5 **(a)** Fig. 5.1 shows a ground fault interrupter (GFI) - a device used in a.c. outlets where the risk of electric shock is high, e.g. bathrooms. The GFI consists of a sensing coil wound around an iron ring that surrounds the wires that transmit electricity to the appliance.

When the appliance functions normally, the net magnetic field in the iron ring is zero. However, when current flows through a person to the ground instead of flowing through the return wiring, the sensing coil activates a circuit breaker.
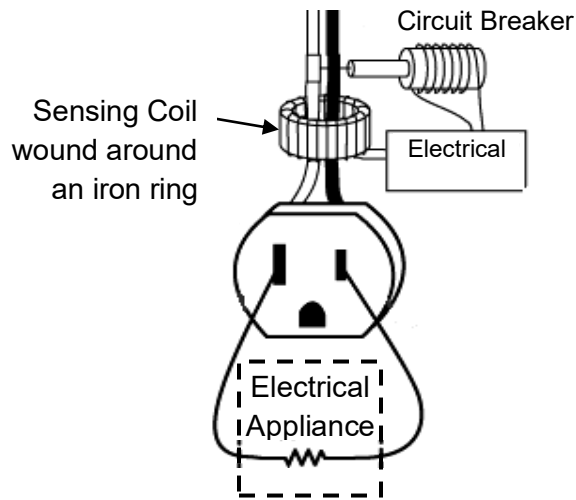

Fig. 5.1

(i) State the purpose of the iron ring.

....

.... [1]

(ii) Use Faraday's law to explain why the circuit breaker is triggered when a fault in the appliance causes the user to be electrocuted.

....

....

....

....

....

.... [3]

(iii) Suggest one way to increase the sensitivity of the sensing coil.

....

.... [1]

(b) The magnetic field shown in Fig. 5.2 below has a uniform magnitude of 25.0 mT directed into the paper. A long wire that forms a loop with an initial diameter of 2.00 cm is placed within the field.
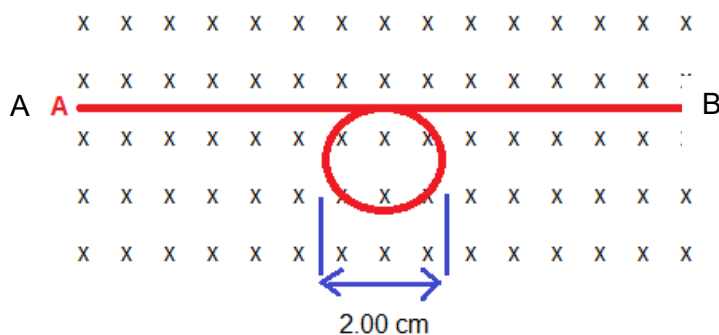

Fig. 5.2

The wire is quickly pulled taut and straightened such that there is no more loop in 50.0 ms.

(i) Determine the average voltage induced between endpoints A and B.

voltage = …………………….. V [2]

(ii) State and explain whether the potential at A is higher or lower than the potential at B.

………………………………………………………………………………….……………

………………………………………………………………………………….……………

………………………………………………………………….………………..……………

……………………………………………………………….…………………..………... [2]

(c) An oscilloscope is used to measure the potential difference across a resistor in an a.c. circuit. The voltage waveform is shown in Fig. 5.3.
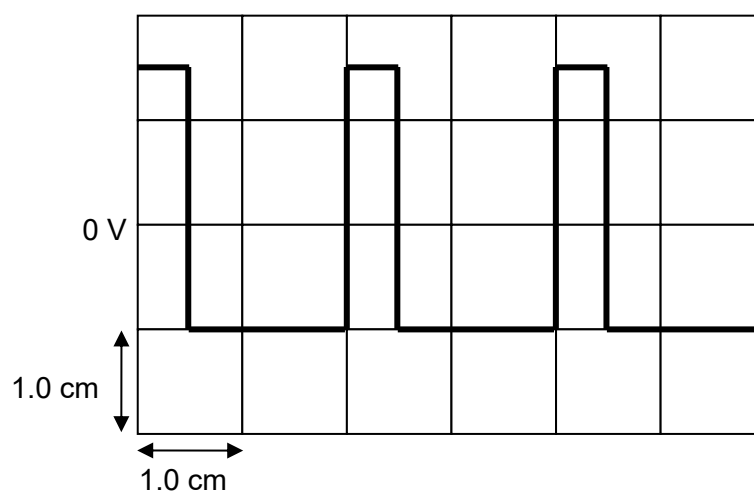

Fig. 5.3

(i) Determine the time base setting of the oscilloscope if the frequency of the waveform is 100 Hz.

time base = ………………………….. ms cm^{-1} [1]

(ii) Determine the root-mean-square value of the potential difference across the resistor if the Y-gain is set at 0.5 V cm^{-1}.

V_{rms} = …………………………... V [2]