Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Physics

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

Monday 6 June 2011 – 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.*
- Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

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 ▶

6/6/6/6/

P 3 8 4 1 9 A 0 1 1 6

edexcel
advancing learning, changing lives

Answer ALL questions.

1 A student wishes to find the density of a metre rule.

The width of the rule is about 28 mm and the thickness is about 6 mm.

(a) In the table below write the names of the instruments you would use to make each of these measurements.

Measurement	**Instrument**
Width	
Thickness	

Give a reason for your choices.

(2)

....

....

(b) The student records measurements from several positions along the rule.

Width/mm	28.2, 29.3, 28.9, 29.0, 29.1
Thickness/mm	6.04, 5.94, 5.97, 6.01, 5.99
Mass/g	106.4

Use these measurements to calculate a value for the density of the rule.

(3)

....

....

....

....

....

....

Density = ...

(c) Estimate the percentage uncertainty in your value for the density. Assume the uncertainty in the mass is negligible.

(3)

....

....

....

....

....

....

....

....

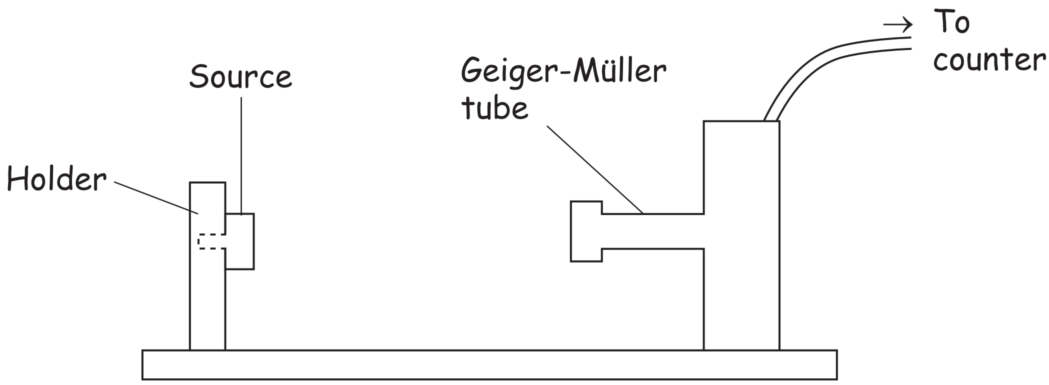
Percentage uncertainty for the density = ...

(Total for Question 1 = 8 marks)

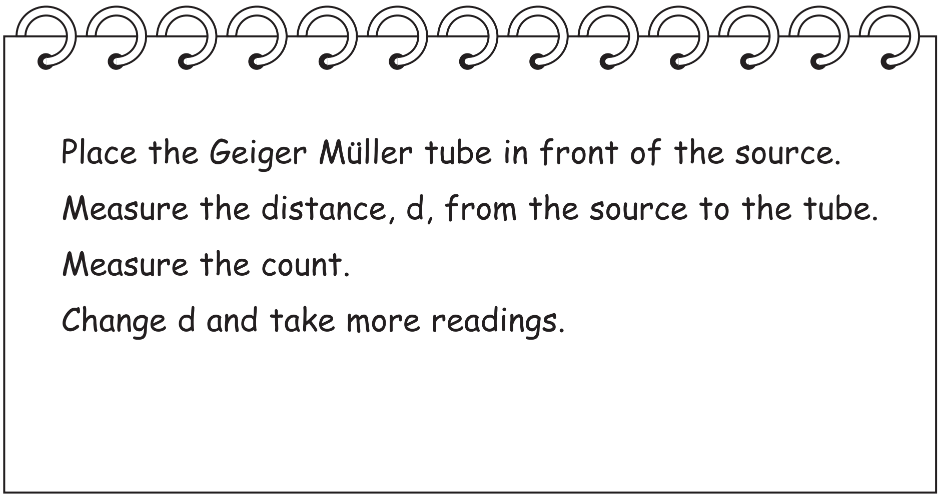
2 A student writes a plan to obtain a value for the distance travelled in air by alpha particles.

He plans to use an alpha particle source, a Geiger-Müller tube with a thin window and a counter.

His diagram is shown below.



He writes the following plan



His teacher says that the plan needs more detail.

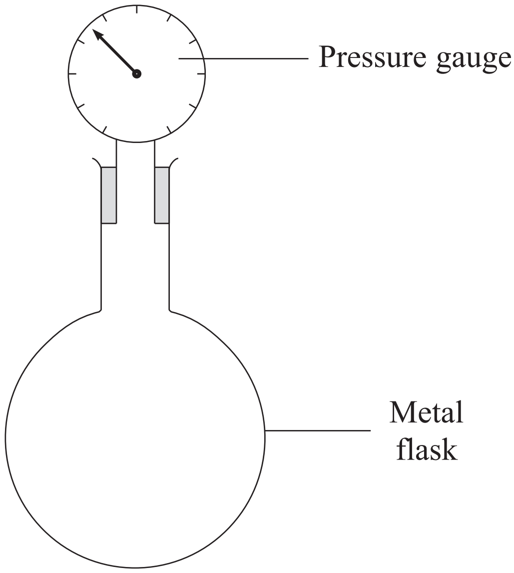
Add more detail to improve this plan, include one safety precaution he should take.

You may add to the diagram if you wish.

(6)

(Total for Question 2 = 6 marks)

3 The diagram below shows a flask containing air. A pressure gauge is screwed into the top of the flask.



You are to plan an experiment to see how the pressure of the air in the flask varies with temperature.

(a) (i) Add to the diagram to show how you would vary the temperature of the air in the flask.

(2)

(ii) Describe how you would change the temperature over the range 0 °C to 100 °C.

(1)

....

....

....

(iii) Suggest how you would determine the temperature of the air in the flask.

(1)

....

....

....

(iv) Describe what you would do to make your readings as accurate as possible.

(2)

....

....

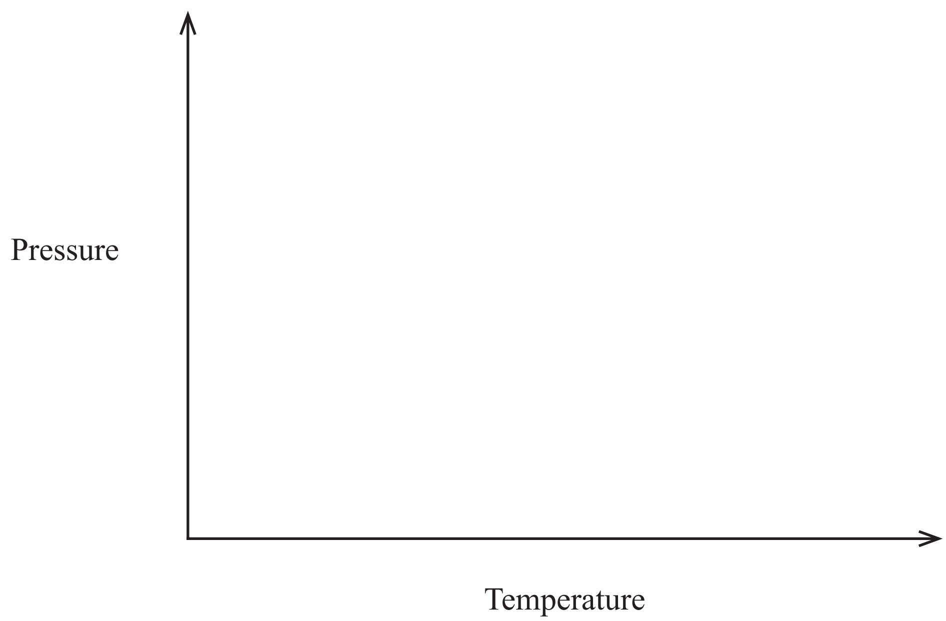
....

....

....

(b) Use the axes below to show how you would expect the pressure of the air in the flask to vary with temperature.

(3)



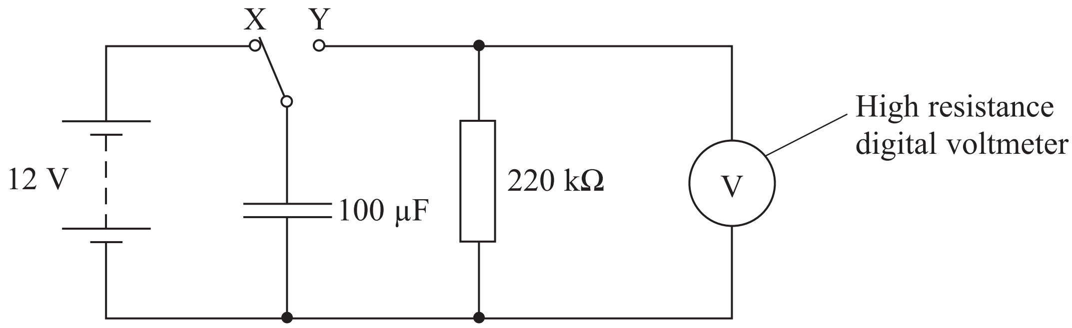
(Total for Question 3 = 9 marks)

4 A designer needs a circuit that will cause a delay in switching off the interior light in a car after the door is shut.

She uses a circuit with a resistor and a capacitor. She knows that the time constant T is given by

$$T = RC$$

where R is the resistance in ohms and C is the capacitance in farads.



With the switch in position X the capacitor is charged to 12 V. When the switch is moved to position Y the capacitor discharges through the resistor and the potential difference (p.d.) across the resistor falls steadily from 12 V.

(a) (i) Calculate a theoretical value for the time constant for this circuit.

(1)

....

....

Time constant = ...

(ii) What is the significance of the time constant for such a discharge?

(1)

....

....

(b) She decides to check the theoretical value for the time constant T using a stopwatch, with a precision of 0.01 s.

(i) State why the voltmeter needs to have a high resistance.

(1)

....

....

....

(ii) State why a stopwatch is suitable for measuring the time in this context.

(1)

....

....

....

(iii) State what she should do to make her value for T as reliable as possible.

(1)

....

....

....

(c) For a capacitor discharging through a resistor, the potential difference V across the resistor at time t is given by

$$V = V_0 \, e^{-t/RC}$$

Explain why a graph of ln V against t should be a straight line.

(2)

....

....

....

....

Question 4 continues on the next page

(d) The designer uses the circuit to obtain the following data.

t/s	V/V	
0	12.00	
5	9.41	
10	7.16	
15	5.49	
20	4.55	
25	3.49	
30	2.68	
35	2.04	

Plot a graph on the grid opposite to show that these data are consistent with $V = V_0\,e^{-t/RC}$.

Use the extra column in the table above for your processed data.

(4)

(e) (i) Use your graph to obtain another value for the time constant.

(2)

....

....

....

Time constant from the graph = ...

(ii) Calculate the percentage difference between your value from the graph and the theoretical value from (a)(i).

(1)

....

....

....

Percentage difference = ...

(f) (i) Use your graph to find how long it takes for the p.d. to decrease to 5.0 V.

Add to your graph to show how you did this.

(2)

....

....

....

(ii) The designer wants the p.d. to decrease to 5 V in about 12 s.
Mark with a cross (☒) the value of R she should use.

(1)

		***R*/kΩ**
☒	**A**	47
☒	**B**	100
☒	**C**	150
☒	**D**	330

(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 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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\% \text{ efficiency} = \dfrac{\text{useful energy output}}{\text{energy input}} \times 100$
	$\% \text{ efficiency} = \dfrac{\text{useful power output}}{\text{power input}} \times 100$
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	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

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

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	$v = H_0 d$