Phys 201
Exam I
Wed 9/29
272 Bascom
545-645pm

REVIEW SESSIONS
1300 STERLING
Fri 9/24 5-7
Sun 9/26 2-4

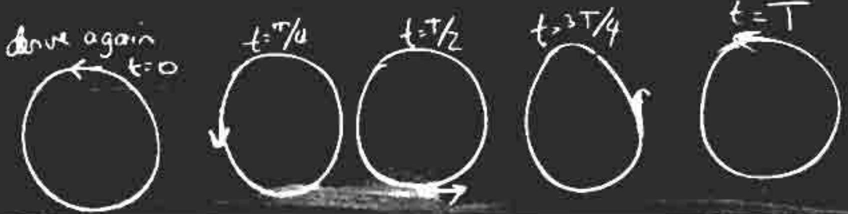
ch 6 Circular motion

1) Uniform circular motion

recall for uniform circular motion,

$$a_{\parallel}=0 \quad , \quad a_{\perp}=v^2/R$$

v = speed, R = radius



first find period T

go distance $2\pi R$

in time T

so $v = \frac{2\pi R}{T}$

$T = \frac{2\pi R}{v}$

How much did velocity change?

$\vec{v}$ vector has done 1 full revolution

so it has changed by $2\pi v$

$$\frac{\Delta \text{velocity}}{\Delta \text{time}} = 2\pi v \Big/ \left(\frac{2\pi R}{v}\right) = \frac{v^2}{R}$$

acceleration is directed inward

centripetal acceleration

Ex 1 1 kg stone attached to a 1 m string with breaking strength 500 N

How fast can stone go before string breaks?

$$F = ma \Rightarrow F_{max} = m\frac{v_{max}^2}{R} \Rightarrow v_{max}^2 = \frac{F_{max} R}{m}$$

$$\text{so } v_{max} = \sqrt{\frac{(500\,N)(1\,m)}{1\,kg}} = 22.4\,\frac{m}{s}$$

Ex 2 Conical pendulum

massless string

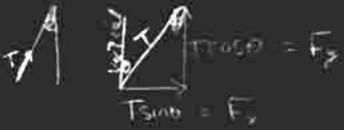
ball has mass m

given θ, L

what is period?

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

vertical component:



$y: T\cos\theta - mg = 0$ since $a_y = 0$

$\Rightarrow T = mg/\cos\theta$

horizontal:

$$T\sin\theta = ma$$

$$\left(\frac{mg}{\cos\theta}\right)\sin\theta = ma \Rightarrow a = g\tan\theta$$

now relate a to period $\mathcal{T}$

$a = \frac{v^2}{R}$ where R is radius of motion

$R = L\sin\theta$

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

recall $v = \frac{2\pi R}{\mathcal{T}}$

so $a = \frac{(2\pi)^2 R}{\mathcal{T}^2} \rightarrow \mathcal{T} = 2\pi\sqrt{\frac{R}{a}}$

$$\mathcal{T} = 2\pi\sqrt{\frac{L\sin\theta}{a}}$$

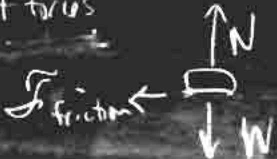
$$= 2\pi\sqrt{\frac{L\sin\theta}{g\tan\theta}} = 2\pi\sqrt{\frac{L\cos\theta}{g}}$$

car on flat road

How fast can car go?

all acceleration is ⊥ to velocity

look at forces



vertical $F = N - mg = 0$

$mg = W = N$

horizontal:

$$F = ma$$

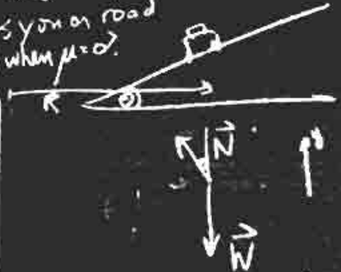
$$\mu N = ma = mv^2/R$$

$$\mu mg = mv^2/R$$

so maximum v is $\sqrt{\mu g R}$

Bank road so friction is not only force keeping you on road.

For a given speed, what θ keeps you on road even when $\mu = 0$.



y component:

$$F_y = N\cos\theta - mg = 0$$

horizontal:

$$F_x = N\sin\theta = m\frac{v^2}{R}$$

$$N\sin\theta = mv^2/R$$

$$N\cos\theta = mg$$

$$\tan\theta = v^2/Rg$$

$$\theta = \tan^{-1}\left(\frac{v^2}{Rg}\right)$$

Eg Highway curve of
1600 ft in radius
traffic travels at $50 \frac{mi}{hr}$

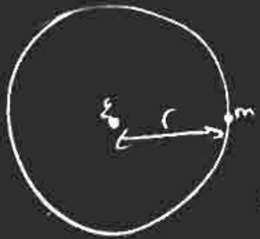
banking angle:

$$\theta = \tan^{-1} \frac{v^2}{Rg} = \tan^{-1}\left(\frac{(50\,mi/hr)^2}{(1600\,ft)(32\,ft/s^2)}\right)$$

$$50 \frac{mi}{hr} = 50 \times 5280 \frac{ft}{mi} \times \frac{1}{3600} \frac{hr}{s}$$

$$\theta = 6^\circ$$

Motion of satellites - circular orbits



Gravitational force causes moon to accelerate

given r
find T, period
(finish next time)