Momentum

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

$[\vec{p}] = MLT^{-1}$

$\frac{d\vec{p}}{dt} = \sum \vec{F}$, $\quad \Delta\vec{p} = \int_{t_i}^{t_f} \sum \vec{F}\, dt = \vec{I}$ = impulse

this is an equation of conservation:

the impulse is the q. of momentum that traverses the borders of the system due to applied force.

Obviously if $\sum \vec{F} = 0 \rightarrow \Delta\vec{p} = 0$, p const.

Example:

The decay of a pion:

π^0 $u\bar{u}$ $d\bar{d}$ ← composition: quark and antiquark

$\pi^0 \longrightarrow \gamma\gamma$ (a pion trasforms itself into two photons)

So, if the π^0 is at rest, $\vec{p}_i = 0$

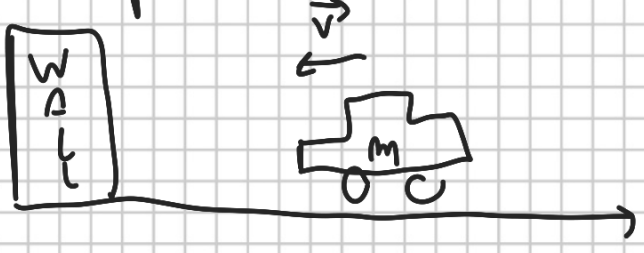
When it decays, the momentum of the two photons becomes:

$\vec{p}_F = \vec{p}_{\gamma 1} + \vec{p}_{\gamma 2}$

$\vec{p}_{\gamma 1} = -\vec{p}_{\gamma 2} = 0$

momentum conservation

Example:



$\vec{v}_i = -v_i$

$\vec{v}_f = v_f$

Δt → time collision

$\vec{I} = ?$ $\quad \vec{F} = ?$

$\sum \vec{F} = \frac{d\vec{p}}{dt} = m\frac{d\vec{v}}{dt} = m\vec{a}$

if $\sum \vec{F} = 0 \quad \vec{p} = \text{const.}$

$p_i = mv_i = -mv_i\,\hat{i}$

$p_f = mv_f = mv_f\,\hat{i}$

$\vec{I} = \Delta\vec{p} = m(v_f + v_i)\,\hat{i}$

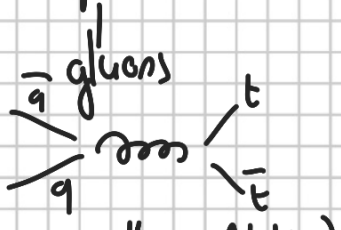
$\langle \sum \vec{F} \rangle = \frac{\vec{I}}{\Delta t} = \frac{m}{\Delta t}(v_f + v_i)$ ← Newton

So, what are the forces?

- Normal
- Friction
- Gravity
- Reaction to collision

Types of collision

Also called scattering: event during which 2 particles interact.
They do not need to touch (think about particles).



(quark annihilation)

There are 2 type of it:

Elastic → it is an approx. in the real world

Inelastic

Init: ① $\vec{v}_1$ ② $\vec{v}_2$

Fin: ① ②

$\vec{v}_1 = \vec{v}_2 = \vec{v}_f$

After the collision, they move together with common velocity.

In an isolated system,

$$m_1\vec{v}_1 + m_2\vec{v}_2 = (m_1 + m_2)\vec{v}_f$$

$$v_f = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}$$

Example:

- $v_0 = 0$
- inelastic
- $x = ?$