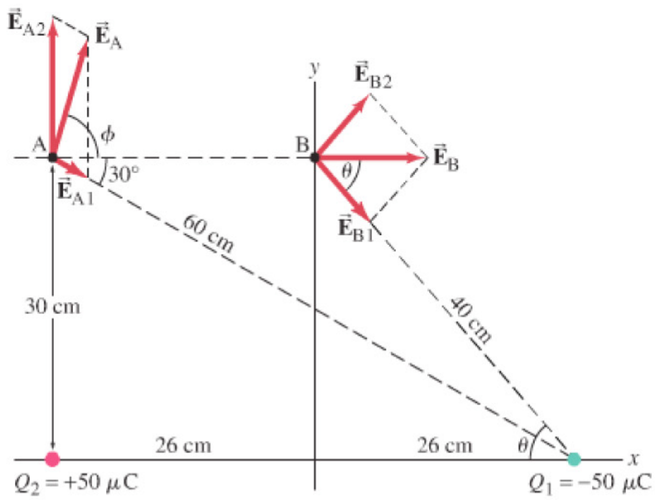

FIGURE 16–28 Calculation of the electric field at points A and B for Example 16–9.

SOLUTION (*a*) The magnitude of the electric field produced at point A by each of the charges Q_1 and Q_2 is given by $E = kQ/r^2$, so

$$E_{A1} = \frac{(9.0 \times 10^9\,\mathrm{N \cdot m^2/C^2})(50 \times 10^{-6}\,\mathrm{C})}{(0.60\,\mathrm{m})^2} = 1.25 \times 10^6\,\mathrm{N/C},$$

$$E_{A2} = \frac{(9.0 \times 10^9\,\mathrm{N \cdot m^2/C^2})(50 \times 10^{-6}\,\mathrm{C})}{(0.30\,\mathrm{m})^2} = 5.0 \times 10^6\,\mathrm{N/C}.$$

➡ **PROBLEM SOLVING**

Ignore signs of charges and determine direction physically, showing directions on diagram

The direction of E_{A1} points from A toward Q_1 (negative charge), whereas E_{A2} points from A away from Q_2, as shown; so the total electric field at A, $\vec{\mathbf{E}}_A$, has components

$$E_{Ax} = E_{A1} \cos 30^\circ = 1.1 \times 10^6\,\mathrm{N/C},$$

$$E_{Ay} = E_{A2} - E_{A1} \sin 30^\circ = 4.4 \times 10^6\,\mathrm{N/C}.$$

Thus the magnitude of $\vec{\mathbf{E}}_A$ is

$$E_A = \sqrt{(1.1)^2 + (4.4)^2} \times 10^6\,\mathrm{N/C} = 4.5 \times 10^6\,\mathrm{N/C},$$

and its direction is ϕ given by $\tan\phi = E_{Ay}/E_{Ax} = 4.4/1.1 = 4.0$, so $\phi = 76^\circ$.
(*b*) Because B is equidistant (40 cm by the Pythagorean theorem) from the two equal charges, the magnitudes of E_{B1} and E_{B2} are the same; that is,

➡ **PROBLEM SOLVING**

Use symmetry to save work, when possible

$$E_{B1} = E_{B2} = \frac{kQ}{r^2} = \frac{(9.0 \times 10^9\,\mathrm{N \cdot m^2/C^2})(50 \times 10^{-6}\,\mathrm{C})}{(0.40\,\mathrm{m})^2}$$
$$= 2.8 \times 10^6\,\mathrm{N/C}.$$

Also, because of the symmetry, the y components are equal and opposite, and so cancel out. Hence the total field E_B is horizontal and equals $E_{B1}\cos\theta + E_{B2}\cos\theta = 2E_{B1}\cos\theta$. From the diagram, $\cos\theta = 26\,\mathrm{cm}/40\,\mathrm{cm} = 0.65$. Then

$$E_B = 2E_{B1}\cos\theta = 2(2.8 \times 10^6\,\mathrm{N/C})(0.65)$$
$$= 3.6 \times 10^6\,\mathrm{N/C},$$

and the direction of $\vec{\mathbf{E}}_B$ is along the $+x$ direction.

NOTE We could have done part (*b*) in the same way we did part (*a*). But symmetry allowed us to solve the problem with less effort.