A Level Physics A

H556/02 Exploring physics

Question Set 9

1 **(a)*** A student conducts an experiment to confirm that the uniform magnetic flux density B between the poles of a magnet is 30 mT.

A current-carrying wire of length 5.0 cm is placed perpendicular to the magnetic field.

The current I in the wire is changed and the force F experienced by the wire is measured. Fig. 22.1 shows the graph plotted by the student.

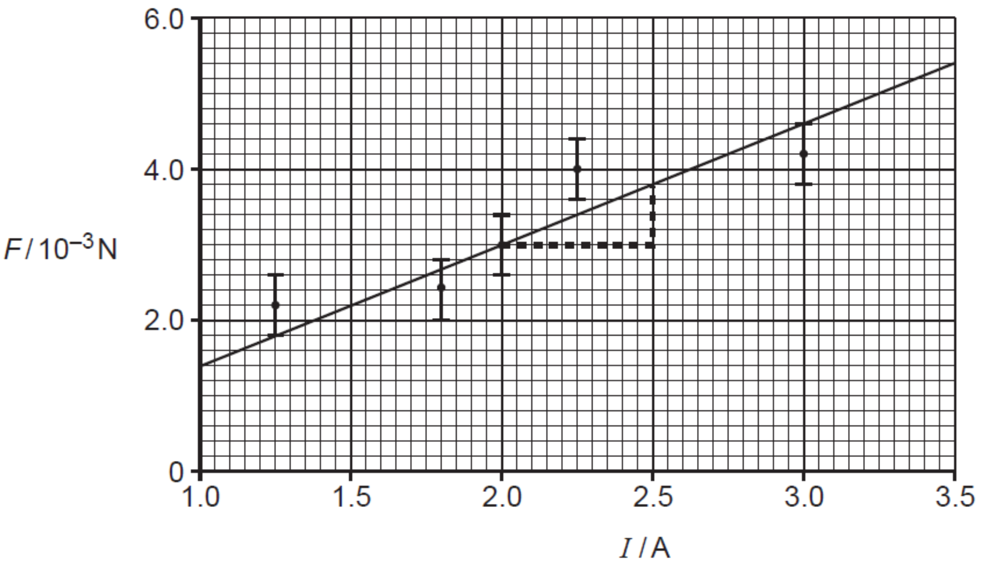

Fig. 22.1

The student's analysis is shown on the graph of Fig. 22.1 and in the space below.

$F = BIL$

$$\text{gradient} = BL = \frac{(3.8 - 3.0) \times 10^{-3}}{2.5 - 2.0} = 0.0016$$

$$B = \frac{0.0016}{0.05} = 0.032\,\text{T} = 32\,\text{mT}$$

This is just 2 mT out from the 30 mT value given by the manufacturer, so the experiment is very accurate.

Evaluate the information from Fig. 22.1 and the analysis of the data from the experiment. No further calculations are necessary.

[6]

- The line of best fit misses the point at $I = 2.5$ A. This is probably an outlier so should be removed and the line should be re-plotted.
- The line would be better if there were more data points, and if there were error bars in I.
- The triangle used for determining the gradient is too small
- The value of B is close to 30 mT - only 7% different, but we don't know how significant this is because no uncertainty is given. Uncertainty could be found by drawing a line of worst fit.

- F against I should be a straight line.

(b) Fig. 22.2 shows a transformer circuit.

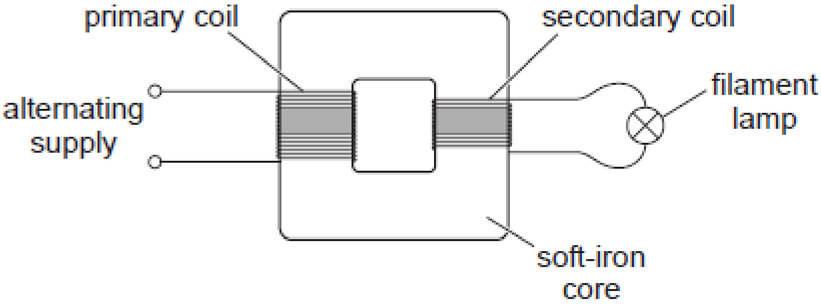

Fig. 22.2

The primary coil is connected to an alternating voltage supply. A filament lamp is connected to the output of the secondary coil.

(i) Use Faraday's law of electromagnetic induction to explain why the filament lamp is lit. **[3]**

There is a changing flux linkage, which is channelled through the core into the secondary coil. $\mathcal{E} \propto$ rate of change of flux linkage, so this induces an e.m.f.

(ii) The primary coil has 400 turns and the secondary coil has 20 turns. The potential difference across the lamp is 12 V and it dissipates 24 W. The transformer is 100% efficient.

1. Calculate the current in the primary coil.

$\frac{n_s}{n_p} = \frac{I_p}{I_s}$ so $I_p = \frac{I_s n_s}{n_p} = \left(\frac{24}{12}\right)\left(\frac{20}{400}\right)$

current = ...0.1........ A **[2]**

2. The alternating voltage supply is replaced by a battery and an open switch in series. The switch is closed. The lamp is lit for a short period of time and then remains off. Explain this observation. **[2]**

- When the switch closes, there is a sudden increase in flux, meaning a rate of change of flux linkage and hence an e.m.f.
- After a while there is no change, as current and flux are constant, so no e.m.f.

Total Marks for Question Set 9: 13