Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Physics

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

Monday 21 May 2012 – Morning
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 ▶

P39858A

©2012 Pearson Education Ltd.

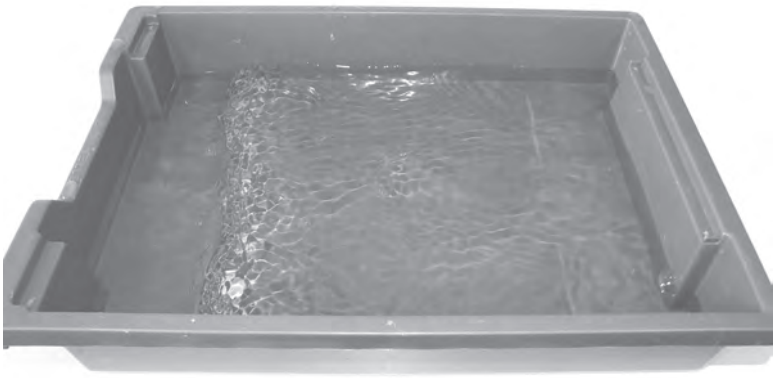
6/6/6/6/

P 3 9 8 5 8 A 0 1 2 0

PEARSON

Answer ALL questions.

1 A shallow tray holds water. The depth d of the water is about 2 cm.



(a) (i) Describe how you would measure d to a precision of 1 mm.

(1)

(ii) Estimate the percentage uncertainty in this measurement.

(1)

(b) One side of the tray is lifted up 2 cm and dropped. This causes a wave to cross the surface of the water. The wave is reflected from side to side across the surface.

The wave takes a time t to cross the surface once.

Describe how you would determine an accurate value for t.

(2)

(c) A student measures the distance across the tray as 33.4 cm with an uncertainty of 0.2 cm.

She then determines $t = 0.92$ s with an uncertainty of 0.03 s.

(i) Use these measurements to calculate v, the velocity of the wave.

(1)

(ii) Estimate the percentage uncertainty in your value for v.

(2)

(d) The student is told that

$$v^2 = kd$$

where k is a constant.

(i) She measures the depth d as 2.1 cm. Calculate a value for k.

(1)

(ii) Use your previous answers to estimate the percentage uncertainty in k.

(1)

(e) It is suggested that the value for k is equal to the strength of the Earth's gravitational field 9.81 N kg^{-1}.

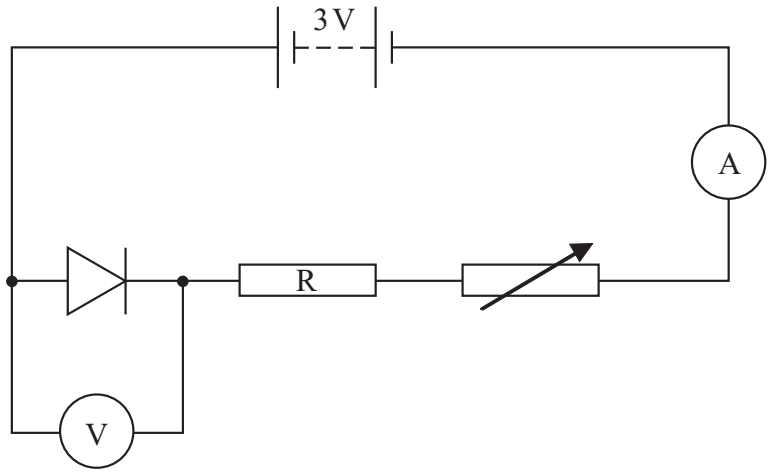
Use your calculations to discuss whether these results support the suggestion.

(2)

(Total for Question 1 = 11 marks)

2 A student is asked to investigate how the current through a semiconductor diode varies with temperature. The potential difference across the diode is kept constant.

The student is given the circuit shown.



(a) Explain why it is necessary to have a fixed resistor R in the circuit.

(2)

.....

.....

.....

.....

(b) The student heats the diode using a small beaker of water.

Draw a diagram to show how you could set up this experiment safely in the laboratory. You need show no electrical components other than the diode in your diagram.

(2)

(c) The temperature is varied and the variable resistor is adjusted to keep the reading on the voltmeter constant. Readings are then taken of the current and the temperature.

(i) The student removes the heat source before taking each reading.

Explain why this will improve the accuracy of the experiment.

(1)

.....

.....

.....

(ii) Give **two** more precautions the student should take to ensure his data are accurate and reliable.

(2)

.....

.....

.....

.....

(d) State why you would expect the current to increase as the temperature increases.

(1)

.....

.....

(Total for Question 2 = 8 marks)

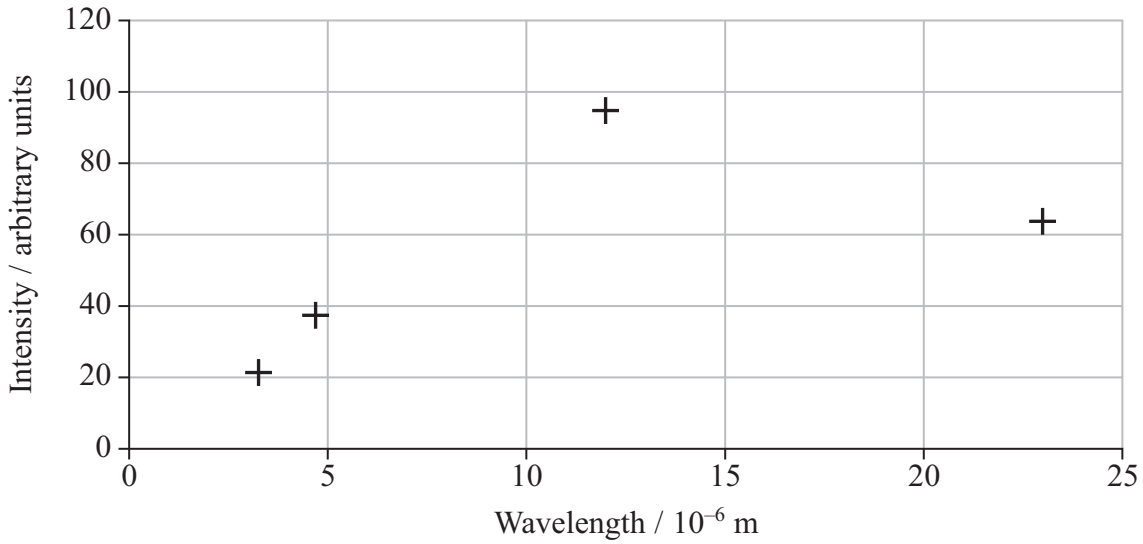
3 Wien's Law states that $\lambda_{max}\ T = 2.898 \times 10^{-3}$ m K

This can be used to estimate the temperature T of distant objects by determining λ_{max}.

A very distant asteroid is observed for the first time and an astronomer measures the intensity of the radiation, in arbitrary units, at four wavelengths.

Wavelength / 10^{-6} m	**Intensity / arbitrary units**
3.3	21
4.7	38
12.0	95
23.0	64

The data is plotted as shown.



(a) (i) On the graph draw a best fit line to show where the intensity is a maximum.

(2)

(ii) Hence estimate the wavelength, λ_{max}, at which the intensity is a maximum.

(1)

λ_{max} = ...

(b) Use Wien's Law to calculate a value for the temperature of the asteroid.

$$\lambda_{max}\, T = 2.898 \times 10^{-3} \text{ m K}$$

(2)

(c) New data like this must be reliable before it is accepted.

Give **two** reasons why any conclusion drawn from this data might not be very reliable.

(2)

(Total for Question 3 = 7 marks)

BLANK PAGE

4 A bar magnet is suspended by a thread attached to a wooden support. The bar magnet hangs horizontally as shown and lines up with the Earth's magnetic field.

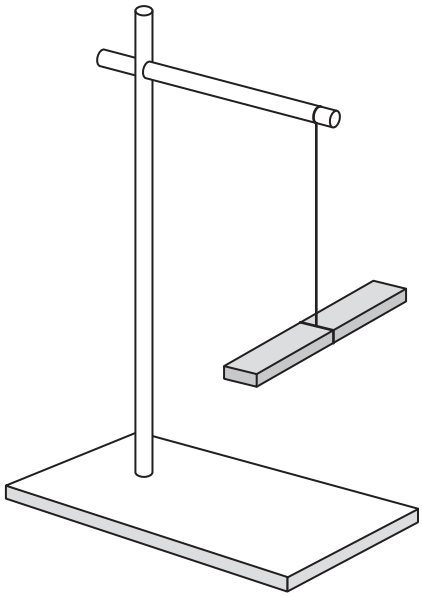


Figure 1

(a) State why the support should be made of wood and not steel.

(1)

.....

.....

(b) The magnet is rotated horizontally about its centre through approximately 20° from its equilibrium position. When it is released it oscillates in a horizontal plane about the string.

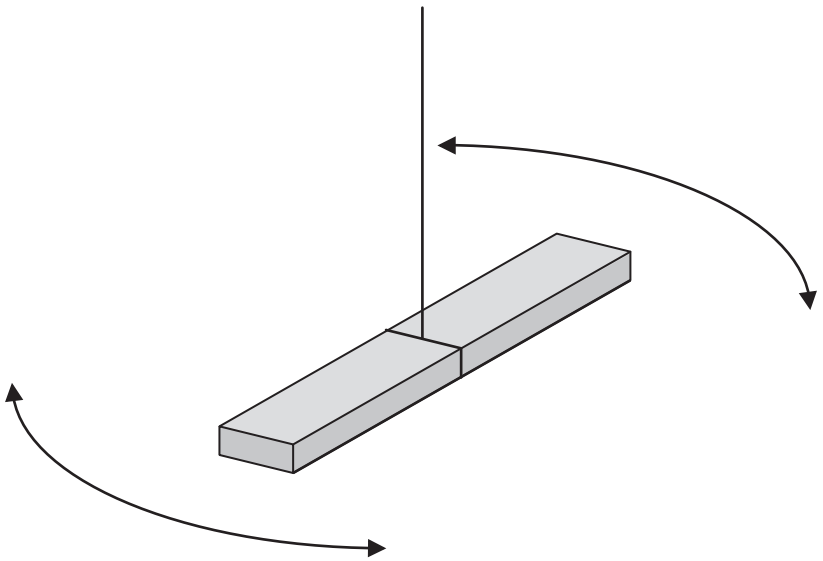


Figure 2

Describe how you would measure the period of these oscillations as accurately as possible.

(3)

(c) You are told that these oscillations are lightly damped.

State what you would observe if the oscillations were heavily damped.

(1)

(d) A large coil of wire is now placed vertically around the centre of the magnet.

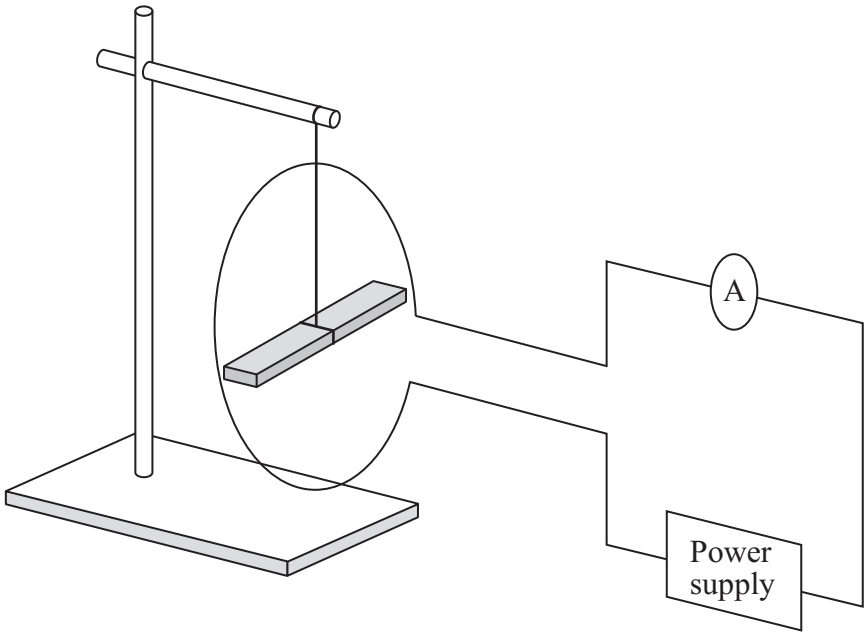


Figure 3

When current is passed through the coil it produces a magnetic field **in the same direction** as the Earth's magnetic field. When the magnet is again rotated horizontally, it oscillates at an increased frequency.

(i) A student thinks that the period T of the oscillations is related to the current in the coil I by

$$\frac{1}{T^2} = kI$$

where k is a constant.

Explain why this suggests a graph of $1/T^2$ against I will produce a straight line through the origin.

(2)

.....

.....

.....

.....

(ii) The student carries out an experiment to measure T as I is varied. He obtains the following data.

***I* / A**	**Mean T / s**	
0	1.230	
1.00	0.827	
2.00	0.673	
3.00	0.581	
4.02	0.520	
5.01	0.475	

Use the grid opposite to draw a graph that would test the relationship

$$\frac{1}{T^2} = kI$$

Use the column provided to show any processed data.

(5)

(iii) His teacher suggests that the equation

$$\frac{1}{T^2} = kI + b$$

is a better mathematical model for the data.

Explain why his teacher is right.

(2)

.....

.....

.....

.....

(Total for Question 4 = 14 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	$Q = Q_0e^{-t/RC}$
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	$\lambda = h/p$

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	$v = H_0 d$

BLANK PAGE

BLANK PAGE

BLANK PAGE