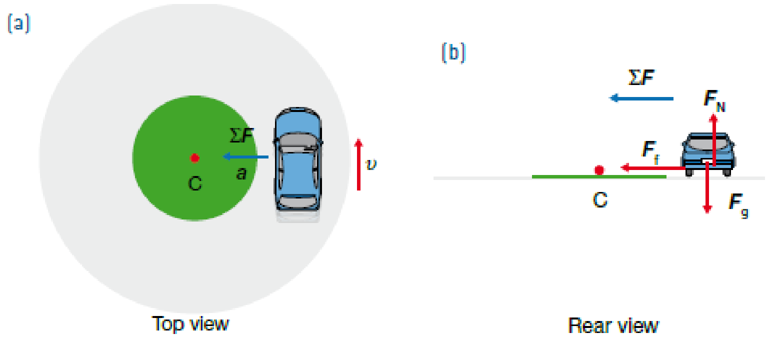
M.4.3.2 Cornering

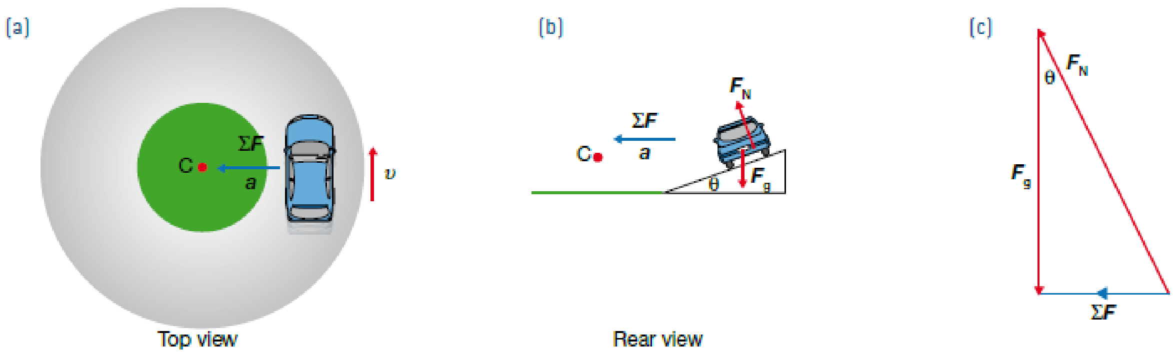
When cars travel in circular paths on horizontal roads, they are relying on the force of friction between the tyres and the road. Friction provides the sideways force that makes the car turn. If the car travels too fast the centripetal force required is greater than the friction between the tyres and the road, the result is the car skidding.



(a) The car is travelling in a circular path on a horizontal track. The acceleration and net force are towards C. (b) The vertical forces balance and it is friction between the tyres and the road that enables the car to corner.

M.4.3.3 Banked Roads

Cars and bikes are able to travel more quickly around a corner if the corner is at an angle to the horizontal, i.e. banked. This is very obvious on Cycling velodromes, although entry and exit ramps on freeways are designed to have a slight banking as are shaper corners on freeways.



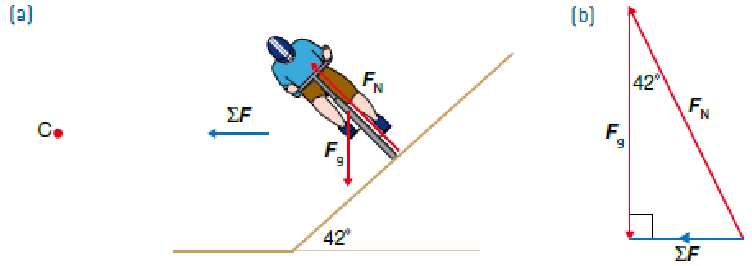
The diagrams above show a car moving around a banked corner. The force of gravity and the normal reaction force are no longer equal and opposite (b) . For a particular speed, the design speed, there will be no sideways frictional force between the tyres and the road and thus the gravitational force and the normal reaction force are the only two forces acting. These two force combine to provide the centripetal force (c).

Example
A curved section of track on an Olympic velodrome has radius of 50 m and is banked at an angle of 42° to the horizontal.
a calculate the net force acting on a cyclist riding at the design speed.

b at what speed would a cyclist of mass 75 kg need to travel if they were to experience zero frictional forces up or down the track, i.e. what is the design speed for this section of the velodrome?

Sol^n

a)



$\tan 42^\circ = \frac{\Sigma \boldsymbol{F}}{\boldsymbol{F}g}$

$0.90 = \frac{\Sigma \boldsymbol{F}}{75 \times 9.8}$

$\Rightarrow \Sigma \boldsymbol{F} = 660$ N towards C

b) the net force is a centripetal force, so:

$\Sigma \boldsymbol{F} = \frac{m\,v^2}{r}$

$660 = \frac{75 \times v^2}{50}$

$\Rightarrow v = \sqrt{441} = 21 \text{ m s}^{-1}$

If the cyclist in the example above travelled at a speed other than the design speed then they would tend to drift up or down the track and sideways friction between the tyres and the track would come into play.

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