Edexcel

GCE

Physics

Advanced Subsidiary

Unit Test PHY3 Practical Test
Group 2

Thursday 15 May 2008 – Afternoon

Time: 1 hour 30 minutes

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, other names and signature.

PHY3 consists of questions 2A and 2B. Each question is allowed 35 minutes plus 5 minutes writing-up time. There is a further 10 minutes for writing-up at the end. The Supervisor will tell you which experiment to attempt first.

Write all your results, calculations and answers in the spaces provided in this question booklet.

In calculations you should show all the steps in your working, giving your answer at each stage.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets.

The total mark for this paper is 48.

The list of data, formulae and relationships is printed at the end of this booklet.

Turn over

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Question 2A

(a) (i) Set up the circuit as shown in the diagram below. Note that the lead C is to be connected to the lamps A and B in turn.

Before you connect the battery to the circuit have your circuit checked by the Supervisor. You will be allowed a short time to correct any faults. If you are unable to set up the circuit, the Supervisor will set it up for you. You will only lose two marks for this.
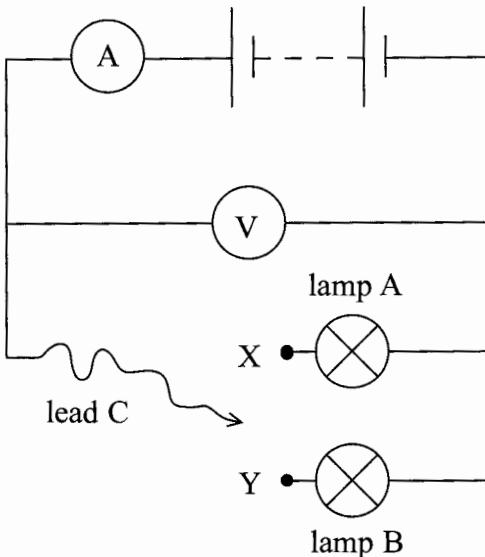
(2)

(ii) Connect the battery. Then connect lead C to lamp A. Measure the current I_A in the circuit and the potential difference V_A across the lamp.

$I_A =$ ....

$V_A =$ ....

(2)

(iii) Connect lead C to lamp B. Measure the current I_B in the circuit and the potential difference V_B across the lamp.

$I_B =$ ....

$V_B =$ ....

(2)

(iv) Leaving lead C connected to lamp B, connect the spare lead between points X and Y so that the lamps are in parallel. Measure the current I_T in the circuit and the potential difference V_T across the lamps.

$I_T =$ ....

$V_T =$ ....

(2)

Disconnect the battery.

(v) Comment on the relationship between

1. I_A, I_B and I_T

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2. V_A, V_B and V_T.

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Discuss, from the evidence of your results, whether the battery has a significant internal resistance.

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(6)

(b) (i) You have been provided with an inclined runway. Determine the time t taken for the sphere to travel a distance x of 0.800 m down the runway.

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(2)

(ii) The linear acceleration a of the sphere down the runway is given by $a = \dfrac{2x}{t^2}$.

Calculate a.

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(1)

(iii) The theoretical acceleration of an object that is sliding down a runway is given by $g\sin\theta$, where

g = acceleration of freefall and

θ = the angle between the runway and the bench.

In the space below draw a diagram of the inclined runway. Show θ carefully on your diagram.

Take such measurements as are necessary to determine $\sin\theta$. Show these measurements on your diagram. State any techniques you used to obtain an accurate value for $\sin\theta$.

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Hence calculate $g\sin\theta$.

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(5)

(iv) Calculate the value of $\dfrac{a}{g\sin\theta}$.

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(2)

(Total 24 marks)

Question 2B

(a) Many modern road bridges have a single pillar from which the bridge is suspended. You are to investigate a model of this arrangement using the extension of a spring to measure the force.

The apparatus shown in the diagram below has already been set up for you.

wooden dowel

spring

paper clip

thread

thread

θ

nail

$m = 100$ g

bench
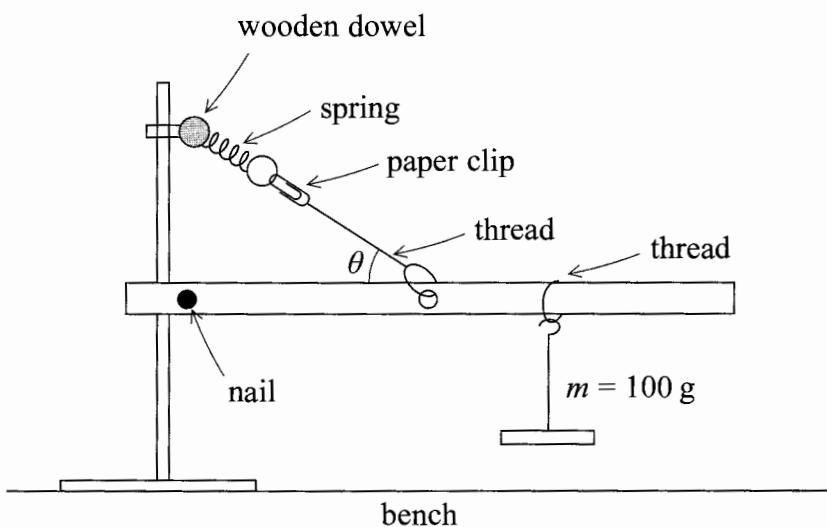
Move the mass $m = 100$ g so that it is suspended from the 90.0 cm mark on the rule.

Adjust the height of the boss holding the wooden dowel until the metre rule is horizontal. Explain how you ensured that the metre rule was horizontal. You may add to the above diagram if you wish.

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(2)

(b) Measure the height h_1 of the centre of the nail above the bench and the height h_2 of the centre of the dowel above the bench. Hence calculate the angle θ between the horizontal metre rule and the thread.

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(2)

(c) You have been provided with a spring which is identical to the one in the experimental arrangement. Measure the unstretched length l of the coiled part of this spring.

l = ...

Measure the stretched length s of the coiled part of the spring that is supporting the metre rule. Hence determine the extension e of the spring.

s = ...

e = ...

Calculate the tension T in the spring given that $T = ke$, where k = the spring constant $= 25 \, \text{N m}^{-1}$ for this spring.

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(4)

(d) When the rule is horizontal and in equilibrium, the following equation applies:

$$T \sin \theta = \frac{mgq}{p} + W \qquad \text{where}$$

p = distance from the centre of the nail to the centre of mass of the rule, which may be assumed to be at the 50.0 cm mark,

q = distance from the centre of the nail to the position on the rule from which the mass m is suspended,

W = the weight of the metre rule.

Determine p and q and use the information from parts (b) and (c) to calculate W.

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(3)

N 3 1 2 0 3 A 0 7 1 2

(e) Suspend the mass $m = 100$ g from the 70.0 cm mark on the rule and adjust the height of the boss holding the wooden dowel until the rule is horizontal. Repeat parts (b), (c) and (d) to obtain a second value of W.

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(5)

(f) Explain which of your values of W you consider to be the more accurate.

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(1)

(g) Using the equation $T\sin\theta = \dfrac{mgq}{p} + W$ a student wishes to investigate how $T\sin\theta$ depends on the distance of the 100 g mass from the nail. You are to plan this investigation. Your plan should include:

(i) an indication of the values in the equation which are constant,

(ii) a description of how the experiment would be performed,

(iii) a sketch of the graph to be plotted,

(iv) an indication of the expected results.

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(7)

(Total 24 marks)

TOTAL FOR PAPER: 48 MARKS

END

List of data, formulae and relationships

Data

Speed of light in vacuum	$c = 3.00 \times 10^8 \, \text{m s}^{-1}$	
Acceleration of free fall	$g = 9.81 \, \text{m s}^{-2}$	(close to the Earth)
Gravitational field strength	$g = 9.81 \, \text{N kg}^{-1}$	(close to the Earth)
Elementary (proton) charge	$e = 1.60 \times 10^{-19} \, \text{C}$	
Electronic mass	$m_e = 9.11 \times 10^{-31} \, \text{kg}$	
Electronvolt	$1 \, \text{eV} = 1.60 \times 10^{-19} \, \text{J}$	
Molar gas constant	$R = 8.31 \, \text{J K}^{-1} \, \text{mol}^{-1}$	

Rectilinear motion

For uniformly accelerated motion:

$$v = u + at$$
$$x = ut + \tfrac{1}{2}at^2$$
$$v^2 = u^2 + 2ax$$

Forces and moments

Moment of F about O $= F \times$ (Perpendicular distance from F to O)

$$\begin{matrix} \text{Sum of clockwise moments} \\ \text{about any point in a plane} \end{matrix} = \begin{matrix} \text{Sum of anticlockwise moments} \\ \text{about that point} \end{matrix}$$

Dynamics

Force $\qquad\qquad F = m\dfrac{\Delta v}{\Delta t} = \dfrac{\Delta p}{\Delta t}$

Impulse $\qquad\qquad F\Delta t = \Delta p$

Mechanical energy

Power $\qquad\qquad P = Fv$

Radioactive decay and the nuclear atom

Activity	$A = \lambda N$	(Decay constant λ)
Half-life	$\lambda t_{\frac{1}{2}} = 0.69$	

Electrical current and potential difference

Electric current	$I = nAQv$
Electric power	$P = I^2R$

Electrical circuits

Terminal potential difference	$V = \varepsilon - Ir$	(E.m.f. ε; Internal resistance r)
Circuit e.m.f.	$\Sigma\varepsilon = \Sigma IR$	
Resistors in series	$R = R_1 + R_2 + R_3$	
Resistors in parallel	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$	

Heating matter

Change of state: energy transfer $= l\Delta m$ (Specific latent heat or specific enthalpy change l)

Heating and cooling: energy transfer $= mc\Delta T$ (Specific heat capacity c; Temperature change ΔT)

Celsius temperature $\theta/°C = T/K - 273$

Kinetic theory of matter

$T \propto$ Average kinetic energy of molecules

Kinetic theory $p = \frac{1}{3}\rho\langle c^2 \rangle$

Conservation of energy

Change of internal energy $\Delta U = \Delta Q + \Delta W$ (Energy transferred thermally ΔQ; Work done on body ΔW)

Efficiency of energy transfer $= \dfrac{\text{Useful output}}{\text{Input}}$

For a heat engine, maximum efficiency $= \dfrac{T_1 - T_2}{T_1}$

Experimental physics

Percentage uncertainty $= \dfrac{\text{Estimated uncertainty} \times 100\%}{\text{Average value}}$

Mathematics

$\sin(90° - \theta) = \cos\theta$

Equation of a straight line	$y = mx + c$
Surface area	cylinder $= 2\pi rh + 2\pi r^2$
	sphere $= 4\pi r^2$
Volume	cylinder $= \pi r^2 h$
	sphere $= \frac{4}{3}\pi r^3$
For small angles:	$\sin\theta \approx \tan\theta \approx \theta$ (in radians)
	$\cos\theta \approx 1$

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