SIMPLE HARMONIC MOTION

Conditions:

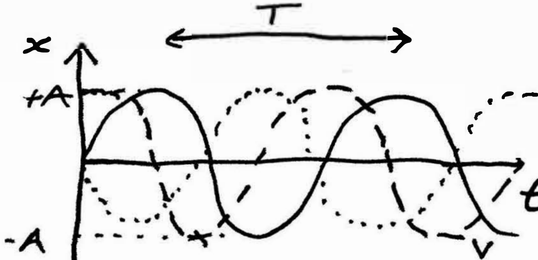
- Force/acceleration is proportional to and in the opposite direction to displacement.

$\boxed{a = -\omega^2 x}$

* Amplitude: max displacement from equilibrium $\therefore \boxed{a_{max} = \omega^2 A}$

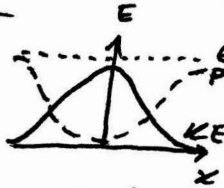
* Displacement at any point: $\boxed{x = A\sin(2\pi f t)}$ (calc: RAD!)
(cos)

* Velocity at any point:
$v = \pm 2\pi f\sqrt{A^2 - x^2}$
$\therefore \boxed{v_{max} = 2\pi f A = \omega A}$ (x=0) at eq^m



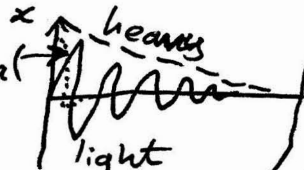
* To get v_{max}, $2\pi f A = \frac{2\pi A}{T}$
or gradient at eq^m.

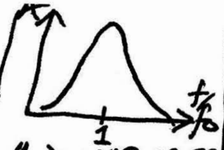
* Total E = max KE = $\frac{1}{2}mv_{max}^2$
or max PE



Damping

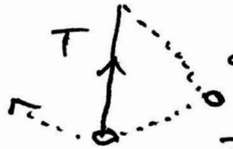
When external force opposes motion (opposite dir to $\underline{v}$)





Resonance: when f of external driving F matches natural f.
$\frac{\pi}{2}$ rad/90° out of phase with (+ light damping)

Pendulum tension:

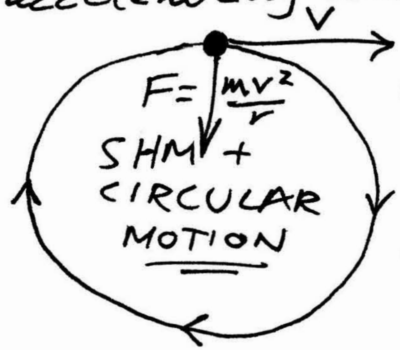


At bottom circ motion, $\therefore$ Tension
$T = \frac{mv^2}{r} + mg$

Circular motion

Force always perpendicular to velocity. Constant speed but always accelerating towards centre (but not getting closer).

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



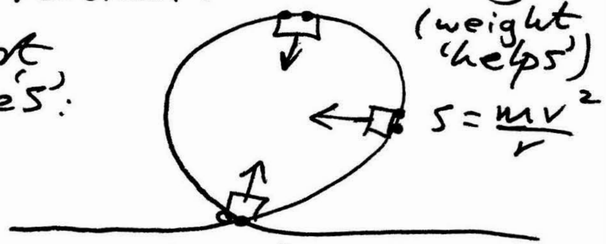
ω: angular vel/freq/speed
radians per second ($rads^{-1}$)

$v = \frac{2\pi r}{T} = \underbrace{(2\pi f)}_{\omega} r \therefore \boxed{v = \omega r}$

$\therefore \boxed{F = m\omega^2 r}$

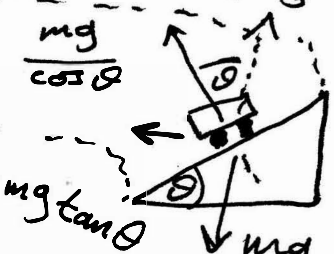
If vertical: $S = \frac{mv^2}{r} - mg$ (weight 'helps')

support forces:



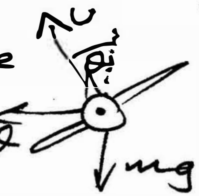
$S = \frac{mv^2}{r} + mg$

Banked tracks



$\frac{mv^2}{r} = mg\tan\theta$

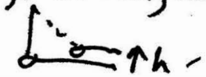
Same for banked plane



$\frac{mv^2}{r} = mg\tan\theta$

Pendulum:

$T = 2\pi\sqrt{\frac{L}{g}}$ ← to centre of bob

* If given height of pendulum


$\underline{GPE = KE}$

Spring:

$T = 2\pi\sqrt{\frac{m}{k}}$ ← ×2 for springs in parallel
÷2 " " " series

Video