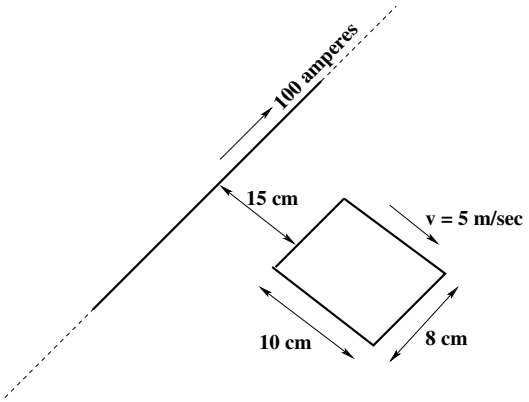
PHY102 : Assignment 7

1. (Purcell 7.4) Calculate the electromotive force in the moving loop in the figure at the instant when it is in the position there shown. Assume the resistance of the loop is so great that the effect of the current in the loop itself is negligible. Estimate very roughly how large a resistance would be safe, in this respect. Indicate the direction in which current would flow in the loop, at the instant shown.



2. A conducting rod of length l moves with velocity v parallel to a long wire carrying a steady current I. The axis of the rod is maintained perpendicular to the wire with the near end a distance r away. Find the magnitude of the emf induced in the rod.

3. (Purcell 7.14) A metal crossbar of mass m slides without friction on two long parallel conducting rails a distance b apart. A resistor R is connected across the rails at one end; compared with R, the resistance of bar and rails is negligible. There is a uniform field $\mathbf{B}$ perpendicular to the plane of the figure. At time $t = 0$ the crossbar is given a velocity v_0 toward the right. What happens then?

   (a) Does the rod ever stop moving?

   (b) If so, when? How far does it go?

   (c) How about conservation of energy?

4. A circular loop of wire of radius a is placed in a uniform magnetic field, with the plane of the loop perpendicular to the direction of the field. The magnetic field varies with time according to $B(t) = B_0 + bt$, where B_0 and b are positive constants.

   (a) Calculate the magnetic flux through the loop at $t = 0$.

   (b) Calculate the induced emf in the loop.

   (c) What are the induced current and its direction if the overall resistance of the loop is R?

   (d) Find the power dissipated due to the resistance of the loop.

5. An infinite solenoid has radius R and n turns per unit length. The current grows linearly with time according to $I(t) = Ct$. Use the integral form of Faraday's law to find the electric field at radius r, both inside and outside the solenoid. Then verify that your answers satisfy the differential form of the law.