COLLISIONS

ET LA CONSERVATION DE LA QUANTITÉ DE MOUVEMENT

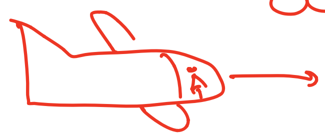
PGC-12

LA QUANTITÉ DE MOUVEMENT

$$\vec{F}_m = \frac{\Delta \vec{p}}{\Delta t}$$

$$\vec{F} = \frac{d\vec{p}}{dt}$$

800 m/s

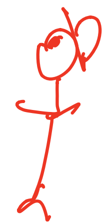


$\Delta \vec{p}$

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

Si $\vec{F}_m = 0 \Rightarrow \Delta \vec{p} = 0$

$\vec{p}_i = \vec{p}_f$



CONVERVATION DE LA QUANTITÉ DE MOUVEMENT

$F_{m\to M}$ $\quad M \quad m \quad$ $F_{M\to m}$

$$\vec F_{m\to M} = -\vec F_{M\to m}$$

$$\vec F_{m\to M} = -\vec F_{M\to m} \Rightarrow \frac{d\bar P_M}{dt} = -\frac{d\bar P_m}{dt} \Rightarrow$$

$$M\frac{d\bar v_M}{dt} = -m\frac{d\bar V_m}{dt} \Rightarrow \frac{d\,M\bar V_M}{dt} = -\frac{d\,m\bar V_m}{dt} \Rightarrow$$

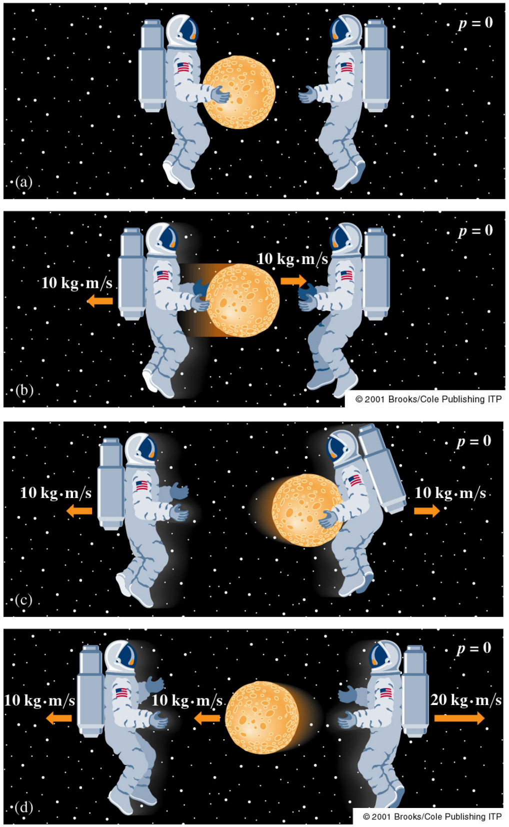
$$\frac{d}{dt}\left(M\bar V_M + m\bar V_m\right) = 0 \Rightarrow M\bar V_M + m\bar V_m = const$$

$$P_f = const = P_i$$

$$\vec P_i = \vec P_F$$

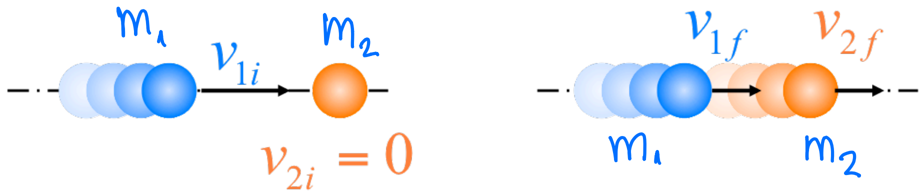
$$m_1V_{1i} + m_2V_{2i} = m_1V_{1f} + m_2V_{2f}$$

m_1 , m_2 constante



COLLISIONS ÉLASTIQUES EN 1-D

$$\text{Conservation} \begin{cases} \vec{P} \\ E_{cinetique} \end{cases}$$



$$P_i = m_1 \cdot V_{1i} + \cancel{m_2 \cdot V_{2i}}^{\,0} = P_f = m_1 V_{1f} + m_2 V_{2f} \quad (*)$$

$$E_{CIN\,i} = \frac{1}{2} m_1 V_{1i}^2 + \cancel{\frac{1}{2} m_2 V_{2i}}^{\,0} = E_{CIN\,F} = \frac{1}{2} m_1 V_{1f}^2 + \frac{1}{2} m_2 V_{2f}^2 \quad (*)$$

$$\left.\begin{aligned} m_1 V_{1i} &= m_1 V_{1f} + m_2 V_{2f} && (1) \\ \frac{1}{2} m_1 V_{1i}^2 &= \frac{1}{2} m_1 V_{1F}^2 + \frac{1}{2} m_2 V_{2f}^2 && (2) \end{aligned}\right\} \text{calcul!}$$

$$1 \Rightarrow \quad m_1 (V_{1i} - V_{1f}) = m_2 V_{2f}$$

$$2 \Rightarrow \quad \frac{1}{2} m_1 (V_{1i}^2 - V_{1f}^2) = \frac{1}{2} m_2 V_{2f}^2$$

$$\Rightarrow$$

$$\cancel{m_1 (V_{1i} - V_{1f})} = \cancel{m_2} \cancel{V_{2f}} \quad 1$$

$$\cancel{\frac{1}{2} m_1 (V_{1i} - V_{1f})} (V_{1i} + V_{1f}) = \frac{1}{2} \cancel{m_2} V_{2f}^{\cancel{2}}$$

$$\div \Rightarrow$$

$$V_{1i} + V_{1f} = V_{2F} \quad 2$$

$$1 \overset{2}{\Rightarrow} \quad m_1 (V_{1i} - V_{1f}) = m_2 (V_{1i} + V_{1f}) \Rightarrow$$

$$\Rightarrow m_1 V_{1i} - m_1 V_{1f} = m_2 V_{1i} + m_2 V_{1f} \Rightarrow$$

$$\Rightarrow \quad V_{1f} = \frac{m_1 - m_2}{m_1 + m_2} V_{1i} \quad 3$$

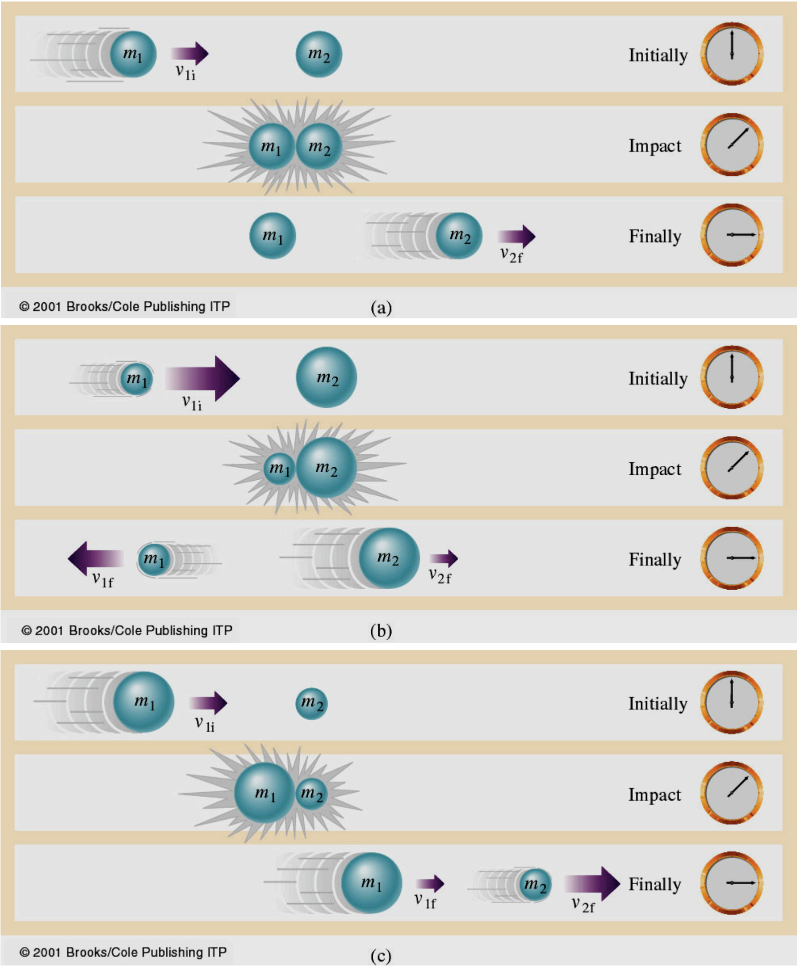
$$2 \overset{3}{\Rightarrow} \quad V_{2F} = \frac{2 m_1}{m_1 + m_2} V_{1i}$$

COLLISIONS ÉLASTIQUES EN 1-D

$$V_{1f} = \frac{m_1 - m_2}{m_1 + m_2} V_{1i}$$

$$V_{2f} = \frac{2m_1}{m_1 + m_2} V_{1i}$$

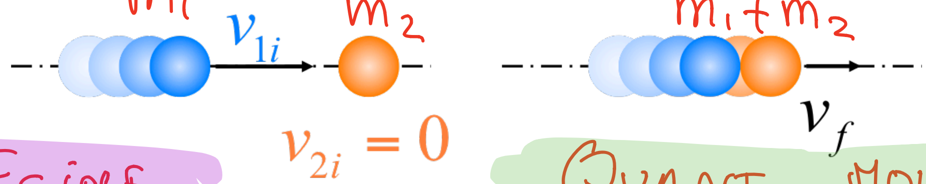
Demo



COLLISIONS INÉLASTIQUES EN 1-D

PERTE D'ÉNERGIE

E_{cin} ≠ conservée



$E_{cin\,i} \neq E_{cin\,f}$

$\vec{P}_i = \vec{P}_f$

QUANT MOUVEM. CONSERV

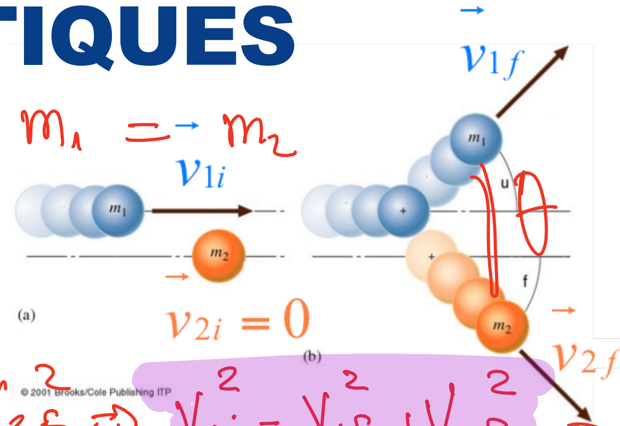
$$m_1 \cdot V_{1i} + \cancel{m_2 V_{2i}}^{\,0} = (m_1 + m_2) V_f \Rightarrow$$

$$V_f = \frac{m_1}{m_1 + m_2} V_{1i}$$

$m_1 = m_2$

$$V_f = \frac{1}{2} V_{1i}$$

COLLISIONS ÉLASTIQUES EN 2-D



$m_1 = m_2$

$E_{cin}^{i} = E_{cin}^{f}$ (1)

$\vec{P}_i = \vec{P}_f$ (2)

(1) $\Rightarrow \frac{1}{2}\cancel{m_1} v_{1i}^2 = \frac{1}{2}\cancel{m_1} v_{1f}^2 + \frac{1}{2}\cancel{m_2} v_{2f}^2 \Rightarrow v_{1i}^2 = v_{1f}^2 + v_{2f}^2$ (1)

(2) $\cancel{m_1}\vec{v}_{1i} = \cancel{m_1}\vec{v}_{1f} + \cancel{m_2}\vec{v}_{2f} \Rightarrow \vec{v}_{1i} = \vec{v}_{1f} + \vec{v}_{2f} \Rightarrow$

$|\vec{v}_{1i}|^2 = |\vec{v}_{1f}|^2 + |\vec{v}_{2f}|^2 + \underbrace{2|v_{1f}||v_{2f}|\cos\theta}_{0}$ (2)

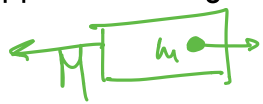
$\| \quad v_{1i}^2 = v_{1f}^2 + v_{2f}^2$

$|v_{1f}| \cdot |v_{2f}| \cdot \cos\theta = 0$

- $v_{1f} = 0$: collision frontale
- $v_{2f} = 0$
- $\cos\theta = 0 \Rightarrow \theta = 90°$

EXEMPLE

Une balle de masse m = 8.0 g est tirée horizontalement avec une vitesse v = 352.0 m/s avec un pistolet Luger de 0.90 kg au repos. Quelle est la vitesse de recul? Négligez l'effet de l'échappement des gaz.



$m = 8g = 0.008\ kg.$

$M = 0.9\ kg$

int $v_M = 0$

$v_m = 0$

fin $v_{mF} = ?$

$v_{mF} = 352.\ m/s$

$$P_i = P_F \Rightarrow 0 = m\vec{v}_{mF} + M\vec{v}_{MF}$$

$$\Rightarrow \vec{v}_{MF} = -\frac{m}{M}\vec{v}_{mF}$$

$$= -3\ m/s$$

sens opposé

FUSÉE

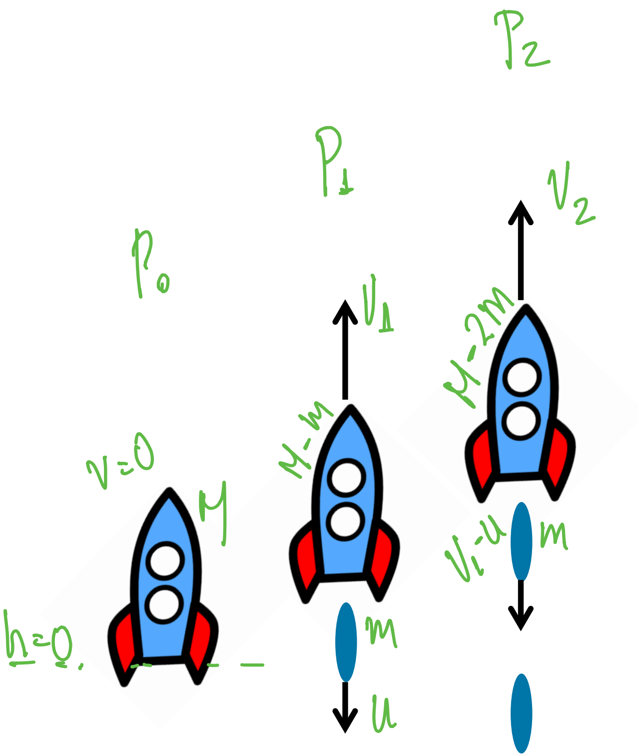
Conservation Quantité Mouvement

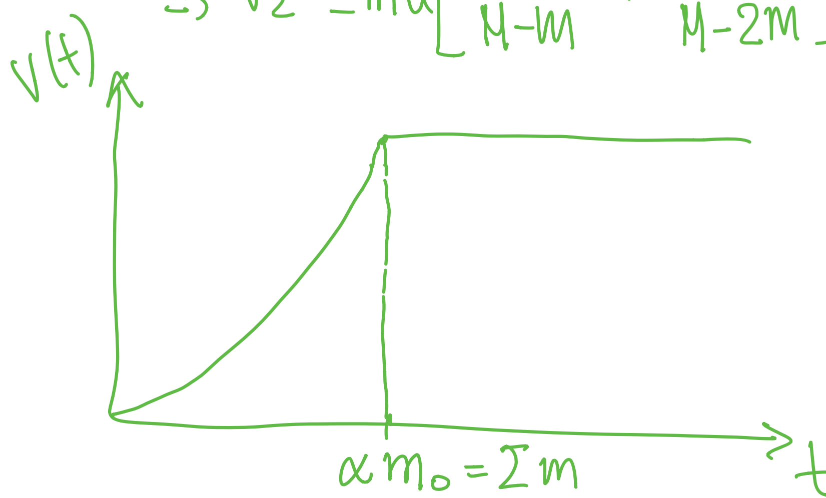
$P_1 \Rightarrow \quad 0 = (M-m)V_1 - m.u \Rightarrow$

$$\Rightarrow V_1 = \frac{mu}{M-m}$$

$P_2 \Rightarrow \quad (M-m)V_1 = (M-2m)V_2 - m(V_1-u)$

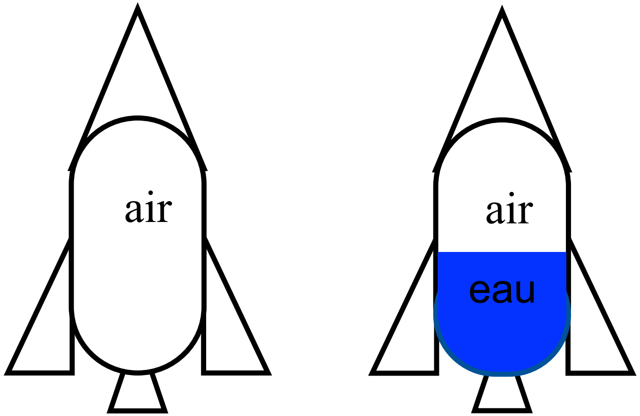
$$\Rightarrow V_2 = mu\left[\frac{1}{M-m} + \frac{1}{M-2m}\right]$$





FUSÉE SUR FIL

Une fusée peut être remplie d'air comprimé ou d'un mélange d'eau et d'air comprimé. Dans quel cas s'envole-t-elle le plus loin ?

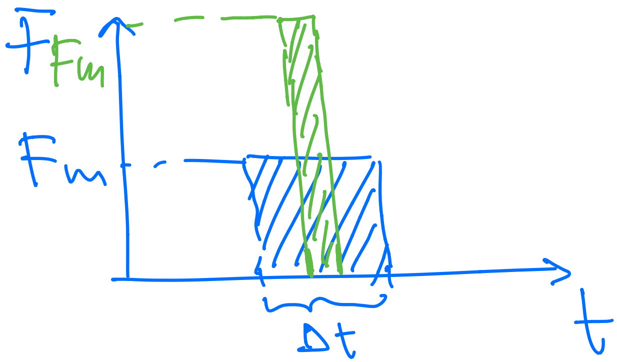


IMPACT DE FORCE

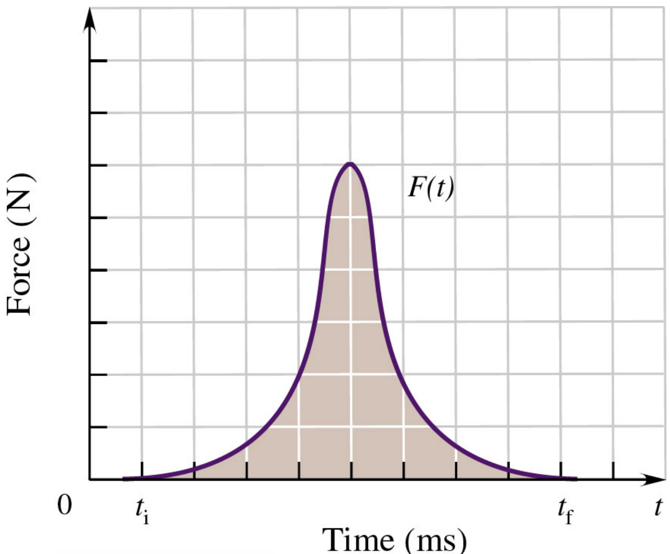
$$\vec{F}_m = \frac{\Delta \vec{P}}{\Delta t} \Rightarrow \Delta \vec{P} = \vec{F}_m \cdot \Delta t$$

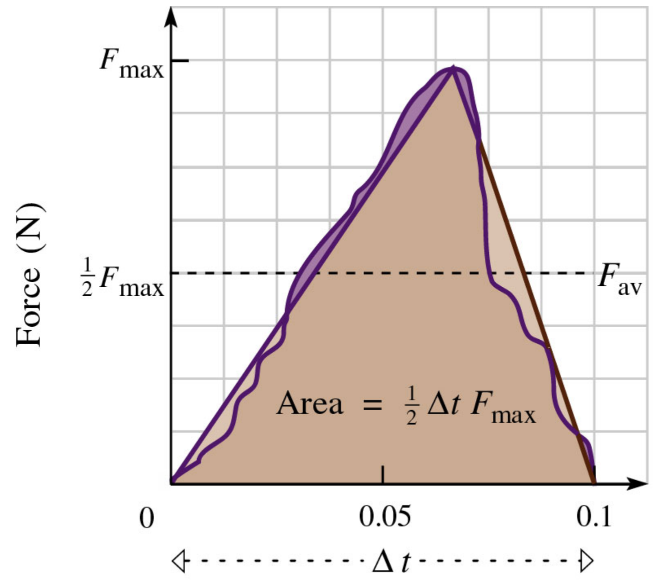
$$\Delta P = F_m \Delta t$$

$$\Delta P = a$$



IMPACT ET FORCE VARIABLE

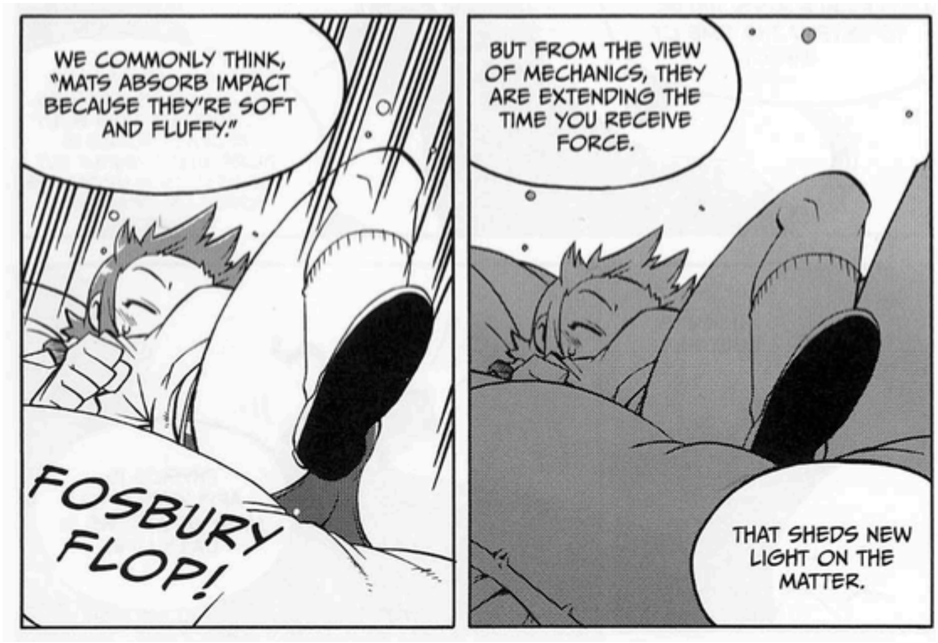




IMPACT ET FORCE VARIABLE

$p_i = mv$

$p_f = 0$



EXEMPLE – PENDULE BALLISTIQUE

$m_b = 1 kg$

Une balle de 10 g est tirée contre une pièce de bois suspendue d'un fil de longueur de 150 cm. La balle entre dans le bois et le bloque se lève à une position correspondante à une angle de 40º. Quelle était la vitesse initialle de la balle?

$m_B = 0.01 kg$

$d = 150 cm$

$\theta = 40°$

$V_1 = ?$