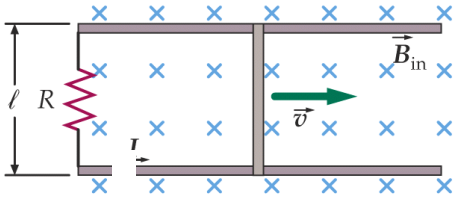
PHYS1022 Electricity and Magnetism

Problem Sheet 10: workshop

1 A rod 30 cm long moves at 8 m/s in a plane perpendicular to a magnetic field of 500×10^{-4} T which is in the positive z direction. The velocity of the rod is perpendicular to its length and in the positive y direction. Find
(a) the magnetic force on an electron in the rod (magnitude and direction),
(b) the electrostatic field $\underline{E}$ in the rod, and
(c) the potential difference V between the ends of the rod. Indicate in a diagram which direction the potential is increasing.

2 In the figure, the rod is moved to make the loop of circuit bigger. Let $B = 0.8$ T, $v = 10$ m/s, $l = 20$ cm , and $R = 2\ \Omega$. Find
(a) the induced emf in the circuit,
(b) the magnitude and direction of the current in the circuit, and
(c) the force needed to move the rod with constant velocity, assuming negligible friction.



3 Use Ampere's Law to derive the expression for the magnetic field inside a solenoid, taking care to define all terms.

A long solenoid is wound with 500 turns per metre and the current in its windings is increasing at the rate of 100 A/s. The cross-sectional area of the solenoid is 4.0 cm^2. A wire loop is placed around the solenoid on the same axis.
(a) Find the magnitude of the induced emf in the wire loop outside the solenoid.
(b) Find the magnitude of the induced electric field within the loop if its radius is 2.0 cm.

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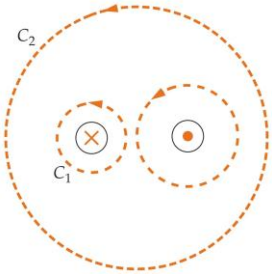
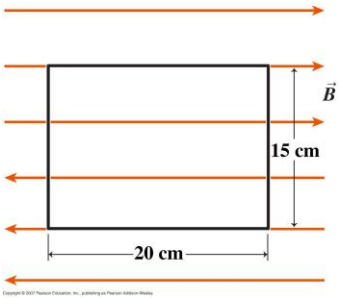
Problem Sheet 9:tutorial

1. When a current is passed through the wire in the figure, will the wire tend to bunch up or form a circle?

2. In the figure, one current is 8 A into the paper, the other current is 8 A out of the paper, and each curve is a circular path.
   (a) Find $\oint_C \underline{B} \cdot d\underline{l}$ for each path indicated, where each integral is taken with $d\underline{l}$ counterclockwise.
   (b) Which path, if any, can be used to find *B* at some point due to these currents?



3. The magnetic field shown in the figure has uniform magnitude 75 μT, but its direction reverses abruptly in space as shown. How much current is encircled by the rectangular loop shown?



4. A magnetic field of 1.2 T is perpendicular to a square coil of 14 turns. The length of each side of the coil is 5 cm.
   (a) Find the magnetic flux through the coil.
   (b) Find the magnetic flux through the coil if the magnetic field makes an angle of 60° with the normal to the plane of the coil.
   (Please use a dot product in your answers.)