Write your name here

Surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | Candidate Number

Physics

Advanced
Unit 6: Experimental Physics

Sample Assessment Material
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 ▶

S45371A

S 4 5 3 7 1 A 0 1 2 0

PEARSON

Answer ALL questions in the spaces provided.

1 A student is asked to determine the density of two coins, X and Y, to decide if they are made from the same material. The diameter of each coin is about 25 mm.

(a) (i) She uses vernier callipers to measure the diameter of coin X.

Show that the percentage uncertainty for this measurement is less than 1%.

(1)

....

....

(ii) Apart from repeating her readings, state one precaution she could take to ensure each measurement is as accurate as possible.

(1)

....

....

(iii) The student measures the thickness of coin X using a micrometer screw gauge. She takes measurements at different points on the coin.

Explain why this would make the mean value for the thickness more accurate.

(1)

....

....

(b) She records the following values for coin X:

diameter/mm 25.9, 25.9, 25.9

thickness/mm 1.80, 1.84, 1.82

(i) Use these measurements to calculate the mean value for the volume of coin X.

(2)

....

....

....

....

....

Mean value for the volume of coin X = ...

(ii) Use the measurements to estimate the percentage uncertainty in the volume.

(3)

....

....

....

....

Percentage uncertainty = ...

(c) She measures the mass of coin X as 7.08 g with negligible uncertainty.

Calculate the density of coin X.

(2)

....

....

Density of coin X = ...

(d) The student makes the same measurements for coin Y. The value of the density for coin Y is 6900 kg m^{-3}. The percentage uncertainties in the measurements are the same for both coins.

Use these measurements to decide if the coins are made from the same material.

(2)

....

....

....

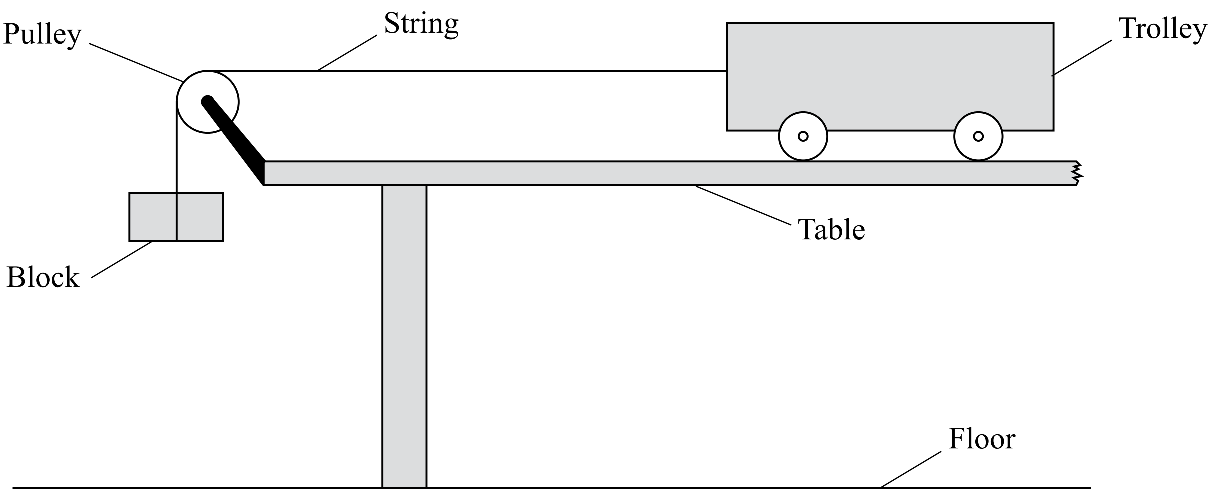
....

....

....

(Total for Question 1 = 12 marks)

2 A student is asked to carry out an experiment about the energy transferred when a trolley is pulled across a table. The apparatus is set up as shown.



As the block falls it loses gravitational potential energy and the trolley and block together gain kinetic energy. The student is asked to find out what fraction of the gravitational potential energy becomes kinetic energy.

The student writes an outline plan for an experiment and produces a table.

1. *Measure the mass M of the trolley and the mass m of the falling block and set up the apparatus as shown.*
2. *Pull back the trolley so that the block is close to the pulley and release the trolley.*
3. *Measure the distance d fallen by the block.*
4. *Measure the time t it takes to fall.*
5. *The final velocity is given by* $v = \frac{2d}{t}$.
6. *Calculate the gravitational potential energy lost and the kinetic energy gained.*
7. *Divide the kinetic energy by the gravitational potential energy. This is the fraction required.*

Quantity to be measured	**Measuring instrument**	**Precision of measuring instrument**
Masses, M and m		*At least 0.1 g*
Distance, d	*Metre rule*	
Time, t	*Stopwatch*	

Add more detail to improve this plan. You should do the following:

(a) complete the table,
(3)

(b) add a line to the diagram to show the distance *d*,
(1)

(c) describe how you would measure *d* accurately (you may add more to the diagram if you wish),
(2)

(d) describe how you would make each measurement of *t* accurate,
(1)

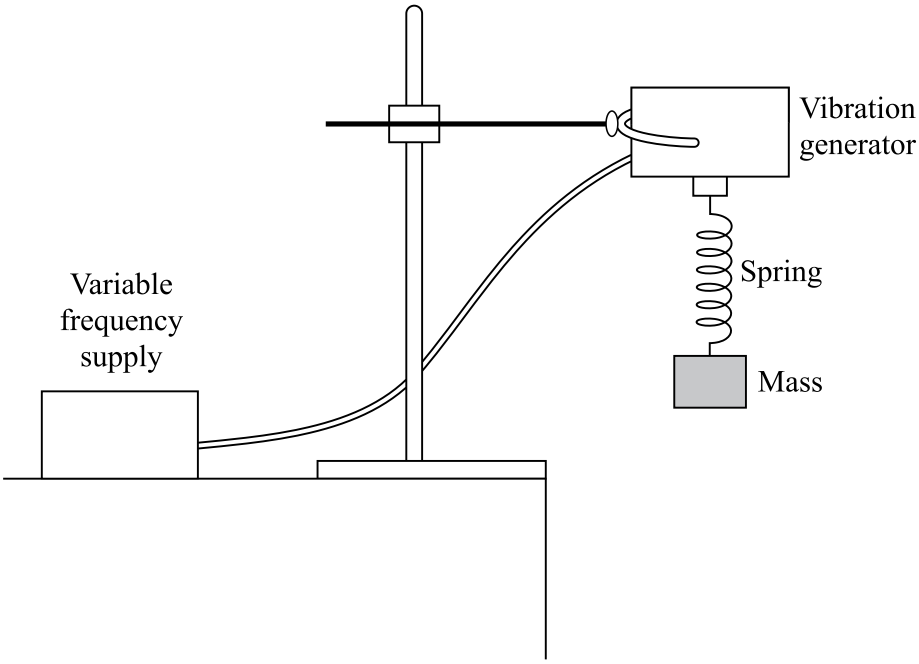
(e) comment on any safety aspect of this experiment.
(1)

(Total for Question 2 = 8 marks)

3 A mass is hung on a spring as shown in the diagram. When the mass is pulled down and released, it oscillates at the natural frequency of the system.

When the top of the spring is forced to move up and down at this natural frequency, resonance occurs.

The system below is set up to observe what happens to the oscillations of the mass as the frequency *f* of the vibration generator is varied.



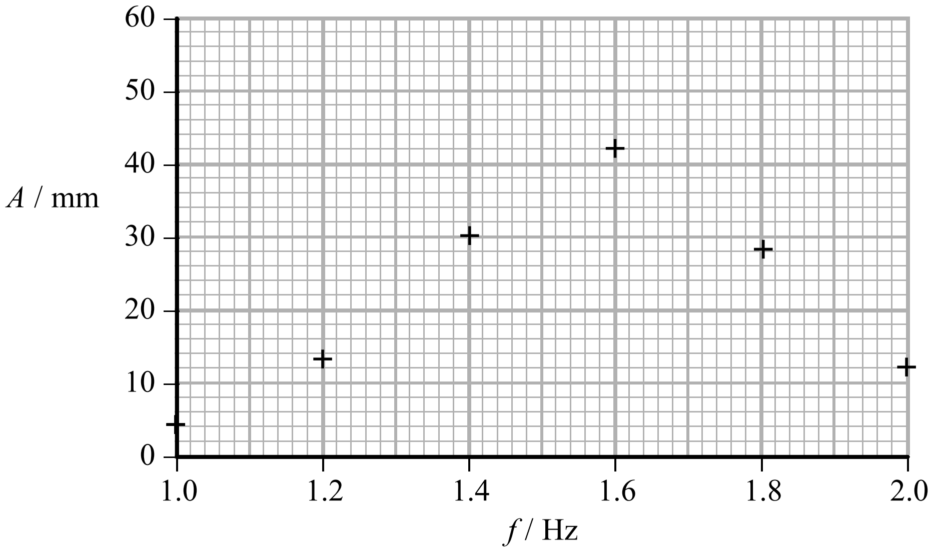
(a) State what you would observe as *f* gets close to the resonant frequency.

(1)

....

....

(b) As f is varied, the amplitude of oscillation A of the mass is recorded. The results are shown on the graph.



(i) Use the graph to estimate the resonant frequency.

(1)

Resonant frequency = ... Hz

(ii) Describe how you would improve the experiment to obtain a more accurate value for the resonant frequency.

(2)

....

....

....

....

....

(iii) Suggest why it would be better to use an ultrasound position sensor and data logger to record the position of the mass.

(1)

....

....

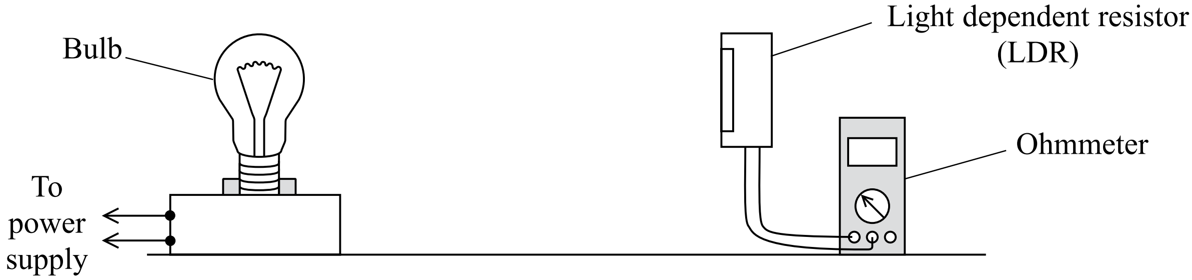
....

....

(Total for Question 3 = 5 marks)

BLANK PAGE

4 A physicist investigates how light intensity varies with distance from a light bulb. He sets up the apparatus as shown.



(a) Mark on the diagram the exact distance d he should measure.

(1)

(b) State why the resistance R of the LDR will increase as it gets further away from the bulb.

(1)

....

....

(c) State the most important quantity to control to ensure a fair test and explain how the physicist might control it.

(2)

....

....

....

....

(d) The relationship between R and d is given by

$$R = k\,d^{\mathrm{p}}$$

where k and p are constants.

Explain why a graph of ln R against ln d will give a straight line.

(2)

....

....

....

....

(e) He measures R for different values of d and records the following results.

***d*/m**	***R*/kΩ**		
1.00	1.79		
1.20	2.24		
1.60	3.32		
2.00	4.04		
2.20	4.70		
2.60	5.50		

Plot a graph of ln R against ln d. Use the column(s) provided to show any processed data.

(5)

(f) (i) Use your graph to find a value for p.

(2)

....

....

p = ...

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

(2)

....

....

k = ...

(Total for Question 4 = 15 marks)

TOTAL FOR PAPER = 40 MARKS

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

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	$\mathrm{d}N/\mathrm{d}t = -\lambda N$
	$\lambda = \ln 2/t_{½}$
	$N = N_0 e^{-\lambda t}$

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	$v = H_0 d$

BLANK PAGE

BLANK PAGE

BLANK PAGE