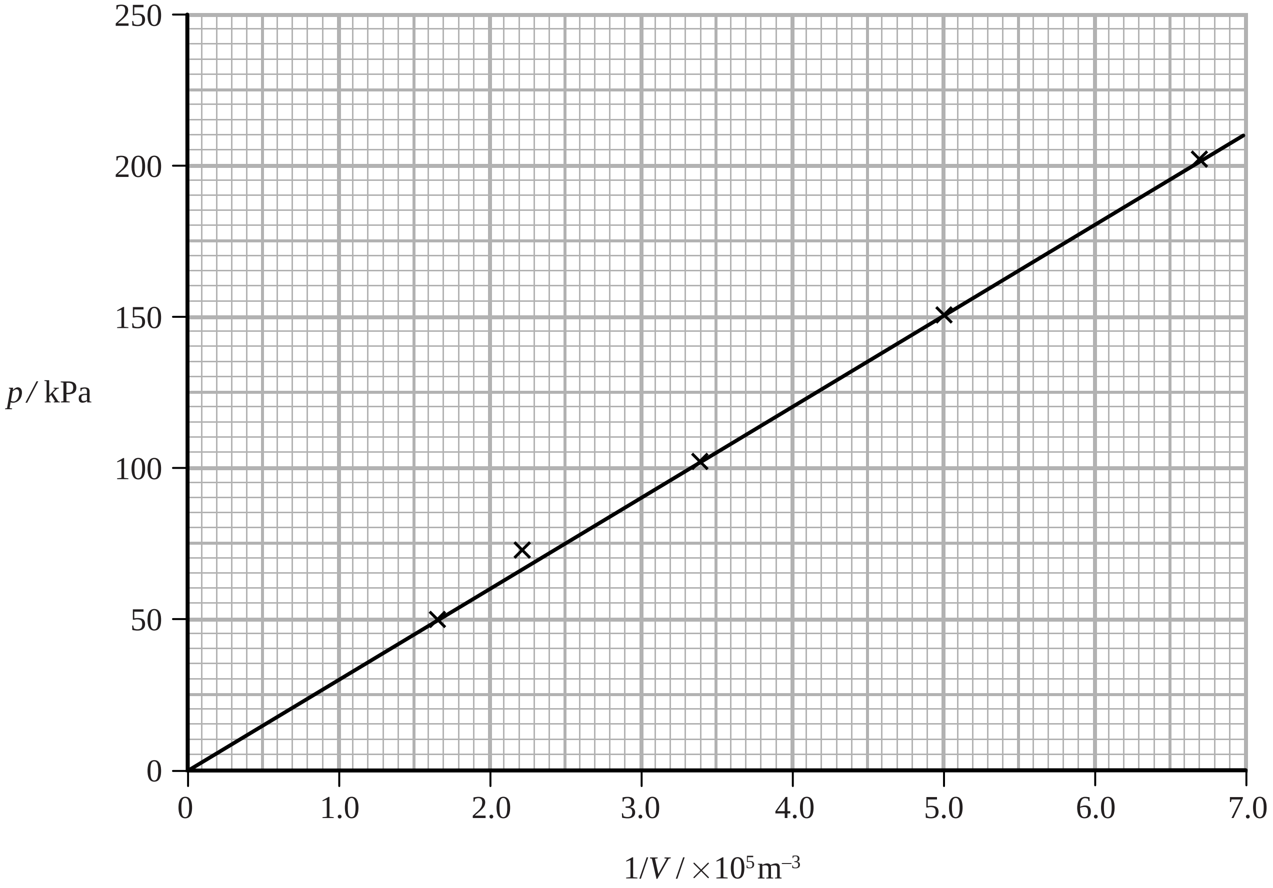
**3** A student investigates how the volume *V* of air in a syringe varies with pressure *p*.

She plots a graph of *p* against 1/*V* as shown.




(a) Determine the gradient of the graph.

**(2)**

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Gradient = ..............................................................

(b) The investigation is carried out at a temperature of 25 °C.

Calculate the number of molecules of air in the syringe.

**(2)**

Number of molecules of air = ........................................

**(Total for Question 3 = 4 marks)**

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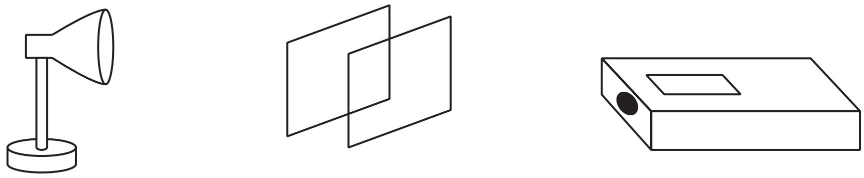
**4** A student places two polaroid filters together. He notices that when he rotates one filter relative to the other, the intensity of transmitted light changes.

He investigates this effect using the arrangement shown.




(a) (i) State why the student should keep the distance between the filament lamp and the light meter constant.

**(1)**

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(ii) State the main source of uncertainty in this investigation.

**(1)**

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(b) The relationship between the measured light intensity $I$ and the angle $\theta$ between the filters is given by

$$I = k(\cos\theta)^n$$

where $k$ and $n$ are constants.

(i) Explain why a graph of log $I$ against log $(\cos\theta)$ should produce a straight line.

**(2)**

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(ii) The student records the following data.

| $\theta$ / ° | $I$ / lux | $\cos\theta$ | | |
|---|---|---|---|---|
| 30 | 398 | 0.866 | | |
| 40 | 330 | 0.766 | | |
| 50 | 256 | 0.643 | | |
| 60 | 172 | 0.500 | | |
| 70 | 105 | 0.342 | | |
| 80 | 40 | 0.174 | | |

Plot a graph of log $I$ against log ($\cos\theta$) on the grid opposite. Use the additional columns to record your processed data.

**(6)**

(iii) Determine the value of $n$.

**(2)**

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$n$ = ........................................

(iv) Determine the value of $k$.

**(2)**

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$k$ = ........................................

**(Total for Question 4 = 14 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 | $P = VI$<br>$P = I^2R$<br>$P = V^2/R$<br>$W = VIt$ |

$$\% \text{ efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$$

$$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{total power input}} \times 100$$

| | |
|---|---|
| Resistivity | $R = \rho l/A$ |
| Current | $I = \Delta Q/\Delta t$<br>$I = nqvA$ |
| 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 | $hf = \phi + \frac{1}{2}mv^2_{max}$ |

**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 | $v = H_0 d$ |