Conservation of momentum

$\frac{dp}{dt} = F = 0$

Conservation of angular momentum

$\frac{dL}{dt} = \tau = 0$

τ Torque vector

$\tau = \frac{dL}{dt}$

$\tau = r \times F$

L angular momentum vector

$L = r \times p$

Position vector r

$L = r \times p$

$r = \frac{dv}{dt}$

$\tau = r \times F$

P momentum vector

$p = mv$

V velocity vector

$W = \int \vec{F} \cdot dr$

$F = dp/dt$

$v = \frac{da}{dt}$

scalar W work

F force vector

$F = ma$

a acceleration vector

$F = -\nabla V$

potential energy scalar V, U

scalar Kinetic energy K, T

$T = \frac{1}{2}mv^2$

$W = \Delta T$

Note: Total ensery $E = T + V$

Harmonic oscillator

$V = Kx^2/2$

Very common potential

Gravitational Force

$\vec{F} = -G \frac{Mm}{r^2} \hat{r}$

For any value X above $X_{tot} = \sum_{i=1}^{N} X_i$ ↳ value for a system

Internal forces

$F_{ij} = -F_{ji}$

Newton's 3rd Law

$\nabla = \frac{\partial}{\partial x} \hat{x} + \frac{\partial}{\partial y} \hat{y} + \frac{\partial}{\partial z} \hat{z}$

del

energy is conserved if the potential does not depend on time ⇒ if the force it generates is conservative

$\vec{a} \cdot \vec{b} = ab \cos\theta$

$\vec{a} \times \vec{b} = ab \sin\theta$

$\nabla \times \vec{a}$ = curl of $\vec{a}$

$\nabla \cdot \vec{a}$ = divergence of $\vec{a}$

$\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$

$\vec{a} \times \vec{b} = (a_y b_z - a_z b_y)\hat{x} + (a_z b_x - a_x b_z)\hat{y} + (a_x b_y - a_y b_x)\hat{z}$

Note: for vectors of length two only use last term

Conservative Force: depends only on spatial degrees of freedom $\rightarrow \nabla \times \vec{F} = 0$; only a change in position changes its value