5 A metal wire is held taut between the poles of a permanent magnet, as illustrated in Fig. 5.1.

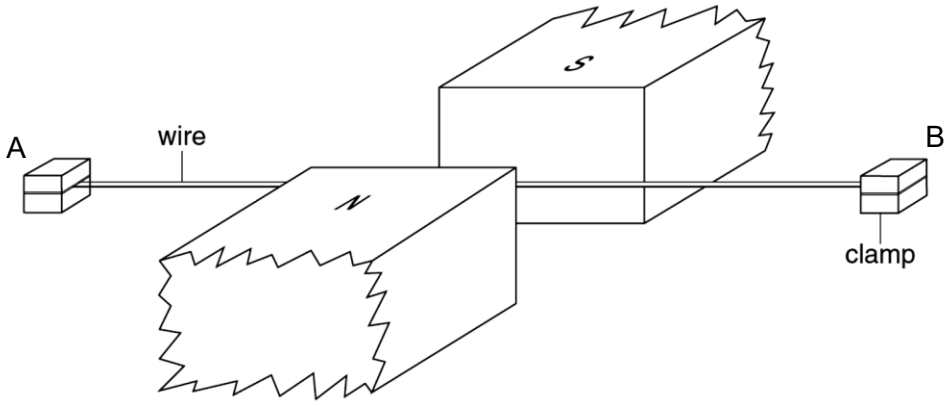

Fig. 5.1

A cathode-ray oscilloscope (c.r.o.) is connected between the ends of the wire. The Y-plate sensitivity is adjusted to 1.0 mV cm^{-1} and the time base is 0.5 ms cm^{-1}.

The wire is plucked at its centre. Fig. 5.2 shows the trace seen on the c.r.o.

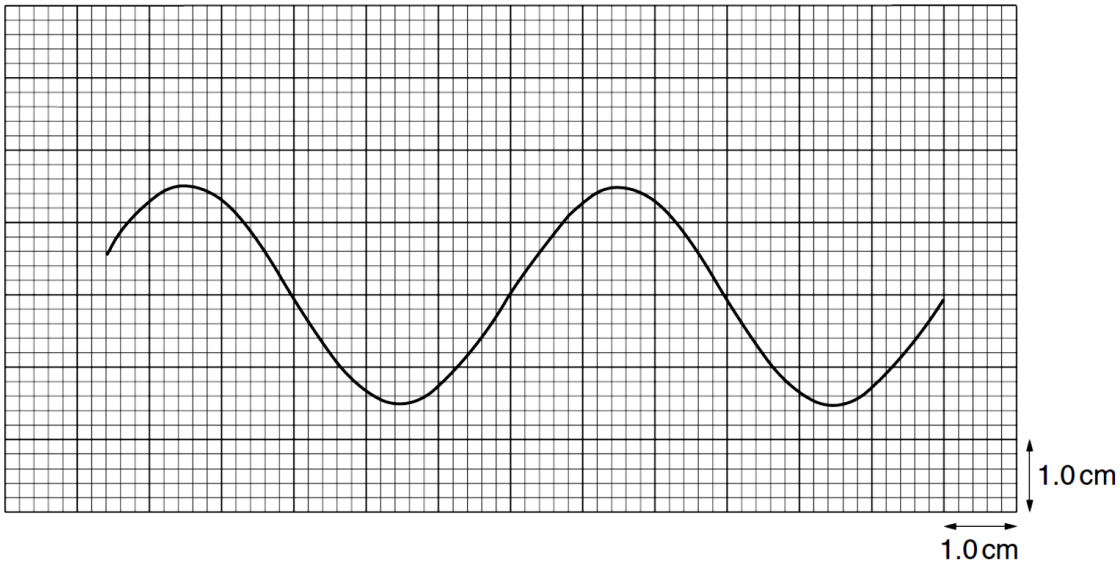

Fig. 5.2

(a) With reference to the laws of electromagnetic induction, explain why

(i) an e.m.f. is induced in the wire,

……

……

……

…… [2]

(ii) the e.m.f. is alternating.

……

……

……

…….…….. [2]

(b) **(i)** Use Fig. 5.2 and the c.r.o. settings to determine the equation representing the induced alternating e.m.f.

[4]

(ii) Mark any two points on Fig. 5.2 with crosses × and label both points with the letter Z to indicate two instances in time when the displacement of the wire is zero.

[1]

(iii) Deduce the direction of the motion of the wire at the instant when the electric potential of A is higher than the potential of B.

…….…….. [1]

(c) **(i)** Given the resistance of the wire is 6.0 Ω and the c.r.o. is replaced with a microammeter, derive the equation representing the induced current.

[2]

(ii) Hence or otherwise, calculate the maximum induced magnetic field strength due to the induced current at a separation of 2.0 μm from the wire.

magnetic field strength = ……..…… T [1]

(iii) State the direction of the induced current **and** its consequent magnetic field at the instant when the electric potential of A is higher than the potential of B.

……..……... [1]

(d) After a while, the wire stops moving. Explain why this occurs, ignoring friction and air resistance.

……..

……. [1]