## Solutions

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

**2.1**

- $|\mathbf{v}| = \sqrt{9 + 16 + 144} = \sqrt{169} = 13$

**2.2**

- $\mathbf{a} \cdot \mathbf{b} = 2 - 3 + 1 = 0$

**3.1 B**

- Perpendicular vectors have scalar product 0

**3.2**

(a)

- $\begin{pmatrix} 4 \\ -1 \\ 3 \end{pmatrix} - 3\begin{pmatrix} 1 \\ 2 \\ -2 \end{pmatrix} = \begin{pmatrix} 1 \\ -7 \\ 9 \end{pmatrix}$

(b)

- direction of $l$ is $\mathbf{b} = (1, 2, -2)$; $\mathbf{b} \cdot \mathbf{d} = (1)(2) + (2)(-1) + (-2)(2) = 2 - 2 - 4 = -4$; $|\mathbf{b}| = \sqrt{1 + 4 + 4} = 3$ and $|\mathbf{d}| = \sqrt{4 + 1 + 4} = 3$; $\cos\theta = \dfrac{-4}{9}$, so $\theta = 116.4°$ – obtuse. The **acute** angle between the two directions is therefore $180° - 116.4° = 63.6°$; equivalently, take the modulus first: $\cos\theta = \frac{4}{9}$

**3.3**

(a)

- $\overrightarrow{AB} = (2, 1, 3)$, $\overrightarrow{AC} = (1, -2, 2)$

(b)

- $\overrightarrow{AB} \cdot \overrightarrow{AC} = 2 - 2 + 6 = 6$; $|\overrightarrow{AB}| = \sqrt{14}$, $|\overrightarrow{AC}| = 3$; $\cos(BAC) = \dfrac{6}{3\sqrt{14}} = 0.5345 \Rightarrow BAC = 57.7°$

**3.4**

(a)

- the direction vectors $\begin{pmatrix} 1 \\ -1 \\ 2 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix}$ are not scalar multiples of each other, so the lines are not parallel

(b)

- equate components: $1 + s = t$, $2 - s = -1 + t$, $3 + 2s = 7 - t$
- the first two give $2 - s = s$, so $s = 1$, $t = 2$; the third: $3 + 2 = 5 = 7 - 2$, consistent, so they intersect
- at $\mathbf{2i} + \mathbf{j} + \mathbf{5k}$