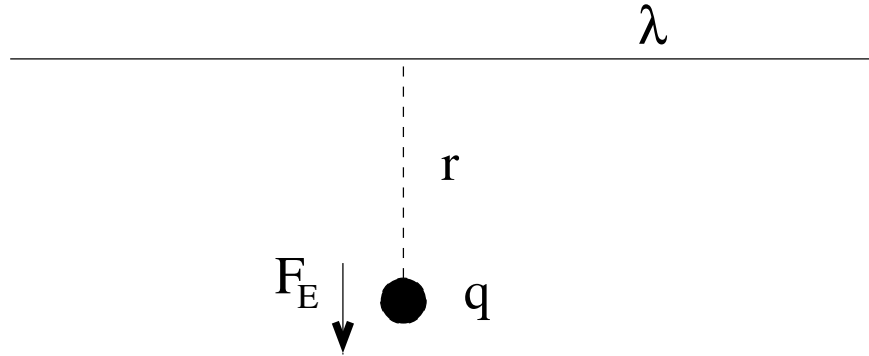


PHY102 : Assignment 7

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 $\text{curl}\mathbf{B} = \mu_0\mathbf{J}$ 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, that 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?