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Mark Scheme (Results)

Summer 2008

GCE

GCE Physics (6735/2B)

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6735/02 Practical Test PHY5

Group 2

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Question 2A

(a) (i) Suspend a total mass of 300 g from one of the springs. Give the mass a small vertical displacement and determine the period T_1 of the subsequent oscillations.

$20T_1/s$: 14.63, 14.63

$T_1 = 0.732\,s$

$\Sigma nT \geq 30$ (2) for both (≥ 20 (1)) T_1 & T_2 + unit

Put the mass of 300 g on the other spring and determine the period T_2 of vertical oscillations for this spring.

$20T_2/s$: 14.70, 14.74

$T_2 = 0.736\,s$

Repeats for all shown (1)

Calculate the average value T of the periods T_1 and T_2.

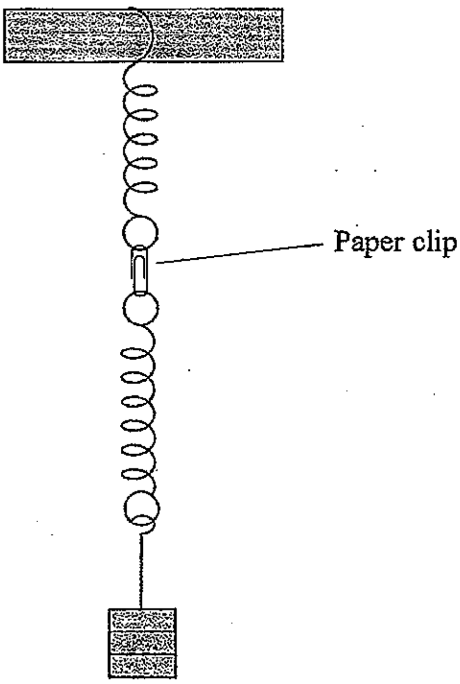
$T = \frac{0.732 + 0.736}{2} = 0.734\,s$

{SE – 2 whole seconds left as nT or f}

(3)

3

(ii) Remove one of the springs from the rod. Connect it to the other spring using the paper clip to give a series arrangement of springs as shown in the diagram below.



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Determine the period T_s of vertical oscillations for this series arrangement of springs.

$20T_s / s = 20.82, 20.82$ — Correct calc^n. of T_s/T to 3sf & no unit (1)

$T_s = 1.04\,s$ — In range 1.39–1.44 (2)

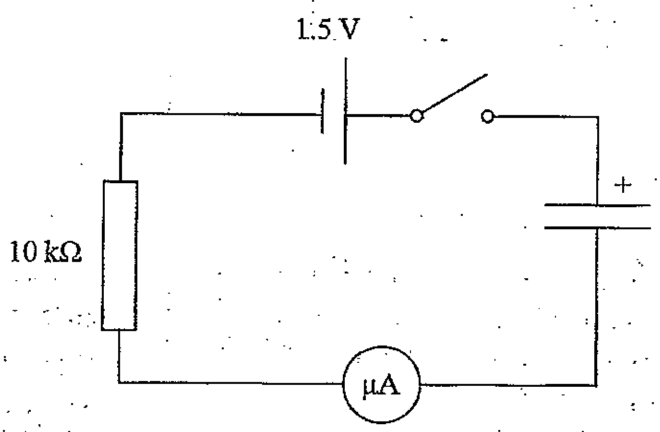
Calculate the ratio T_s / T.

$T_s/T = 1.04/0.734 = 1.42$ — [1.34 – 1.48 gets (1)]

Inverted :– 0.707 (1) 0.69–0.72 (2) 0.67 – 0.74 (1) **(3)**

3

(b) (i) The circuit shown in the diagram below has been set up ready for you to use.



Discharge the capacitor by connecting one of the spare leads across it. Now remove the lead.

Close the switch and determine the time t that it takes for the current in the circuit to fall from 100.0 μA to 36.8 μA. Open the switch when you have done this.

t/s : 25.24, 25.21 — t in range

$\bar{t} = 25.2\,s$ — 15–30 s + unit (1)

(Not whole seconds)

Describe the procedure you adopted to make this timing as accurate as possible.

Discharged capacitor before each reading (1) Repeat shown (1)

(1)

(3)

3

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(ii) Connect the second capacitor **in series** with the capacitor in the circuit, making sure that its polarity is correct. When you have done this, you **must** ask the Supervisor to check your circuit before proceeding. If your circuit is not correct, the Supervisor will correct it for you. You will only lose 1 mark for this.

Follow the same procedure as before to determine the time t_s for the current to drop from 100.0 μA to 36.8 μA for the series arrangement of capacitors. Open the switch when you have done this.

t_s/s : 12.66, 12.70

$\bar{t}_s$ = 12.7 s

Calculate the ratio t_s/t.

$t_s/t = \frac{12.7}{25.2} = 0.504$

anywhere
No help with circuit (1)
t_s/t correctly calculated to ≥ 2sf (1)
In range 0.40 → 0.60 (2)
[0.30 → 0.70 gets (1)]
no unit
(allow ecf from a(ii))

(4)

4

(iii) For this circuit, the time *t* is proportional to the capacitance *C* of the circuit. Discuss whether your results suggest that the two capacitors have the same capacitance when taking into account a manufacturing tolerance of 20%.

If t ∝ C, then the capacitance of the two capacitors in series is 0.504 of the capacitance of the first capacitor.

If the capacitors were of the same value this would be exactly half, i.e. 0.500.

The difference is less than 1% ~~and well within the 20%~~ tolerance of the capacitors, suggesting that the two capacitors were of the same nominal capacitance.

Should be 0.500 if equal (1)
% difference calculated using 0.504 as denominator (1)
Related to 20% (or 40%) (1)

(3)

3

Q2A

(Total 16 marks)

16

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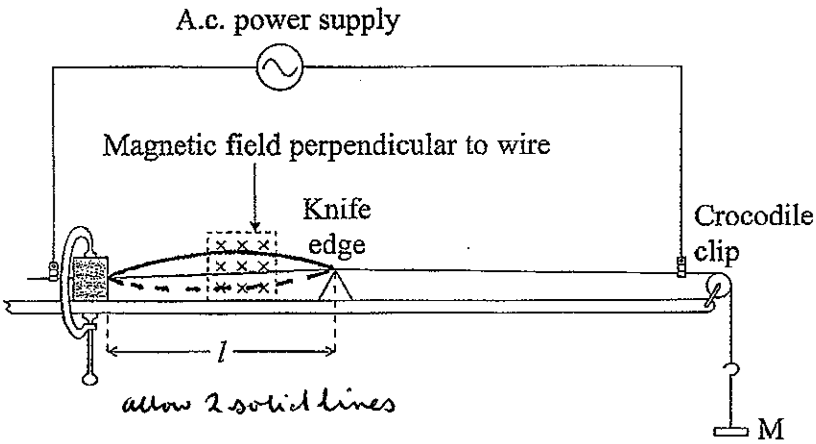
Question 2B

(a) The apparatus has been set up for you as shown in the diagram with $M = 100$ g. For clarity the magnet has not been drawn.



The fundamental mode of a stationary (standing) wave can be formed on a length l of the wire. Draw on the diagram the shape you would see. State the relationship between the wavelength λ of the wave and the length l.

(see diagram) | Correct shape, with one antinode (1)

$\lambda = 2l$ | $\lambda = 2l$ (1)

(2) 2

(b) (i) Switch on the power supply. Increase l until you can see that the amplitude of vibration of the wire is at a maximum.

Determine, as accurately as possible, the length l_1 at which this resonance occurs.

l_1/cm : 44.0, 43.4, 43.6. $\bar{l}_1 = 43.7$ cm | ±2 cm of Supervisor (2) [±3 cm gets (1)] allow cm. −1 no unit

Explain carefully how you ensured that your value for l_1 was as accurate as possible.

• Approached resonance from both directions. ——— (1)

Viewing technique ——— (1)

Leave blank

The frequency f of the supply is as stated on the card. Use this value and your value for l_1 to determine a value for the speed c of the wave along the wire.

$c = f\lambda = 50 \times 2 \times 0.437$

$= 43.7 \text{ ms}^{-1}$

$c = f\lambda$ used to give correct speed, with unit (no ecf from $\lambda = l$) (1)

(5) 5

(ii) Add 300 g to the mass hanger to make $M = 400$ g. For standing waves on a wire the tension T in the wire and the resonant length l are related by the equation:

$$T = k\,l^2$$

You are to determine the new resonant length, l_2.

Explain whether you would expect the new length to be longer or shorter than l_1.

EGs

Larger, because increasing mass increases T and $l \propto \sqrt{T}$

Increase T increases l

(Mentions stretching − 1)

$l \propto \sqrt{T}$, or words to this effect (1)

Suggest where the magnet should be placed to obtain the largest possible vibration.

In the centre of the new length (1)

Adjust the position of the knife edge and magnet until you can see that the amplitude of vibration of the wire is at its maximum value for the fundamental mode. Determine an accurate value of this length, l_2.

l_2/cm : 89.4, 89.7, 88.9 : $\bar{l}_2 = 89.3$ cm

l_1 & l_2 repeated (1)

$l_2 = 2l_1 \pm 20$ mm (1)

[... mm gets (1)]

Estimate the percentage uncertainty in your value for l_2.

$\Delta l = \pm 4$ mm (half spread)

% uncertainty $= \frac{4}{893} \times 100 = 0.4\%$

Range or ½ range provided ≥ 1 mm (allow ≥ 1 mm if from single reading) and correct % calcn. (1)

(5) 5

QUESTION 2B CONTINUES ON THE NEXT PAGE

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(c) Take measurements to determine the diameter d of the wire.

d/mm : 0.267, 0.266, 0.263 | 0.25 mm < d < 0.29 mm with unit (1)

$\bar{d}$ = 0.265 mm | Repeat (1)

The density ρ of the material of the wire is given by:

$$\rho = \frac{4Mg}{\pi d^2 c^2}$$

Use $M = 0.100$ kg and your value for the speed c from (b)(i) to calculate a value for ρ.

$\rho = \frac{4 \times 0.100 \times 9.81}{\pi \times (0.265 \times 10^{-3})^2 \times 43.7^2}$ | Correct S.I. units shown in calculation and answer given to 2/3 sf + unit (1)

$= 9.3 \times 10^3$ kg m^{-3} | Value $(8.0 - 10.0) \times 10^3$ kg m^{-3} (1)

[Allow e.c.f. for value of c ONLY]

(4)

4

Q2B

(Total 16 marks)

Leave blank

Question 2C

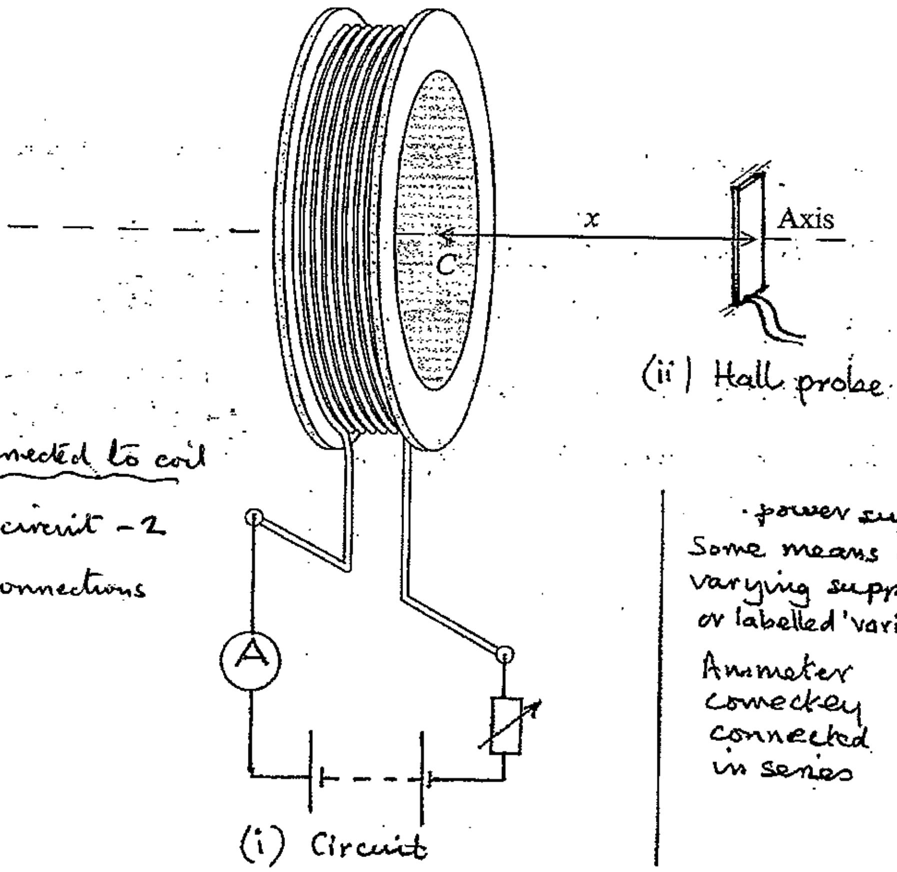
You are to plan an investigation of how the magnetic field strength varies along the axis of a coil. You are then to analyse a set of data from such an experiment.

(a) (i) A flat circular coil is set up as shown in the diagram below. Add to the diagram the circuit you would connect to the coil to set and maintain a known value of current in the coil.

If not connected to coil

No gap in circuit – 2

Allow no connections



· power supply (1)

Some means of varying supply, or labelled 'variable' (1)

Ammeter connected connected in series (1)

(3) 3

(ii) Draw how you would place a Hall probe to measure the magnetic field strength at a point along the axis a distance x from the centre C of the coil. You should be careful to show the orientation of the Hall chip (sensor) correctly.

must cross axis. Clearly shown ⊥r to axis (1)

(1) 1

(iii) Describe how you would determine the average diameter of the coil. You may add to the diagram if you wish.

- Used rule & two set squares
- Repeated in ⊥r direction
- Made allowance for thickness of coil.

Any (2) sensible points of technique

(2) 2

Turn over

Leave blank

(b) The coil has a diameter of 124 mm and has 70 turns. When the current in the coil was adjusted to 500 mA, the calibrated Hall probe indicated that the magnetic field strength at the centre of the coil was 0.350 mT.

The magnetic field strength B at the centre of a coil having a radius r and N turns is given by

$$B = \frac{\mu_0 NI}{2r}$$

when the current in the coil is I.

Discuss the extent to which you think that the Hall probe is correctly calibrated.

$B = \frac{4\pi \times 10^{-7} \times 70 \times 0.500}{0.124}$	Correct substitution of data (1)
$= 3.55 \times 10^{-4}$ T $= 0.355$ mT	0.355 mT (value, 3sf and unit) (1)
The Hall probe reads 0.350 mT, which differs by only just over 1% This is an acceptable difference	Sensible comment (accept 'very small' difference) (1)

(3) 3

(c) The following data were obtained when the magnetic field strength B was measured along the axis at different distances x from the centre of the coil, keeping the current constant at 500 mA.

x / mm	B / mT
0	0.350
20	0.304
40	0.219
50	0.163
60	0.120
80	0.071
100	0.039
120	0.024

Plot a graph of B against x on the grid opposite.

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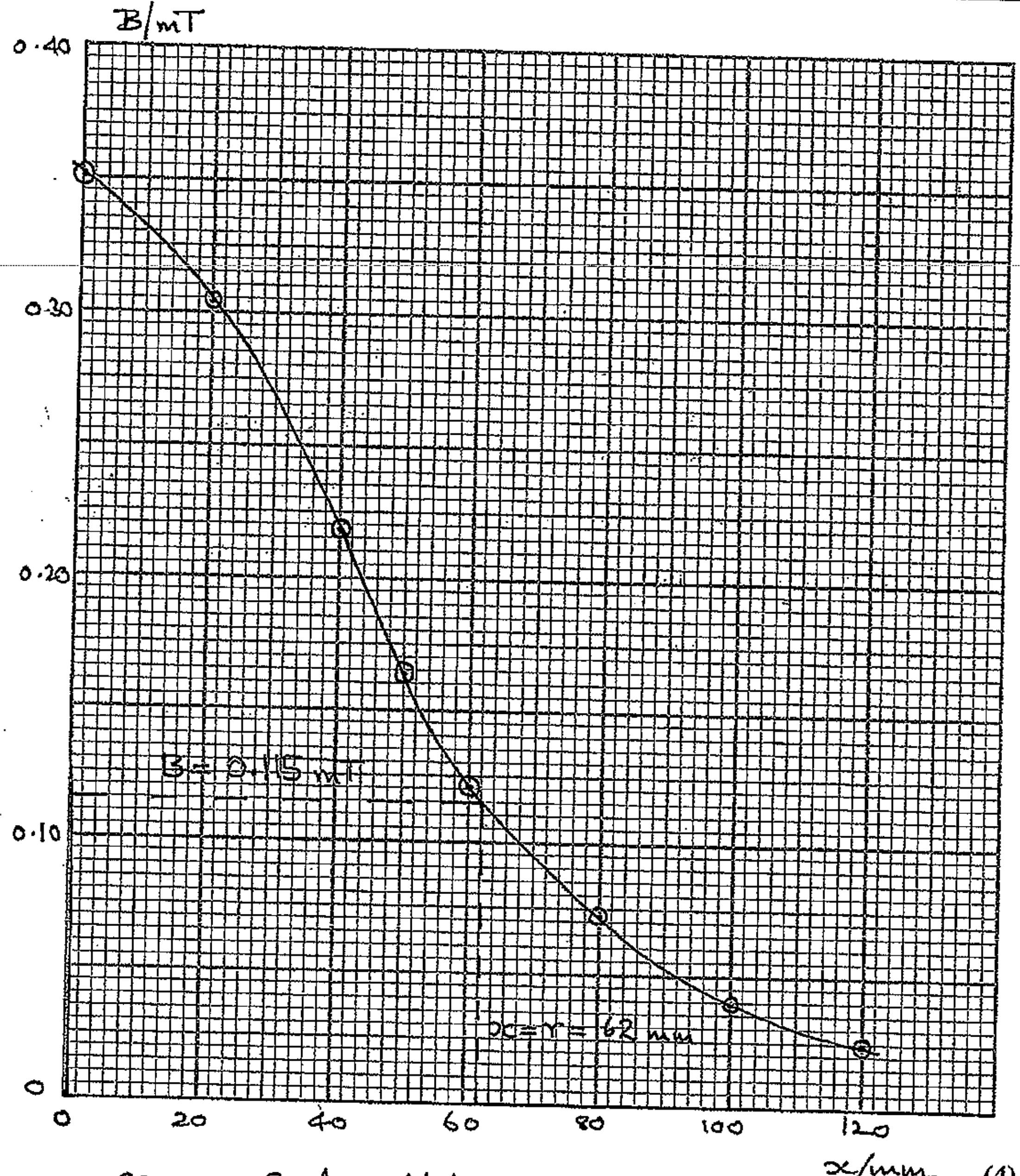

(4)

GRAPH Scale : At least ½ graph paper in both x & y direction, avoiding 3's, etc. (1)

(transposed −1) ← Axes : Labelled with quantity & units (1)

Plots : Accurate to ½ square (1)

Line : Thin, smooth curve of best fit (1)

4

QUESTION 2C CONTINUES ON THE NEXT PAGE

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(d) Theory suggests that when $x = r$, the radius of the coil, the magnetic field strength is $1/\sqrt{8}$ of the field strength at the centre of the coil. Discuss the extent to which this experiment supports this suggestion.

When $x = r = 62$ mm

$B = 0.115$ mT

$1/\sqrt{8}$ of field at centre

$= \frac{0.350 \text{ mT}}{\sqrt{8}}$

$= 0.124$ mT

The experimental value is about 7% different, which is acceptable experimental error.

B read off at 62mm correctly with unit (1)

% difference calculated either value or av value as denominator; and hence sensible comment. (1) (1)

need not show calculation

3

(3)

Q2C 16

(Total 16 marks)

TOTAL FOR PAPER: 48 MARKS

END