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Mark Scheme (Results)
Summer 2008

GCE

GCE Physics (6733/2B)

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6733/02 Practical Test PHY3

Group 2

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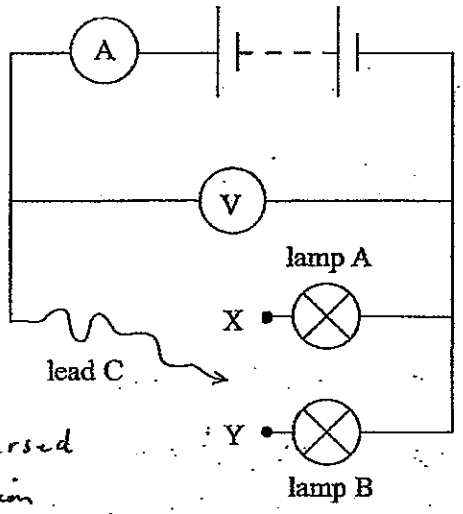
Question 2A

(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.



- Ignore lamps reversed
- Systematic / conversion errors (−1) once then ecf.

Circuit set up correctly without help. (2) 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. (when rounded)

I_A = 0.265 A. — I_A 0.25 → 0.30 A measured to 1 mA or better + unit (1)

V_A = 5.43 V. — V_A 5.0 → 6.5 V measured to 0.01 V or better + unit (1) (2) 2

(Penalise unit, then precision, then range)

(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 = 0.056 A. — I_B 50 → 68 mA measured to 1 mA or better + unit (1)

V_B = 5.76 V. — Sensible $V_B > V_A$ and measured to 0.01 V or better + unit (1)

[Apply unit of I penalty, once only. Apply unit of V penalty once only (2)] 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 = 0.317 A. — $I_T < (I_A + I_B)$ measured to 1 mA or better + unit. (1)

V_T = 5.40 V. — Sensible $V_T < V_A$ measured to 0.01 V or better + unit (1) (2) 2

[Watch out for centres with meters on 10 A range giving currents to 0.01 A only]

Disconnect the battery.

Leave blank

(v) Comment on the relationship between

1. I_A, I_B and I_T

(Expect) $I_T = I_A + I_B$ (1)

$I_A + I_B = 0.265 + 0.056 = 0.321\,A$

$I_T = 0.317\,A < (I_A + I_B)$ (1) Sensible comparison.

2. V_A, V_B and V_T.

(Expect) $V_A = V_B = V_T$ (1)

But $V_B > V_A > V_T$ (1) Sensible comparison.

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

The greater the current drawn from the cell, the smaller the p.d. between the terminals (1)

Hence cell has significant internal resistance. (1)

(6) 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.

$t = 1.41, 1.41, 1.41, 1.38, 1.43$ s Sensible t from ≥ 3 results (0.5 to 2.5 s) + unit. (2)

$\bar{t} = 1.41$ s [2 results … (1)]

[If all readings to whole seconds – no marks. > half the readings to 0.1 s or better, else (–1)] (2) 2

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

Calculate a.

$a = \frac{2 \times 0.8}{1.41^2}$ Correct calc

$= 0.805\ m\,s^{-2}$ ≥ 2 s.f. + unit (1)

(1) 1

[If $\bar{t}$ given as 0.0141 s – systematic error –2]

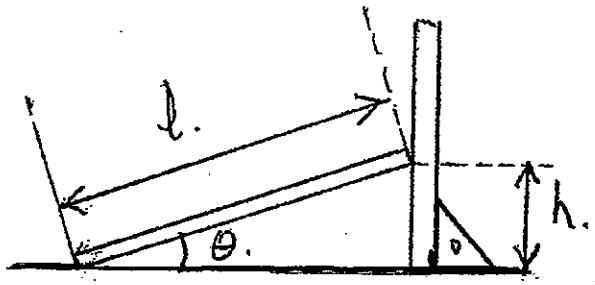
Leave blank

(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.



Correct diagram with runway of finite thickness on a bench (1)

Hence correct θ shown } with correct corresponding l and h. (1)

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 $\sin\theta$.

$l = 1.20$ m.

$h = 15.3$ cm

h recorded to the nearest mm or better with unit, $h \geq 5$ cm (1)

CAN BE SHOWN ON DIAGRAM

Vertical rule checked with set square

Eye level with reading / Measurements at end of runway (1)

Hence calculate $g\sin\theta$.

ACCEPT $g = 9.8$ or 10.

$9.81 \times \frac{0.153}{1.2}$

$= 1.25\ m\,s^{-2}$

Correct calc

$\geq$ 2 s.f. + unit (1)

(ecf from (ii) on unit) (5)

5

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

$\frac{0.805}{1.25}$

$= 0.644$

Value

$0.60 \rightarrow 0.80$ (2)

[$0.50 \rightarrow 0.90$ (1)]

If unit given (-1)

No ecf on value

(2)

2

Q2A

2 4

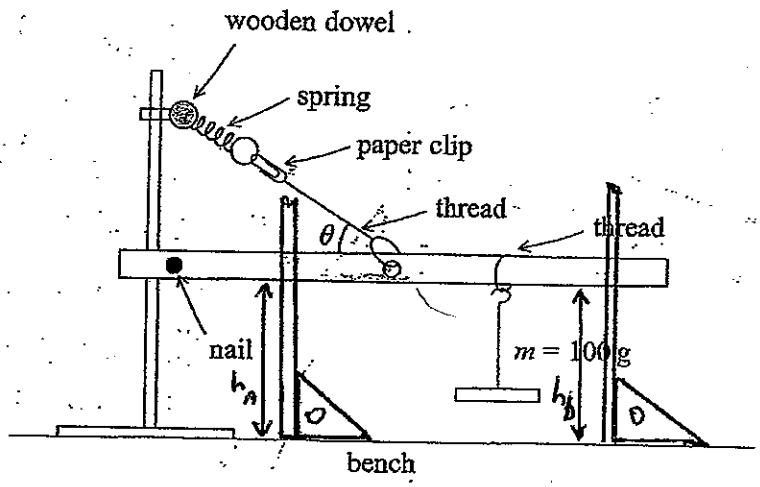
(Total 24 marks)

Leave blank

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.



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.

Measure the height above the bench at two places, $h_A = h_B$ (1)

Used set square as shown to check that the metre rule is vertical (1)

2

(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.

$h_1 = 345$ mm.

$h_2 = \frac{1}{2}(747 + 735) = 741$ mm.

$\tan\theta = \frac{741 - 345}{400} = 0.99$

$\theta = 44.6°$

(Accept 390 to 410 mm NOT 500mm)

heights recorded to nearest mm with units seen once (1)

Correct calc. of θ, ≥ 2 s.f. + unit (1)

2.

(2)

Allow use of $\sin\theta$.

Leave blank

(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.

$l =$ 23 mm. | l recorded to the nearest mm or better and in the range 1.6 cm to 2.4 cm (1)

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.

$s =$ 174 mm | s recorded to the nearest mm or better and in the region of 20 cm (1)

$e =$ 174 − 23 = 151 mm. | e calculated correctly with unit seen somewhere (1)

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

$T = 25 \times 0.151$

$= 3.78$ N. | Correct calc of T to 2/3 s.f. + unit (1)

(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.

$p = 40.0$ cm (Accept 39.0 − 41.0)

$q = 80.0$ cm. (Accept 79.0 − 81.0) | p and q correct (1)

$W = T \sin\theta - \frac{mgq}{p}$

$= 3.78 \sin(44.6) - \frac{0.1 \times 9.81 \times 0.8}{0.4}$ | Correct substitution (1)

$= 2.65 - 1.96$

$= 0.69$ N. | Correct calc of W to 2/3 s.f. + unit (1)

(3)

Leave blank

(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.

$h_2 = \frac{1}{2}(720 + 707) = 714$ mm.

$h_1 = 345$ mm

$\tan\theta = \frac{714 - 345}{400} = 0.923.$

$\theta = 42.7°$

$s = 153$ mm.

$e = 153 - 23 = 130$ mm.

$T = 3.25$ N.

$p = 400$ mm, $q = 600$ mm.

$W = 3.25\sin(42.7) - \frac{0.1 \times 9.81 \times 0.6}{0.4}$

$= 2.20 - 1.47$

$= 0.73$ N.

h_2 to nearest mm and < value in (b) (1) (ecf on precision)

s to nearest mm and less than value in (c). (1) (ecf on precision)

q 60.0 ± 1.0 cm (1)

W values same within ± 0.2 N (2) [± 0.4 N (1)]

(5)

5

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

First value because all the measurements made are greater (1)

(1)

1

Leave blank

(g) Using the equation $T\sin\theta = \frac{mgq}{p} + W$ 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.

i) m, g, p and W are constant (1)

ii) Vary q. (or move mass along rule) (1)
Adjust the position of the nail, boss or dowel to make the rule horizontal. (1)
(Measure h_2 and h_1 to) determine θ (1)
(Measure the length of the stretched spring to) find the extension (1)
Calculate the tension (in the spring) (1)
} Max (2)

iii) Plot $T\sin\theta$ against q. (1)

iv) Straight line +VE intercept (1)
Slope = $\frac{mg}{p}$, Intercept = W. (1)

7

If wrong expt, (fix q vary M), they lose first two marks, can get marks in (ii) and allow ecf for graph in (iii) and (iv)

(7) Q2B

(Total 24 marks) 24

TOTAL FOR PAPER: 48 MARKS

END