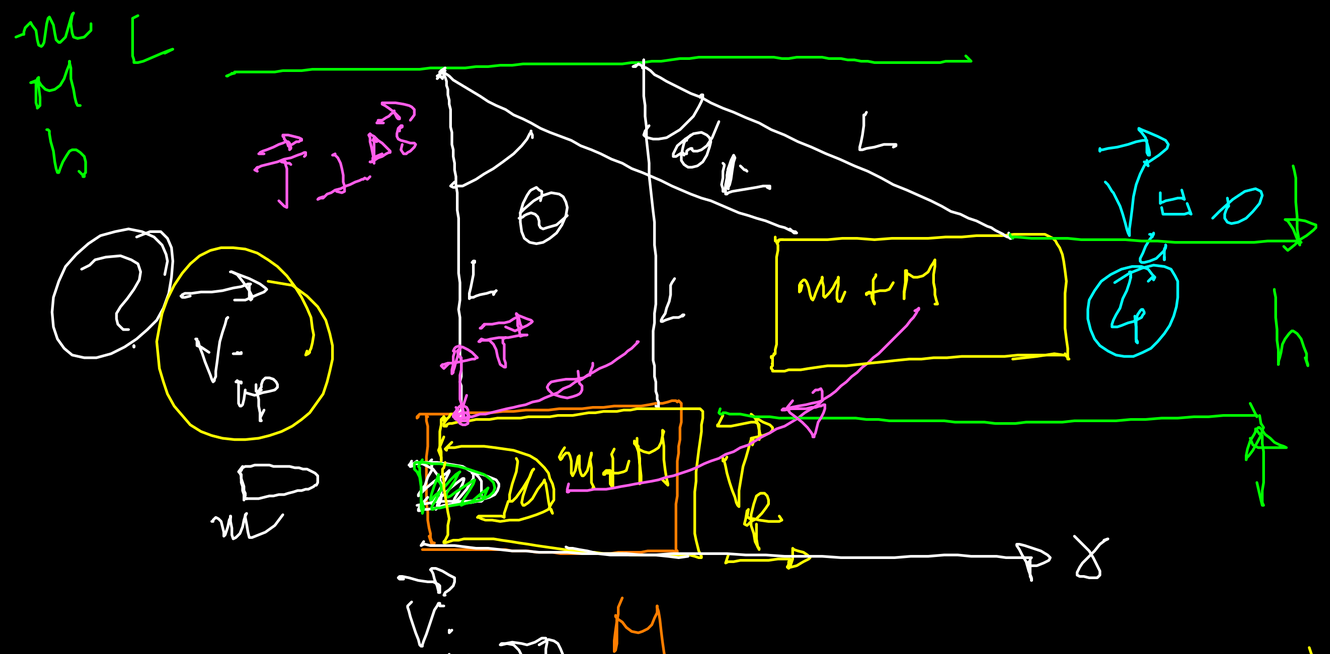
PENDOLO BALISTICO



① Prima dell'urto

② Urto anelastico

③ Dopo l'urto

④ Max altezza

$V_{ip} = 0$

③ → ④ CONS. E_M

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

$$\frac{1}{2}V_f^2 = gh$$

$$V_{ip} = \sqrt{2gh\left(\frac{m+M}{m}\right)^2}$$

CONS. DELLA Q.d.M.

$$\textcircled{2}\quad P_2 = m\,V_{ip} = P_3 = (m+M)V_f \Rightarrow V_f = \frac{m}{m+M}V_{ip}$$

$E_M \neq$ costante

$\Sigma F_{est,x} =$ costante $\Rightarrow P_x =$ costante

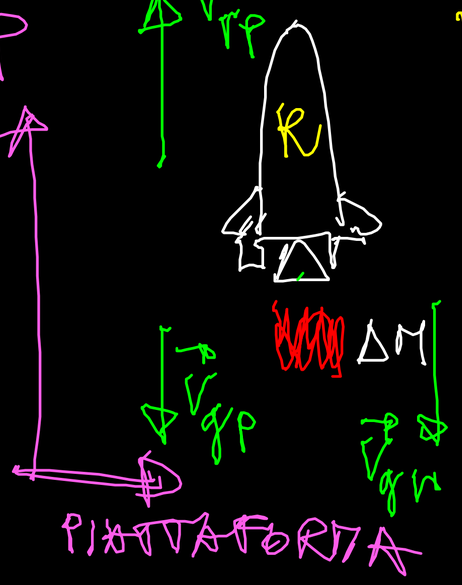
MOTO DEL RAZZO

$$\sum \vec{F}_{est} = \frac{d\vec{p}}{dt} \qquad \left(\neq m\vec{a}_{cm}\right)$$

$\vec{V}_{rp}$

m = massa istantanea del razzo

$m = m(t)$



ΔM GAS DI SCARICO

IN Δt vengono emessi ΔM di gas

$$\vec{V}_{gp} = \vec{V}_{gr} + \vec{V}_{rp}$$

$$\vec{P}_i = m\vec{V}_{rp}$$

$$\vec{P}_f = (m-\Delta M)(\vec{V}_{rp}+\Delta\vec{V}_{rp}) + \Delta M\,\vec{V}_{gp}$$

$$\vec{P}_f = (m-\Delta M)(\vec{V}_{rp}+\Delta\vec{V}_{rp}) + \Delta M\,(\vec{V}_{gr}+\vec{V}_{rp})$$

① t

② $t+\Delta t$

$$= m\vec{V}_{rp} + m\Delta\vec{V}_{rp} - \Delta M\vec{V}_{rp} - \Delta M\Delta\vec{V}_{rp} + \Delta M\vec{V}_{gr} + \Delta M\vec{V}_{rp}$$

$$\Delta t \begin{cases} \vec{p}_i = m\,\vec{V}_{rp} \\ \vec{p}_f = m\,\vec{V}_{rp} + (m-\Delta M)\Delta\vec{V}_{rp} + \Delta M\,\vec{V}_{gr} \end{cases}$$

$$\sum \vec{F}_{ext} \cong \frac{\Delta\vec{p}}{\Delta t} = \frac{\vec{p}_f - \vec{p}_i}{\Delta t} = \frac{(m-\Delta M)\Delta\vec{V}_{rp} + \Delta M\,\vec{V}_{gr}}{\Delta t}$$

$$\sum \vec{F}_{ext} = \lim_{\Delta t \to 0} \frac{\Delta\vec{p}}{\Delta t} = \lim_{\Delta t \to 0} \frac{m\Delta\vec{V}_{rp} + \Delta M\Delta\vec{V}_{rp} + \Delta M\,\vec{V}_{gr}}{\Delta t}$$

$\Delta t \to 0$ se $\Delta M \to 0$

Se $\Delta t \to 0$

$\frac{\Delta M}{\Delta t} \to \frac{dm}{dt}$

$\Delta\vec{V}_{rp} \to d\vec{V}_{rp}$

$$\boxed{\sum \vec{F}_{ext} = m\frac{d\vec{V}_{rp}}{dt} + \frac{dm}{dt}\vec{V}_{gr}}$$