

# Mark Scheme (Results)

## Summer 2008

GCE

GCE Physics (6735/2A)

6735/02 Practical Test PHY5

Group 1

Question 1A

- (a) (i) Suspend a total mass of 400 g from one of the springs. Give the mass a small vertical displacement and determine the period  $T_1$  of the subsequent oscillations.

$$20T_1/s : 16.77, 16.73$$

$$T_1 = 0.838 \text{ s} \text{ Whole secs}$$

or Not T (-2)

$\sum nT \geq 30$   
for both

$T_1 \& T_2$  (2)  
seconds in all answers

Put the mass of 400 g on the other spring and determine the period  $T_2$  of vertical oscillations for this spring.

$$20T_2/s : 16.81, 16.76$$

$$T_2 = 0.839 \text{ s}$$

[ $\geq 20$  sets (1)]

Repeat's for all T shown (1)

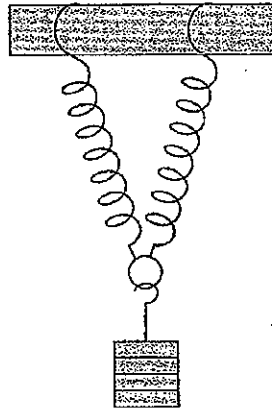
Calculate the average value  $T$  of the periods  $T_1$  and  $T_2$ .

$$T = \frac{0.838 + 0.839}{2} = 0.838 \text{ s}$$

(3)

3

- (ii) Hook the 400 g mass onto the loops of both springs as shown in the diagram below.



Convert calc<sup>n</sup>. of  $T_p/T$  to 3 sf & no unit  
allow 1:1.414 (1)

Determine the period  $T_p$  of vertical oscillations for this arrangement of springs.

$$20T_p/s : 12.05, 12.04$$

$$T_p = 0.602 \text{ s}$$

In range

$$0.69 \rightarrow 0.72$$

$$1.44 \leftarrow 1.39 \text{ (2)}$$

Calculate the ratio  $T_p/T$ .

$$\frac{T_p}{T} = \frac{0.602}{0.838} = 0.718$$

[0.67  $\rightarrow$  0.74  
1.48  $\leftarrow$  1.34] (3)

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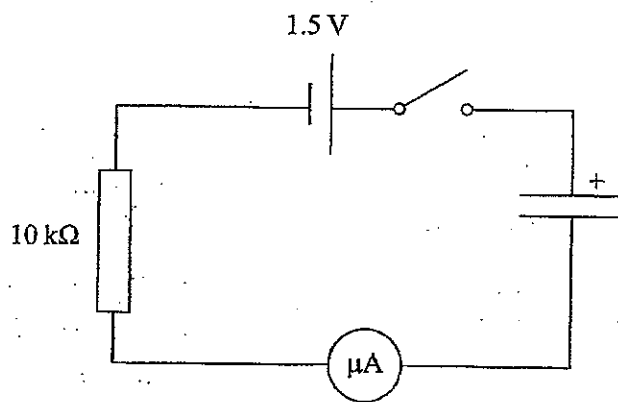


(iii) Theory predicts that for a parallel arrangement of identical springs  $T_p/T = 1/\sqrt{2}$ . Discuss the extent to which your results support this prediction.

$1/\sqrt{2} = 0.707$	$1/\sqrt{2}$ found (1) $\gg 25F$
$\% \text{ Difference} = \frac{0.718 - 0.707}{0.707} \times 100$	$\% \text{ difference}$
$= 1.6\%$	calculated with 0.707 as the denominator (1)
This is acceptable experimental error and so the results support the suggestion, particularly as the springs are not exactly parallel.	Sensible comment based on % difference related to possible experimental error (1)
	(3)

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



QUESTION 1A CONTINUES ON THE NEXT PAGE



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  $100.0 \mu\text{A}$  to  $36.8 \mu\text{A}$ . Open the switch when you have done this.

$t/s : 11.22, 11.23$	$t$ in range
$\bar{t} = 11.2s$	$8 \rightarrow 15s$ (1) with unit Better than whole sec.

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

Discharged capacitor before each reading.	Repeat shown with mean for both (1)
	Discharge C each time (1)
	(3)

3

- (ii) Connect the second capacitor in parallel 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  $t_p$  for the current to drop from  $100.0 \mu\text{A}$  to  $36.8 \mu\text{A}$  for the parallel arrangement of capacitors. Open the switch when you have done this.

$t_p/s : 21.73, 21.62$	No help with circuit anywhere (1)
$\bar{t}_p = 21.7s$	$t_p/t$ correctly calculated and no (> 2 sf) unit-ect a)(ii) (1)
Calculate the ratio $t_p/t$ .	In range 1.60 → 2.40 (2)
$t_p/\bar{t} = 21.7/11.2$	[1.20 → 2.80 gets (1)]
$= 1.94$	(4)

4

(Total 16 marks)

Q1A  
16

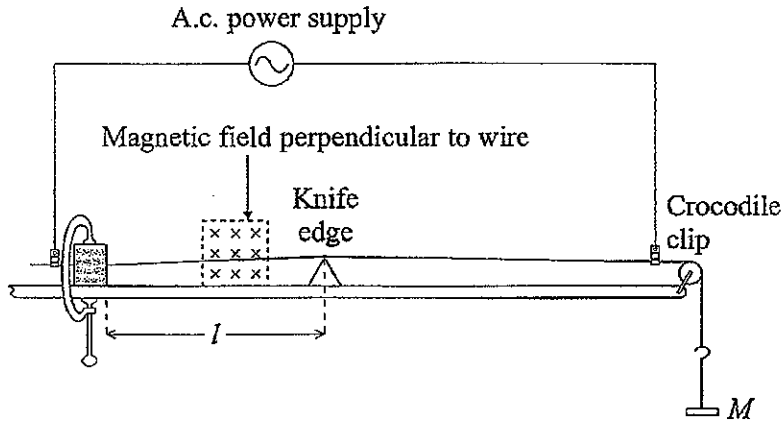


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Question 1B

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



When there is an alternating current in the wire the current passes through the magnetic field. This causes the section of the wire between the wooden blocks and the knife edge to oscillate up and down. Explain why this oscillation occurs.

- By Fleming's LHR, wire experiences a force perpendicular to the field. (1)
  - As the current is alternating, the force alternates, causing the wire to oscillate. (1)
- Force perpendicular to field or vertical (1)  
alternating current, hence alternating force/field (1)  
(2)

- (ii) Switch on the power supply. Increase the length  $l$  until you can see that the amplitude of the vibration is at a maximum.

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

$l_1$  / cm: 44.3, 43.9, 44.0.  $\bar{l} = 44.1$  cm  $\pm 2$  cm of Supervisor (2)  
[ $\pm 3$  cm gets (1)]

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)
- (-1) if no unit seen



Estimate the percentage uncertainty in your value for  $l_1$ .

$\Delta l = \pm 2 \text{ mm}$  (half spread)

$\% \text{ uncertainty} = \frac{2}{441} \times 100 = 0.5\%$

Range,  $\frac{1}{2}$  range provided  $> 1 \text{ mm}$  (allow  $> 2 \text{ mm}$  from single reading.)  
and correct % calc. (1)

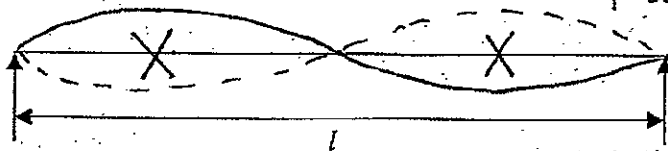
Use your value of  $l_1$  to calculate the wavelength  $\lambda$  of the stationary (standing) wave.

$\lambda = 2l_1 = 2 \times 44.1 \text{ cm}$   
 $= 88.2 \text{ cm}$

$\lambda = 2l_1 + \text{unit}$   
(1)  
(6)

6

(b) (i) If  $l$  is increased without changing the mass  $M$  a stationary wave with two antinodes can be formed. Draw below the shape of this oscillation.



Correct shape, with 2 antinodes  
and

X close to one of the antinodes (1)

On your sketch mark with an X where the magnet may be placed to produce the greatest effect.

both  $l_1 + l_2$  repeated (1)

(ii) Increase  $l$  and adjust the position of the magnet until you can see that the amplitude of this mode of vibration is at a maximum. Determine an accurate value of this length,  $l_2$ .

$l_2 / \text{cm} : 90.3, 86.7, 88.4 \dots \bar{l}_2 = 88.5 \text{ cm}$

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

Hence determine a second value for  $\lambda$ .

$\lambda = l_2 = 88.5 \text{ cm}$

$\lambda = l_2$  and unit for  $l_2$  &  $\lambda$  seen once each. (4)  
Both given to mm precision (1)

4

Switch off the power supply.

QUESTION 1B CONTINUES ON THE NEXT PAGE



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

$d/\text{mm}$ , 0.267, 0.266, 0.263

$\bar{d} = 0.265 \text{ mm}$

$0.25 \text{ mm} < d < 0.29 \text{ mm}$   
with unit (1)

Repeat (1)

The density  $\rho$  of the material of the wire is given by:

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

where  $f$  is the frequency of the a.c. supply that is written on the card.

Calculate a value for  $\rho$ .

Average  $\lambda = 88.4 \text{ cm} = 0.884 \text{ m}$

$$\rho = \frac{4 \times 0.100 \times 9.81}{\pi \times (0.265 \times 10^{-3})^2 \times 50^2 \times 0.884^2}$$

$$= 9.1 \times 10^3 \text{ kg m}^{-3}$$

Convert S.I. units shown in calculation and answer given to 2/3 sf. + unit (1)

Value  $(8.9 \times 10^3) \text{ kg m}^{-3}$   
(No. of) (1)

Q1B

16

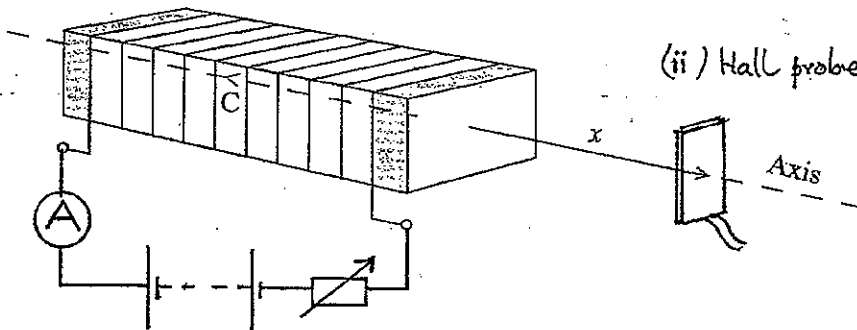
(Total 16 marks)



Question 1C

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

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



(i) Circuit

(3)

If not connected to solenoid  
No gap (-2)

Cap for solenoid no penalty

power supply (1)  
some means of varying supply,  
or labelled 'variable' (1)  
ammeter connected  
correctly in series (1)

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 solenoid. You should draw the Hall probe outside the solenoid and should take care to show the orientation of the chip (sensor) correctly.

crossing and  
clearly shows/perpendicular (1)  
to axis or stated (1)

1

- (iii) Describe how you would determine the distance  $x$ . You may add to the diagram if you wish.

- Measure length of solenoid.
- Put rule inside solenoid so that its zero end is at mid point of solenoid.
- Read  $x$  directly from rule

Determine centre of solenoid (1)

Suitable technique for  $x$  inside and outside (1)  
solenoid

(2)

2

QUESTION 1C CONTINUES ON THE NEXT PAGE



- (b) The solenoid has a length of 276 mm and has 337 turns. When the current in the solenoid was adjusted to 500 mA, the calibrated Hall probe indicated that the magnetic field strength at the centre of the solenoid was 0.761 mT.

The magnetic field strength  $B$  at the centre of a solenoid having  $n$  turns per metre is given by:

$$B = \mu_0 n I$$

when the current in the solenoid is  $I$ .

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

$B = 4\pi \times 10^{-7} \times \frac{337}{0.276} \times 0.500$	Correct substitution of data (1)
$= 7.67 \times 10^{-4} \text{ T} = 0.767 \text{ mT}$	
The Hall probe reads 0.761 mT, which is less than 1% different.	0.767 mT (value, 3sf as unit) (1)
This is an acceptable difference.	Sensible comment (accept very small difference) (1)
	(3)

3

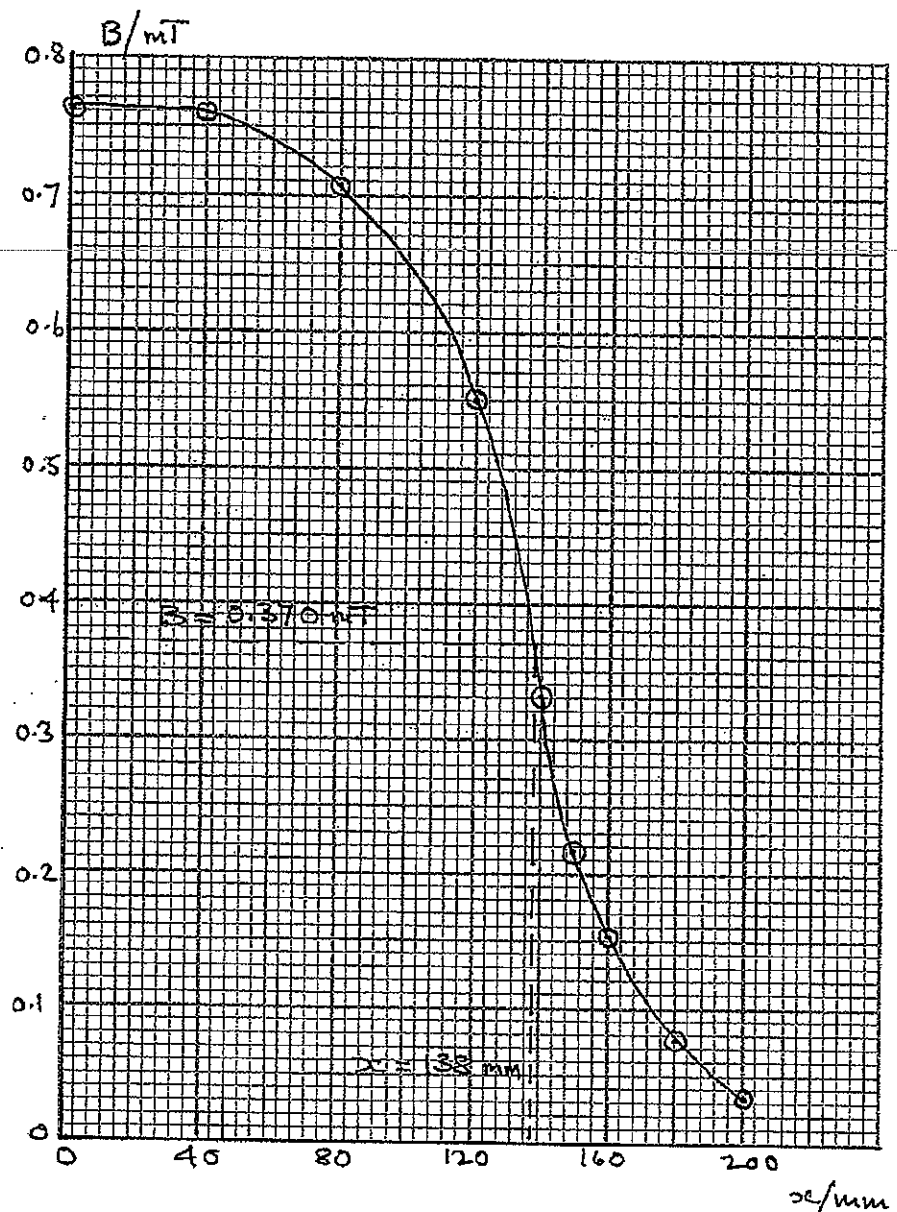
- (c) The following data were obtained when the magnetic field strength  $B$  was measured along the axis at different distances  $x$  from the centre of the solenoid, keeping the current constant at 500 mA.

$x / \text{mm}$	$B / \text{mT}$
0	0.761
40	0.760
80	0.706
120	0.549
140	0.330
150	0.217
160	0.151
180	0.077
200	0.032

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



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(4)

- GRAPH Scale : At least  $\frac{1}{2}$  graph paper in both  $x$  &  $y$ , avoiding 3's etc. (1)
- Axes : labelled with quantity and units (1)
- Plots : Accurate to  $\frac{1}{2}$  square (1)
- Line : Smooth, thin curve of best fit (1)

4

QUESTION 1C CONTINUES ON THE NEXT PAGE



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(d) Theory suggests that the magnetic field strength at the end of a long solenoid is exactly half that at its centre. Discuss the extent to which this experiment supports this suggestion.

End of solenoid is  $\frac{276}{2} = 138 \text{ mm}$   $x = 138 \text{ mm}$  at end

From the graph, when  $x = 138 \text{ mm}$ ,

Field strength is  $0.370 \text{ mT}$  Band read off correctly at  $x = 138 \text{ mm}$  with unit (1)

Band =  $\frac{0.370 \text{ mT}}{0.761 \text{ mT}} = 0.49$  % difference calculated

This differs by only 2% from "exactly half" (0.50), which is an acceptable experimental error. (Need not show actual calculation) (1) and hence sensible comment (1)

The experiment therefore supports the suggestion. (3)

(Total 16 marks)

3

QIC

16

TOTAL FOR PAPER: 48 MARKS

END

