Solutions

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

2.1

- velocity is a **vector**, so it changes whenever the **direction** of travel changes, even at constant speed
- a changing velocity means the car is accelerating
- that acceleration is directed towards the **centre** of the roundabout, at right angles to the velocity

2.2

- $a = v^2/r$
- $a = r\omega^2$

2.3

- $m = 0.20$ kg, $v = 3.0$ m s^{-1}, $r = 0.50$ m
- $F = mv^2/r$

$$F = \frac{(0.20\text{ kg})(3.0\text{ m s}^{-1})^2}{0.50\text{ m}} = \mathbf{3.6}\text{ N}$$

2.4

- **friction** between the tyres and the road

3.1 B

- the centripetal force (and the acceleration) is directed **towards the centre**
- **A** is the tangent (velocity); **C** is the fictitious "centrifugal" direction; **D** would reverse the motion

3.2

- $m = 900$ kg, $v = 15$ m s^{-1}, $r = 30$ m
- $F = mv^2/r$

$$F = \frac{(900\text{ kg})(15\text{ m s}^{-1})^2}{30\text{ m}} = 6750\text{ N} \approx \mathbf{6.8 \times 10^3}\text{ N}$$

3.3

(a) its **velocity is changing direction**, and a changing velocity is an acceleration (towards the centre)

(b) the electric force is the centripetal force: $F = mv^2/r$, so $v = \sqrt{Fr/m}$

$$v = \sqrt{\frac{(8.2 \times 10^{-8}\text{ N})(5.3 \times 10^{-11}\text{ m})}{9.1 \times 10^{-31}\text{ kg}}} = \mathbf{2.2 \times 10^6}\text{ m s}^{-1}$$

3.4

- the **tension** in the string provides it

- if the string breaks the stone flies off along a **straight line (the tangent)**, since there is no longer a centripetal force