CENTRIPETAL ACCELERATION

Centripetal acceleration is the quotient of the square of the velocity and the radius of the circle.

$$a_c = \frac{v^2}{r}$$

Quantity	Symbol	SI unit
centripetal acceleration	a_c	$\frac{\text{m}}{\text{s}^2}$ (metres per second squared)
velocity (magnitude)	v	$\frac{\text{m}}{\text{s}}$ (metres per second)
radius (of circle)	r	m (metres)

Unit Analysis

$$\frac{\text{metre}}{\text{second}^2} = \frac{\left(\frac{\text{metre}}{\text{second}}\right)^2}{\text{metre}} \qquad \frac{\left(\frac{\text{m}}{\text{s}}\right)^2}{\text{m}} = \frac{\frac{\text{m}^2}{\text{s}^2}}{\text{m}} = \frac{\text{m}}{\text{s}^2}$$

Note: The direction of the centripetal acceleration is always along a radius pointing toward the centre of the circle.

CENTRIPETAL FORCE

The magnitude of the centripetal force is the quotient of the mass times the square of the velocity and the radius of the circle.

$$F_c = \frac{mv^2}{r}$$

Quantity	Symbol	SI unit
centripetal force	F_c	N (newtons)
mass	m	kg (kilograms)
velocity	v	$\frac{\text{m}}{\text{s}}$ (metres per second)
radius of circular path	r	m (metres)

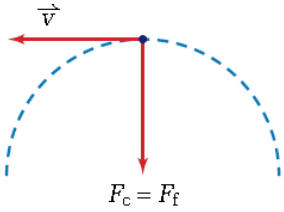
Unit Analysis

$$(\text{newtons}) = \left(\frac{\text{kilogram}\left(\frac{\text{metres}}{\text{second}}\right)^2}{\text{metres}}\right)$$

$$N = \frac{\text{kg}\left(\frac{\text{m}}{\text{s}}\right)^2}{\text{m}} = \frac{\text{kg}\frac{\text{m}^2}{\text{s}^2}}{\text{m}} = \frac{\text{kg}\cdot\text{m}}{\text{s}^2} = \text{N}$$

Figure 11.8 Any force that is directed toward the centre of a circle can provide a centripetal force.

A car with a mass of 2135 kg is rounding a curve on a level road. If the radius of curvature of the road is 52 m and the coefficient of friction between the tires and the road is 0.70, what is the maximum speed at which the car can make the curve without skidding off the road?



Variables and Constants

Known		Implied	Unknown	
$m = 2135\ \text{kg}$	$\mu = 0.70$	$g = 9.81\ \frac{\text{m}}{\text{s}^2}$	F_f	F_N
$r = 52\ \text{m}$			v	

$$F_f = F_c$$

$$\mu F_N = \frac{mv^2}{r}$$

$$\mu mg = \frac{mv^2}{r}$$

$$v^2 = \mu mg\left(\frac{r}{m}\right)$$

$$v = \sqrt{\mu rg}$$

$$v = \sqrt{(0.70)(52\ \text{m})\left(9.81\ \frac{\text{m}}{\text{s}^2}\right)}$$

$$v = \sqrt{357.08\ \frac{\text{m}^2}{\text{s}^2}}$$

$$v = 18.897\ \frac{\text{m}}{\text{s}}$$

$$v \cong 19\ \frac{\text{m}}{\text{s}}$$