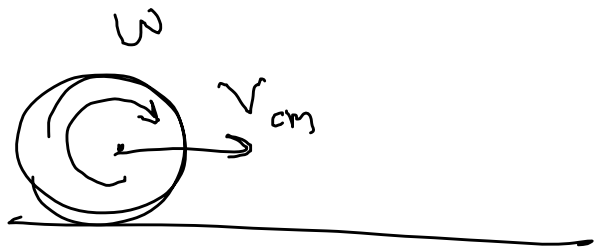
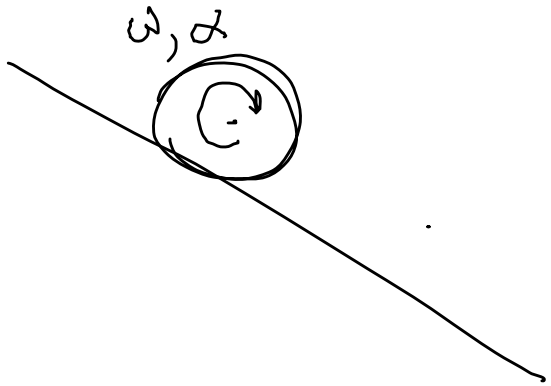
Phys 2110 - 4 11/7/11

Note Title 11/7/2011

Chap 10 Rotations





$$v_{cm} = R\omega$$

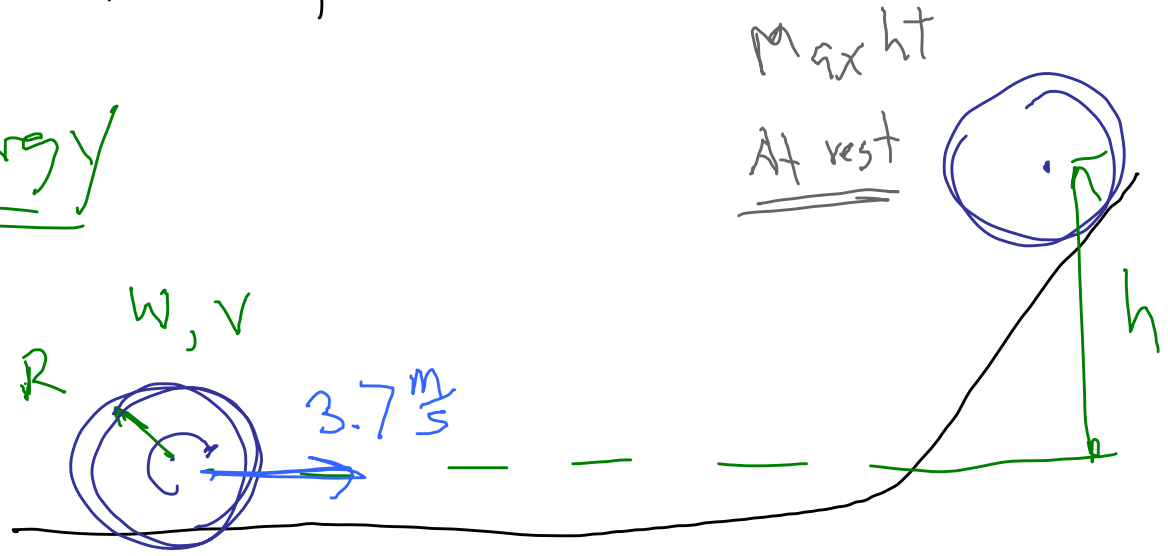
$$a_{cm} = R\alpha$$

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

10.62 Hollow ball rolls along horiz surface & encounters incline. Rolls w/o slipping up incline. What is max height?

speed $= 3.7 \frac{m}{s}$

Cons of energy



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

$$= E_f = mgh$$

Substitute $I = \frac{2}{3}MR^2$ (hollow sphere) $\quad \omega = \frac{v}{R}$

$$\frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{3}MR^2\right)\left(\frac{v}{R}\right)^2 = mgh$$

R cancels

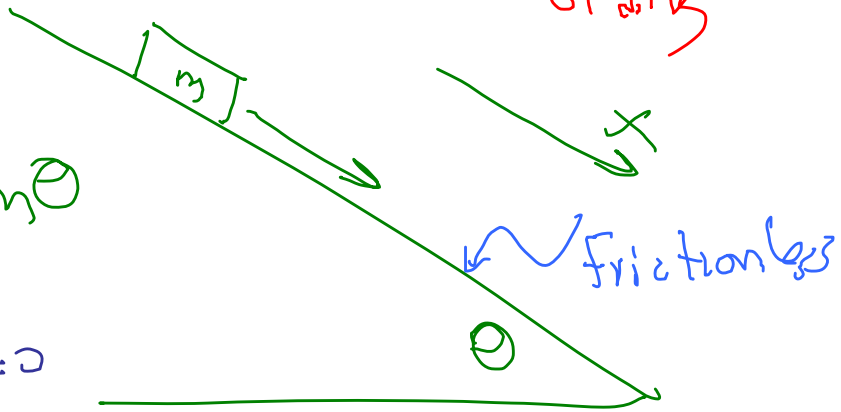
Solve for h

Example

Recall:

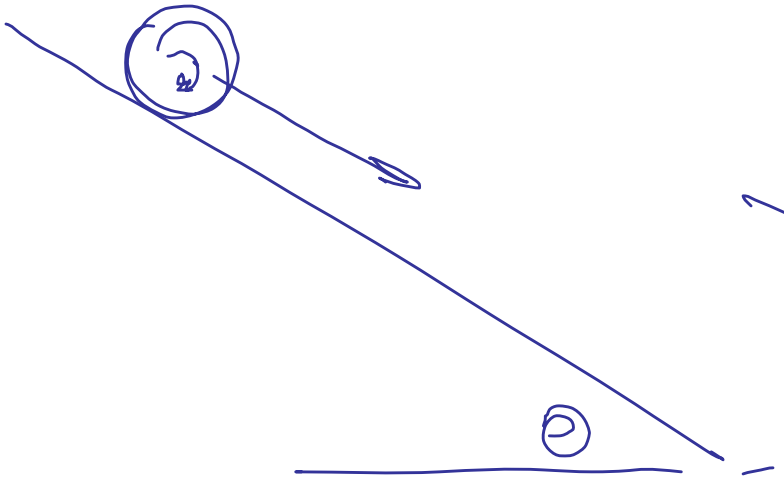
$a_x = g \sin\theta$

Sliding

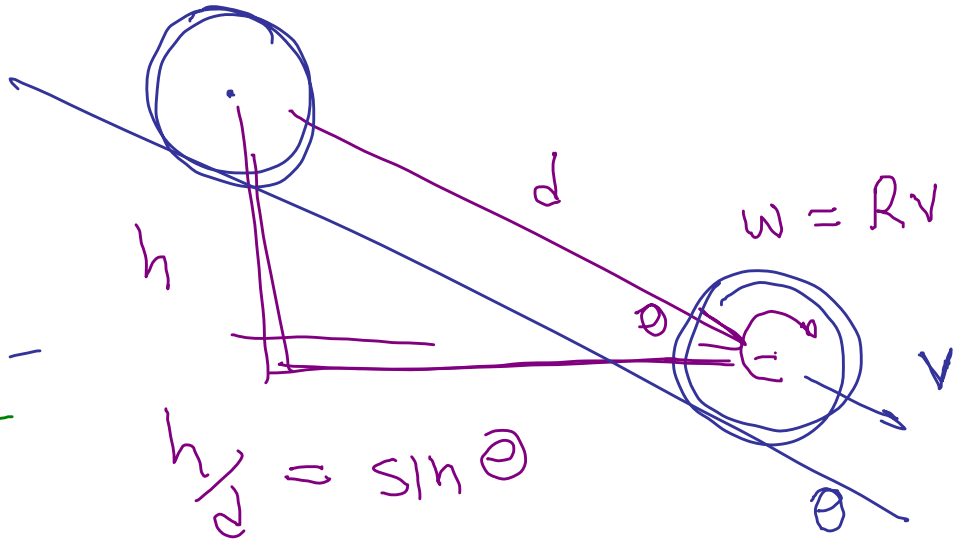


Rolling

Solid ball



$mgh = \frac{1}{2}mv^2 + \frac{1}{2}Iw^2$



$\frac{h}{d} = \sin\theta$

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

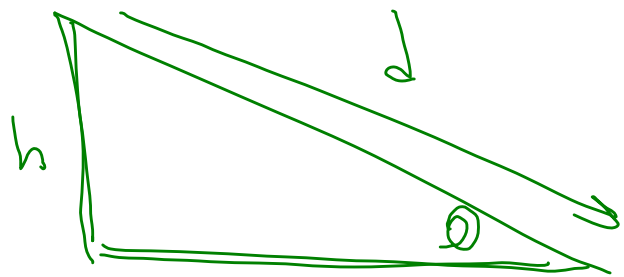
$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mR^2\right)\left(\frac{v}{R}\right)^2$$

$$= \frac{1}{2}mv^2 + \frac{1}{5}mv^2$$

$$mgh = \frac{7}{10}mv^2$$

$$v^2 = \frac{10}{7}gh$$

$$v^2 = \frac{10}{7}gd\sin\theta$$



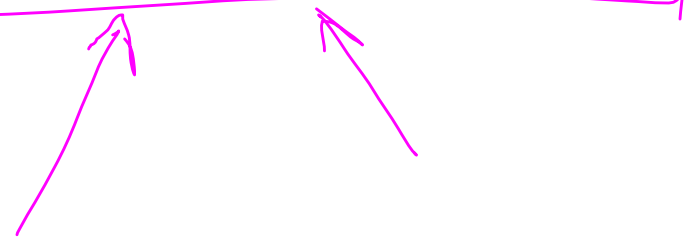
$$d = \frac{h}{\sin\theta}$$

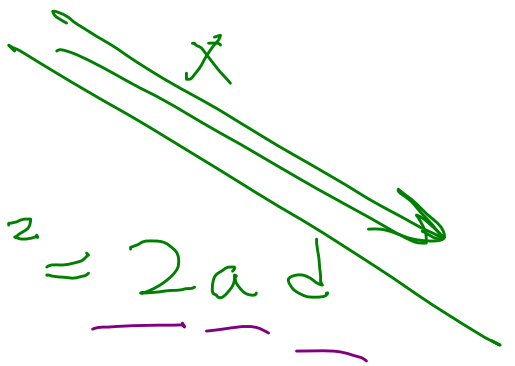
$$h = d\sin\theta$$

$$v^2 = \frac{10}{7} g d \sin\theta$$

$$v^2 = 2\left(\frac{5}{7} g \sin\theta\right) d$$

$$\boxed{a = \frac{5}{7} g \sin\theta}$$





$$v^2 = 2ad$$

$$v^2 = v_0^2 + 2a_x x$$

Another way, forces

y - forces

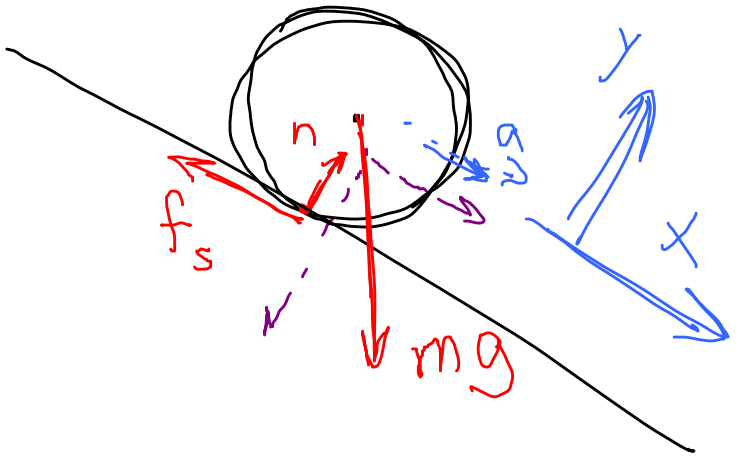
$$n - mg\cos\theta = 0$$

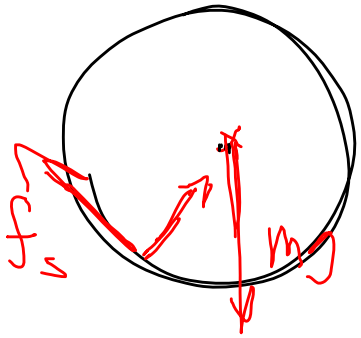
$$n = mg\cos\theta$$

x - forces

$$mg\sin\theta - f_s = ma$$

- torques $\tau = f_s R = I\alpha$





$$mg\sin\theta - f_s = ma$$

$$f_s R = I\alpha = \frac{2}{5}mR^2\frac{a}{R}$$

$$= \frac{2}{5}mRa$$

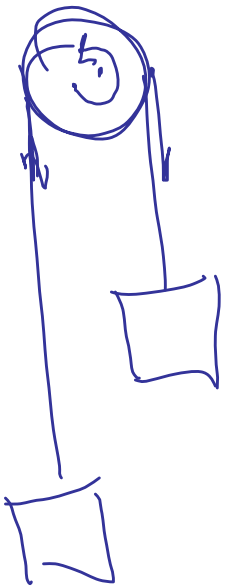
$$f_s = \frac{2}{5}ma \quad \text{Sub!}$$

$$mg\sin\theta - \frac{2}{5}ma = ma$$

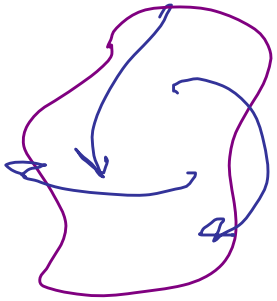
$$g\sin\theta = \frac{7}{5}a$$

$$\boxed{a = \frac{5}{7}g\sin\theta}$$

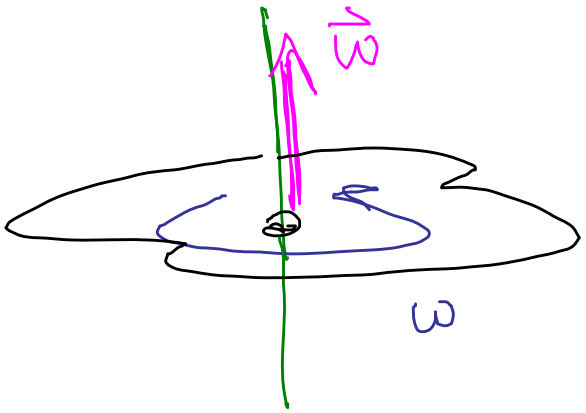
$$\tau = T_2 R - T_1 R$$



Chap 11 More rotations



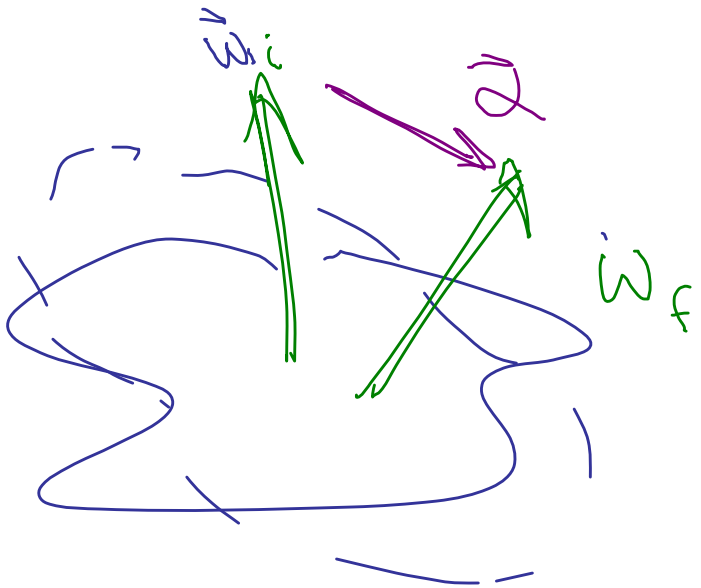
What we've treated as scalars, Vectors.



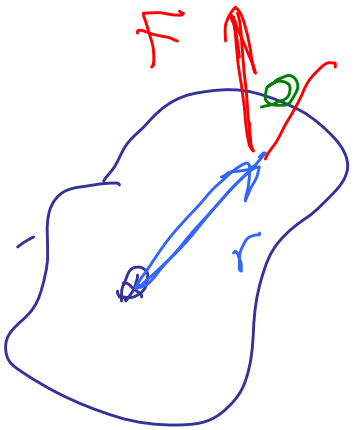
In fact ω is a vector

Points along axis

Rt-hand rule.



$$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$$



$$\tau = rF\sin\theta$$

Torque is a vector:
Really defined as:

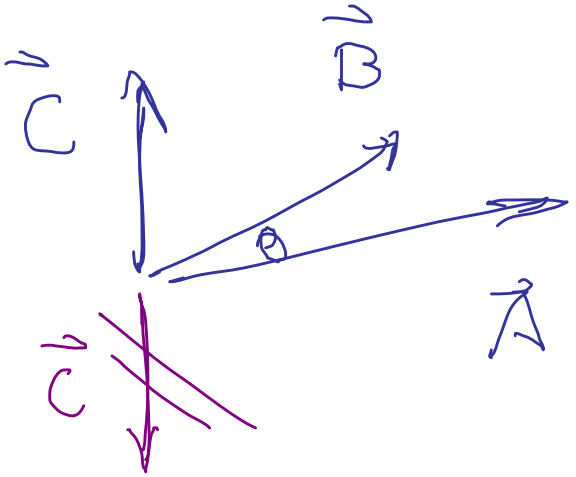
$$\vec{\tau} = \vec{r} \times \vec{F}$$

cross product (of two vectors)

Dot product: $\vec{a}, \vec{b} \longrightarrow$ Scalar

Cross product $\vec{a}, \vec{b} \longrightarrow$ vector, $\vec{c}$

$\vec{A} \times \vec{B} = \vec{C}$



$|\vec{C}| = |\vec{A}||\vec{B}||\sin\theta|$

$\vec{C}$ is perd. to both

Right-hand rule.