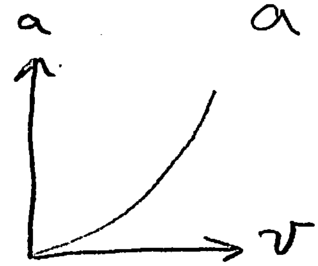
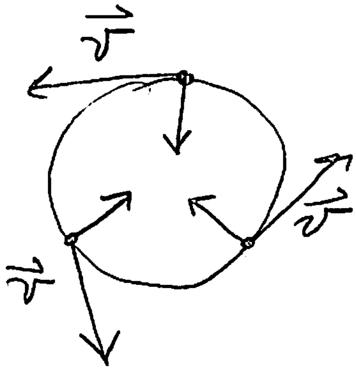
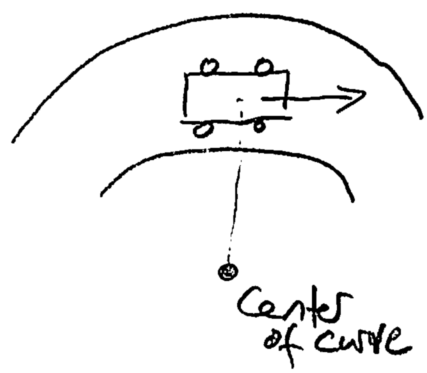
Speed ≠ velocity
$s \neq \vec{v}$



$$a = \frac{v^2}{r}$$



Centripetal acceleration
for uniform circular motion



$\vec{v}$ = const

where is $\vec{a}$?

Towards the center

the acceleration is due to the change in direction, not the change in speed

---

for a circle, motion is periodic, T. You go around the same place again & again

Rather than expressing time for a revolution, we use ~~frequency~~, f

$$f = \frac{1}{T}$$; revolutions (count) per second

If we know distance traveled, we know the radius, r

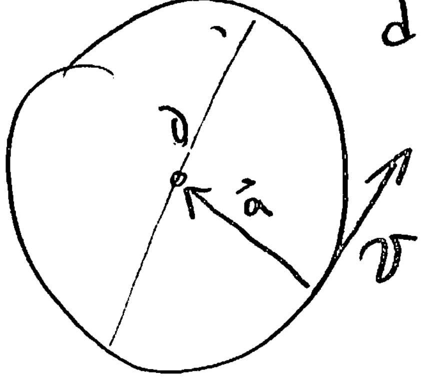
$$v = \frac{2\pi r}{T} \quad \text{or} \quad v = 2\pi f r$$

Trey/Dylan 120 pm

Combining equations:

$$a = \frac{v^2}{r} = \frac{(2\pi f)^2 r}{}$$

$$a = \left(\frac{2\pi}{T}\right)^2 r$$



$d = 120mm$

$f = 540\,rpm$

What is the time of 1 revolution, T
velocity @ edge?
acceleration?

Step 1 convert to SI

$d = 120\,\cancel{mm} \left|\, \frac{m}{1000\,\cancel{mm}} \right.$

$f = 540 \frac{1}{\cancel{min}} \left|\, \frac{\cancel{min}}{60\,sec} \right.$

$d = 0.12m$

$r = 0.06m$

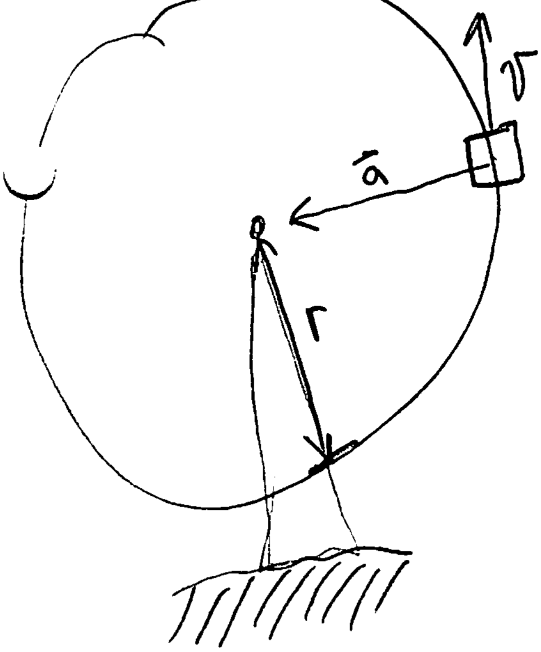
$f = 9 \frac{rev}{sec}$

$$T = \frac{1}{f} = \frac{1}{9\frac{1}{sec}} = \frac{1}{9}\,sec = 0.11\,sec$$

$$v = 2\pi f r = 2\left(\frac{22}{7}\right) 9\frac{1}{sec} \cdot 0.06m = 3.39\frac{m}{sec}$$

$$\vec{a} = (2\pi f)^2 r = \left[2\left(\frac{22}{7}\right)9\right]^2 \cdot 0.06 = 192\frac{m}{sec^2}$$

So, Period is 0.11 sec, velocity is 3.4 m/sec, Accel is 190 m/sec²



$r = 5m$

$a_{max} = 20\, m/s^2$

find period, T

velocity, v

@ safe max speed

$$a = \frac{v^2}{r} \Rightarrow (ar)^{\frac{1}{2}} = v$$

$$\left(20\frac{m}{sec^2} \cdot 5m\right)^{\frac{1}{2}} = v$$

$$\left(100\frac{m^2}{sec^2}\right)^{\frac{1}{2}} = v$$

$$\underline{\underline{10\, m/sec}} = v$$

$$a = \left(\frac{2\pi}{T}\right)^2 r$$

$$\left(\frac{a}{r}\right)^{\frac{1}{2}} = \frac{2\pi}{T} \qquad \left[\frac{\frac{m}{sec^2}}{m}\right]^{\frac{1}{2}} = \frac{1}{sec}$$

$$\sqrt{\frac{r}{a}} = \frac{T}{2\pi} \qquad \left[\frac{1}{sec^2}\right]^{\frac{1}{2}} = \frac{1}{sec}$$

$$\left[\frac{1}{sec}\right] = \left[\frac{1}{sec}\right]$$

$$2\pi\sqrt{\frac{r}{a}} = T$$

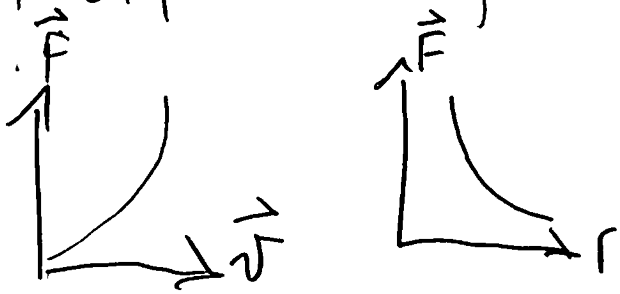
$$\frac{2 \cdot 22}{7}\sqrt{\frac{5}{20}} = T$$

$$\underline{\underline{3.1 sec}} = T$$

At maximum safe acceleration, the carriage travels @ $10\frac{m}{sec} \approx 25$mph and has periocity $= 3.1$ sec

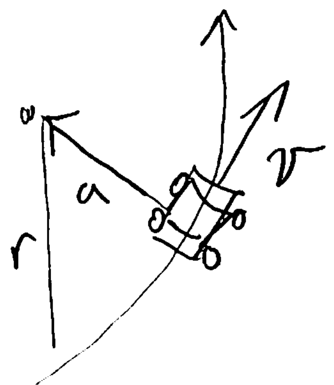
♡ Feb 14

Uniform motion

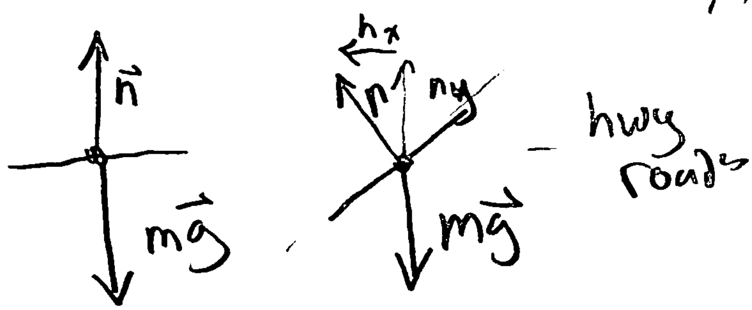


Dynamics of Circular motion

$$F_{net} = m\vec{a} = \left(\frac{mv^2}{r}, \text{ towards center}\right)$$



Newtons First: Object in motion stays in a straight line motion, unless... Acted upon by an outside force



$$\vec{f} = \mu \vec{n}$$

μ = coeff friction

μ_k = kinetic friction

μ_s = static friction

μ_r = rolling friction

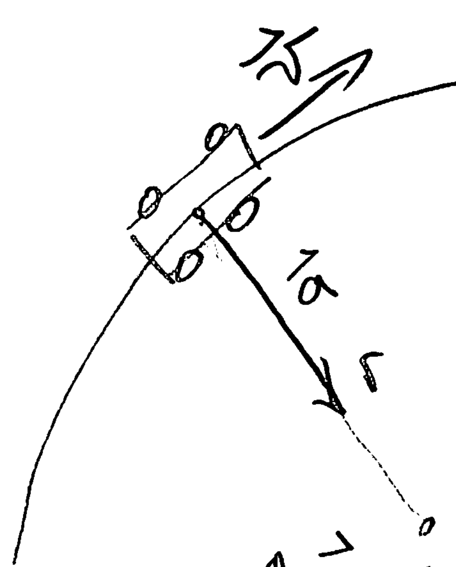
1500 Kg car

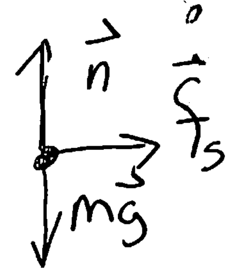
$r = 20m$

non banked road

[city road ; intersection]

find the max $\vec{v}$elocity you can travel





$\vec{f}_s = \mu_s \vec{n}$

$\mu_s = 1.0$ for dry road; regular tires

$$\sum F_y : n - mg = \emptyset$$

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

$$\sum F_y \quad n = m\vec{g}$$

$$n = 1500(9.81)$$

$$\vec{n} = 14715\,N$$

$$\vec{f}_s = \mu \vec{n}$$

$$= (1.0)(14715\,N)$$

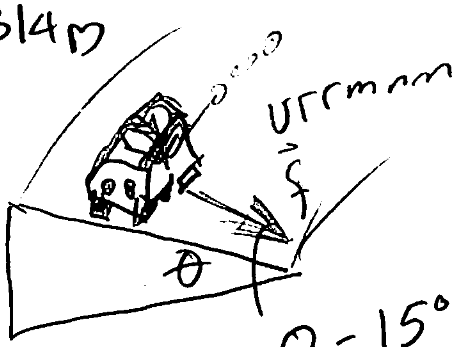
$$\vec{f}_s = 14{,}715\,N$$

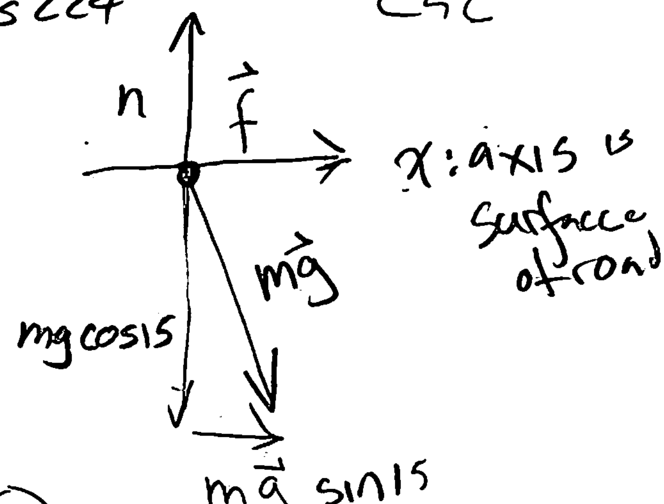
$$\sum F_x : \vec{f}_s = \frac{mv^2}{r} \Rightarrow f_s \frac{r}{m} = v^2$$

$$\sqrt{14715 \frac{20}{1500}} = v$$

$$14\,m/s = v$$

$$30\,mph \approx v$$





$\Sigma F_x : \vec{f} + mg \sin(15)$

$\Sigma F_y : \cancel{0} = n - mg \cos 15$

$n = 1500_{kg} \cdot 9.81\ m/s^2\ \cos(15)$

$\vec{n} = 14{,}213\ N$

$F_x : \mu_s n + mg \sin(15)$

$14213\ N + 9.81 \cdot 1500 \cdot \sin(15)$

$\vec{F}_x = 18{,}021\ N = m\frac{v^2}{r}$

$18\,021 = \frac{1500}{20} v^2$

$240.3 = v^2$

$15.5\ m/s = v$

So, banking gets you a little more speed...

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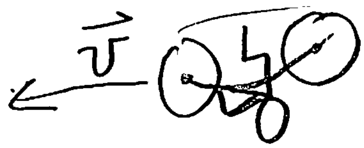
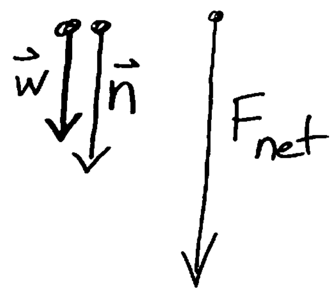
Phys224
Circular Motion CSC

7/9

ring of death



$r = 2.2m$



$\vec{n} \geq \vec{w}$

$$\vec{F}_x : mg + mg = \frac{m v_{min}^2}{r}$$

$$2\cancel{m}g = \frac{\cancel{m}v_{min}^2}{r}$$

$$2gr = v^2$$

$$(2gr)^{\frac{1}{2}} = v$$

$$\sqrt{2 \cdot 9.81 \cdot 2.2} = v$$

$$6.6 m/s = v$$

The minimum speed to stay in the ring of death is 6.6 m/s or ≈15 mph

Feb14♡

CSC 8/9

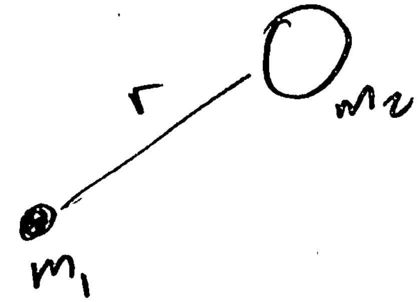
Newtons Laws of Gravity

Every object attracts another object

Force is inversly proportional to

(1) Square of dist apart

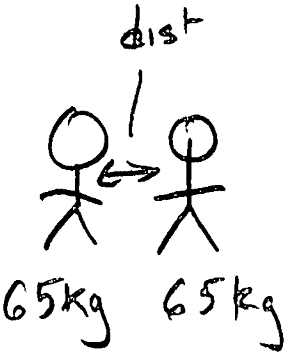
(2) Square of the mass



$$F_{1 on 2} = F_{2 on 1} = \frac{G\, m_1 m_2}{r^2}$$

$$G = 6.67 \times 10^{-11} \frac{Nm^2}{Kg^2}$$

Force on two students



Students = 65 kg

dist = 0.6 m

How much are they attracted to one another?

$$F_{1 on 2} = \frac{G \cdot m_1 m_2}{r^2}$$

$$= \frac{6.67 \times 10^{-11} \cdot 65 \cdot 65}{(0.6)^2}$$

$$= 7.8 \times 10^{-7} N$$

So, the bigger the students are, the more they are attracted to one another

Find your attraction to the earth ...

$r = 6.37 \times 10^{6}\, m$

$m_{earth} = 5.98 \times 10^{24}\, kg$

$$F_{earth\,on\,you} = \frac{4 \cdot 65 \cdot 5.98 \times 10^{24}}{\left[6.37 \times 10^{6}\right]^2}$$

$$= \frac{6.67 \times 10^{-11} \cdot 5.98 \times 10^{24}}{6.37^2 \times 10^{12}}$$

$$\frac{(6.67 \cdot 5.98) \times 10^{13}}{6.37^2 \times 10^{12}}$$

0.983×10^{1}

$9.83\ m/sec^2$

w/ rounding error, the same number...