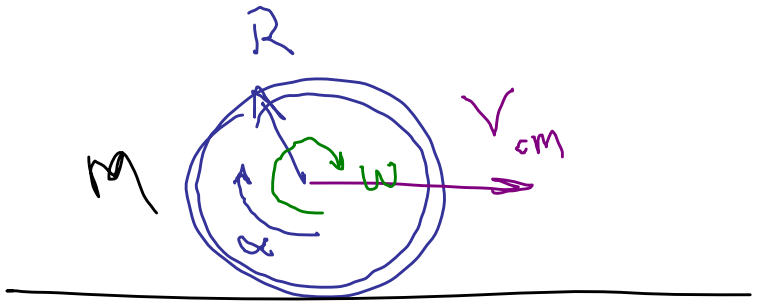
Phys 2110-4 3/28/12

Note Title 3/28/2012

Rotational Mechanics

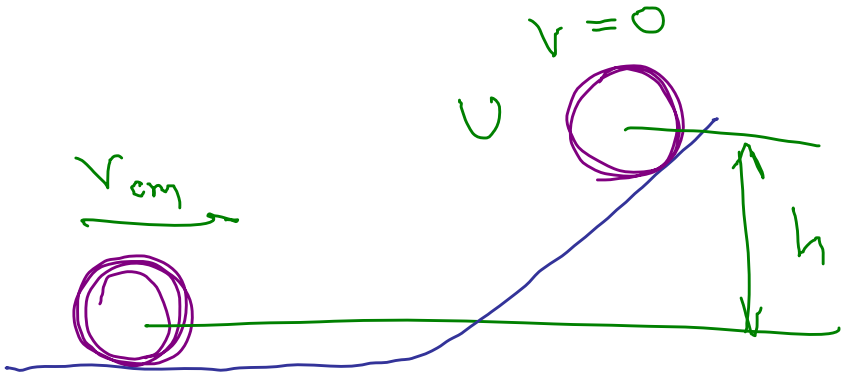


$V_{cm} = R\omega$

$a_{cm} = R\alpha$

$$K_{rolling} = K_{trans} + K_{rot} = \frac{1}{2}MV_{cm}^2 + \frac{1}{2}I\omega^2$$

10.62 A hollow ball rolls along horizontal surface at $3.7\ m/s$ when it encounters incline. Rolls w/o slipping up incline, what max ht?



E consd.

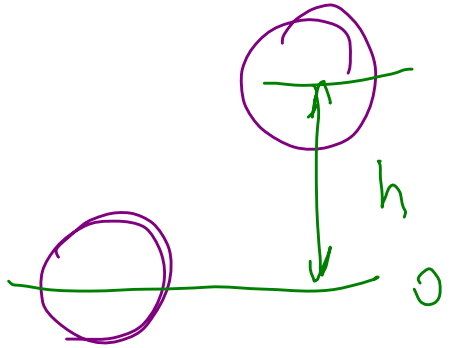
$$K = \frac{1}{2}mv_{cm}^2 + \frac{1}{2}I\omega^2$$

$$= \frac{1}{2}Mv_c^2 + \frac{1}{2}\left(\frac{2}{3}MR^2\right)\left(\frac{v_{cm}}{R}\right)^2$$

$$= \left(\frac{1}{2}+\frac{1}{3}\right)Mv_{cm}^2 = \frac{5}{6}Mv_{cm}^2$$

$$U = mgh$$

$$\frac{5}{6} M v_{cm}^2 = Mgh$$

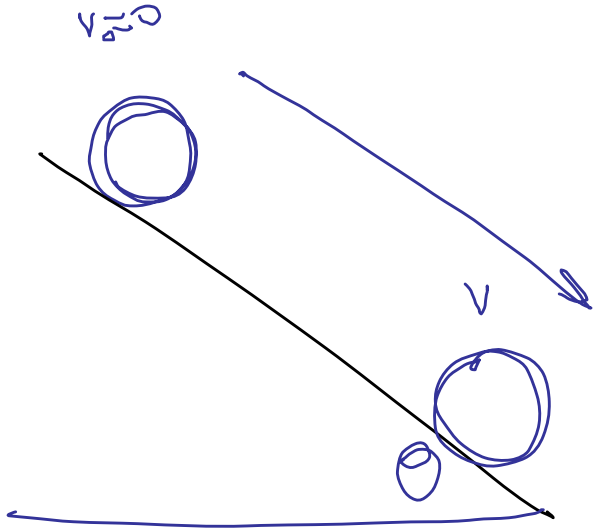


$$h = \frac{5 v_{cm}^2}{6g} = 1.164 \text{ m}$$

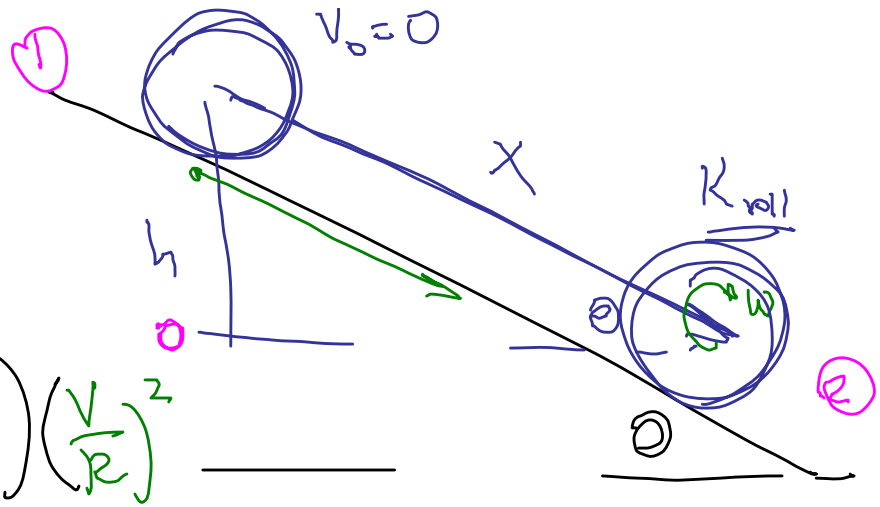
Solid sphere, $I = \frac{2}{5} MR^2$,

Acceleration, rolling down hill

$g \sin\theta$



E consd:



$$Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}\left(\frac{2}{5}MR^2\right)\left(\frac{v}{R}\right)^2$$

$$= \left(\frac{1}{2}+\frac{1}{5}\right)Mv^2 = \frac{7}{10}Mv^2 \qquad \omega = \frac{v}{R}$$

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

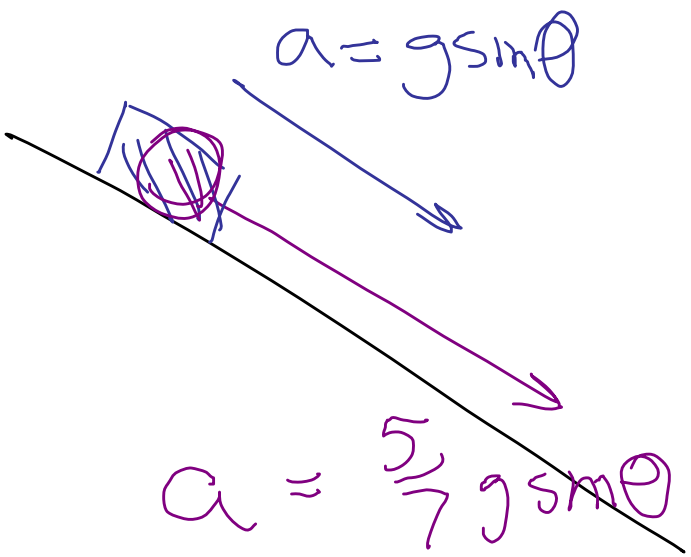
$v^2 = v_0^2 + 2a\Delta x$

Linear

$$v^2 = 2ax = 2a\frac{h}{\sin\theta}$$

$$2a\frac{h}{\sin\theta} = \frac{10}{7}gh$$

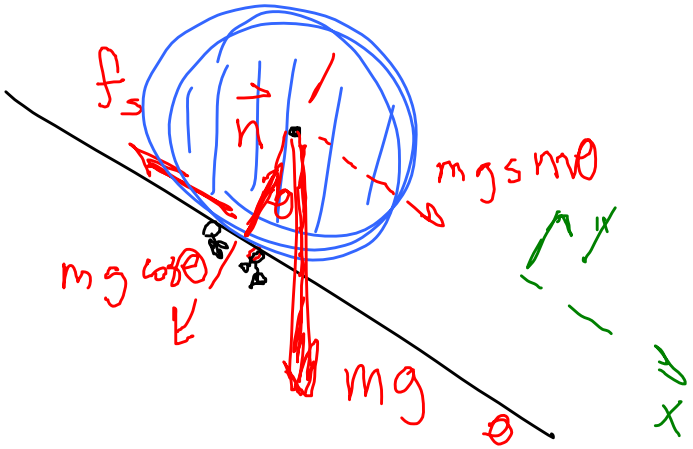
$$a = \frac{5}{7}g\sin\theta$$



Do this problem w/ forces accel's toques

$$\vec{F}_{net} = m\vec{a}$$

$$\tau = I\alpha = \Sigma F \cdot r \cdot \sin\theta$$



$n = mg\cos\theta \qquad f_s$

$$\Sigma F_x = ma_x = mg\sin\theta - f_s = ma$$

$$\Sigma\tau = f_s R = I\alpha = I\frac{a}{R}$$

$$= \frac{2}{5}MR^2\frac{a}{R} = \frac{2}{5}MRa$$

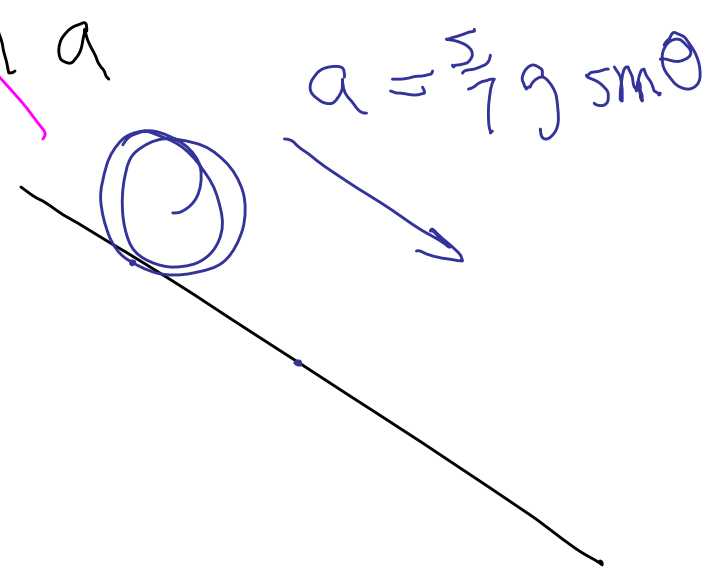
$$f_s = \frac{2}{5}ma \qquad mg\sin\theta - \frac{2}{5}ma = ma$$

sub

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

$$= \frac{7}{5}ma$$

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



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