

4.35 For the electric dipole shown in Fig. 4-13, $d = 1$ cm and $|\mathbf{E}| = 8$ (mV/m) at $R = 1$ m and $\theta = 0^\circ$. Find \mathbf{E} at $R = 2$ m and $\theta = 90^\circ$.

Solution: For $R = 1$ m and $\theta = 0^\circ$, $|\mathbf{E}| = 8$ mV/m, we can solve for q using Eq. (4.56):

$$\mathbf{E} = \frac{qd}{4\pi\epsilon_0 R^3} (\hat{\mathbf{R}} 2 \cos \theta + \hat{\boldsymbol{\theta}} \sin \theta).$$

Hence,

$$|\mathbf{E}| = \left(\frac{qd}{4\pi\epsilon_0} \right) 2 = 8 \text{ mV/m} \quad \text{at } \theta = 0^\circ,$$

$$q = \frac{10^{-3} \times 16\pi\epsilon_0}{d} = \frac{10^{-3} \times 16\pi\epsilon_0}{10^{-2}} = 1.6\pi\epsilon_0 \quad (\text{C}).$$

Again using Eq. (4.56) to find \mathbf{E} at $R = 2$ m and $\theta = 90^\circ$, we have

$$\mathbf{E} = \frac{1.6\pi\epsilon_0 \times 10^{-2}}{4\pi\epsilon_0 \times 2^3} (\hat{\mathbf{R}}(0) + \hat{\boldsymbol{\theta}}) = \hat{\boldsymbol{\theta}} \frac{1}{2} \quad (\text{mV/m}).$$
