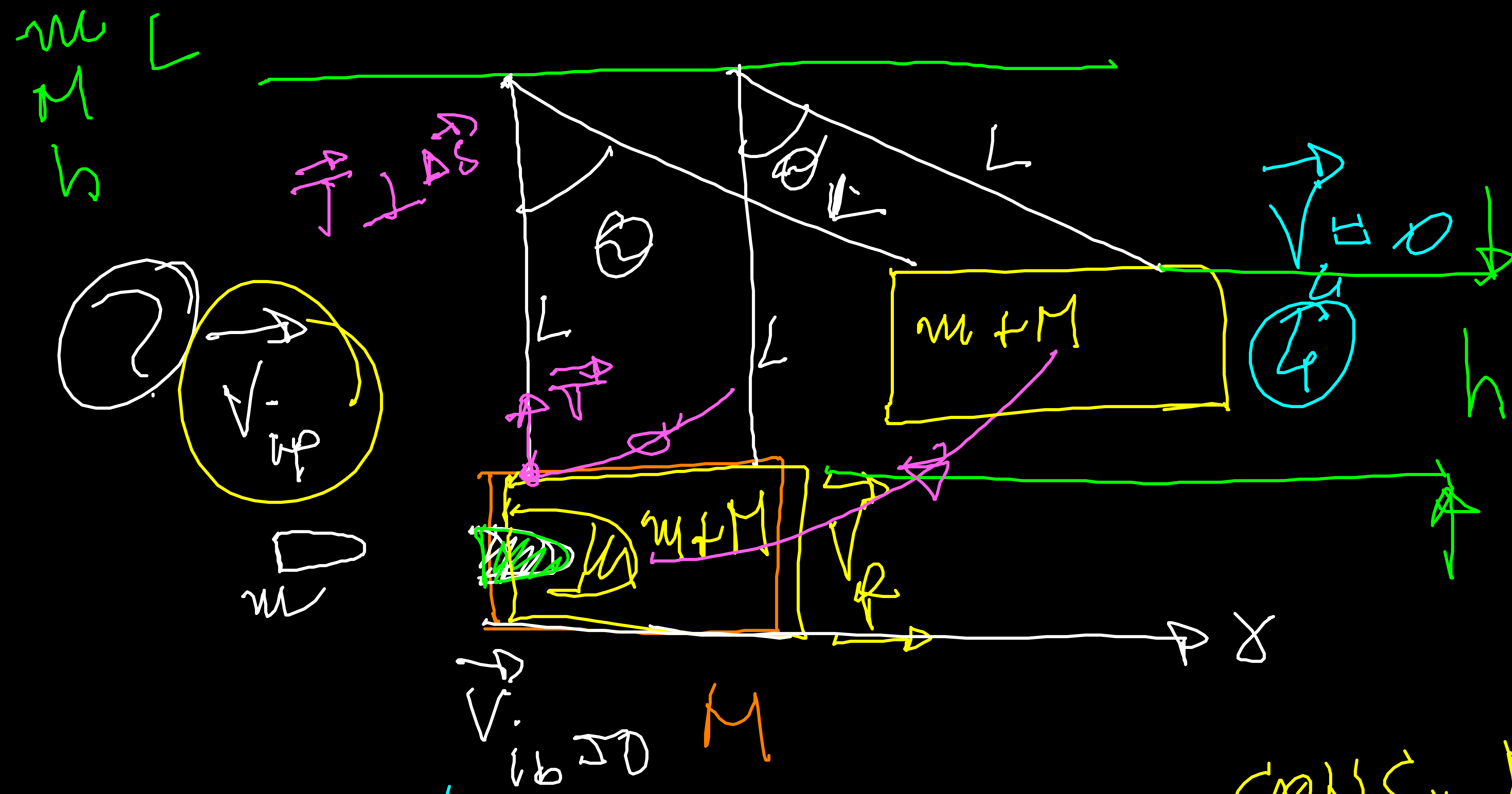
PENDOLO BALISTICO



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.

① Prima dell'urto

② urto anelastico

③ Dopo l'urto

④ Max altezza

$$P_1 = mV_{ip} = P_3 = (m+M)V_f \Rightarrow V_f = \frac{m}{m+M}V_{ip}$$

$E_M \neq$ costante

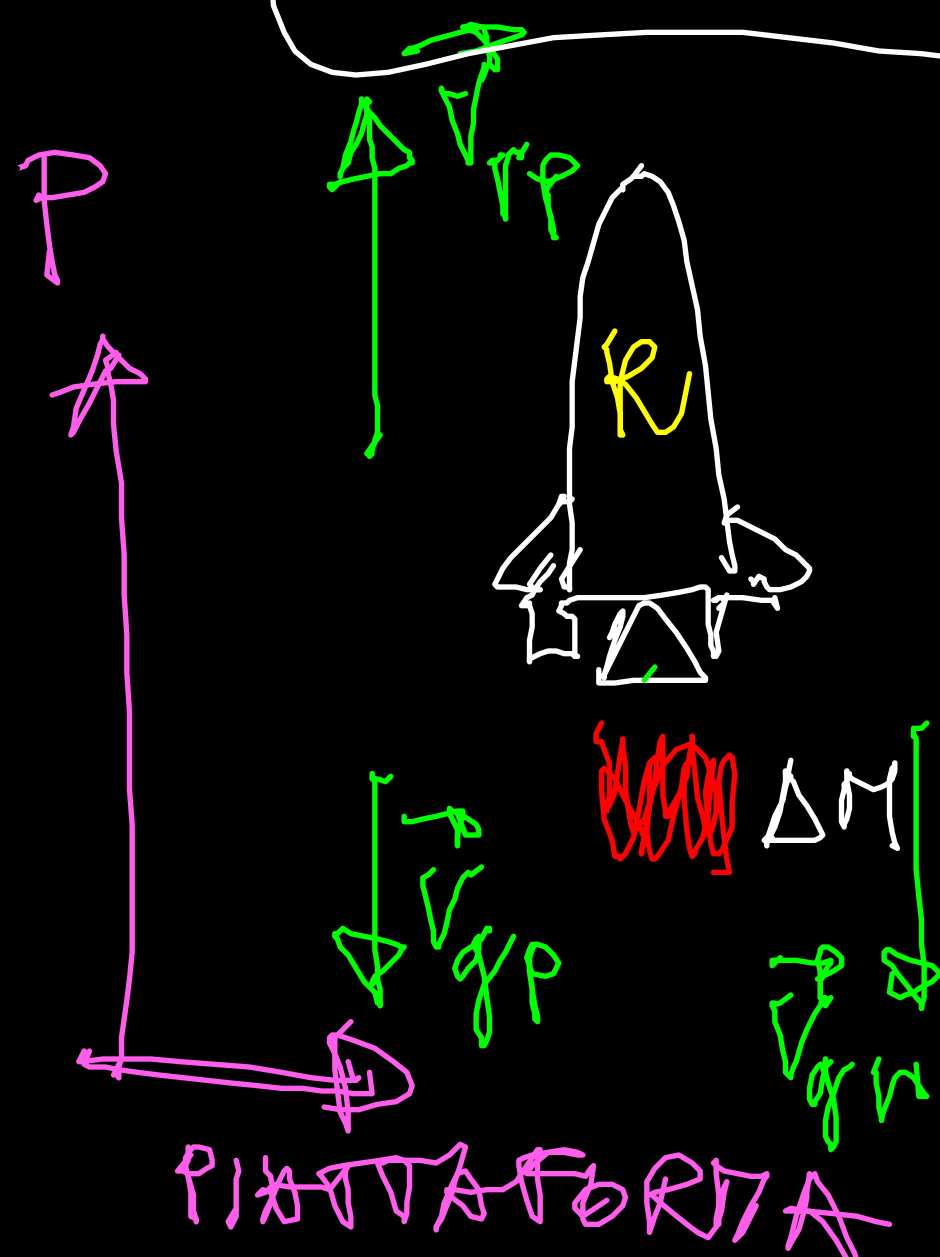
$\sum F_{ext,x} =$ costante $\Rightarrow P_x =$ costante

MOTO DEL RAZZO

$$\boxed{\sum \vec{F}_{ext} = \frac{d\vec{P}}{dt}} \qquad \left(\neq m\,\vec{a}_{cm}\right)$$

m = massa variabile del razzo

$m = m(t)$



ΔM GAS DI SCARICO

IN Δt vengono emessi ΔM di gas

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

(i) t

(f) $t+\Delta t$

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

Δt

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

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

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

$$\Delta t \left(\begin{aligned} \vec{P}_i &= m\,\vec{V}_{rp} \\ \vec{P}_f &= m\,\vec{V}_{rp} + (m-\Delta M)\Delta\vec{V}_{rp} + \Delta M\,\vec{V}_{gr} \end{aligned} \right.$$

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

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

$\to 0$, her $\Delta t \to 0$

Se $\Delta t \to 0$

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

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

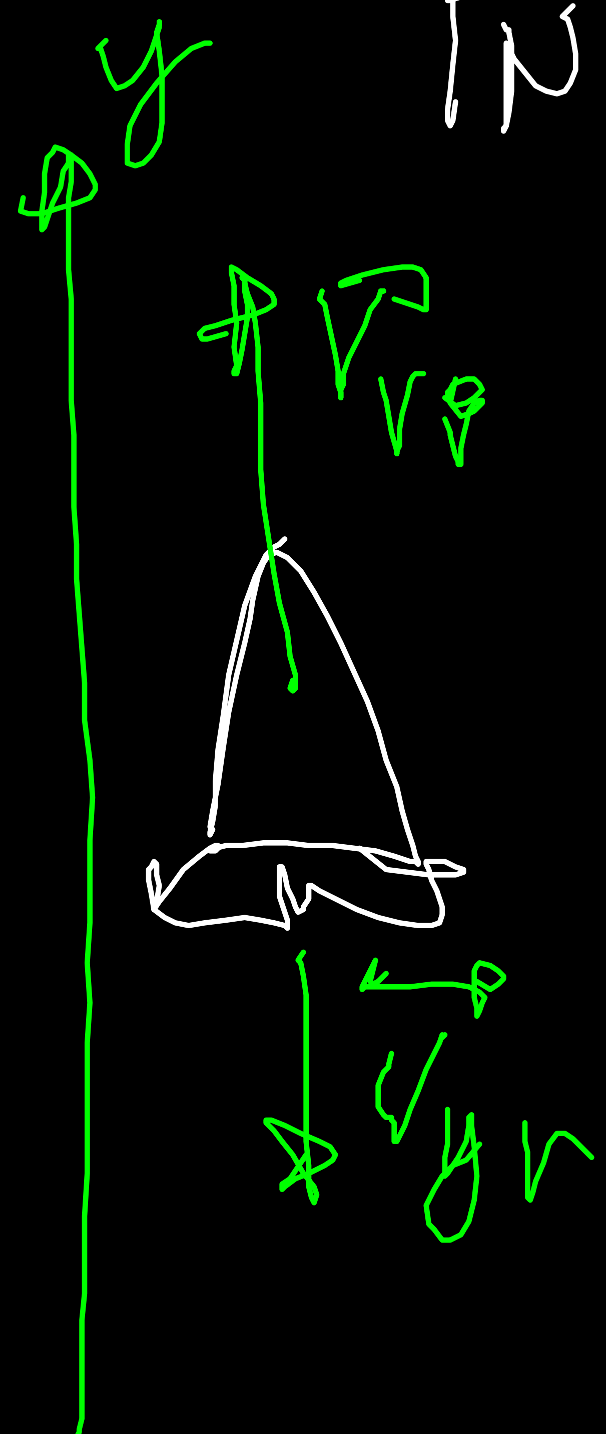
$$\sum F_{ext} = m\frac{d\vec{V}_{rp}}{dt} - \frac{dm}{dt}\vec{V}_{gr}$$

$$m\frac{d\vec{V}_{rp}}{dt} + \cancel{\frac{dm}{dt}\,d\vec{V}_{rp}} + \frac{dm}{dt}\vec{V}_{gr}$$

$\Delta t \to 0$

$$\sum \vec{F}_{est} = m\frac{d\vec{V}_{rp}}{dt} - \frac{dm}{dt}\vec{V}_{gr}$$

IN VOLO $\sum \vec{F}_{est} \simeq 0$



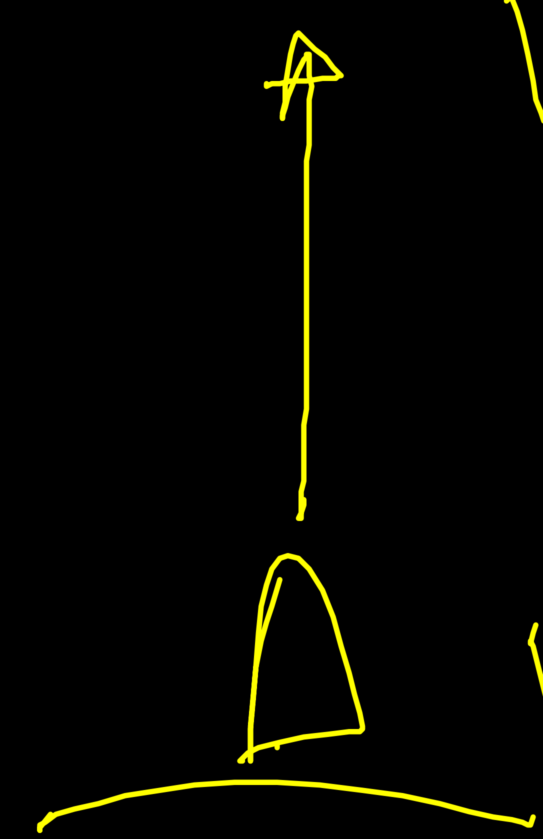
$$m\frac{d\vec{V}_{rp}}{dt} = \frac{dm}{dt}\vec{V}_{gr} \Rightarrow \text{lungo } y \quad m\frac{dV_{rp}}{dt} = -V_{gr}\frac{dm}{dt}$$

$$m\,dV_{rp} = -dm\,V_{gr}$$

constante

$$\Rightarrow \int_{V_{rpi}}^{V_{rpf}} \frac{dV_{rp}}{V_{gr}} = -\int_{m_i}^{m_f}\frac{dm}{m} \Rightarrow \frac{(V_{rpf}-V_{rpi})}{V_{gr}} = \ln\left(\frac{m_i}{m_f}\right)$$

$$V_{f_r} - V_{i_r} = V_{gr} \ln\left(\frac{m_i}{m_f}\right)$$



$V_f = 10 V_{gr}$, m_f

$V_i = 0$, m_i

$$V_f = 10 V_{gr}$$

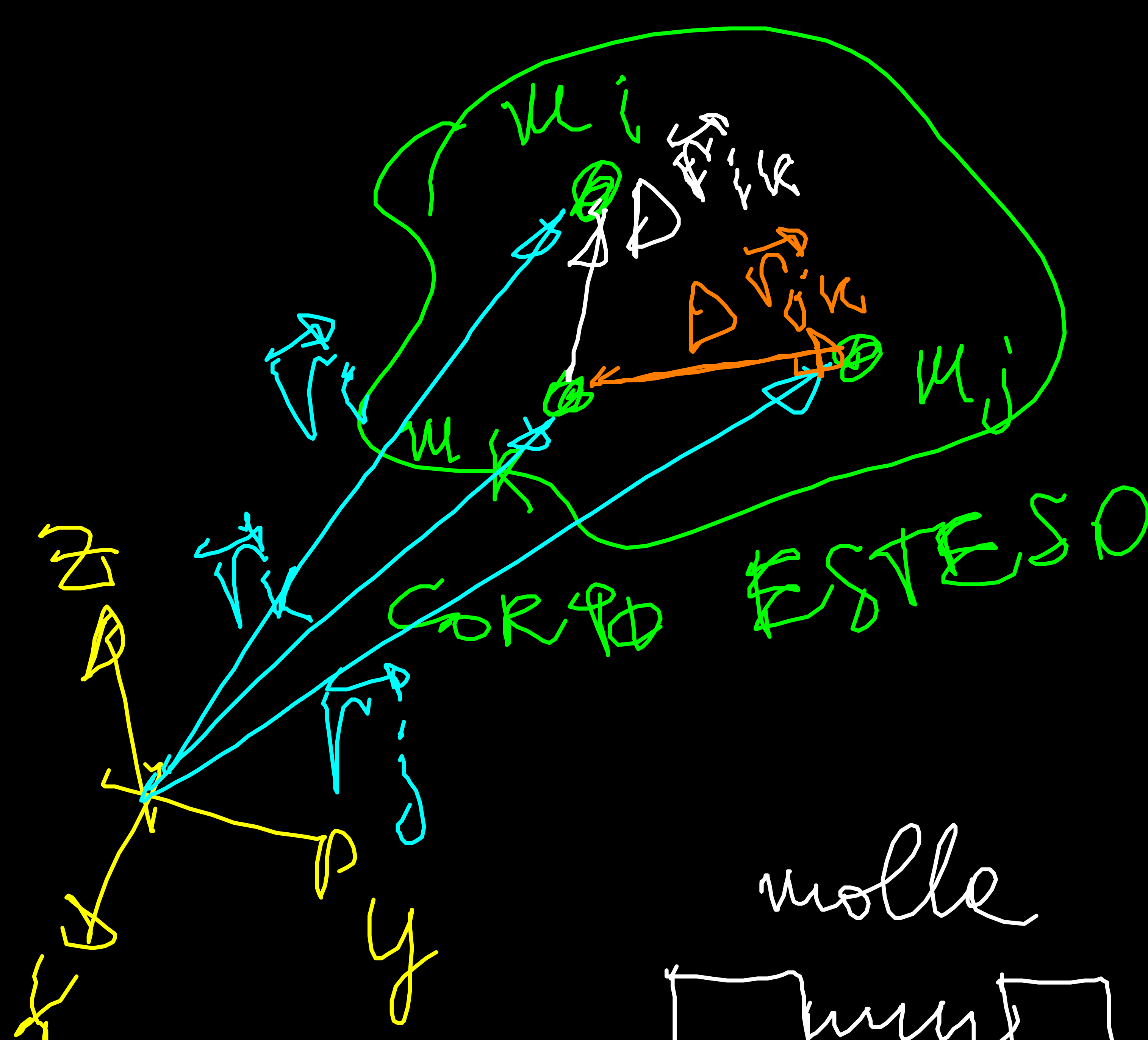
$$10 \cancel{V_{gr}} = \cancel{V_{gr}} \ln \frac{m_i}{m_f}$$

$$\frac{m_i}{m_f} = e^{10}$$

$$m_i = e^{10} m_f$$

$e^{10} \to 2{,}2 \times 10^4$

EQUILIBRIO STATICO DEL CORPO RIGIDO



$$\vec r_j - \vec r_k = \Delta \vec r_{jk}$$

$|\Delta \vec r_{jk}| \equiv$ "DISTANZA" TRA j E K

SE $|\Delta \vec r_{jk}|$ è costante $\forall$ coppia (j,k)

$\Rightarrow$ il CORPO È <u>RIGIDO</u>

EQ. STATICO

$\vec{r}_i(t)$ è costante $\forall i$ in un dato S.d.R. inerziale

$\left(e \ \frac{d\vec{r}_i}{dt} = 0 \quad \forall i \right) \Rightarrow$ QUIETE

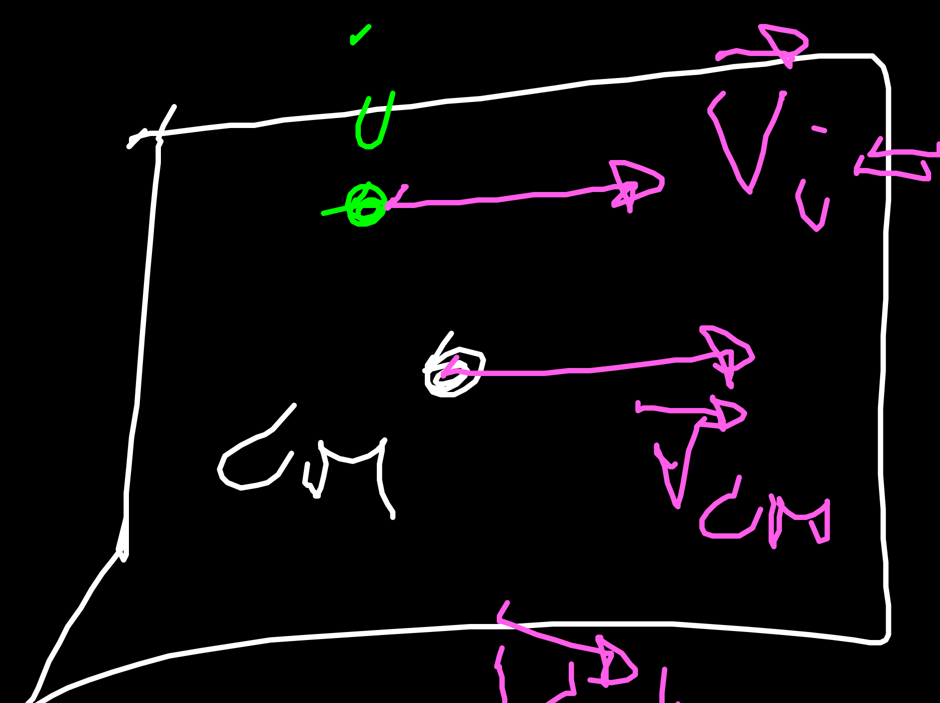
$\vec{V}_{cm} = 0 \qquad \vec{a}_{cm} = 0$

$$\boxed{\sum \vec{F}_{ext} = 0}$$

PRIMA CONDIZIONE DI EQ. STATICO

$$\boxed{\sum \vec F_{ext} = 0} \Rightarrow \vec a_{CM} = 0 \Rightarrow \vec V_{CM} = \text{costante}$$

COND. DI EQ. TRASLATORIO



TRASLAZIONE $\Rightarrow$ Soddisfa $\sum \vec F_{e} = 0$

$\vec V_i = \vec V_{CM}\ \forall i$ — Se $\vec V_{cm}$ è costante

$\vec V_i \neq \vec V_{CM} \Rightarrow$ ROTAZIONE

$\vec V_{CM} = 0 \quad \vec a_{CM} = 0 \Rightarrow \sum \vec F_{ext} = 0 = \vec P + \vec N$

Soddisfatta

NON È IN EQ. STATICO