

Write your name here

Surname	Other names
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Centre Number	Candidate Number

Edexcel GCE

Physics

Advanced Level

Unit 6B: Experimental Physics

International Alternative to Internal Assessment

Tuesday 1 February 2011 – Morning Time: 1 hour 20 minutes	Paper Reference 6PH08/01
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You must have: Protractor, ruler.	Total Marks
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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.

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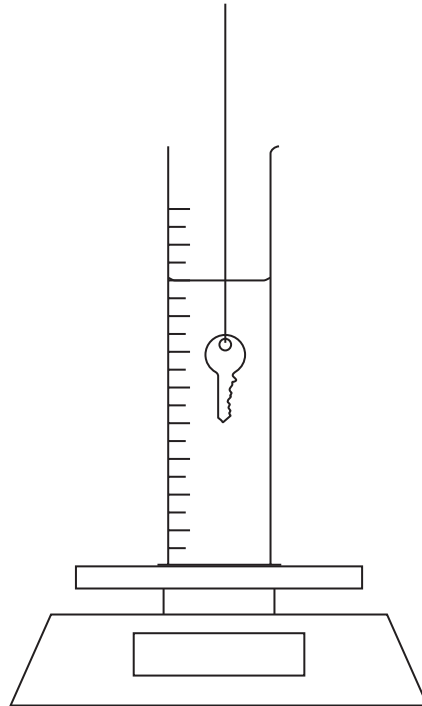


Turn over ►

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Answer ALL questions.

- 1 A student wants to find the density of a key by using a top pan balance to measure the upthrust acting on the key when it is suspended in water.



- (a) First, she finds the density of the water.

Using a top pan balance calibrated in newtons, she measures the weight of an empty measuring cylinder as 2.2305 N. She puts 191 cm^3 of water into the cylinder and measures the new weight as 4.1408 N. The measuring cylinder is left on the balance.

- (i) Use these measurements to calculate the weight of water in the cylinder.

(1)

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Weight of water = ...

- (ii) Show that the density of the water is about 1000 kg m^{-3} .

(2)

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(b) When an object is submerged in a fluid it experiences an upthrust equal to the weight of fluid displaced. In this experiment the balance reading will increase by the amount of this upthrust.

- (i) The student now suspends the key in the water and notes that the balance reading increases to 4.1671 N. Calculate the upthrust.

(1)

Upthrust = ...

- (ii) The upthrust U on the key is given by

$$U = V \rho g$$

where V is the volume of the key and ρ is the density of the water.

Calculate the volume of the key.

(2)

Volume = ...

- (iii) She measures the mass of the key on its own as 9.38 g.

Calculate the density of the key.

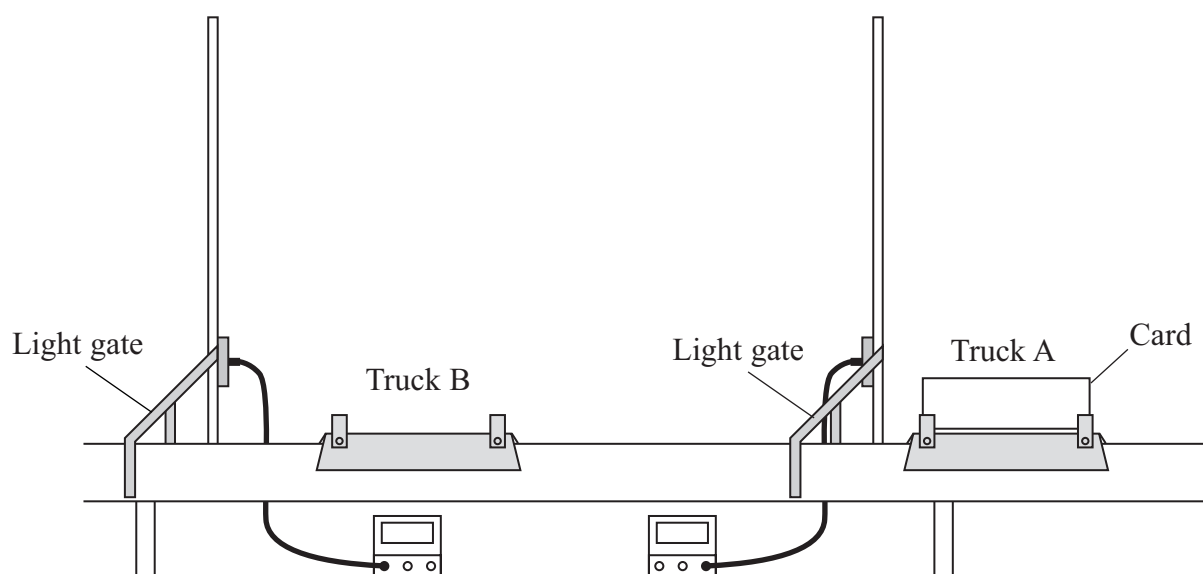
(2)

Density = ...

(Total for Question 1 = 8 marks)



- 2 A student has an air track which has two trucks, A and B, supported by a cushion of air. He does an experiment to see whether momentum is conserved when the two trucks collide.



- (a) Using an air track reduces friction on the trucks. State why this is important in a momentum conservation experiment.

(1)

- (b) The student uses two light gates as shown in the diagram. Truck A carries a card of negligible mass and length l . A light gate records the time t taken by the card to pass through it.

Explain how you would show that the air track is horizontal before starting the experiment.

(2)



- (c) Truck B carries no card and is placed so that it is stationary between the light gates. Truck A is set off towards truck B. As the card passes through the first gate it records a time t_1 . Truck A then collides with truck B. They stick together and move through the second gate which records the time t_2 .

Both trucks have the same mass. Explain why $t_2 = 2t_1$ if momentum is conserved.

(3)

- (d) The student records the following data for 5 separate collisions:

t_1/s	0.34	0.15	0.21	0.28	0.24
t_2/s	0.70	0.35	0.39	0.55	0.52
t_2/t_1	2.1	2.3	1.9	2.0	2.2

Use this data to discuss whether momentum can be considered to be conserved in this experiment.

(3)

(Total for Question 2 = 9 marks)



- 3 A student measures the energy stored in a capacitor of unknown capacitance.

She charges the capacitor to a potential difference V using a battery and then discharges the capacitor through a joulemeter which records the energy W stored in the capacitor. She uses two different batteries and records the following readings.

V/V	W/mJ			Mean W/mJ	C/mF
4.5	19.57	19.51	19.63		
6.0	36.14	36.12	36.22		

- (a) (i) For each potential difference, calculate the mean energy W stored in the capacitor. Hence calculate the capacitance C using the formula $W = \frac{1}{2} CV^2$.

Add your values to the table.

(2)

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- (ii) Calculate the percentage difference between your two values of C .

(1)

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Percentage difference = ...



(b) The uncertainty in the values of potential difference in the table is 0.1 V.

(i) Estimate the uncertainty in your mean value of W when using the 4.5 V battery.

(1)

Uncertainty = ...

(ii) Use these uncertainties to estimate the percentage uncertainty in the value of C obtained using the 4.5 V battery.

(2)

Percentage uncertainty = ...

(c) Explain whether the unknown capacitor could be a 2200 μF capacitor with a tolerance of 20%.

(2)

(Total for Question 3 = 8 marks)



N 3 7 5 0 5 A 0 7 1 6

4 You are to plan an experiment to investigate the rate of cooling of cooking oil. You are then to analyse a set of data from such an experiment.

- (a) You are provided with a thermometer and a stop clock to record temperature and time. You also have access to all usual laboratory apparatus.

A liquid loses heat at a rate proportional to its temperature difference above its surroundings. This leads to the temperature difference $\Delta\theta$ at a time t being given by

$$\Delta\theta = \Delta\theta_0 e^{-kt}$$

where k is a constant for the liquid.

Describe the measurements you would make to verify this relationship. 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.

(5)

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- (b) The following data were obtained using cooking oil. θ is the temperature at time t .
Room temperature = 22 °C

t/s	$\theta/^\circ\text{C}$		
0	70		
60	63		
120	56		
180	51		
240	46		
300	43		
360	39		



(i) Explain why a graph of $\ln \Delta\theta$ against t should be a straight line.

(1)

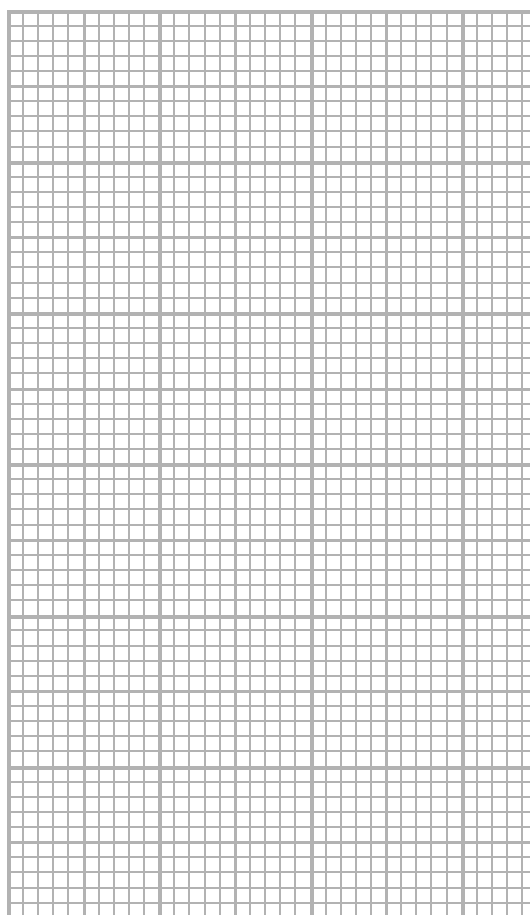
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(ii) Use the column(s) provided for your processed data, and then plot a suitable graph on the grid below to show that these data are consistent with $\Delta\theta = \Delta\theta_0 e^{-kt}$.

(5)



(iii) Use your graph to determine a value of the constant k for the oil.

(3)

$k =$

(c) Your teacher suggests using a temperature sensor and a data logger in place of the thermometer and stop clock.

State an advantage of using a temperature sensor and a data logger in this experiment.

(1)

(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	$k = 1/4\pi\epsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
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	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$	
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	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{\text{grav}} = mg\Delta h$

Materials

Stokes' law	$F = 6\pi\eta r v$
Hooke's law	$F = k\Delta x$
Density	$\rho = m/V$
Pressure	$p = F/A$
Young's modulus	$E = \sigma/\epsilon$ where Stress $\sigma = F/A$ Strain $\epsilon = \Delta x/x$
Elastic strain energy	$E_{\text{el}} = \frac{1}{2}F\Delta x$



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

$$P = VI$$

$$P = I^2 R$$

$$P = V^2 / R$$

$$W = VIt$$

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

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

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

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



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

$$F = kQ_1Q_2/r^2 \text{ where } k = 1/4\pi\epsilon_0$$

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

$$\epsilon = -d(N\phi)/dt$$

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	$dN/dt = -\lambda N$
	$\lambda = \ln 2/t_{1/2}$
	$N = N_0 e^{-\lambda t}$

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	$\lambda_{\max} T = 2.898 \times 10^{-3} \text{ m K}$
Redshift of electromagnetic radiation	$z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$
Cosmological expansion	$v = H_0 d$



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