

Physics of Banked and Unbanked Curves

Unbanked Curves

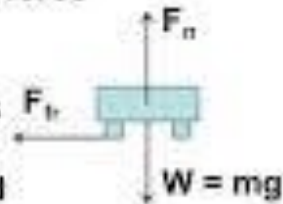
On an unbanked curve, the static frictional force provides the centripetal force.

A car rounds a curve having a 100m radius Travelling at 20m/s. What is the minimum Coefficient of friction between the tires and the road required?

$$F_c = F_{tr} = \mu F_n$$

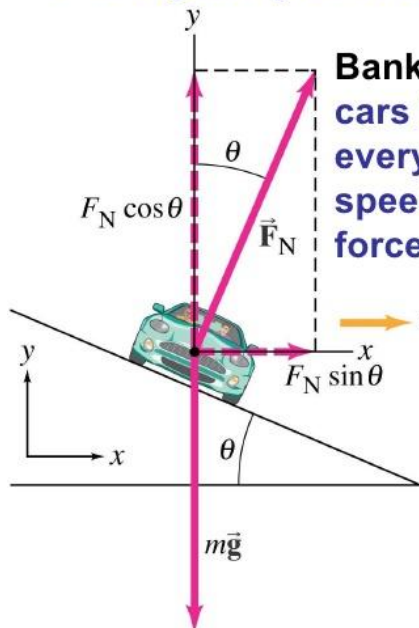
$$\frac{mv^2}{r} = \mu mg$$

$$\therefore \mu = \frac{v^2}{gr} = \frac{(20\text{m/s})^2}{(9.8\text{m/s}^2)(100\text{m})} = 0.41$$



Banked Curves w/out Friction

5-3 Highway Curves, Banked and Unbanked



Banking the curve can help keep cars from skidding. In fact, for every banked curve, there is one speed where the entire centripetal force is supplied by the horizontal component of the normal force, and no friction is required. This occurs when:

$$F_N \sin \theta = m \frac{v^2}{r}$$

Finding the banking angle for a given speed and radius (No friction force acting)

$$F_{net} = F_{centripetal}$$

$$mg \tan \theta = \frac{mv^2}{r}$$

$$\tan \theta = \frac{v^2}{rg}$$

$$\theta = \tan^{-1} \left(\frac{v^2}{rg} \right) = \tan^{-1} \left[\frac{\left(25 \frac{m}{s} \right)^2}{(100m) \left(9.8 \frac{m}{s^2} \right)} \right] = 33^\circ$$

Banked Curves w/Friction

In this case, the friction force acts down the bank (opposite to the direction of impending motion – the car tends to slide up the bank) in addition to a component of the normal force. Both of these components add to provide the centripetal force. In this case friction would be an added advantage in helping the car to maintain circular motion around the curve.

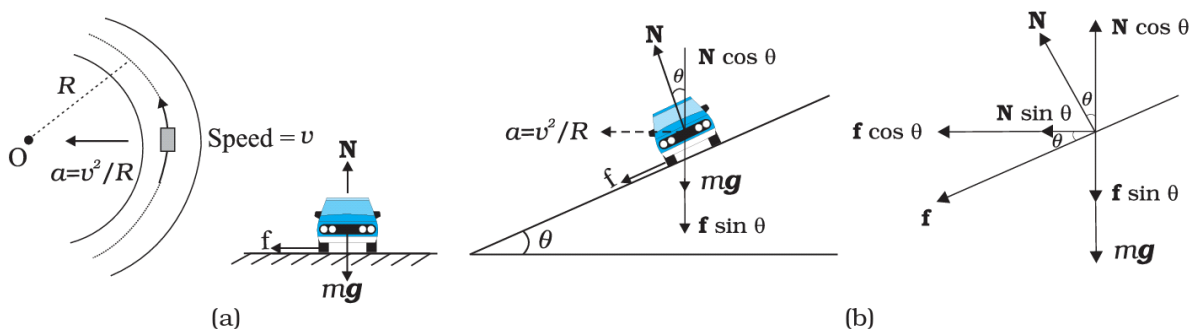
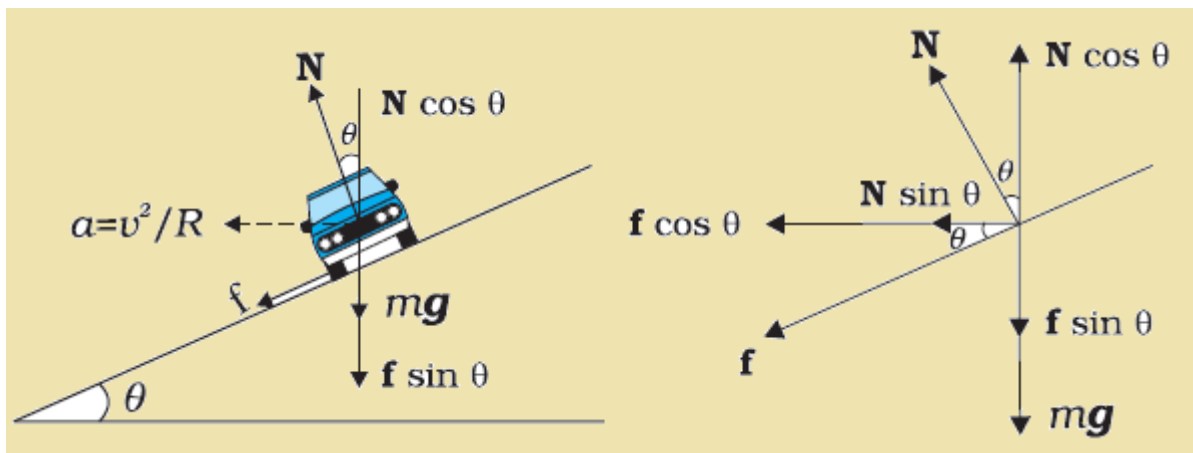


Fig. 5.14 Circular motion of a car on (a) a level road, (b) a banked road.