Solutions

Each answer shows the steps, then the **result**.

2.1

- field of a point charge:

$$E = k\frac{q}{r^2} = (8.99 \times 10^9\ \text{N m}^2\,\text{C}^{-2})\,\frac{5.0 \times 10^{-6}\ \text{C}}{(0.20\ \text{m})^2}$$

- $E = \mathbf{1.1 \times 10^6}\ \text{N C}^{-1}$, away from the charge

2.2

- force on a charge in a field:

$$F = qE = (2.0 \times 10^{-6}\ \text{C})(3000\ \text{N C}^{-1})$$

- $F = \mathbf{6.0 \times 10^{-3}}\ \text{N}$

2.3

- radially inward, toward the charge

3.1 B

- F/q.

3.2 B

- qE.

3.3

(a)

- field of a point charge:

$$E = k\frac{q}{r^2} = (8.99 \times 10^9\ \text{N m}^2\,\text{C}^{-2})\,\frac{4.0 \times 10^{-6}\ \text{C}}{(0.30\ \text{m})^2}$$

- $E = \mathbf{4.0 \times 10^5}\ \text{N C}^{-1}$, pointing away from the charge

(b)

- force on a charge in a field (size):

$$F = |q|E = (1.0 \times 10^{-6}\ \text{C})(4.0 \times 10^5\ \text{N C}^{-1})$$

- $F = \mathbf{0.40}$ N, towards the $+4.0\ \mu$C charge: a negative charge feels a force opposite to $\vec{E}$

3.4

(a)

- each charge gives $E = \dfrac{kq}{r^2} = \dfrac{(8.99 \times 10^9)(3.0 \times 10^{-6})}{(0.30)^2} = 3.0 \times 10^5\ \text{N C}^{-1}$
- both fields point the same way at P: away from $+3.0\ \mu$C and towards $-3.0\ \mu$C, so they add
- $E = \mathbf{6.0 \times 10^5}\ \text{N C}^{-1}$, towards the negative charge

(b)

- a large charge would push or pull the source charges and change the field it is measuring

3.5

(a)

- $E = \mathbf{0}$ inside a conductor in equilibrium
- the excess charge sits on the outer surface

(b)

- outside, the sphere acts like a point charge at its centre: $E = \dfrac{(8.99 \times 10^9)(2.0 \times 10^{-9})}{(0.30)^2}$
- $E = \mathbf{2.0 \times 10^2}\ \text{N C}^{-1}$

(c)

- not zero: charge is spread through the inside of an insulator, so charge is enclosed within 0.05 m

3.6 A

- line density shows field strength; field lines never cross