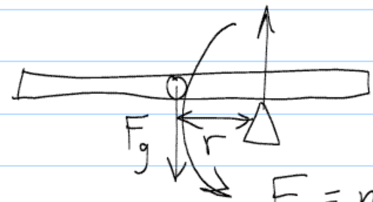
# PHY131 - Class 18 - Wed. Nov. 16, 2011

Example.




$F_g = mg$

$r = 0.80\,m$

$\phi = 90°$

$$|\tau| = F r \overbrace{\sin\phi}^{=1}$$

$$|\tau| = mgr$$

$$= (500)(9.8)\,0.8)$$

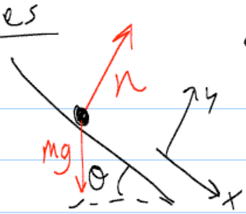
$$|\tau| = 3920\ N\cdot m$$

$\tau$ will cause counterclockwise rotation $\Rightarrow$ $\tau$ is +

$$\boxed{\tau = +3920\ N\cdot m}$$

Examples

(1)




← No rotation (like chicken broth....)

$$(F_g)_x = mg\sin\theta$$

$$(n)_x = 0$$

$$\Rightarrow (F_{Net})_x = \cancel{m}g\sin\theta = \cancel{m}a_x$$

$$\boxed{a_x = g\sin\theta}$$

(2)


torque of gravity around centre of mass = 0

Let's make a table:

around centre of disk.

| | x | y | $\tau$ |
|---|---|---|---|
| $F_g = mg$ | $mg\sin\theta$ | $-mg\cos\theta$ | 0 |
| n | 0 | n | 0 |
| $f_s$ | $-f_s$ | 0 | $-f_s r$ |

Net

$$(F_{Net})_x = mg\sin\theta - f_s = ma_x$$

$$\tau_{Net} = -f_s r = I\alpha$$

Use a rolling without slipping constraint:

$$a_x = -r\alpha \qquad \left(\begin{array}{l} a_x + \text{ when} \\ \alpha \text{ is } - \end{array}\right)$$

$$\tau_{Net} = \left(\frac{1}{2}mr^2\right)\left(\frac{-a_x}{r}\right) = -f_s r$$

$$f_s = \frac{m a_x}{2} \quad \leftarrow \text{plug into } (F_{Net})_x \text{ eq.}$$

$$ma_x = mg\sin\theta - \frac{ma_x}{2} \qquad \text{Solve for } a_x$$

$$\frac{3}{2}a_x = g\sin\theta$$

$$\boxed{a_x = \frac{2}{3}g\sin\theta} \qquad \text{for solid disk.}$$

(3) $\rightarrow$ Same analysis as disk, but with

$$I = mr^2$$

$$\Rightarrow f_s r = (mr^2)\left(\frac{a_x}{r}\right)$$

$$\Rightarrow f_s = m a_x$$

$$\Rightarrow m a_x = mg\sin\theta - m a_x$$

$$2a_x = g\sin\theta$$

$$\boxed{a_x = \frac{1}{2} g \sin\theta}$$ for ring

Basketball rolling... $K_{tot} = ?$

$$K = K_{lin} + K_{rot}$$

$$K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

R.W/O.S. constraint: $v = \omega r$ , $I =$ that of

$\Rightarrow$

a spherical shell.

$\boxed{I = \frac{2}{3} m r^2}$

$$K = \frac{1}{2} m v^2 + \frac{1}{\cancel{2}}\left(\frac{\cancel{2}}{3} m \cancel{r^2}\right)\left(\frac{v}{\cancel{r}}\right)^2$$

$$= \frac{1}{2} m v^2 + \frac{1}{3} m v^2 = \frac{5}{6} m v^2 = \frac{5}{6}(0.5)(1)^2$$

$\boxed{K = 0.42 \text{ Joules}}$