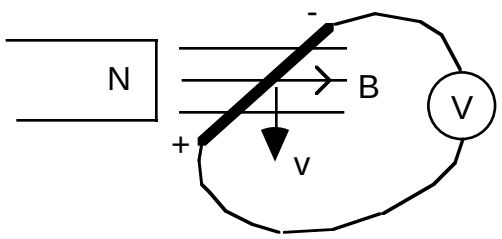
Magnetic Induction : Notes/W.S.-10

When a charge moves in a magnetic field, there will be a force on it. When a wire or conductor moves across a magnetic field, there will be a force on the electrons within the wire and therefore an electromotive force in the wire. If the wire is connected to a circuit, a current will flow. This is called **<u>electromagnetic induction</u>**.

In the diagram below, a conductor of length L, moves with a velocity v through a magnetic field B. The conductor, velocity and field are perpendicular to each other. An electromotive force is induced in the wire. The magnitude of the emf is given by the equation below.

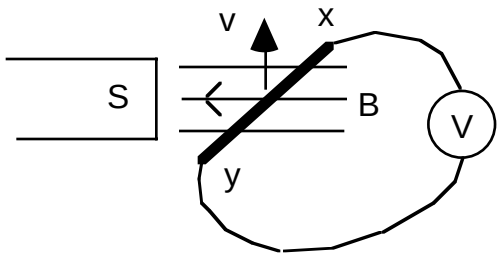


$$emf = BvL$$

The force on the electrons is into the page by the right hand rule.

Problems:

1)a) Find the reading of the voltmeter, when a 1.5 cm long conductor moves perpendicular to a field of 3.5 T with a velocity of 75 cm/s as shown in the diagram below.



b) Will electrons move to point x or point y?

c) Find the force on each electron. (use F = qvB)

d) Find the work done in moving an electron through a distance L. (use W = FxL)

e) Find the work done in moving a coulomb of electrons through a distance L. (compare with answer to 1a)

f) If the wire moves parallel to the B field, what is the reading of the voltmeter?

2) Show that the SI units for BvL are equal to the SI units for volts. (SI units are; m, kg, s, A)

3) Find the emf induced between the wing tips of a plane flying through the Earth's magnetic field. The plane's speed is 85 km/hr, the perpendicular component of the field is 1.5×10^{-5} T, and the wingspan is 12 m.

4) Your blood contains ions. We can measure the speed of the blood in a vessel by measuring the emf across the vessel when it is in a magnetic field. The emf is measured to be 0.050 mV, B = 0.060 T, and the width of the vessel is 1.5 mm. Find the rate of blood flow.

Answers: 1)a) 0.039 V, b) x, c) 4.2×10^{-19} N [into page], d) 6.3×10^{-21} J, e) 0.039 J, f) 0.0 V, 2) units for volts are N m/C or kg m^2 s^{-3} A^{-1}, units for B are kg s^{-2} A^{-1}, units for v are m s^{-1}, units for L are m, therefore units for BvL are kg s^{-2} A^{-1} x m s^{-1} x m = kg s^{-3} A^{-1} m^2, same as for volts, 3) 4.3 mV, 4) 55 cm/s.