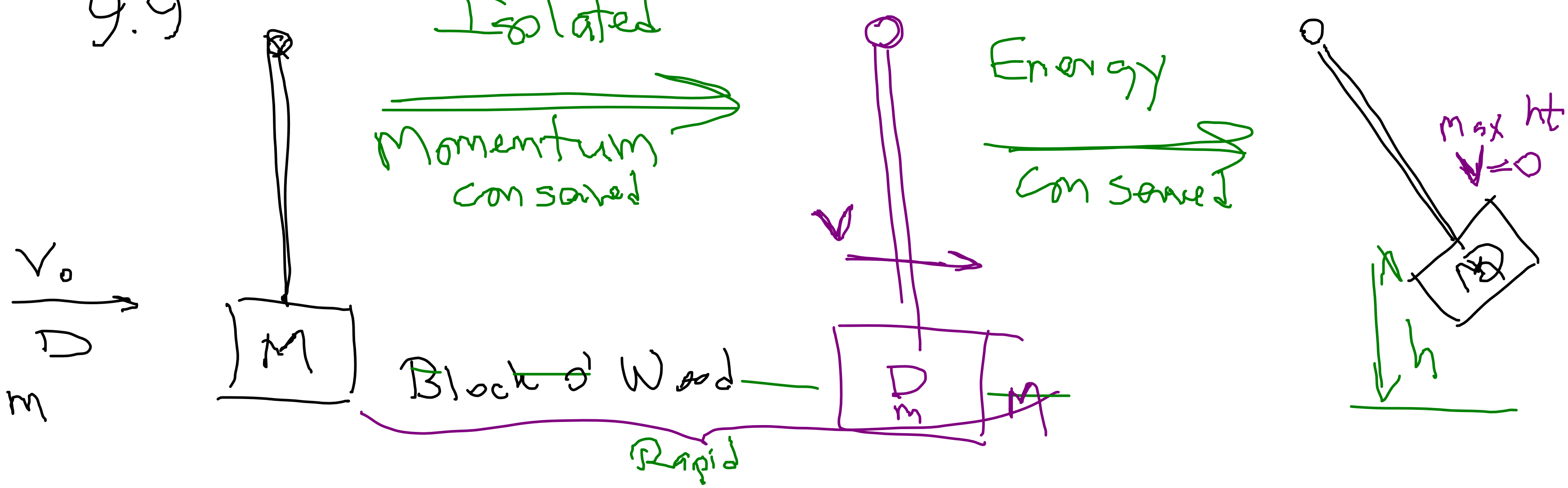
Phys 2110-4 10/26/11

Note Title 10/26/2011

Chap 9 (Momentum)

Example: Ballistic Pendulum

9.9



Mom Cons:

$m \ll M$

$$mV_0 = (m+M)V$$

Energy Cons:

$$\frac{1}{2}(m+M)V^2 = (M+m)gh$$

KE

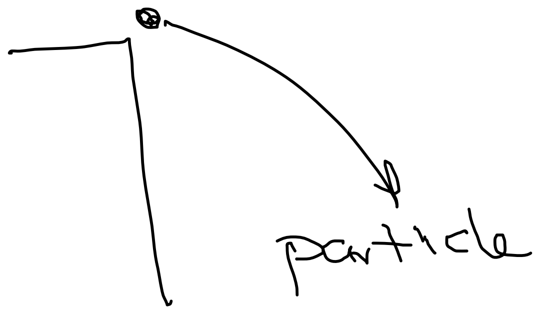
Algebra

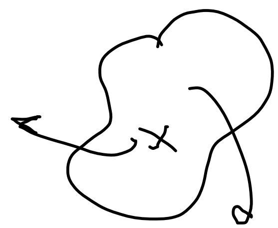
$$V^2 = 2gh \qquad V = \sqrt{2gh}$$

$$V_0 = \frac{(m+M)}{m}V = \frac{(m+M)}{m}\sqrt{2gh} \quad \text{etc.}$$

Chap 10

objects have dimensions.





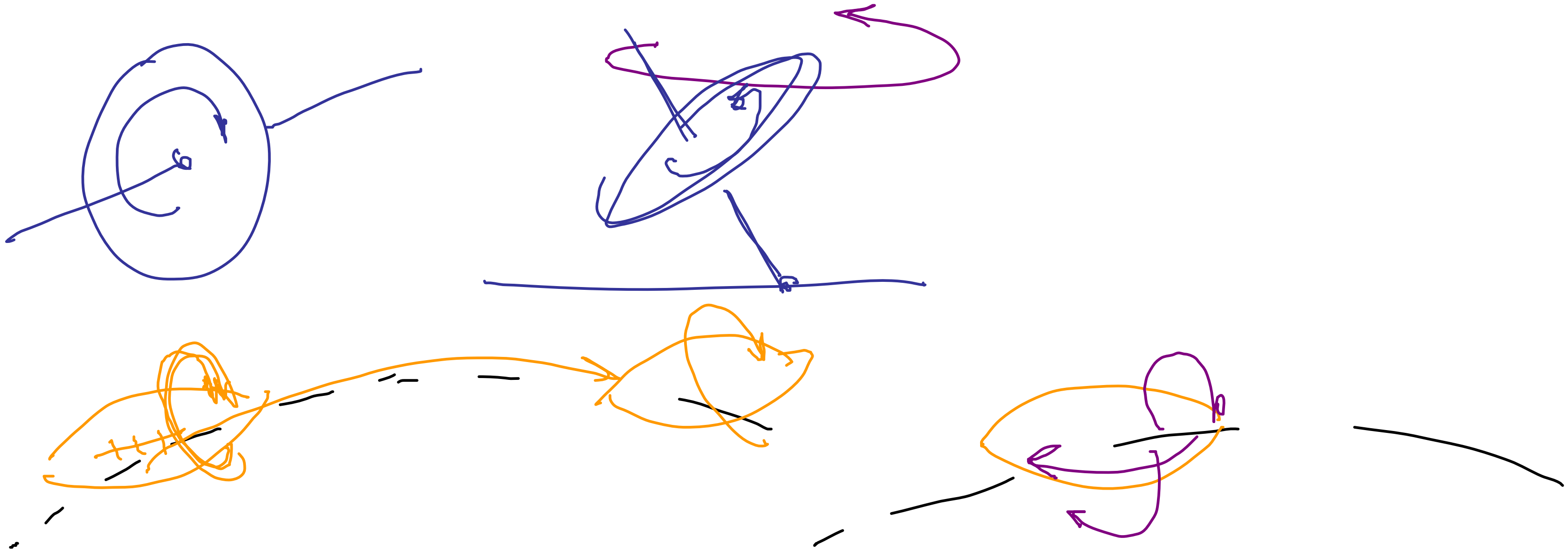
Rotations

Chap 10, 11 Rotational Motion

Results we get will look similar to stuff in Chap 2 (one-dim)

x
v
a

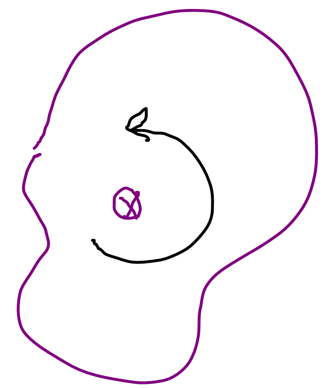
$v^2 = v_0^2 + 2ax$

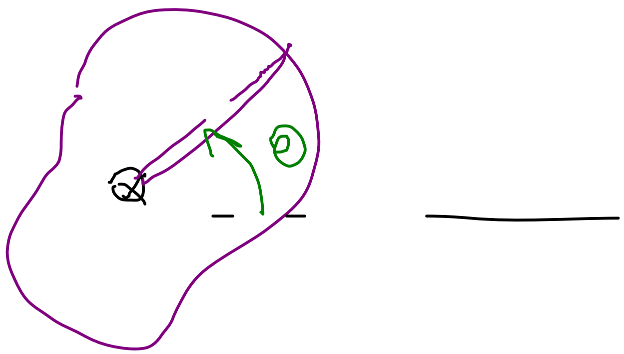


Simple rotations

One fixed axis.

One "degree of freedom"





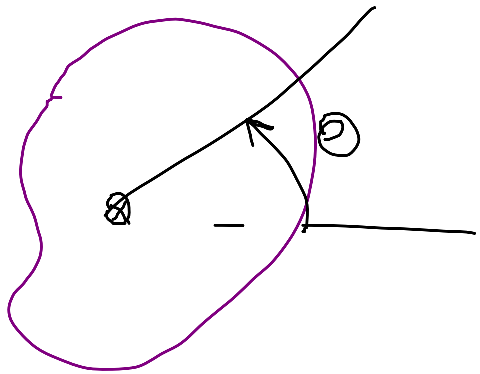
θ angular displacement

Radian: 2π radians $= 360$ degrees

$= 1$ revolution

$180^\circ = \pi$ radians

θ is a scalar can be pos or neg.



θ changes with time

Choose some interval Δt,

$\Delta\theta$

Avg rate of rotation $\omega_{avg} = \frac{\Delta\theta}{\Delta t}$

angular velocity

θ is a scalar, radians

Units of ω. $\frac{\text{radians}}{\text{sec}} = \frac{1}{\text{sec}}$

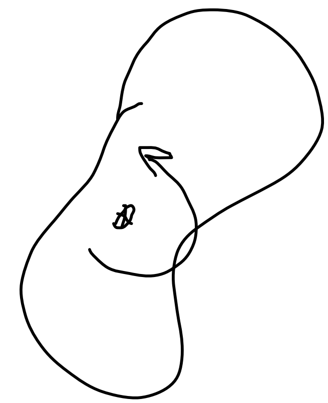
Can omit "rad" in units

Can't omit degrees rev

Instantaneous ang. velocity

$$\lim_{\Delta t \to 0} \frac{\Delta \theta}{\Delta t} = \frac{d\theta}{dt} = \omega$$

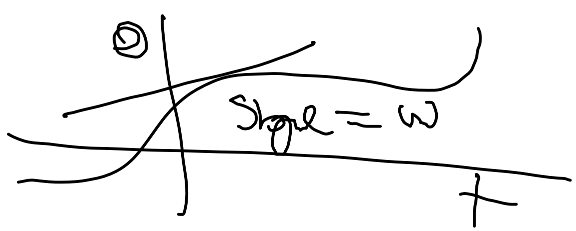
rad/sec

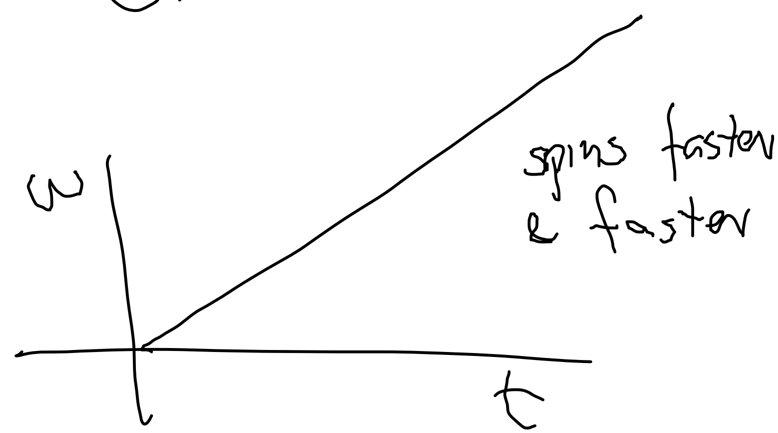


ω is pos if rot'n is CCW

ω is neg if rot'n is CW

Just be consistent





Angular acceleration

ω change with . —

10.15 Express in rad/sec

$$720\ \text{rpm} = 720\,\frac{\cancel{\text{rev}}}{\cancel{\text{min}}}\cdot\frac{2\pi\ \text{rad}}{1\ \cancel{\text{rev}}}\cdot\frac{1\ \cancel{\text{min}}}{60\ \text{s}}$$

$$= 75.4\ \frac{\text{rad}}{\text{s}}$$

b)

$$50°/\text{h} = 50\,\frac{\text{deg}}{\text{h}}\cdot\frac{\pi\ \text{rad}}{180\ \text{deg}}\cdot\frac{1\ \text{h}}{3600\ \text{s}} = 2.42\times10^{-4}\ \frac{\text{rad}}{\text{s}}$$

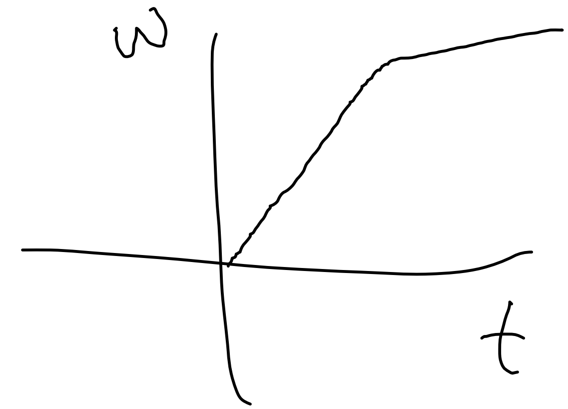
Angular acceleration

Interval Δt, avg

$$\alpha_{avg} = \frac{\Delta\omega}{\Delta t}$$

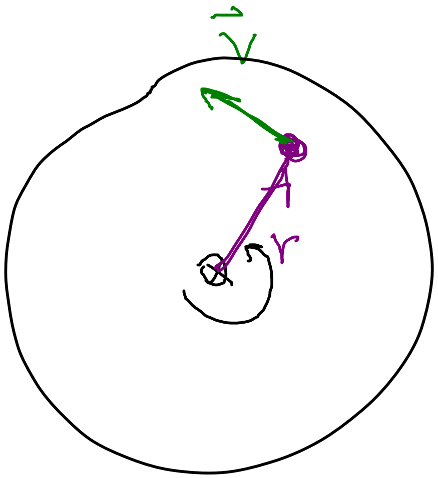
Instantaneous ang accel

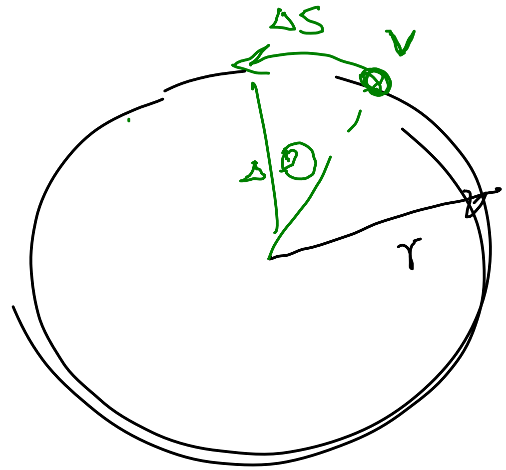
$$\alpha = \frac{d\omega}{dt} = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t}$$



Units $\frac{rad/s}{s} = \frac{rad}{s^2} = \frac{1}{s^2}$

Next step $\frac{d\alpha}{dt} = \beta = \frac{d^3\theta}{dt}$ Don't need it.



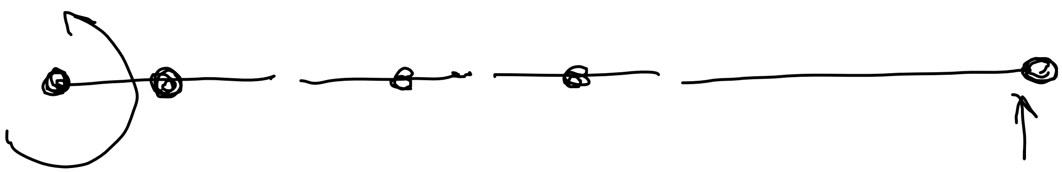


$$\Delta s = r\Delta\theta$$

linear dist

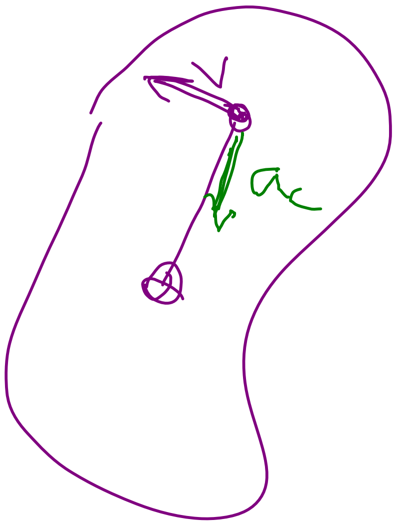
angular disp

True if θ is in radians!



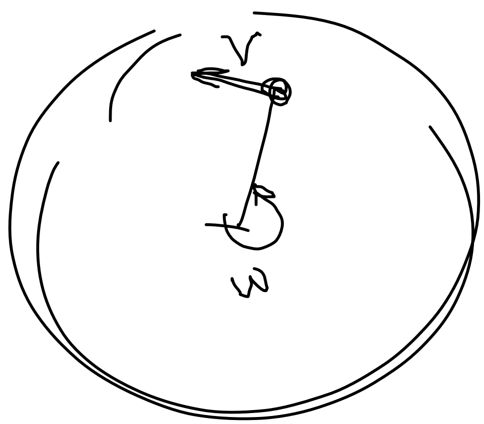
$$v = \frac{\Delta s}{\Delta t} = \frac{r\Delta\theta}{\Delta t} = r\omega$$

$$\boxed{v = r\omega}$$



$$v_t = v = r\omega$$

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



$$a_t = \frac{dv_t}{dt} = r\frac{d\omega}{dt} = r\alpha$$

$$\boxed{a_t = r\alpha}$$

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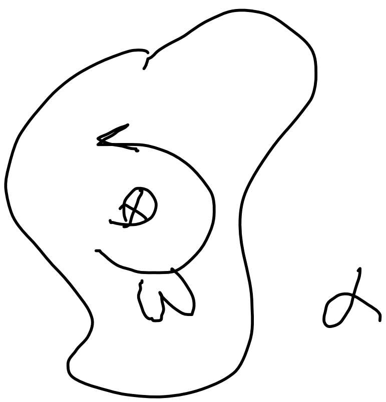
Also $a_c = r\omega^2$



$$\alpha = \frac{d\omega}{dt} \qquad \omega = \frac{d\theta}{dt}$$

$$a = dv/dt \qquad v = \frac{dx}{dt}$$

a changes because of a force

α changes because of $\underbrace{\text{torques}}_{\text{moment of the force.}}$

Constant angular acceleration.

$$\alpha = \text{const}$$

Gives rise eqns which look same as in Chap 2

$v = v_0 + at$

$x = x_0 + v_0 t + \frac{1}{2} a t^2$

$\omega = \omega_0 + \alpha t$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$

ω_0 = initial ang velocity

θ_0 = initial angle

Usually

$\theta_0 = 0$