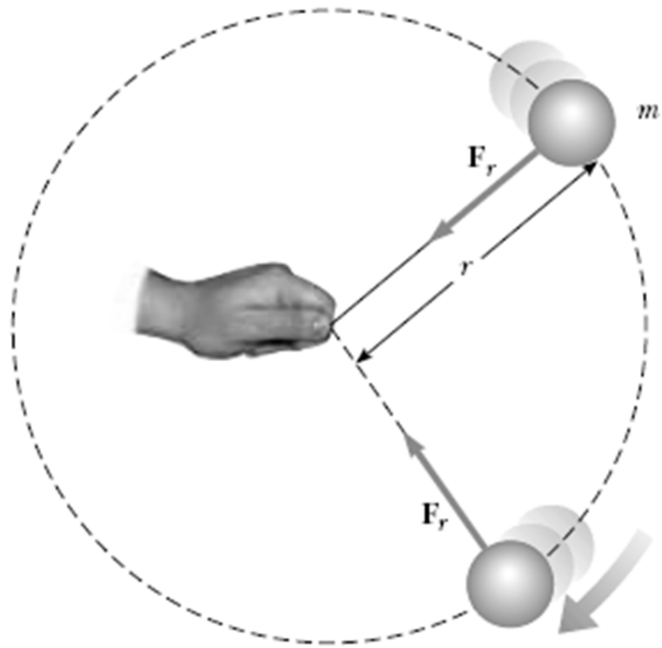
Chapter 6
Circular motion and applications of Newton's Law

Dr. Feras Fraige

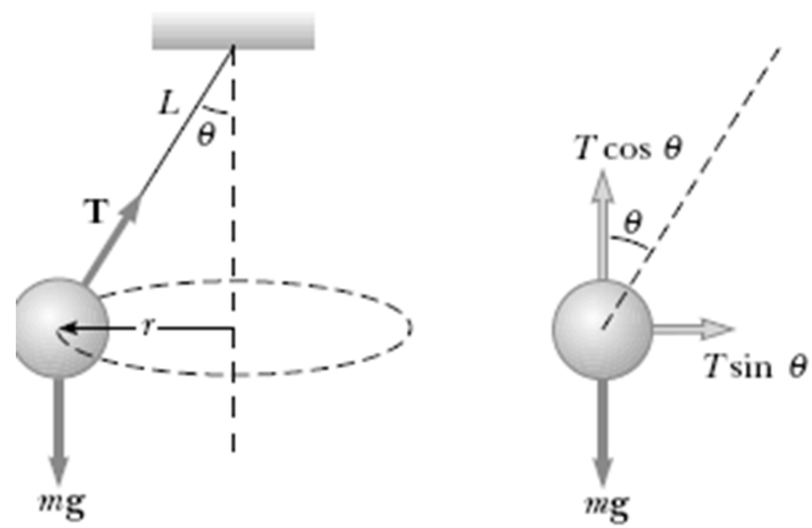
Circular motion

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



Example

A small object of mass m is suspended from a string of length L. The object revolves with constant speed v in a horizontal circle of radius r, as shown in Figure 6.4. (Because the string sweeps out the surface of a cone, the system is known as a *conical pendulum.*) Find an expression for v.



(1) $$T\cos\theta = mg$$

(2) $$\sum F = T\sin\theta = ma_c = \frac{mv^2}{r}$$

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

$$v = \sqrt{rg\tan\theta}$$

$$v = \sqrt{Lg\sin\theta\tan\theta}$$

Example

A 1 500-kg car moving on a flat, horizontal road negotiates a curve, as shown in Figure 6.5. If the radius of the curve is 35.0 m and the coefficient of static friction between the tires and dry pavement is 0.500, find the maximum speed the car can have and still make the turn successfully.

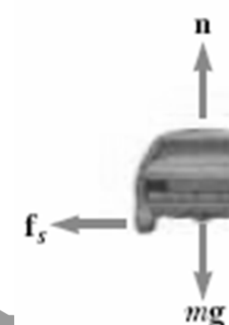
(1) A small sphere of mass m is attached to the end of a cord of length R and set into motion in a *vertical* circle about a fixed point O, as illustrated in Figure 6.10a. Determine the tension in the cord at any instant when the speed of the sphere is v and the cord makes an angle θ with the vertical.

(a)

$$v_{\max} = \sqrt{\frac{f_{s,\max}\, r}{m}} = \sqrt{\frac{\mu_s m g r}{m}} = \sqrt{\mu_s g r}$$

$$= \sqrt{(0.500)(9.80\ \text{m/s}^2)(35.0\ \text{m})}$$

$$= 13.1\ \text{m/s}$$



Example

A small sphere of mass m is attached to the end of a cord of length R and set into motion in a *vertical* circle about a fixed point O, as illustrated in Figure 6.10a. Determine the tension in the cord at any instant when the speed of the sphere is v and the cord makes an angle θ with the vertical.

$$\sum F_t = mg \sin \theta = ma_t$$

$$a_t = g \sin \theta$$

$$\sum F_r = T - mg \cos \theta = \frac{mv^2}{R}$$

$$T = m\left(\frac{v^2}{R} + g \cos \theta\right)$$