Solutions

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

2.1

- $F = BIL\sin\theta$
- F = force, B = flux density, I = current, L = length, θ = angle between wire and field

2.2

- $F = BIL$

$$F = (0.50\text{ T})(3.0\text{ A})(0.20\text{ m}) = \mathbf{0.30}\text{ N}$$

2.3

- the **force per unit current per unit length** on a wire placed at **right angles** to the field

2.4

- **force (motion)**, **field**, **current**

3.1 C

- F is maximum when the wire is **at** $90°$ **to the field**

3.2

- $F = BIL$

$$F = (0.30\text{ T})(4.0\text{ A})(0.15\text{ m}) = \mathbf{0.18}\text{ N}$$

3.3

- the force is **zero** ($\sin 0° = 0$)

3.4

- first finger = field (right), second finger = current (out of page)
- the thumb points **upwards**, so the force is **upward**

3.5

(a) the current-carrying wire in a magnetic field experiences a force $F = BIL$

- by Newton's third law the wire pushes back on the magnet with an equal and opposite force, and here that push is **downwards** on the balance, so the reading rises

(b) $F = mg$

$$F = (1.6 \times 10^{-3}\text{ kg})(9.81\text{ m s}^{-2}) = \mathbf{1.6 \times 10^{-2}}\text{ N}$$

(c) $F = BIL$, so $B = F/(IL)$

$$B = \frac{1.57 \times 10^{-2}\text{ N}}{(2.4\text{ A})(0.080\text{ m})} = \mathbf{8.2 \times 10^{-2}}\text{ T}$$

(d) (i) the force reverses, so the reading **decreases** by the same 1.6 g instead

(ii) with the wire **along** the field the force is **zero** ($\theta = 0$ in $F = BIL\sin\theta$), so the reading returns to its original value

(e) a **straight line through the origin**

- because $F \propto I$ when B and L are fixed
- the gradient of force against current is BL, so dividing the gradient by the length L gives the flux density B