$$F_c = ma_c = m\frac{v^2}{r}$$

$$v = \frac{2\pi r}{T}, \quad T = \frac{2\pi r}{v} \ (s/rev)$$

f_s

5.2 A conical pendulum consists of a stone of mass $m = 2.00$ kg at the end of a cord of length $L = 0.750$ m The stone is swung in a horizontal circle with constant speed v while the cord makes and angle of 30.0° with the vertical direction.

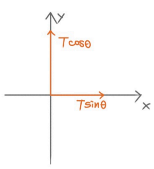
a) Calculate the speed of the stone.
b) What is the centripetal force acting on the stone?

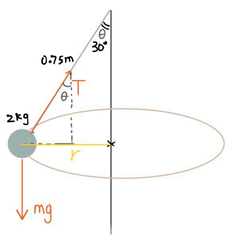
a)

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

$\Sigma\vec{F} = ma$

$\Sigma\vec{F}_x = T\sin\theta = m\frac{v^2}{r}$





$\Sigma\vec{F}_y = T\cos\theta - mg = 0$

$$\begin{cases} T\sin\theta = m\frac{v^2}{r} \\ T\cos\theta = mg \end{cases} \Rightarrow \tan\theta = \frac{v^2}{rg} \Rightarrow v = \sqrt{g\,r\tan\theta} \qquad r = L\sin\theta$$

b) $F_c = T\sin\theta = \left(\frac{mg}{\cos\theta}\right)\sin\theta = mg\tan\theta = 11.3\,N$

5.4 On the ride "Spindletop" at Six Flag Over Texas, people stand against the inner wall of a hollow vertical cylinder with radius 2.50 m. The cylinder starts to rotate, and when it reaches a constant rotation rate of 0.600 rev/s, the floor on which the people are standing drops about 0.500 m. The people, however, remain stuck against the wall.

a) What is the acceleration of each person?
b) What force is acting as the centripetal force on each peron?
c) What minimum coefficient of friction is required if the people on the ride are not to slide downward to the new position of the floor?

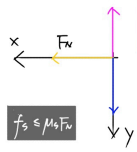
a) $a_c = \frac{v^2}{r}$

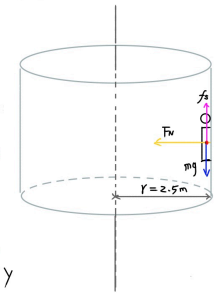
$v = \left(0.6\frac{rev}{s}\right)\left(\frac{2\pi r}{rev}\right) = 35.5\,m/s^2$

b) $F_c = F_N$

c) $\Sigma F_x = ma_x$

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





$\Sigma F_y = ma_y$

$\boxed{f_s \le \mu_s F_N}$

$mg - f_s = 0$

$f_s = mg \le \mu_s F_N = \mu_s\left(m\frac{v^2}{r}\right)$

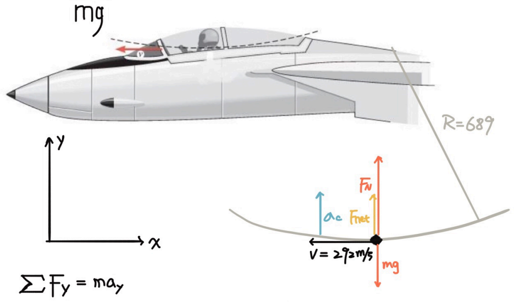
$\mu_s \ge \frac{rg}{v^2} = 0.276$

$$\frac{F_N}{mg} \qquad F_N = mg + \underbrace{m\frac{v^2}{r}}_{F_c} \qquad \frac{F_N}{mg} = 1 + \frac{v^2}{gr}$$

5.42 Pilots of high-performance fighter planes can be subjected to large centripetal accelerations during high-speed turns. Because of these accelerations, the pilots are subjected to forces that can be much greater than their body weight, leading to an accumulation of blood in the abdomen and legs. As a result, the brain becomes starved for blood, and the pilot can lose consciousness ("black out"). The pilots wear "anti-G suits" to help keep the blood from draining out of the brain. To appreciate the forces that a fighter pilot must endure, consider the magnitude of the normal force that the pilot's seat exerts on him at the bottom of a dive. The plane is traveling at 292 m/s on a vertical circle of radius 689 m.

Determine the ratio of the normal force to the magnitude of the pilot's weight. For comparison, note that black-out can occur for ratios as small as 2 if the pilot is not wearing an anti-G suit.

$\frac{F_N}{mg}$



$\Sigma F_y = ma_y$

$F_N - mg = m\frac{v^2}{r}$

$F_N = mg + m\frac{v^2}{r}$

$\frac{F_N}{mg} = 1 + \frac{v^2}{gr} = 13.6$

$F_N = 13.6\,mg$