Modelling in mechanics 8D

1 a 2.1 m s^{-1}

b 500 m

c −1.8 m s^{-1}

d −2.7 m s^{-1}

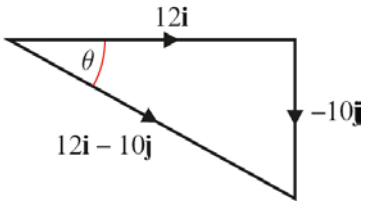
e −750 m

f 2.5 m s^{-1}

2 a speed $|\mathbf{v}| = \sqrt{12^2 + 10^2} = \sqrt{244}$

The speed of the car is 15.6 m s^{-1} (to 3 s.f.)

b Let the acute angle made with **i** be θ, then



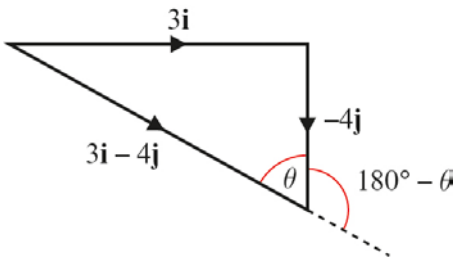
$\tan\theta = \frac{10}{12} = 0.8333$ so $\theta = 39.8°$ (to 3 s.f.)

The direction of motion of the car is 39.8° from the **i** vector.

3 a $|\mathbf{a}| = \sqrt{3^2 + 4^2} = \sqrt{25}$

The magnitude of the acceleration is 5 m s^{-2}.

b Let the acute angle made with **j** be θ



$\tan\theta = \frac{3}{4} = 0.75$ so $\theta = 36.9°$ (to 3 s.f.)

Angle required = 180° – θ = 180° – 36.9° = 143.1°

The direction of the acceleration is 143° from the **j** vector.

4 a $\overrightarrow{AC} = \overrightarrow{AB} + \overrightarrow{BC}$

$$\overrightarrow{AC} = \begin{pmatrix} 10 \\ 3 \end{pmatrix} + \begin{pmatrix} -7 \\ 12 \end{pmatrix} = \begin{pmatrix} 3 \\ 15 \end{pmatrix}$$

$$\left|\overrightarrow{AC}\right| = \sqrt{3^2 + 15^2} = \sqrt{234}$$

The magnitude of the displacement is 15.3 m (to 3 s.f.)

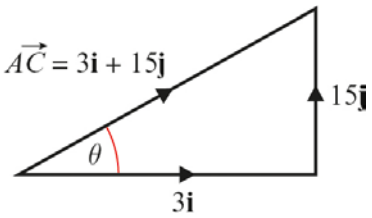
b $\left|\overrightarrow{AB}\right| = \sqrt{10^2 + 3^2} = \sqrt{109}$

$$\left|\overrightarrow{BC}\right| = \sqrt{7^2 + 12^2} = \sqrt{193}$$

$$\left|\overrightarrow{AB}\right| + \left|\overrightarrow{BC}\right| = \sqrt{109} + \sqrt{193} = 24.3$$

The girl cycles 24.3 km (to 3 s.f.)

c Let the acute angle made with **i** be θ



$\tan\theta = \dfrac{15}{3} = 5$ so $\theta = 78.7°$ (to 3 s.f.)

The direction of motion of the car is 78.7° from the **i** vector.