Physics 115: Contemporary Physics III

Spring 2013

Homework 5

Due May 10, 2013

1. In one frame of reference a positive charge q is at rest at the origin of coordinates and there is no magnetic field. Write down a vector expression for the electric field at some point $\mathbf{r}$ in this frame. A second reference frame is moving at velocity $\mathbf{v}$ relative to the first frame. Apply the "alternative" form of the field transformation given in Chabay & Sherwood, p. 879, to derive the relativistic form of the Biot-Savart law in the second (primed) frame

$$\mathrm{B}' = -\gamma \frac{\mu_0}{4\pi} \frac{q\mathbf{v} \times \hat{\mathbf{r}}}{r^2}.$$

2. Chabay & Sherwood, Problem 22.X.21.

3. Chabay & Sherwood, Problem 22.P.23.

4. Chabay & Sherwood, Problem 22.P.30.

5. Gauss's law for gravitation is

$$\Phi_g = \int \mathbf{g} \cdot d\mathbf{A} = -4\pi G m,$$

   where $\mathbf{g}$ is the gravitational field, m is the enclosed mass, and G is Newton's constant. Derive Newton's law of gravitation from Gauss's law. What is the significance of the minus sign?

6. Chabay & Sherwood, Problem 22.P.34.