A. 1. Opposites attract, so the electron is pulled toward the origin:

\[
\text{The field’s direction is that of the force a positive charge would feel: (It’s a property of the point in space, not of what is located there. It’s similar with gravity: Earth’s gravitational field in a certain place is the same whether an elephant or a bread crumb is located there.)}
\]

2. Coulomb’s law gives the force between point-like charges, or charged spheres. With a different charge distribution, like these plates, \( E \) would be given by a different formula.

3. Convert to metric: 

\[
(1.0 \times 10^9 \text{ lb}) \left( \frac{1 \text{ N}}{225 \text{ lb}} \right) = 4.444 \times 10^9 \frac{N}{C}
\]

Electric field: 

\[
E = k \frac{|q|}{r^2}
\]

\[
r^2 = k \frac{|q|}{E} = (8.988 \times 10^9) \frac{(26)(1.602 \times 10^{-19})}{4.444 \times 10^9} = 8.424 \times 10^{-18}
\]

Take square root: \( r = 2.90 \times 10^{-9} \text{ m} \) ans.

B. 1. Field lines point away from + charges, and toward -. So, since \( \vec{E} \) points toward it, this is a negative charge.

\[
E = k \frac{|q|}{r^2} \Rightarrow |q| = \frac{Er^2}{k} = \frac{(40)(.25^2)}{8.988 \times 10^9} = 2.78 \times 10^{-10} \text{ C}
\]

Answer: \(-2.78 \times 10^{-10} \text{ C}\)

2. Field from A: 40.0 N/C, south (given)

Field from B: 

\[
E = k \frac{|q|}{r^2} = (8.988 \times 10^9) \frac{2.78 \times 10^{-10}}{(0.50 \text{ m})^2} = 10.0 \text{ N/C}, \text{ south}
\]

Total: 40 + 10 = 50.0 N/C ans.
C. a. \[ F = k \frac{|q_1||q_2|}{r^2} = \frac{\left(8.988 \times 10^9\right) \left(2.70 \times 10^{-4}\right) \left(1.60 \times 10^{-19}\right)}{(0.014)^2} = 1.98 \times 10^{-11} \text{ N} \quad \text{Left.} \]

(Opposites attract, so the electron is pulled toward the ball.)

b. \[ E = \frac{F}{q} = \frac{1.98 \times 10^{-11} \text{ N}}{1.60 \times 10^{-19} \text{ C}} = 1.24 \times 10^8 \text{ N/C} \quad \text{Right.} \] (\( \vec{E} \)'s direction is defined with a positive charge in mind. A positive charge at the electron’s location would be repelled by the +2.7 μC.)

c. Same answer as (b). \( \vec{E} \) is a property of the point in space, not of what is located there.

D.

\[ \begin{align*}
q_1 & \quad 5 \mu \text{C} \\
q & \quad -5 \mu \text{C} \\
q_2 & \quad 3 \mu \text{C}
\end{align*} \]

(x)

\( F_1 \) is the force that \( q \) feels from \( q_1 \). \( F_2 \) is the force that \( q \) feels from \( q_2 \). The directions come from the fact that opposite charges attract: \( q \) is pulled toward \( q_1 \), and \( q \) is pulled toward \( q_2 \). The magnitude of each force comes from Coulomb’s law:

\[ F_1 = k \frac{|q_1||q|}{r^2} = 8.988 \times 10^9 \left(5.00 \times 10^{-6}\right) \left(5.00 \times 10^{-6}\right) \left(1.00 \text{ m}\right)^2 = 0.2247 \text{ N} \]

\[ F_2 = k \frac{|q_2||q|}{r^2} = 8.988 \times 10^9 \left(3.00 \times 10^{-6}\right) \left(5.00 \times 10^{-6}\right) \left(1.50 \text{ m}\right)^2 = 0.0599 \text{ N} \]

Add them, remembering to call right positive and left negative:

\[-0.2247 + 0.0599 = -0.1649 \quad \text{Answer: } 0.165 \text{ N to the left} \]
\[ F = \frac{k \cdot 8 \cdot 8}{r^2} \]  
so if the forces are equal

\[ q_p = \text{charge of proton} \quad \frac{k(6 \times 10^{-8} c)(6.4 c)}{x^2} = \frac{k(4 \times 10^{-8} c)(6.4 c)}{(x-3)^2} \]

\[ \frac{6}{x^2} = \frac{4}{(x-3)^2} \]

\[ 6(x-3)^2 = 4x^2 \]

\[ \sqrt{6(x-3)} = 2x \]

\[ x-3 = 0.8165x \]

\[ x = 0.8165x = 3 \]

\[ 1.835x = 3 \Rightarrow x = \boxed{16.3 \text{ m}} \]