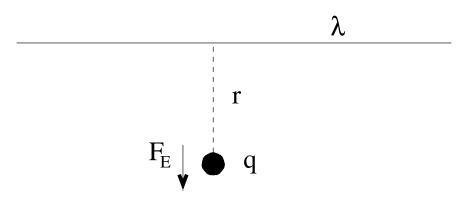# PHY102 : Assignment 7

1. A wire of radius R is carrying current I with uniform current density. The wire may be viewed as the superposition of a large number of thin wires running parallel to each other. Find the field both inside and outside the wire. Verify that $curl\mathbf{B} = \mu_0\mathbf{J}$ both inside and outside the wire. You may need the expression for curl in cylindrical coordinates.

2. A charge q is at rest a distance r from a long rod with linear charge density λ, as shown in the Fig. The charges in the rod are also at rest. The electric field due to the rod takes the standard form of $E = \lambda/2\pi\epsilon_0 r$, so the force on the charge q in the lab frame is simply $F = qE = q\lambda/2\pi\epsilon_0 r$. This force is repulsive, assuming q and λ have the same sign. Now

consider the setup in the frame that moves to the left with speed v. In this frame both the charge q and the charges in the rod move to the right with speed v. What is the force on the charge q in this new frame ? Solve this in three different ways.

   (a) Transform the force from the lab frame to the new frame.
   (b) Directly calculate the electric and magnetic forces in the new frame.
   (c) Transform the fields using the Lorentz transformations.

3. Consider a particle at rest at the origin. There is a magnetic field $\mathbf{B}$ that points in the x-direction and an electric field $\mathbf{E}$ in the z-direction. The particle is released. Show that the path is a cycloid.

4. (Purcell 6.1) Suppose the current I that flows in two parallel wires carrying current in the opposite direction, is 20 amperes. The distance between the wires is 5 cm. How large is the force per meter of length, tha pushes horizontally on one of the wires ?

5. (Purcell 6.4) A long wire carrying current is bent into a hairpin like shape. Find an exact expression for the magnetic field at the point P which lies at the center of the half-circle (the bent region) of radius r.

6. (Purcell 6.24) An electron is moving at a speed 0.01c on a circular orbit of radius 10^{-10}m. What is the strength of the resulting magnetic field at the center of the orbit.

7. (Purcell 6.30) In the neighborhood of the origin in the coordinate system x, y, z, there is an electric field $\mathbf{E}$ of magnitude 100 V/m, pointing in a direction that makes angles of 30 degrees with the x axis and 60 degrees with the y axis. The frame F' has its axes parallel to those just described, but is moving, relative to the first frame, with a speed 0.6c in the positive y direction. Find the direction and magnitude of the electric field that will be reported by an observer in F'. What magnetic field does the observer report ?