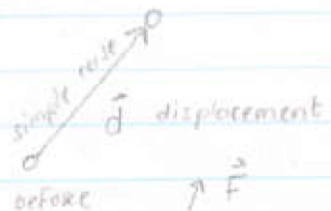
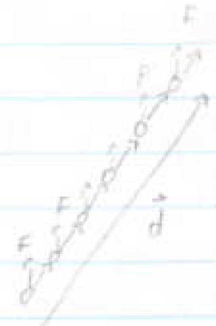
Physics

(Chp. 7) Work
(and Ch. 8)





- $W = \vec{F} \cdot \vec{d} = Fd\cos\theta$ when $\vec{F}, \vec{d}$ constant
- Work done by spring force:

- Force of spring on block
  $= \vec{F}_{spring} = -k x$
  (k: spring constant)

$$\int_0^b -kx\,dx = -\frac{k}{2}x^2$$

- <u>Work-Energy Theorem</u> - Total work done by all forces on object equal the change in the E_K (kinetic energy)

$$W_{net} = \Delta K$$
$$K = \frac{1}{2}mv^2$$

Chp 8 | Conservative forces

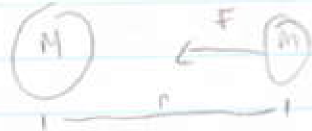
potential E | $\Delta U = -W$ (work done

$\Delta E = \Delta K + \Delta U = 0$ if only conservative forces act

ΔE = Work done by nonconservative forces

- Friction
- Air resistance
- normal forces

Universal gravitation : $F = \frac{GMm}{r^2}$



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

gravity on Earth's surface $\downarrow \vec{F} = mg$ $\cdot U = mgh$ height

Spring $\cdot F = -kx$ $U = \frac{1}{2}kx^2$

Momentum (linear)

- Particle

  $\vec{p} = m\vec{v}$

  $\frac{d\vec{p}}{dt} = m\vec{a} = \Sigma\vec{F}$ force acting on particle.

  System

  $\vec{P} = \Sigma m_i \vec{v}_i = \underbrace{M}_{\text{total mass}}\vec{v}_{cm}$

  $\frac{d\vec{P}}{dt} = M\vec{a}_{cm} = \Sigma\vec{F}_{\text{external forces}}$

- Nice case for collisions is a short time interval. The external forces dont change $\vec{P}$ much, so $\vec{P}$ is approx same just before and after collision

- Elastic collisions: Total K of system is conserved.
- Completely inelastic collisions: The colliding objects stick together

More terms:

Δp = impulse = $F\Delta t$.

$\therefore F_{avg} = \frac{\Delta p}{\Delta t}$ acting on a particle

Centre of mass

- $\vec{r}_{cm} = \frac{\Sigma m_i \vec{r}_i}{\Sigma M}$ ← position of particle

$x_{cm} = \frac{\Sigma m_i x_i}{\Sigma m_i}$

Momentum (angular)

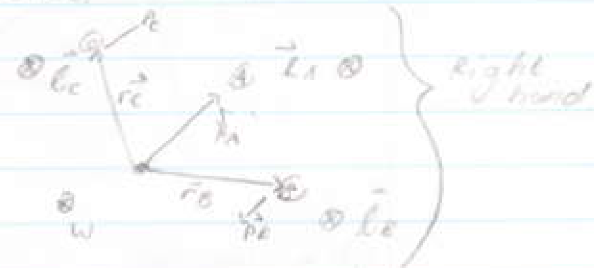
particle

$\vec{l} = \vec{r} \times \vec{p}$

System

$\vec{L} = \sum \vec{r}_i \times P_i$

Pick a point often CM or centre of some other rotate.



Nice case: Fixed axis of rotation = axis of symm

$\Rightarrow \vec{L} = I\vec{\omega}$ - angular velocity

I - moment of inertia

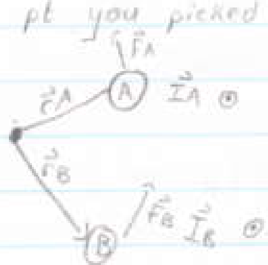
$\omega = \frac{V}{R}$

$I = \frac{2}{5} MR^2$

$\frac{d\vec{L}}{dt} = I \frac{d\vec{\omega}}{dt} = I\vec{\alpha}$

Torque: $\vec{\tau} = \vec{r} \times \vec{F}$

Using the same pt you picked to define $\vec{L}$



Total $\vec{\tau}$ on a system is $\sum \vec{r}_i \times \vec{F}_i$

$|\vec{A} \times \vec{B}| = AB\sin\theta$

$\vec{A} \cdot \vec{B} = AB\cos\theta$

$\vec{A} \times \vec{B}$ is $\perp$ to $\vec{A}$ and $\perp$ to $\vec{B}$ and follows right hand rule

Explicit Formula 11.2

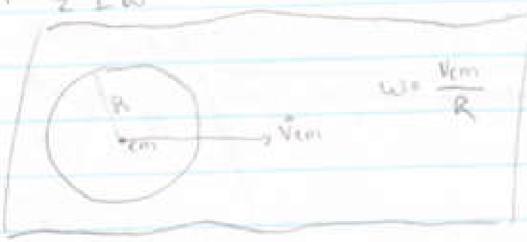
In collisions

$\vec{L}$ is conserved

just like $\vec{p}$ is conserved

Rotational $K = \frac{1}{2} M v^2 + \frac{1}{2} I \omega^2$

Rolling :

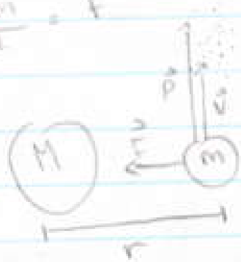


$\omega = \frac{v_{cm}}{R}$

Ch 6. Gravity

Circular orbits (always have uniform speed)

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



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

$\therefore \frac{GMm}{r^2} = m \cdot a = \frac{mv^2}{r}$

$\therefore \frac{GM}{r} = v^2$

Chp 5: $v = \frac{2\pi r}{T}$ $\underbrace{\omega = \frac{v}{r} \qquad L = rp = rmv}_{\text{Ch 10, 11}}$

Rocketry M not constant

$M \frac{d\vec{v}}{dt} = \Sigma \vec{F}_{ext} + \underbrace{\vec{u} \frac{dM}{dt}}_{\text{thrust}}$

$\vec{u}$ = velocity relative to M