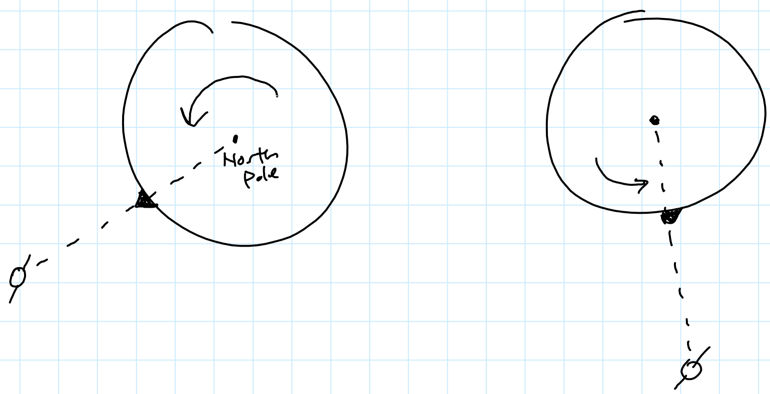
Phy 4A 12/5

Monday, December 5, 2016 10:09 AM

Goals for the Lecture:

1) Understand what Period, Frequency, and angular frequency are and how they relate to one another
2) Understand how velocity and acceleration change during a cycle
3) Understand that simple harmonic motion comes about when the force is proportional to displacement

Geosynchronous orbit



Find R for geosynchronous orbit:

$$\Sigma \vec{F}_{radial} = m a_c$$

$$\Sigma F_{radial} = m \frac{v^2}{R}$$

$$\frac{G \cancel{m} M_E}{R^2} = \frac{\cancel{m} v^2}{R}$$

$$v = \frac{\text{distance}}{\text{time}} = \frac{2\pi R}{T}$$

period = 24 hours

$$\frac{G M_E}{R^2} = \frac{\left(\frac{2\pi R}{T}\right)^2}{R}$$

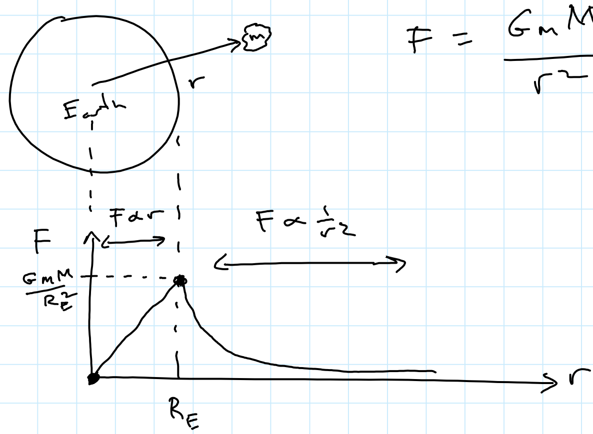
$$\frac{G M_E}{4\pi^2} T^2 = R^3$$

T = 1 day

solve for R

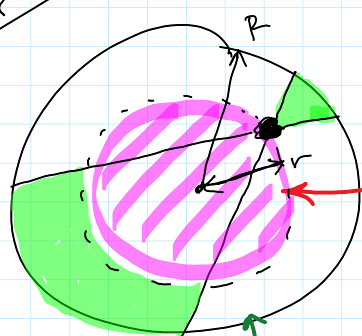
Gravity:

For $r > R_E$



$$F = \frac{G m M_E}{r^2}$$

For $r < R$



only mass inside our radius has an effect

all mass outside our radius cancels out

$$F = \frac{G m M_{inside}}{r^2}$$

if uniform density:

$$M_{inside} = \frac{V_{inside}}{V_{total}} M_{total}$$

$$= \frac{\frac{4}{3}\pi r^3}{\frac{4}{3}\pi R^3} M$$

$$= \frac{r^3}{R^3} M$$

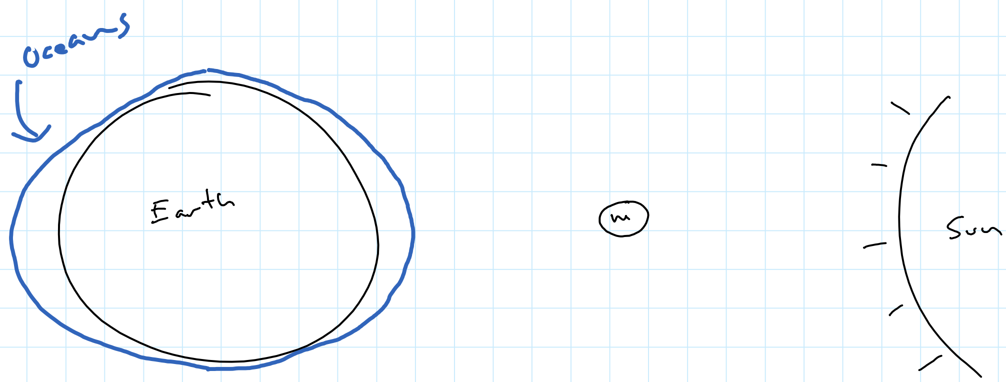
$$F = \frac{G m \left(\frac{r^3}{R^3} M_{total}\right)}{r^2}$$

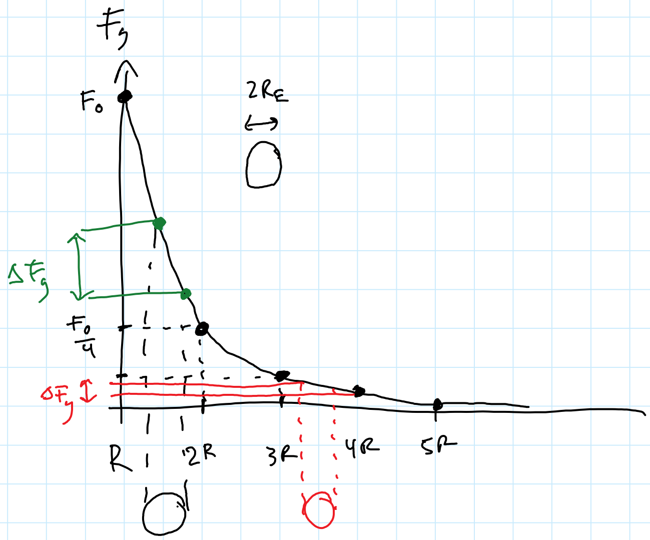
$$= \left(\frac{G m M_{total}}{R^3}\right) r$$

$F \propto r$ inside planet

$F \propto r$ inside planet

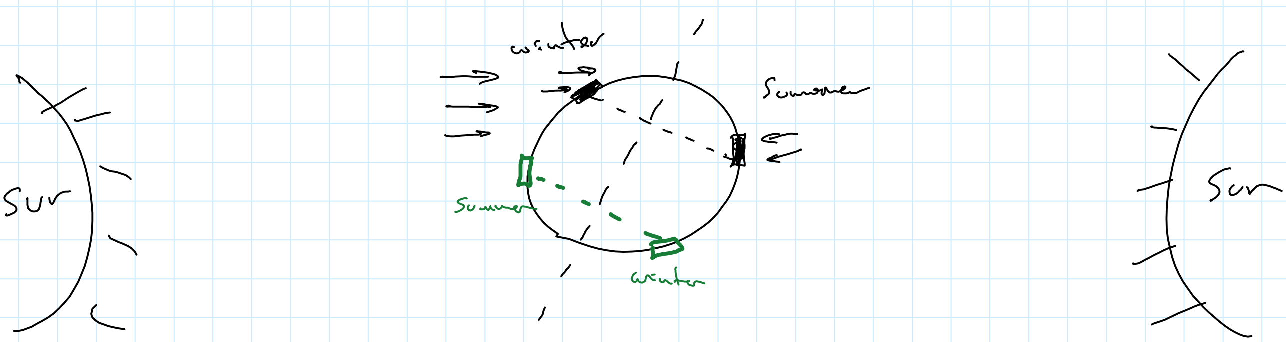
Tides





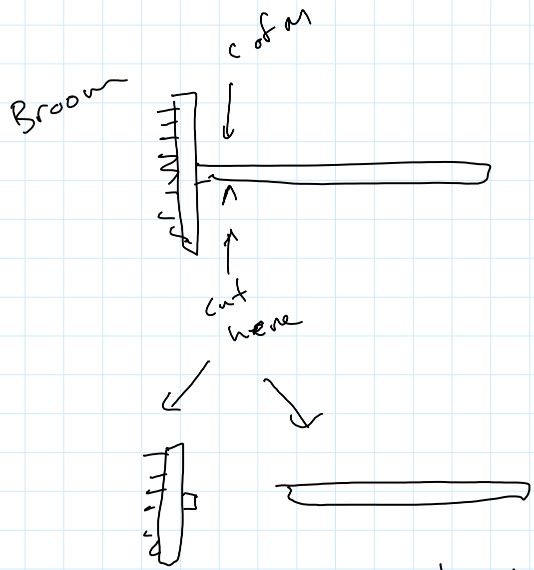
$$F = \frac{GmM}{r^2}$$

Seasons:



Flux

c of M

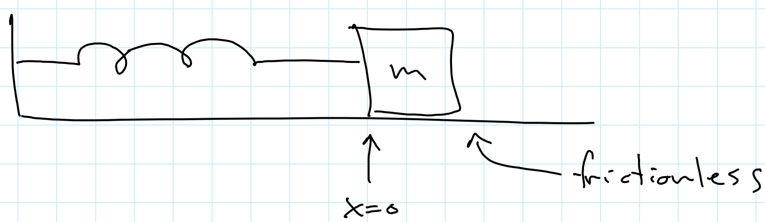


which is heavier?

Broom end is heavier because it has a smaller lever arm

$$\tau_{Rt} = \tau_{left}$$

Mass on a spring:



$$F = -kx$$

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

$$-kx = ma$$

$$-kx = m\frac{d^2x}{dt^2}$$

$$-\frac{k}{m}x = \frac{d^2x}{dt^2}$$

$$x(t) = ?$$

if $x(t) = A\cos(\omega t + \phi)$

for setting initial conditions

if $x(t) = A\cos(\omega t + \phi)$

$x'(t) = -\omega A \sin(\omega t + \phi) = v(t)$

$$x''(t) = \underbrace{-\omega^2}_{-\frac{k}{m}} \underbrace{A\cos(\omega t + \phi)}_{x(t)} = a(t)$$

if $\omega = \sqrt{\frac{k}{m}}$

$x(t) = A\cos(\omega t + \phi)$ satisfies

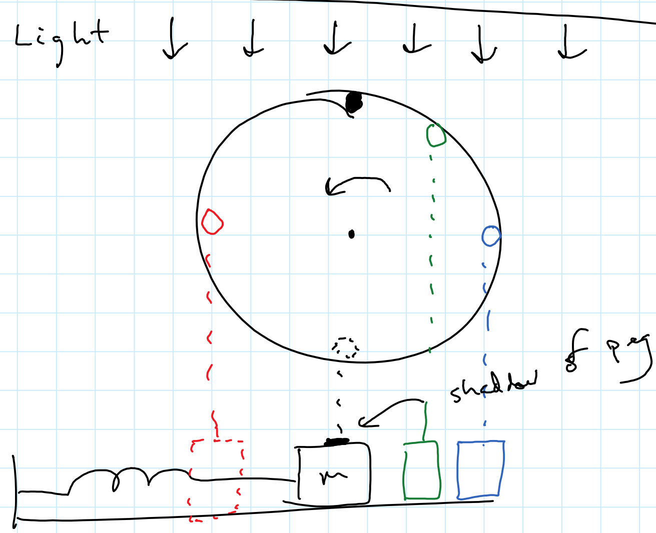
ω = angular frequency   units: $\frac{\text{radians}}{\text{sec}}$

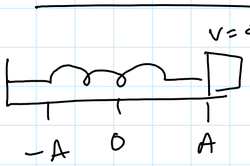
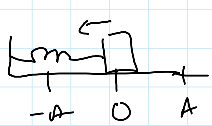
$\omega = 2\pi f$

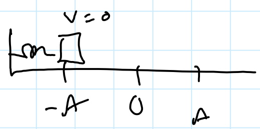
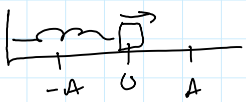
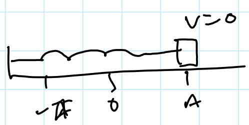
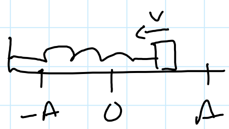
↑ frequency

f units $\frac{\text{cycles}}{\text{sec}}$ or Hertz (Hz)

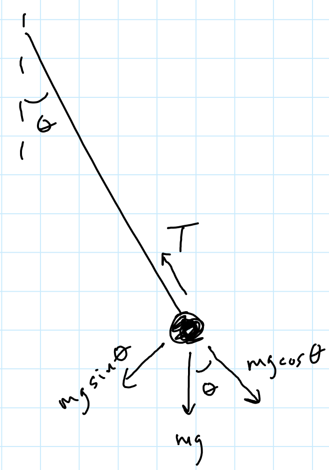
$Hz = \frac{1}{sec}$



	t	x	v	a	KE	U_{sp}	
 v=0, −A 0 A	0	A	0	$-\frac{k}{m}A$ or $-\omega^2 A$	0	$\frac{1}{2}kA^2$	$\phi = 0$
 −A 0 A	$\frac{T}{4}$	0	$-\omega A$	0	$\frac{1}{2}kA^2$	0	
v=0	T			$+\frac{kA}{m}$		$\frac{1}{2}kA^2$	

	$\frac{T}{2}$	$-A$	0	$+\frac{kA}{m}$ or $\omega^2 A$	0	$\frac{1}{2}kA^2$
	$\frac{3}{4}T$	0	ωA	0	$\frac{1}{2}kA^2$	0
	T	A	0	$-\omega^2 A$	0	$\frac{1}{2}kA^2$
	t	x	$-v$	$-\omega^2 x$	$\frac{1}{2}mv^2$	$\frac{1}{2}kx^2$

simple pendulum



$$F = ma$$

$$-\cancel{m}g\sin\theta = \cancel{m}a$$

$$-g\sin\theta = a$$

if θ is small: $\sin\theta \approx \theta$ in radians

$$-g\theta = a$$

$$a = \frac{d^2 s}{dt}$$

$$s = R\theta$$

$$-\frac{g}{L}\theta = \frac{d^2\theta}{dt}$$

$$\theta(t) = A\cos(\omega t + \phi)$$

$$\omega = \sqrt{\frac{g}{L}}$$