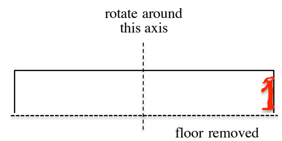
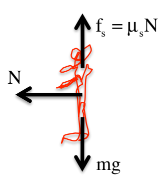
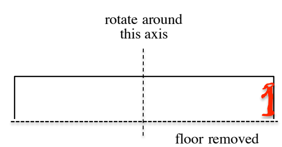
Carnival Ride



A rider stands against the wall of a huge cylinder of radius "R" that is constrained to rotate about its central axis. Once up to speed, the rider finds himself pinned against the wall as the floor drops out from under him. If the coefficient of static friction between the rider and the wall is μ_s, what is the minimum speed the cylinder can rotate and keep the man from falling through to the ground?

As always, we must start with a f.b.d. on the man as he stands in the "snapshot" we are looking at.

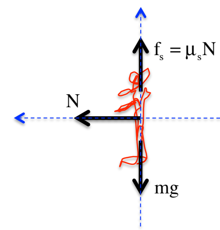


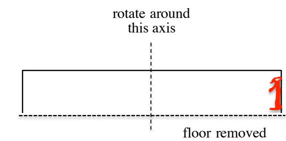


Note 1: Remember, the normal force acts away from the support that provides it, and

Note 2: The static frictional force is UPWARD as the body would move DOWNWARD if it broke loose. Remember, it's the static frictional force that KEEPS the body from breaking loose!

The center seeking direction is toward the center of the arc, so our axis becomes:





With the f.b.d., we can write:

$\sum F_y$: and $\sum F_{c.s.}$:

$$\mu_s N - mg = ma_y$$

$$\Rightarrow \quad N = \frac{mg}{\mu_s}$$

$$N = ma_{c.s.}$$

$$\Rightarrow \quad \left(\frac{mg}{\mu_s}\right) = m\left(\frac{v^2}{R}\right)$$

$$\Rightarrow \quad v = \left(\frac{Rg}{\mu_s}\right)^{1/2}$$