1. Use the Lorentz transformation to show that the electric field caused by a point charge moving with constant velocity $\mathbf{v}$ is

$$\mathbf{E}(\mathbf{R}) = \frac{e}{4\pi\epsilon_0} \frac{\mathbf{R}}{R^3} \frac{1 - \frac{v^2}{c^2}}{(1 - \frac{v^2}{c^2}\sin^2\theta)^{3/2}}.$$

   Here $\mathbf{R}$ is the displacement from the charge at the given moment and θ is the angle between $\mathbf{v}$ and $\mathbf{R}$. Draw a conclusion that the electric field caused by charged particle moving with large velocity can be seen as a short pulse at angle $\theta = \pi/2$ ($\Delta\theta \propto \sqrt{1 - v^2/c^2}$).

2. Use Maxwell's equations in 3-vector form and the generalization of equation

$$\frac{dE_{kin}}{dt} = e\mathbf{v} \cdot \mathbf{E}$$

   to derive the law for conservation of energy

$$\frac{d}{dt}\left[\sum E_{kin} + \int dV\left(\frac{\epsilon_0}{2}E^2 + \frac{1}{2\mu_0}B^2\right)\right] = -\oint d\mathbf{a} \cdot \mathbf{S}.$$

   Here $\mathbf{S}$ is the Poynting vector

$$\mathbf{S} = \frac{1}{\mu_0}\mathbf{E} \times \mathbf{B}.$$