Solutions

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

2.1

- the **force per unit positive charge** on a small test charge ($E = F/q$)

2.2

- $\mathrm{N\ C^{-1}}$ (or $\mathrm{V\ m^{-1}}$)

2.3

- $F = qE$

2.4

- **outward** (away from the charge)

3.1 B

- field lines leave a **positive** charge

3.2

- $E = F/q$

$$E = \frac{0.10\ \mathrm{N}}{2.0 \times 10^{-6}\ \mathrm{C}} = \mathbf{5.0 \times 10^{4}\ N\ C^{-1}}$$

3.3

(a) radial lines pointing **outward** from the positive charge

(b) radial lines pointing **inward** to the negative charge

3.4

(a) the **force per unit positive charge** acting at that point

(b) the field lines are **straight, parallel and evenly spaced**, so the field is **uniform**

- they run from the **positive** plate to the negative one, i.e. vertically **downwards** here

(c) $E = V/d$

$$E = \frac{430\ \mathrm{V}}{0.067\ \mathrm{m}} = \mathbf{6.4 \times 10^{3}\ V\ m^{-1}}$$

(d) $F = Eq$

$$F = (6.4 \times 10^{3}\ \mathrm{V\ m^{-1}})(1.60 \times 10^{-19}\ \mathrm{C}) = \mathbf{1.0 \times 10^{-15}\ N}$$

- directed **upwards** — the field points down but the electron's charge is negative

(e) between the plates the horizontal velocity is unchanged while a constant vertical force acts, so the path is a **parabola** curving upwards, towards the positive plate

- beyond the plates there is no field, so it travels in a **straight line** in whatever direction it had on leaving

(f) undeviated means the magnetic force balances the electric one: $Bqv = Eq$, so $B = E/v$

$$B = \frac{6.4 \times 10^3 \text{ V m}^{-1}}{2.6 \times 10^7 \text{ m s}^{-1}} = \mathbf{2.5 \times 10^{-4}} \text{ T}$$

- the magnetic force must be **downwards**, opposite to the electric force on the electron