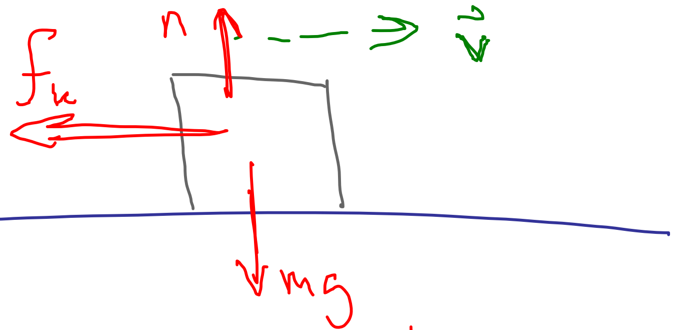
Phys 2110-4 2/15/12

Note Title 2/15/2012

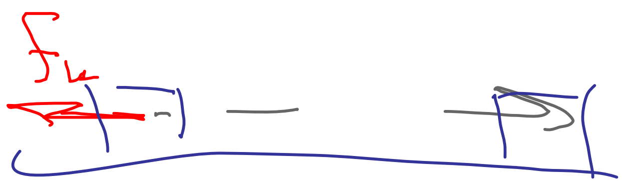
Friction forces (sliding)



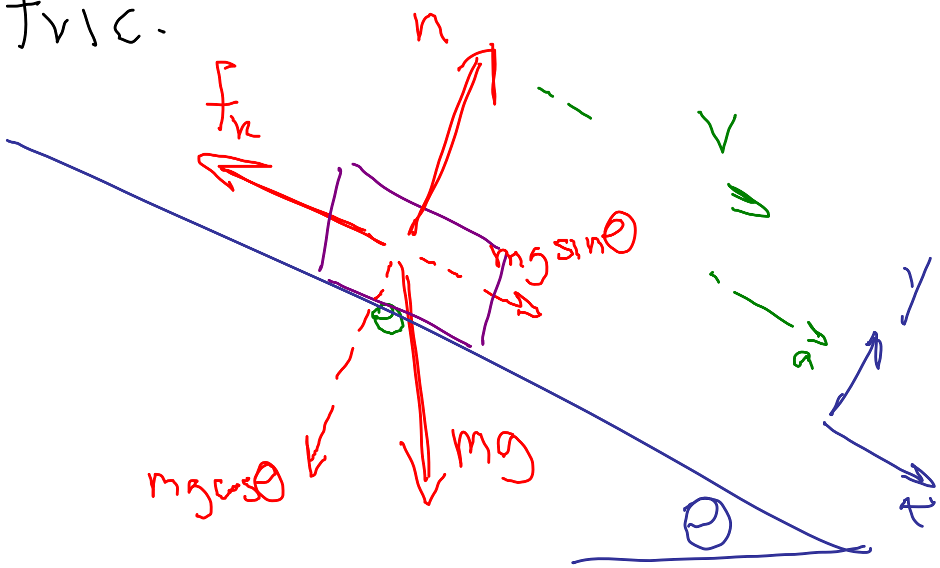
$n = mg$ here.

$$f_k = \mu_k n$$

coeff of kinetic



Block slides down incl. plane w/ kinetic fric.



$$\sum F_y = 0$$

$$n = mg\cos\theta$$

$$f_k = \mu_k n$$

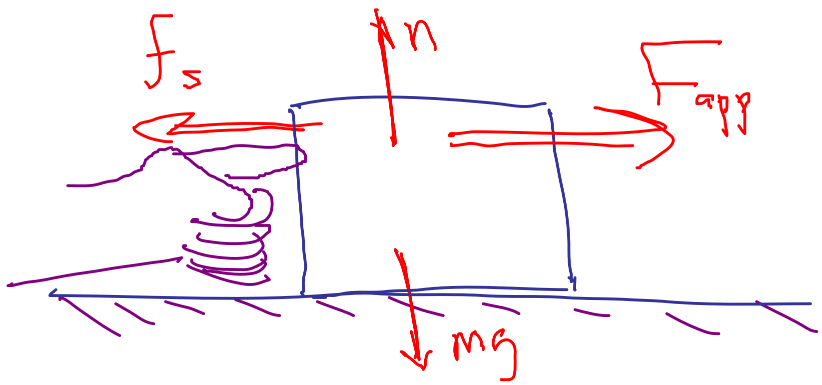
$$= \mu_k mg\cos\theta$$

Net force in x dir =

$$-f_k + mg\sin\theta$$

$$-\mu_k(mg\cos\theta) + mg\sin\theta$$

$$= mg(-\mu_k\cos\theta + \sin\theta)$$



Another kind of friction

Try to get block moving by exerting a force

Until block starts to move $f_s = F_{app}$

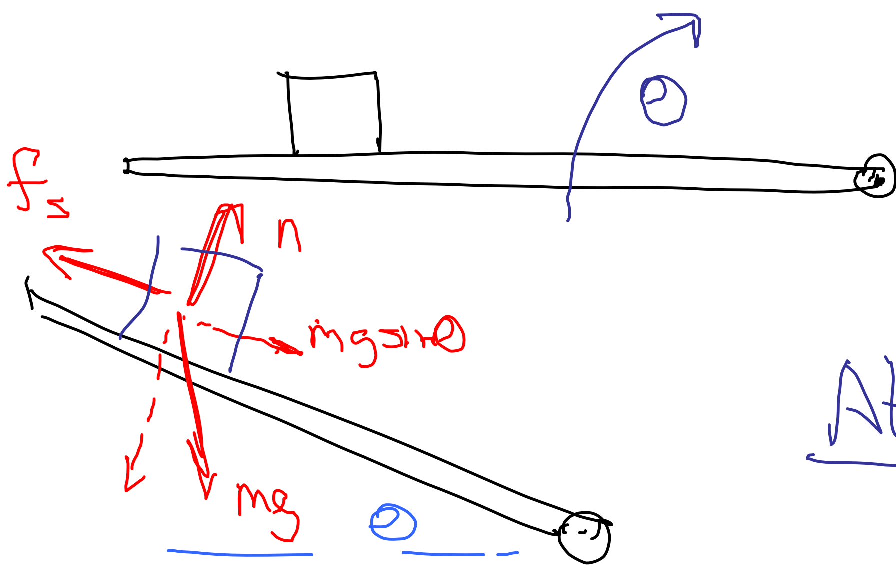
$\longrightarrow$ f_s has a max value, f_s^{max}

$$f_s^{max} = \mu_s n$$

μ_s coeff. of static friction

$\longrightarrow \mu_s^{max} \geq \mu_k$

Expt:



Raise ramp up until block starts to slip. What can we say?

At slipping $f_s = f_s^{max}$

$$= \mu_s n$$

$$n = mg\cos\theta$$

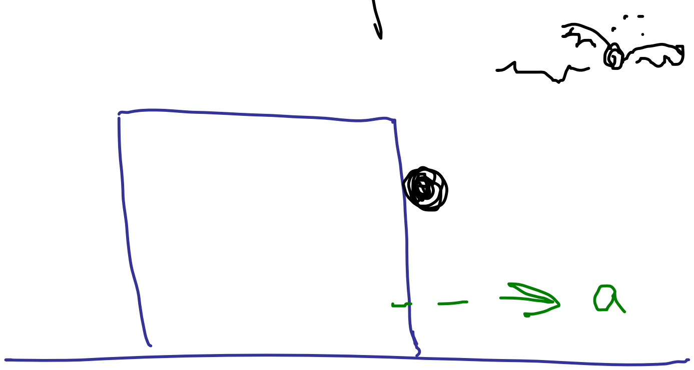
$$mg\sin\theta = f_s^{max}$$

$$\mu_s = \frac{\sin\theta}{\cos\theta}$$

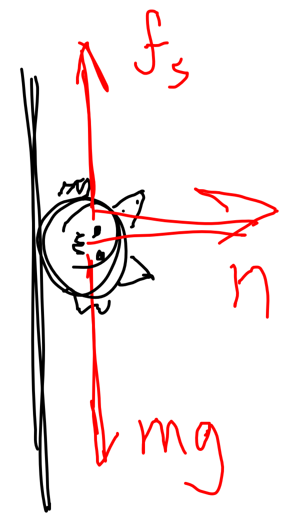
$$= \tan\theta$$

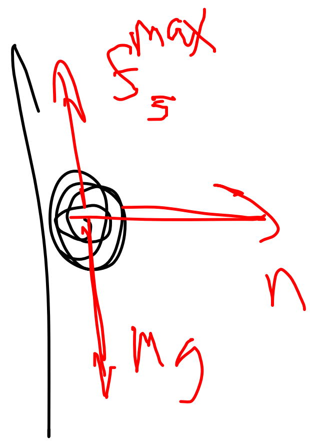
$$mg\sin\theta = f_s = \mu_s n = \mu_s mg\cos\theta$$

5.46 Bat crashes into accelerating subway train. Friction coefficient between bat & train is 0.86. What's the minimum acceleration of train that will allow bat to remain in place?



Forces on bat





$$f_s^{max} = mg$$

No accel up/down

$$\underline{n = ma}$$

a = accel of bat or train.

$$f_m^{max} = \mu_s n = mg$$
$$= \mu_s m a$$

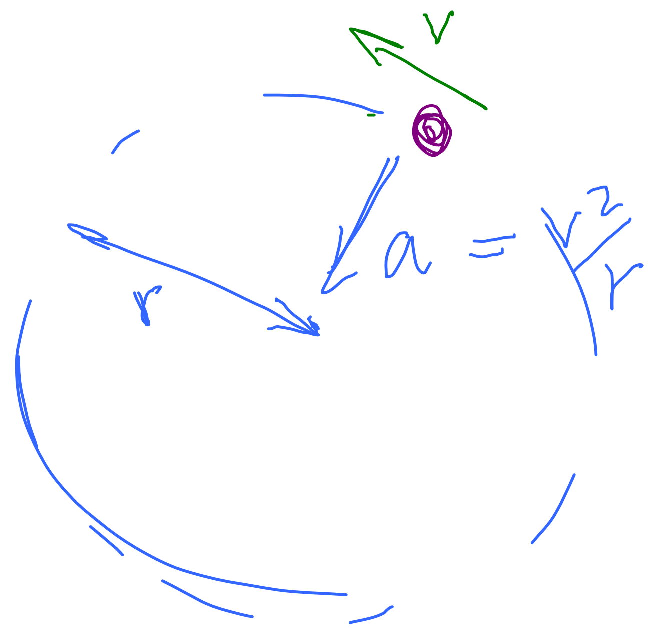
$$\cancel{m}g = \mu_s \cancel{m} a$$

$$a = \frac{g}{\mu_s} = 11 \frac{m}{s^2}$$

Uniform Circ. Motion

Why does it go in circle.

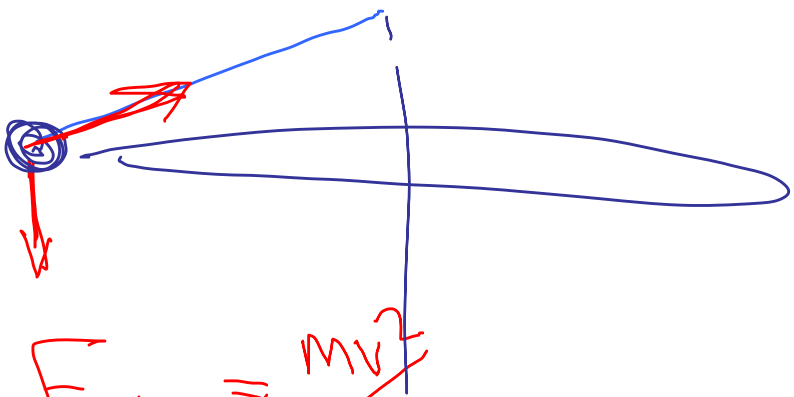
$$\vec{F}_{net} = m\vec{a}$$



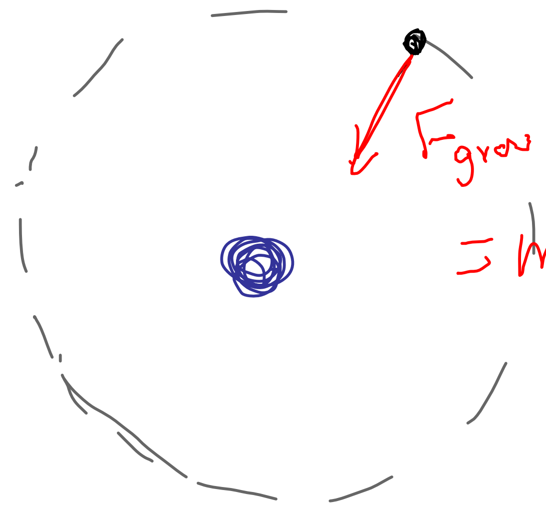
Net force points toward center, has mag

$$\boxed{F_{net} = \frac{mv^2}{r}}$$

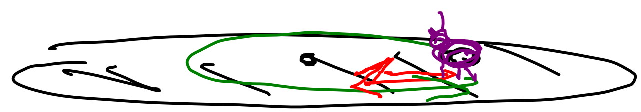
(p. 71)



$$F_{net} = \frac{mv^2}{r}$$



$$= \frac{mv^2}{r}$$

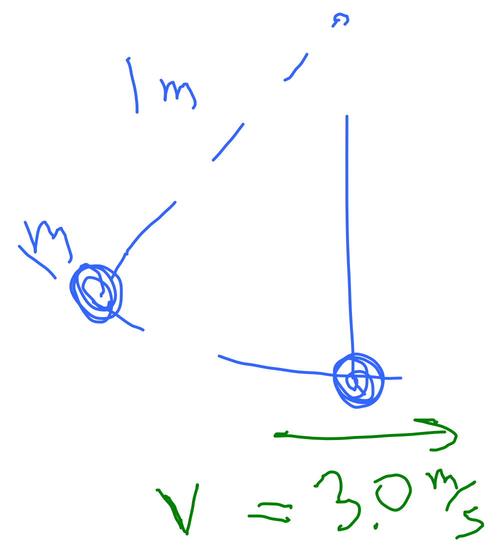


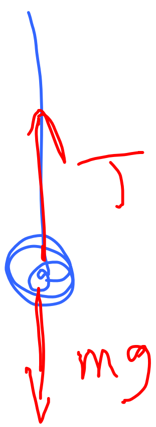
$$f_s = \frac{mv^2}{r}$$

Example

$m = 1.5\ \text{kg}$

What is tension in string at bottom of swing. ($v = 3.0 \frac{m}{s}$)





$\cancel{T = mg}$

Net force is toward center,

$mg = mv^2/r$

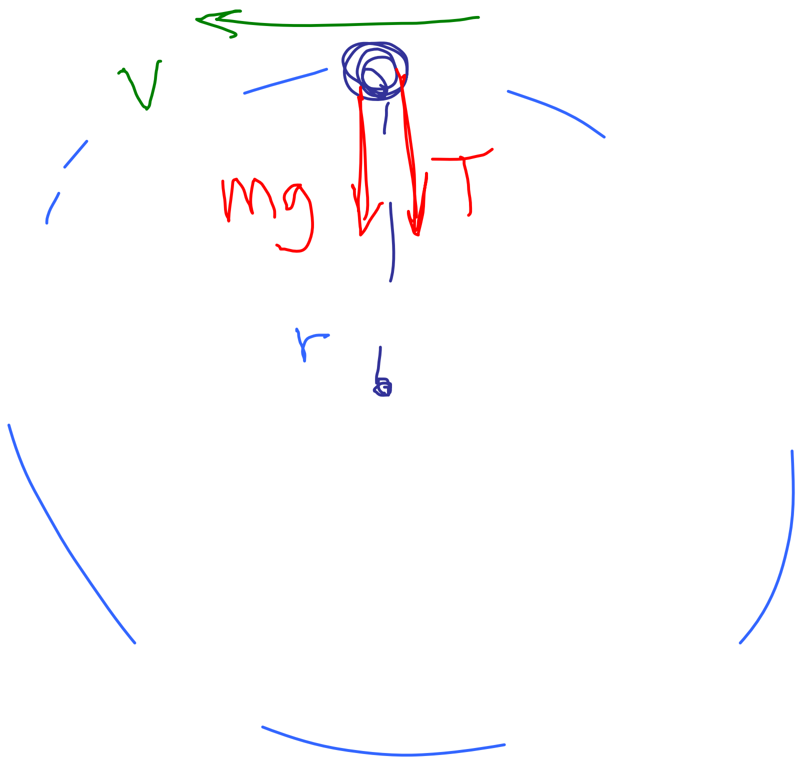
$$T - mg = \frac{mv^2}{r}$$

$$T = mg + \frac{mv^2}{r}$$

$$= m\left(9.8\,\frac{m}{s^2} + \frac{\left(3.0\,\frac{m}{s}\right)^2}{(1\,m)}\right)$$

$$= (1.5\,kg)\left(18.8\,\frac{m}{s^2}\right) = 28.2\,N$$

Suppose ball is whirling in vertical circle $v = 4.0\,\frac{m}{s}$ at top of swing. What is tension in string then?



$r = 1.0\,m$

If v were too small, T neg! Impossible!

$v = 4.0\,\frac{m}{s}$

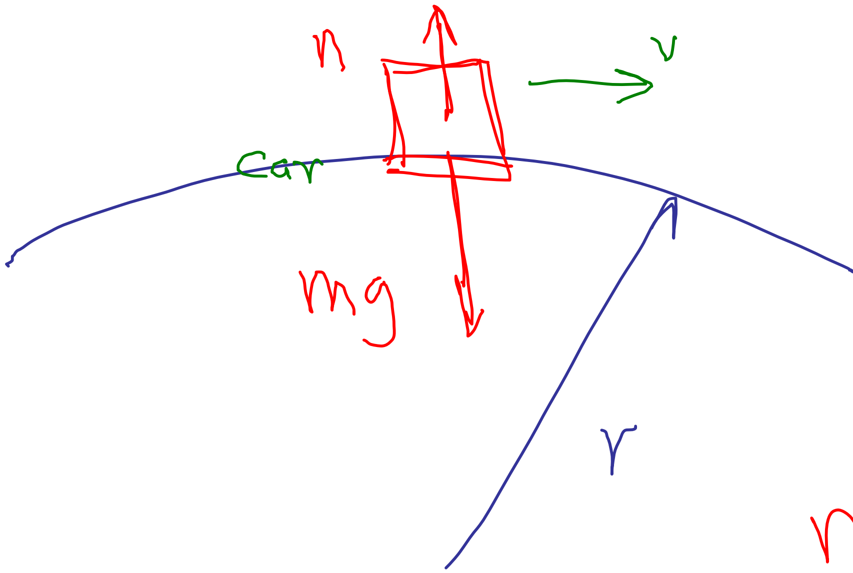
Forces toward center

$$mg + T = \frac{mv^2}{r}$$

$$T = \frac{mv^2}{r} - mg$$

$$T = m\left(\frac{v^2}{r} - g\right)$$

$$= m\left(6.2\,\frac{m}{s^2}\right) = 9.3\,N$$



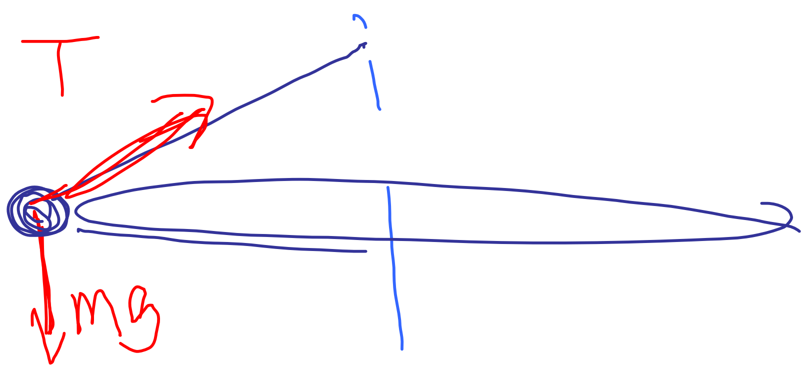
Force toward center

$$mg - n = \frac{mv^2}{r}$$

$$n = mg - \frac{mv^2}{r}$$

v can't be too big, or n is neg, impossible.

5.24 940-g rock is whirled in horizontal circle at end of 1.30-m long string. Breaking str. of string is 120 N. What's min. angle w/ horiz.



Find T...