5 **(a)** A main coil is made of a coil of wire wound round the end of a soft iron core, as shown in Fig. 5.1. The main coil is connected to a variable power supply.

The axis of the soft iron core and main coil are both vertical. An aluminium ring is placed over the soft iron core and is free to move along the core.

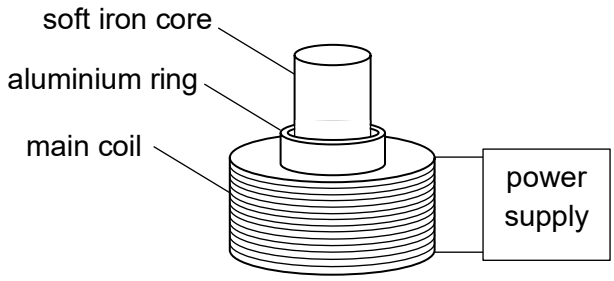

Fig. 5.1

The power supply provides an alternating voltage to the main coil. The variation with time t of the supply voltage V is given by

$$V = 240\sin(377t)$$

where V is measured in volts and t in seconds.

(i) Calculate the frequency of the supply voltage.

frequency = ... Hz [2]

(ii) Determine the root-mean-square value of the supply voltage.

root-mean-square voltage = ……. V [2]

(iii) When the power supply is switched on, the aluminium ring is observed to float above the main coil.

Using the laws of electromagnetic induction, explain why the ring floats above the main coil.

…….

…….

…….

…….

…….

…….

…….

……... [4]

(iv) The power supply is switched off. A small slit is then made on the ring, as shown in Fig. 5.2.

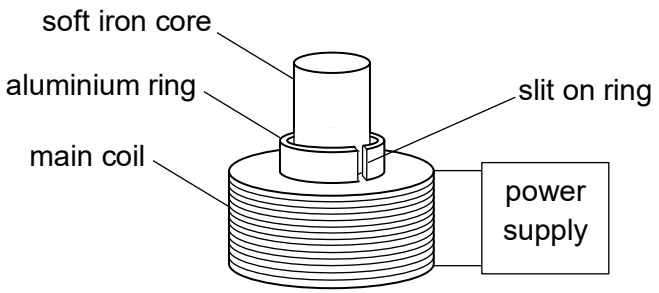

Fig. 5.2

State and explain what will be observed when the power supply is switched on again.

…….

…….

…….

……... [2]

(b) The ring is now removed, and a small coil is placed over the soft iron core, as shown in Fig. 5.3.

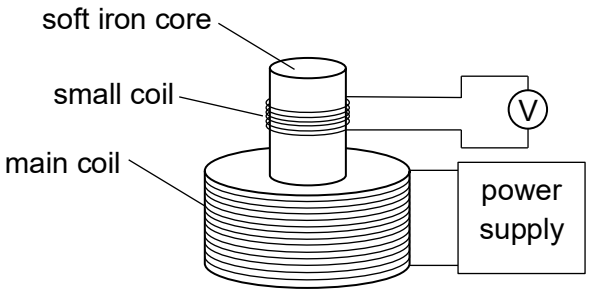

Fig. 5.3

The power supply now provides a varying current to the main coil to create a magnetic field. Fig. 5.4 below shows the variation of the magnetic flux density, B, through the small coil with time, t.

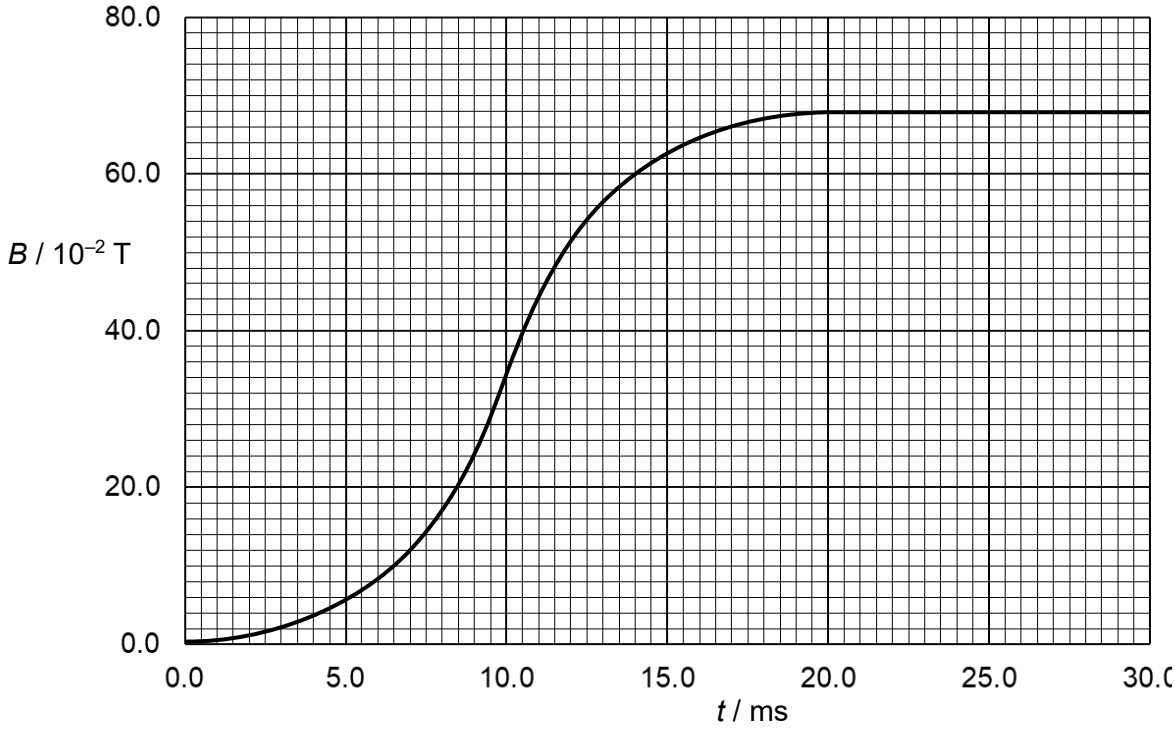

Fig. 5.4

The small coil has 80 turns, and a cross-sectional area of 4.2×10^{-5} m^2.

Using Fig. 5.4, estimate the magnitude of the maximum e.m.f. induced in the small coil.

maximum e.m.f. = ... V [2]

Section B

Answer **one** question from this Section in the spaces provided.