Electromagnetic Theory: Homework 14

Due: 13 October 2020

1 Dipole along the x-axis

Consider a point charge dipole consisting of two charges along the x-axis. One is located at $x = d/2$ and has charge $+q$. The other is located at $x = -d/2$ and has charge $-q$.

a) Determine an exact expression, using spherical coordinates, for the electrostatic potential produced by these charges at any location $\mathbf{r}$.

b) Show that the lowest order approximation to the potential when $r \gg d$ is

$$V = \frac{1}{4\pi\epsilon_0} \frac{qd}{r^2} \hat{\mathbf{x}} \cdot \hat{\mathbf{r}}.$$

Express this in terms of spherical coordinates.

c) Use the approximation to determine an expression, in spherical coordinates, for the electric field produced by the charges.