SB/HCV

PHY 103: General Physics 2 (2014 – 2015, Semester – I)

Department of Physics

Indian Institute of Technology - Kanpur

Assignment- 8

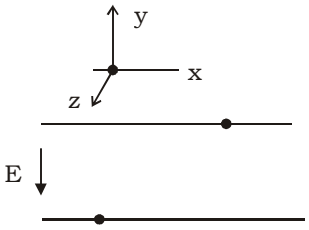
1. A capacitor consists of two parallel rectangular plates with edge lengths parallel to x and y axes and separated by 2 cm. The edges parallel to the x-axis are 20 cm long and the other edges are 10 cm long. The capacitor is charged by connecting it temporarily to a battery of 80 volts. A frame of reference S' moves along the x-axis, relative to the laboratory frame, with speed 0.6c. Answer the following questions in S'. (a) What are the lengths of the edges of the plates and the separation between them? (b) What is the number of excess electrons on the negative plate? (c) Find the electric and magnetic field strengths between the plates using the charge and current distribution in S'. (d) Find the electric and magnetic field strengths between the plates using the fields in S and E-B transformation equations.

Neglect fringing effect.

2. A parallel plate capacitor is at rest in S. Its plates are titled at 45^0 to the x axis. The charge densities on the plates are $\pm\sigma_0$. A frame S' is moving to the right at speed 0.6c relative to S. Find (a) the electric field in S, (b) the electric field in S', (c) the angle made by the plates with the x-axis in S', (d) the angle made by the electric field with the normal to the plates in S'.

3. A region has electric and magnetic fields given by $\mathbf{E} = E_0\,\hat{j}$ and $\mathbf{B} = \frac{1}{2c}E_0\,\hat{k}$. A positively charged particle is released from rest at the origin at $t = 0$. (a) Is there a frame S' in which one of the fields is zero? If so, find its velocity with respect to S. (b) Show that the y-coordinate keeps on increasing with time.

4. A capacitor with a separation d between the plates is placed in a laboratory and produces an electric field $\mathbf{E} = -E_0\,\hat{j}$ between the plates. Electrons are emitted with negligible velocity from the plate. A uniform magnetic field $\mathbf{B} = B_0\hat{k}$ is applied to prevent electrons reaching the positive plate. Analyze the motion from the frame S' moving with velocity $-\frac{E_0}{B_0}\hat{i}$ and find the minimum value of B_0 needed. Assume $E_0 << B_0 c$.



5. A charge q_1 is moving along the x-axis with a velocity 0.5c and another charge q_2 is kept at rest on the x-axis at $x = a$. At $t = 0$ the first charge crosses the origin. Find (a) the force on q_1 at $t = 0$ due to the field of q_2 (b) the force on q_2 at $t = 0$ due to the field of q_1.

6. A conductor is moving along the x-axis with a velocity $0{\cdot}6c\hat{i}$ as seen from frame S. The surface of conductor at time t is given by $\left(\frac{5x - 3ct}{4}\right)^2 + y^2 + z^2 = R^2$. There is an otherwise uniform magnetic field existing in the region. Find the charge appearing on half of the conductor defined by $z > 0$.