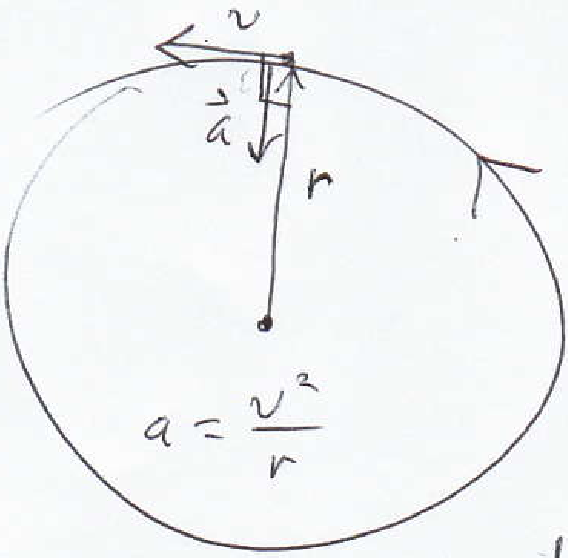


$$a = \frac{v^2}{r}$$

$$\vec{v} = \frac{d\vec{r}}{dt} \perp \vec{r}$$

uniform ~~constant~~
circular
motion

$$|\vec{v}| = v \text{ constant}$$

$\vec{v}$ changes direction

$$v = \frac{\text{circumference}}{\text{period}} = \frac{2\pi r}{T} = \frac{\text{distance per cycle}}{\text{time per cycle}}$$

$$\omega = \frac{2\pi}{T} = \frac{v}{r} = \frac{\text{rotation per cycle}}{\text{time per cycle}}$$

Ch. 3 momentum ($\vec{p}$) is conserved

Ch. 4 angular momentum ($\vec{L}$) is conserved

Transfer of momentum:

$$\frac{d\vec{p}_A}{dt} = \vec{F}$$

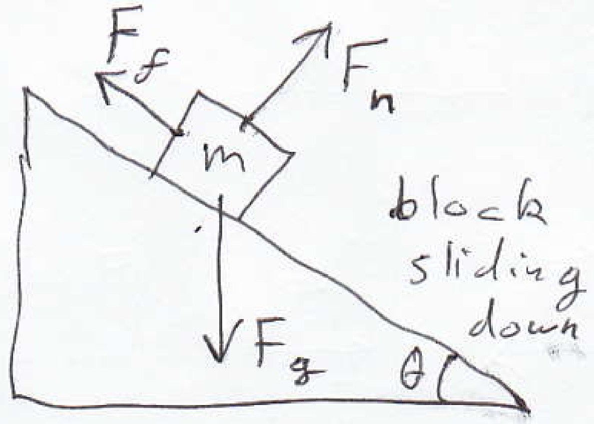
$$\frac{d\vec{p}_B}{dt} = -\vec{F}$$

If m_A is constant,

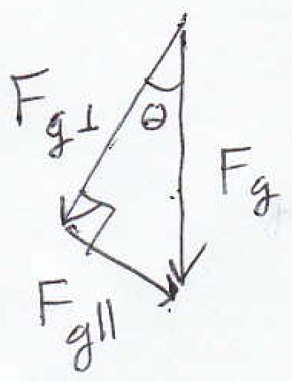
$$\vec{F} = \frac{d\vec{p}_A}{dt} = \frac{d(m_A \vec{v}_A)}{dt} = m_A \frac{d\vec{v}_A}{dt}$$

$$= m_A \vec{a}_A$$

If multiple interactions...



$$\frac{d\vec{p}_{block}}{dt} = \vec{F}_n + \vec{F}_f + \vec{F}_g$$



In direction down the ramp:

$$ma = F_{g\parallel} - F_f$$

$$F_n = F_{g\perp} = F_g \cos\theta$$

$$F_{g\parallel} = mg \sin\theta$$

$$F_n = F_{g\perp} = mg \cos\theta$$

Block sliding down (moving):

kinetic friction: $F_f = \mu_k F_n$

Block stuck: $\begin{cases} F_f \le \mu_s F_n. \\ F_f = F_{g\parallel} \end{cases}$

$a = 0$

$v = 0$

Remember relations between

a, Δv, Δx, Δt, etc.

when a is constant:

$$v_f^2 - v_i^2 = \Delta(v^2) = 2a\Delta x = 2a(x_f - x_i)$$

$$v_f - v_i = \Delta v = a\Delta t = a(t_f - t_i)$$

$$\Delta x = \frac{1}{2}a(\Delta t)^2 + v_i \Delta t$$

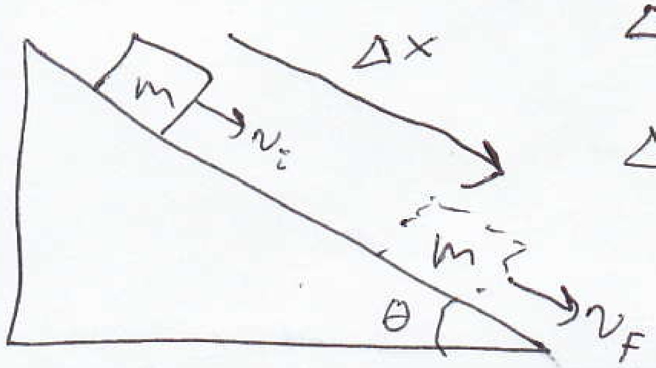
↑ Chapter 0.

$$F = -\frac{dU}{dx} = \frac{dK}{dx} \quad \begin{pmatrix} \text{Work} \\ \text{done by } F \end{pmatrix} = \int \underbrace{F_\parallel}_{\text{part of } F \text{ parallel to motion}} dx$$

$F_\parallel$ constant $\Rightarrow$ $W = (\Delta x) F_\parallel$

Add up work done by all forces acting on object to get ΔK

$$= \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 .$$



$$\Delta K = W_f + W_g$$

$$\Delta K = -F_f \Delta x + F_{g\parallel} \Delta x$$

$$F_{g\parallel} = mg \sin\theta$$

~~Spring~~ Spring

$$U = \frac{1}{2} k x^2$$

$$F = -\frac{dU}{dx} = -kx$$

Gravity near earth's surface

$$U = mgy$$

$$F = -mg = -\frac{dU}{dy}$$

$$g = 9.8\ m/s^2$$

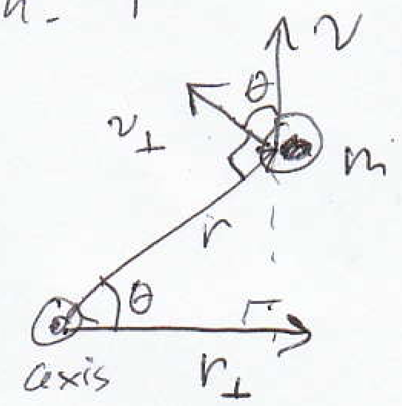
Out in space

$$g = \frac{GM}{r^2}$$

$$U = \frac{GMm}{-r}$$

$$F = \underbrace{\frac{GMm}{r^2}}_{mg} = -\frac{dU}{dr}$$

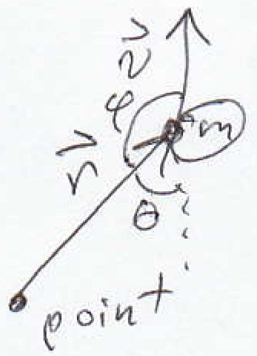
Ch. 4 (2D)



$$L = mrv_\perp = mr_\perp v$$

$$L = mrv \sin\theta$$

3D:



$$\vec{L} = m\vec{r} \times \vec{v}$$

$$\vec{L} = \vec{r} \times m\vec{v} = \vec{r} \times \vec{p}$$

$$|\vec{L}| = m|\vec{r}||\vec{v}|\sin\theta$$

$$|\vec{L}| = m|\vec{r}||\vec{v}|\sin\varphi$$

2D: $L = I\omega$ (rigid body)

3D: $\vec{L} = I\vec{\omega}$ if rotating around axis of symmetry.

Formulas for I on page 268.

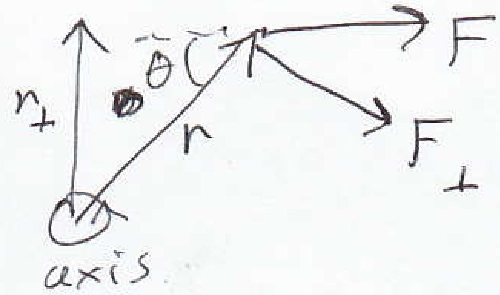
$\vec{L}$ is conserved like $\vec{p}$ is conserved.

2D $\frac{dL}{dt} = \tau = \pm r_\perp F = \pm r F_\perp$

$\uparrow$

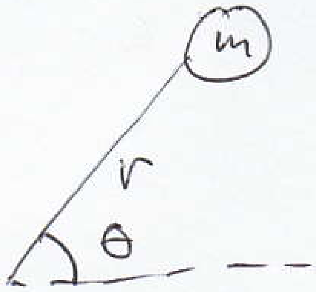
transfer rate of L to another object

$\pm r F \sin\theta$



3D: $d\vec{L}/dt = \vec{\tau} = \vec{r} \times \vec{F}$

$\cancel{v = \frac{dx}{dt}}$



$v = \frac{dx}{dt}$ $\qquad$ $\omega = \frac{d\theta}{dt}$

$a = \frac{dv}{dt}$ $\qquad$ $\alpha = \frac{d\omega}{dt}$

$F = ma$ $\qquad$ $\tau = I\alpha$

$F = \frac{dp}{dt}$ $\qquad$ $\tau = \frac{dL}{dt}$

a constant $\Rightarrow \Delta(v^2) = 2a\Delta x$

α constant $\Rightarrow \Delta(\omega^2) = 2\alpha\Delta\theta$

$p = mv$ $\qquad$ $L = I\omega$