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

Solution: For $R = 1$ m and $\theta = 0°$, $|\mathbf{E}| = 4$ mV/m, we can solve for q using Eq. (4.56):

$$\mathbf{E} = \frac{qd}{4\pi\varepsilon_0 R^3}(\hat{\mathbf{R}}2\cos\theta + \hat{\boldsymbol{\theta}}\sin\theta).$$

Hence,

$$|\mathbf{E}| = \left(\frac{qd}{4\pi\varepsilon_0}\right)2 = 4 \text{ mV/m} \quad \text{at } \theta = 0°,$$

$$q = \frac{10^{-3} \times 8\pi\varepsilon_0}{d} = \frac{10^{-3} \times 8\pi\varepsilon_0}{10^{-2}} = 0.8\pi\varepsilon_0 \qquad \text{(C)}.$$

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

$$\mathbf{E} = \frac{0.8\pi\varepsilon_0 \times 10^{-2}}{4\pi\varepsilon_0 \times 2^3}(\hat{\mathbf{R}}(0) + \hat{\boldsymbol{\theta}}) = \hat{\boldsymbol{\theta}}\,\frac{1}{4} \qquad \text{(mV/m)}.$$