Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Physics

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

Wednesday 19 May 2010 – 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 ▶

6/6/6/4/
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Answer ALL questions.

1 A student is taking measurements from a piece of wire.

(a) She measures the diameter *d* using a micrometer. She obtains the following readings.

d/mm	0.27, 0.29, 0.26, 0.77, 0.26

(i) Explain how you would use her readings to obtain the most accurate mean value for the diameter of the wire.

(1)

....

....

....

(ii) Use her readings to obtain the most accurate mean value for the diameter of the wire.

(1)

....

....

Wire diameter = ...

(iii) Estimate the percentage uncertainty in your value for the diameter of the wire.

(2)

....

....

....

....

Percentage uncertainty = ...

(b) She then makes the following measurements.

length of wire = 663 mm
mass of wire = 0.32 g

(i) Use her measurements to calculate the volume of the wire.

(2)

Volume = ...

(ii) Calculate the density of the material of the wire.

(2)

Density = ...

(c) The tables below are taken from a data book.

Material	**Density / kg m^{-3}**
Zinc alloy	7200
Iron	7900
Nichrome	8300
Constantan	8900

Standard thickness	**Diameter / mm**
34 swg	0.234
32 swg	0.274
30 swg	0.315
28 swg	0.376

Use the information in the tables to identify the material of the wire and its standard thickness.

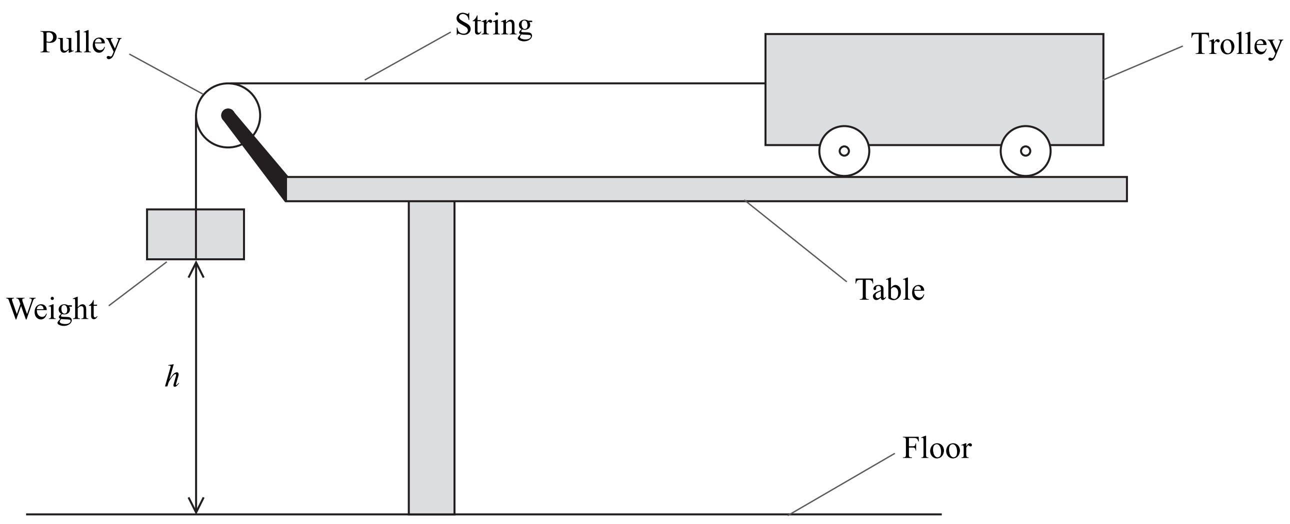
(2)

Material of wire is ....

Standard thickness of wire is ....

(Total for Question 1 = 10 marks)

2 A student is investigating kinetic energy. He sets up the apparatus as shown.



The trolley starts from rest with the weight close to the pulley and at a height *h* above the floor.

(a) Describe how you would measure the height *h*. You may add to the diagram if you wish.

(1)

....

....

....

(b) The student records the distance *h* and the time *t* it takes for the weight to fall to the floor. His measurements are shown below.

$h = 885$ mm

t/s	2.94	2.76	3.28	3.15	3.02

The maximum velocity of the trolley is given by $\frac{2h}{t}$

(i) Estimate the uncertainty in the value for *h*. This should relate to your method in part (a).

(1)

....

N 3 6 2 2 6 A 0 4 1 6

(ii) Estimate the uncertainty in the readings for *t*.

(1)

....

....

(iii) Calculate the mean maximum velocity.

(1)

....

....

....

Maximum velocity = ...

(iv) The mass of the trolley is 0.930 kg and the falling weight has a mass of 0.030 kg. Calculate a value for the total maximum kinetic energy of the trolley and weight.

(1)

....

....

Maximum kinetic energy = ...

(v) Estimate the percentage uncertainty in your calculated value for the kinetic energy.
Assume the uncertainty in the values of both masses is negligible.

(2)

....

....

....

....

....

....

Percentage uncertainty = ...

(Total for Question 2 = 7 marks)

3 In 2006 astronomers determined a new value for the Hubble constant. They calculated the velocity of recession v for a number of stars at a distance d from the Earth. They used units of km s^{-1} for v and Mpc (Megaparsecs) for d.

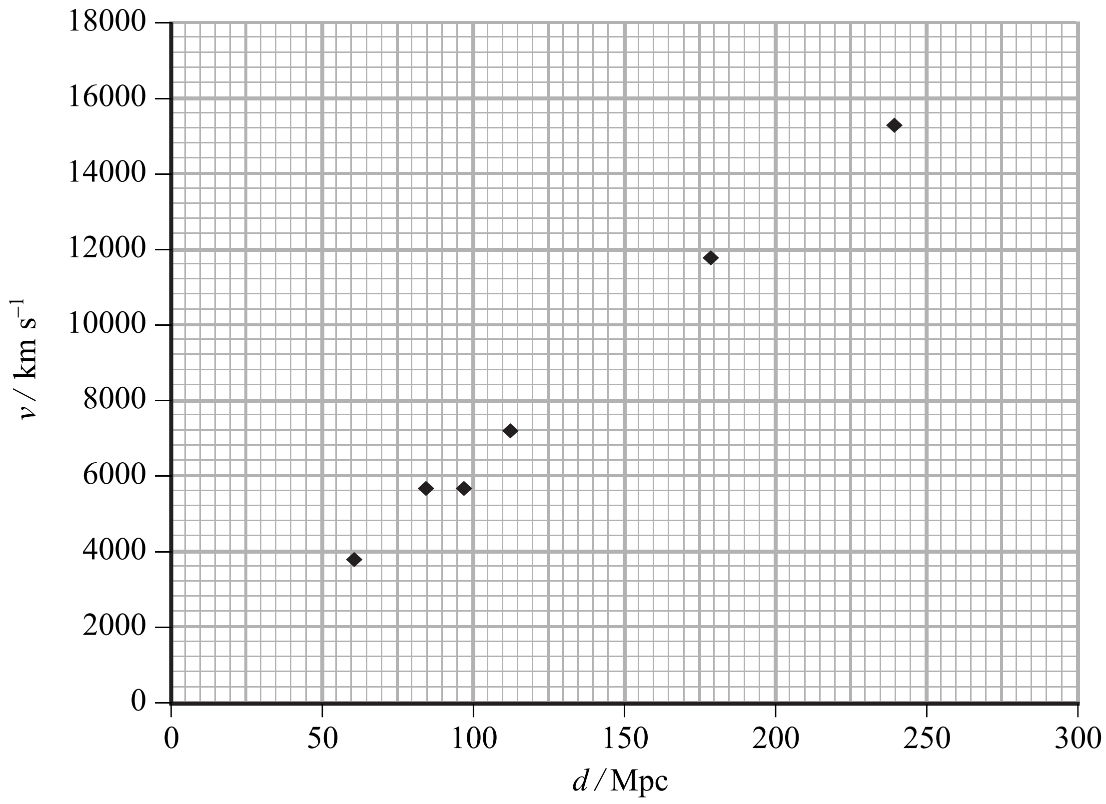
(a) What might an astronomer actually measure to calculate a value for v?

(1)

....

....

(b) The graph below is a plot of their data.



(i) Draw a line of best fit for this data.

(1)

(ii) Determine the gradient of your line.

(2)

....

....

Gradient = ...

(c) (i) Hubble's law states that v is directly proportional to d. Explain whether the plotted data supports Hubble's law.

(1)

....

....

(ii) The value of the gradient is the Hubble constant.
Until 2006, the accepted value of the Hubble constant was 71 km s^{-1} Mpc^{-1}.
Calculate the percentage difference between this accepted value and your value.

(1)

....

....

Percentage difference = ...

(Total for Question 3 = 6 marks)

4 *You are to plan an experiment to investigate the ability of gamma rays to penetrate lead. You are then to analyse a set of data from such an experiment.*

(a) You have a source of radiation and a detector and counter. Describe briefly a simple experiment to confirm that the source emits gamma radiation.

(3)

(b) You are provided with sheets of lead and apparatus to support them safely between the source and the detector.

The thickness of lead affects the count rate. Describe the measurements you would make to investigate this.

Your description should include:

- a variable you will control to make it a fair investigation
- how you will make your results as accurate as possible
- one safety precaution.

(6)

(c) For gamma rays passing through lead of thickness x, the count rate A is given by

$$A = A_0 \, e^{-\mu x}$$

where A_0 is the count rate when there is no lead between source and detector, and μ is a constant.

Explain why a graph of ln A against x should be a straight line.

(1)

....

....

....

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

The background count was 40 minute^{-1}.

x / mm	Measured Count Rate / minute^{-1}		
0	1002		
6.30	739		
12.74	553		
19.04	394		
25.44	304		
31.74	232		

Use the column(s) provided for your processed data, and then plot a suitable graph on the grid opposite to show that these data are consistent with $A = A_0 \, e^{-\mu x}$.

(5)

(e) Use your graph to determine a value for the constant μ.

(2)

....

....

....

μ = ...

(Total for Question 4 = 17 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's 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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\% \text{ efficiency} = \frac{\text{useful energy output}}{\text{energy input}} \times 100$
	$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{power input}} \times 100$
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	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

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	$v = \omega r$ $T = 2\pi/\omega$ $F = ma = mv^2/r$ $a = v^2/r$ $a = r\omega^2$

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	$\varepsilon = -\mathrm{d}(N\phi)/\mathrm{d}t$

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	$dN/dt = -\lambda N$
	$\lambda = \ln 2/t_{½}$
	$N = N_0e^{-\lambda t}$

Mechanics

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

Observing the universe

Radiant energy flux	$F = L/4\pi d^2$
Stefan-Boltzmann law	$L = \sigma T^4A$ $L = 4\pi r^2\sigma T^4$
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	$v = H_0d$