L'ÉNERGIE
TRAVAIL ET ÉNERGIE MÉCANIQUE

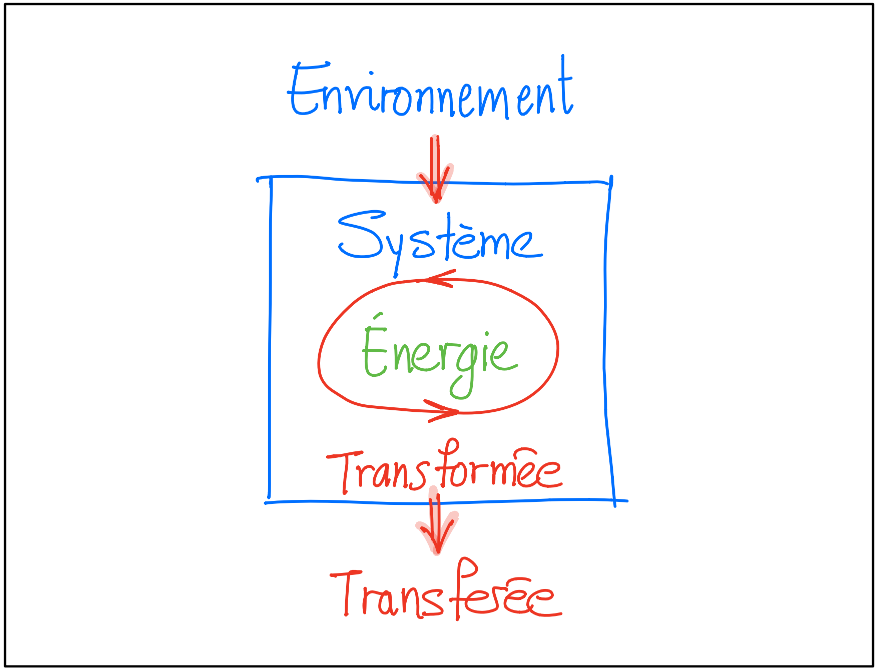
PGC-05



L'ÉNERGIE

Une mesure de l'état d'un système.

L'énergie peut être transferée entre un système et son environnement, ou transformée dans le système.



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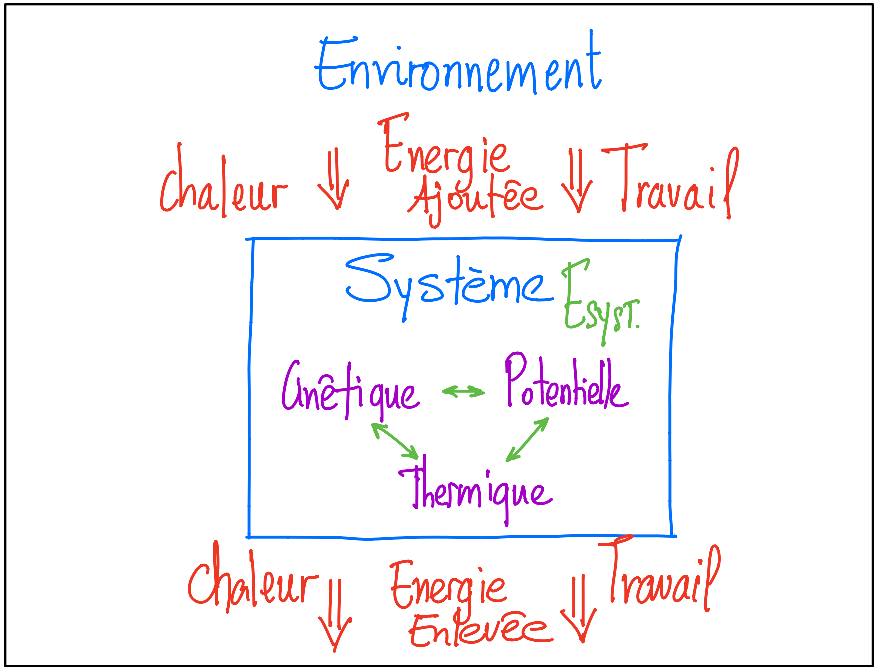
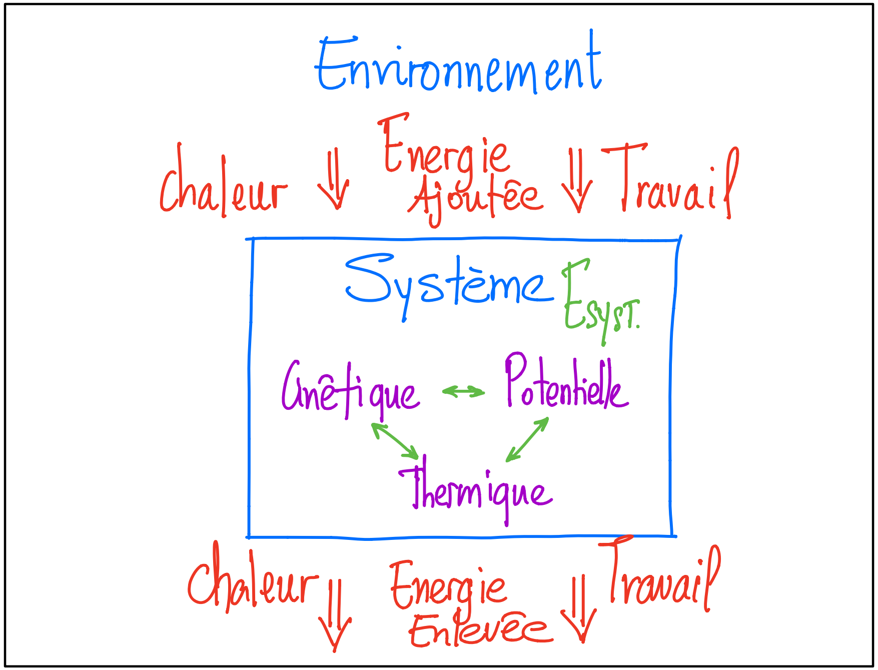


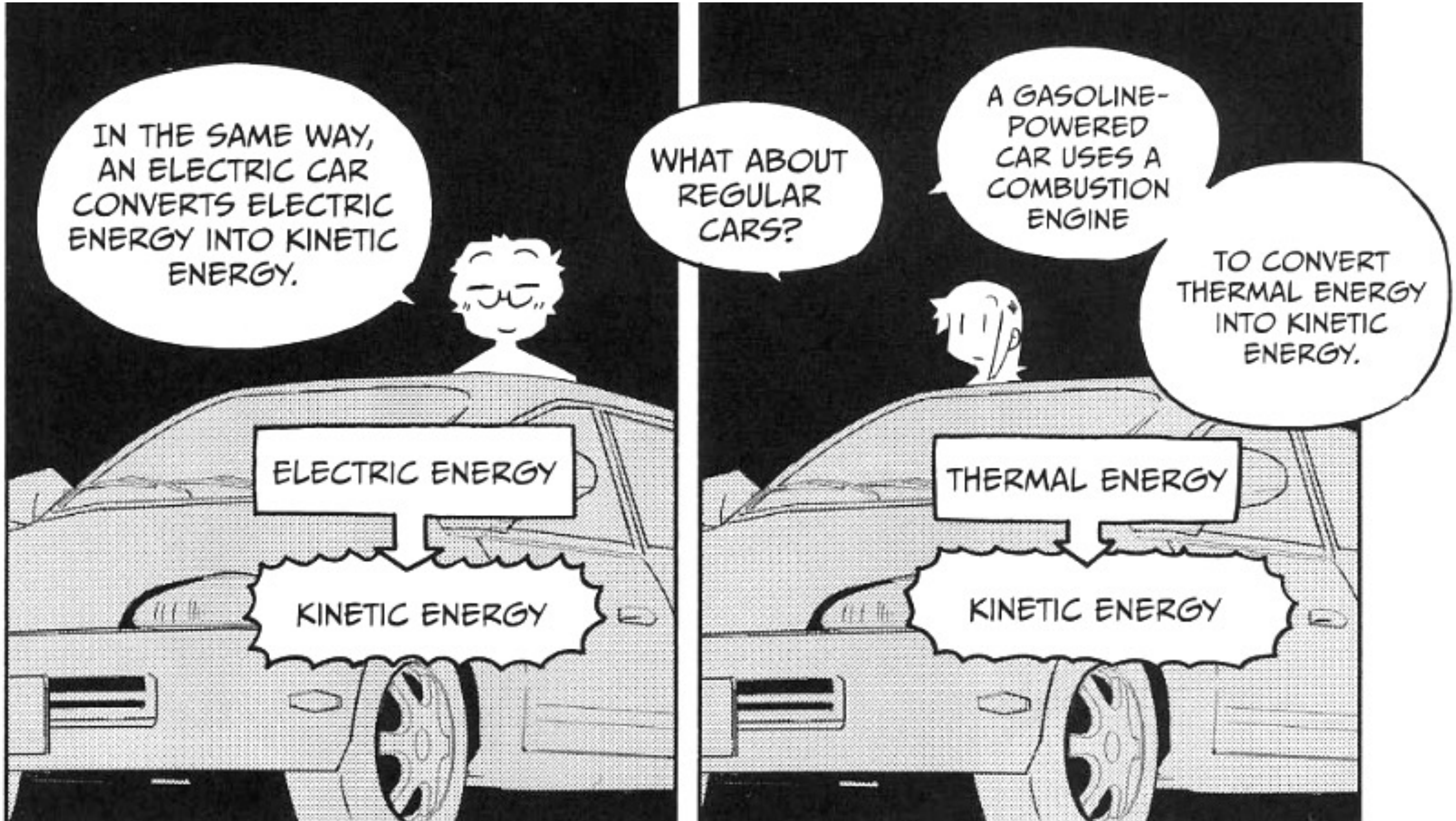
L'ÉNERGIE

L'énergie totale d'un système isolé est conservée!

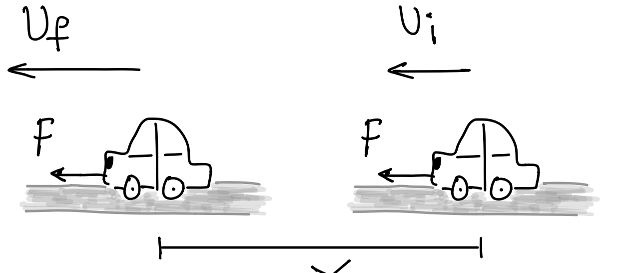
Elle peut être transférée par interaction d'un système à un autre.

Mais on ne peut ni créer de l'énergie, ni en détruire.




IN THE SAME WAY, AN ELECTRIC CAR CONVERTS ELECTRIC ENERGY INTO KINETIC ENERGY.
ELECTRIC ENERGY
KINETIC ENERGY
WHAT ABOUT REGULAR CARS?
A GASOLINE-POWERED CAR USES A COMBUSTION ENGINE
TO CONVERT THERMAL ENERGY INTO KINETIC ENERGY.
THERMAL ENERGY
KINETIC ENERGY

TRAVAIL



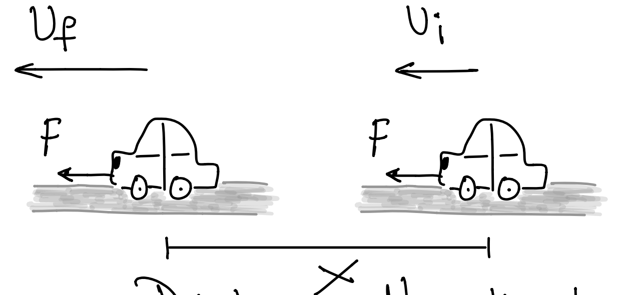
Distance d'application de la Force F

Le travail mesure le changement de l'énergie d'un système qui résulte de l'application d'une force qui agit sur un certain parcours.

$$W = F \cdot X$$

$$[W] = [F] \cdot [x] = N \cdot m = kg \cdot \frac{m^2}{s^2} = J$$

TRAVAIL



Distance d'application de la Force F

$$F = m \cdot a = m \frac{dv}{dt}$$

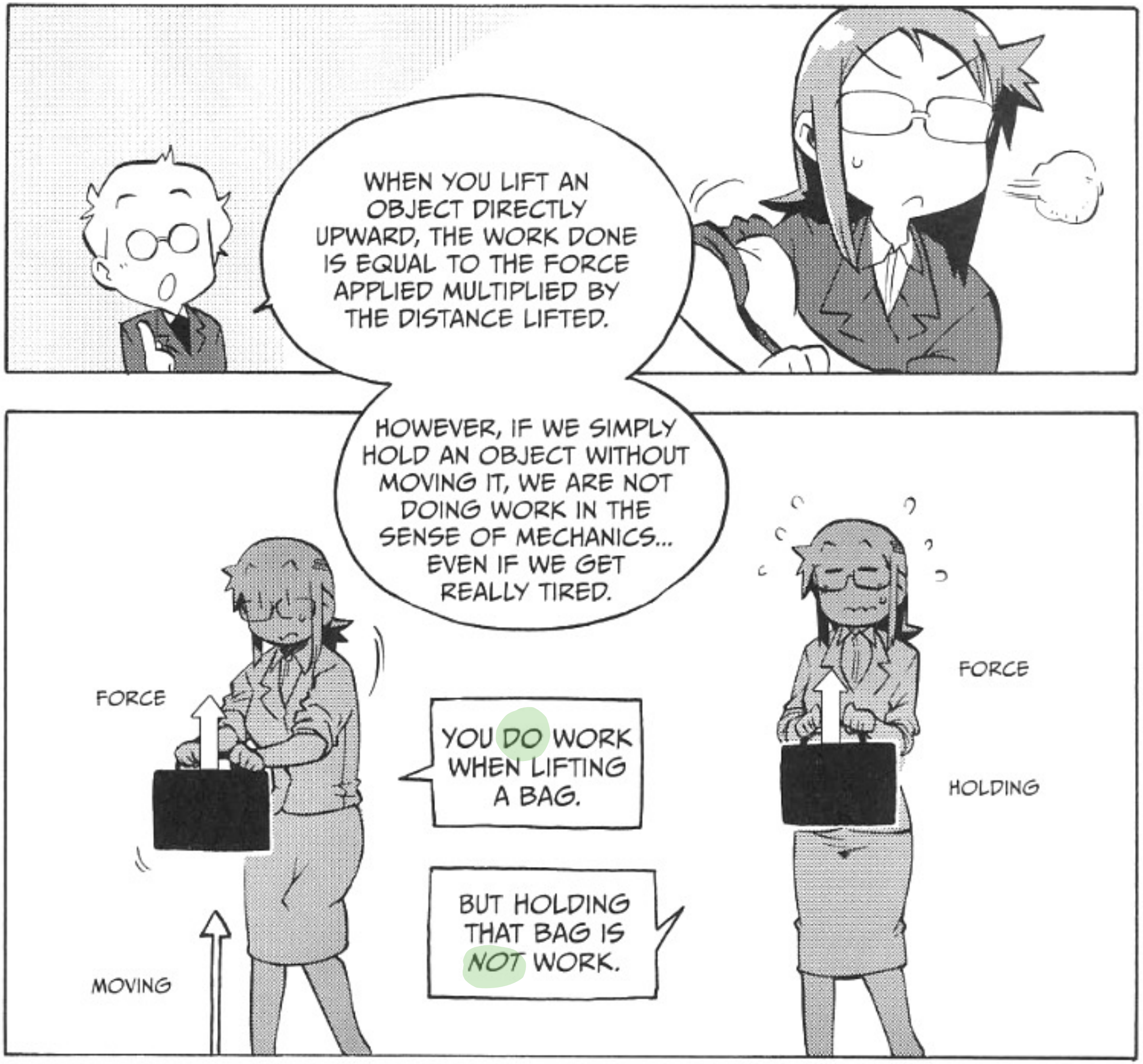
$$\frac{dv}{dt} = \frac{dv}{dx}\frac{dx}{dt} = v\frac{dv}{dx}$$

$$\Rightarrow F = mv\frac{dv}{dx} \Rightarrow$$

$$\Rightarrow \int_{x_i}^{x_f} F\,dx = \int_{v_i}^{v_f} mv\,dv \Rightarrow$$

$$\Rightarrow F(x_f - x_i) = \frac{1}{2}m(v_f^2 - v_i^2) \Rightarrow$$

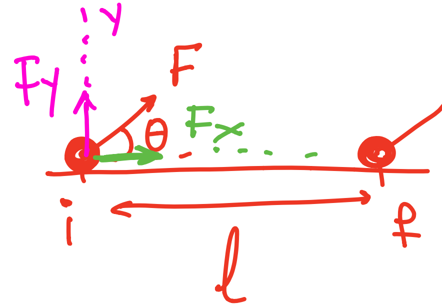
$$\Rightarrow F \cdot \Delta x = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \Rightarrow W = E_c^f - E_c^i$$


WHEN YOU LIFT AN OBJECT DIRECTLY UPWARD, THE WORK DONE IS EQUAL TO THE FORCE APPLIED MULTIPLIED BY THE DISTANCE LIFTED.
HOWEVER, IF WE SIMPLY HOLD AN OBJECT WITHOUT MOVING IT, WE ARE NOT DOING WORK IN THE SENSE OF MECHANICS... EVEN IF WE GET REALLY TIRED.
FORCE
MOVING
YOU DO WORK WHEN LIFTING A BAG.
BUT HOLDING THAT BAG IS *NOT* WORK.
FORCE
HOLDING

TRAVAIL – DÉFINITION GÉNÉRALE

$$W = \vec{F} \cdot \vec{l}$$

$$= F \cdot l \cdot \cos\theta$$



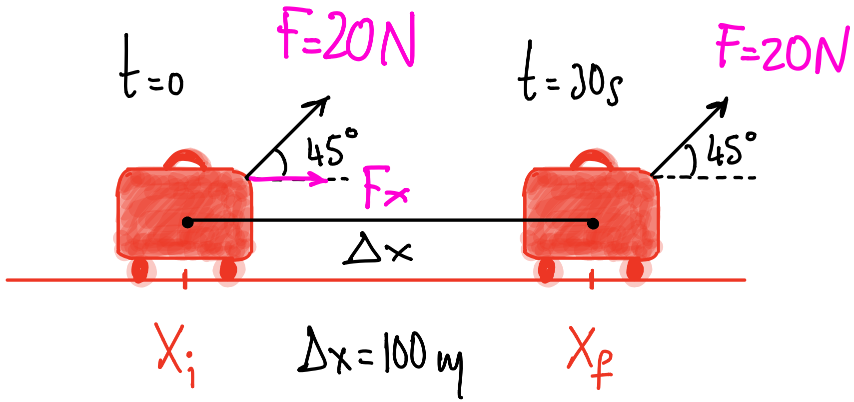
$$F_x = F\cos\theta$$

$$F_y = F\sin\theta$$

$$W_{F_x} = W = F\, l \cos\theta$$

$$W_{F_y} = 0$$

EXEMPLE



$$W = \vec{F} \cdot \vec{l} = F\, l \cos\theta$$

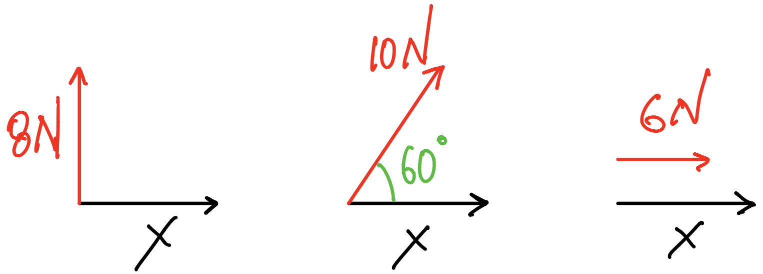
$$= 20\,\text{N} \cdot 100\,\text{m} \cdot \cos 45°$$

$$= 1400\,\text{J}$$

QUESTION

Quelle force fait le plus grand travail pour le même déplacement x?

$W = \vec{F} \cdot \vec{x} = F x \cos\theta$



(a) $W = 0$

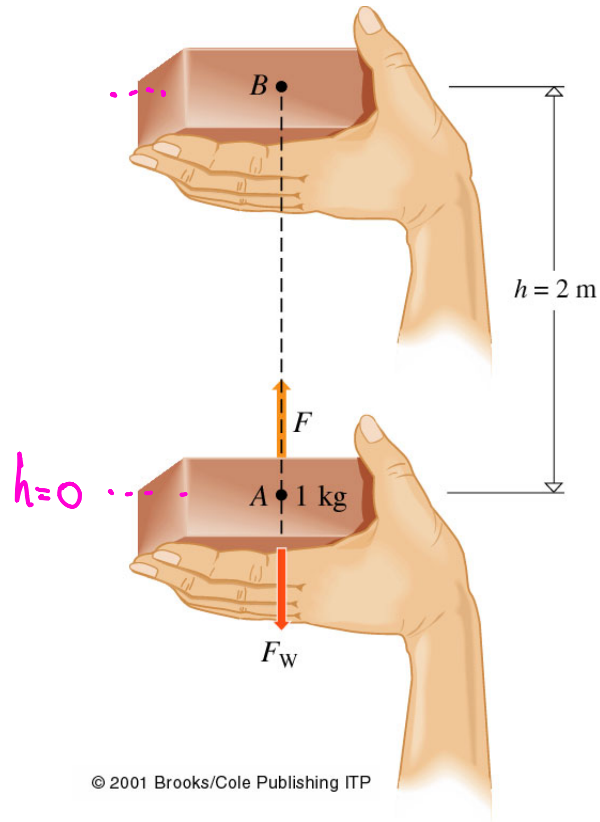
(b) $W = 10N \cdot \cos 60° \cdot x$

(c) $W = 6N \cdot x$

TRAVAIL CONTRE LA PESANTEUR

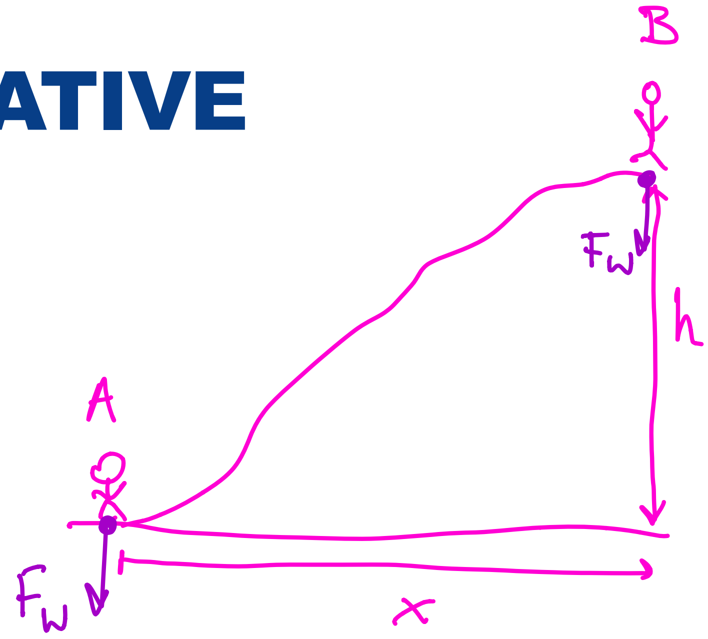
$$W = F \cdot h = F_W \cdot h = mgh$$

$$W_o = -W = -mgh$$



FORCE CONSERVATIVE

$W = -mgh$



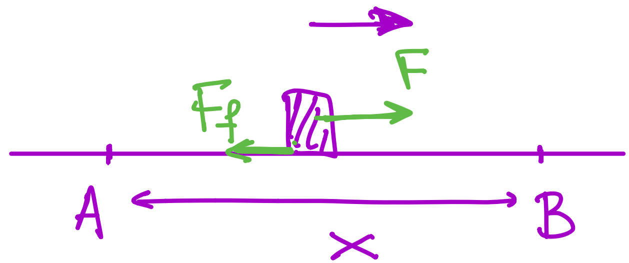
$A \to B: \quad W = -mgh$

$B \to A: \quad W = mgh$

$A \to B \to A: \quad W_{TOT} = 0$

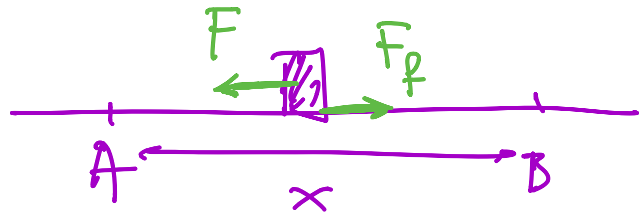
FORCE NON-CONSERVATIVE

$$W_{A \to B} = -F_f \cdot x$$



$$W_{B \to A} = -F_f \cdot x$$

$$W_{A \to B \to A} = -2F_f \cdot x$$

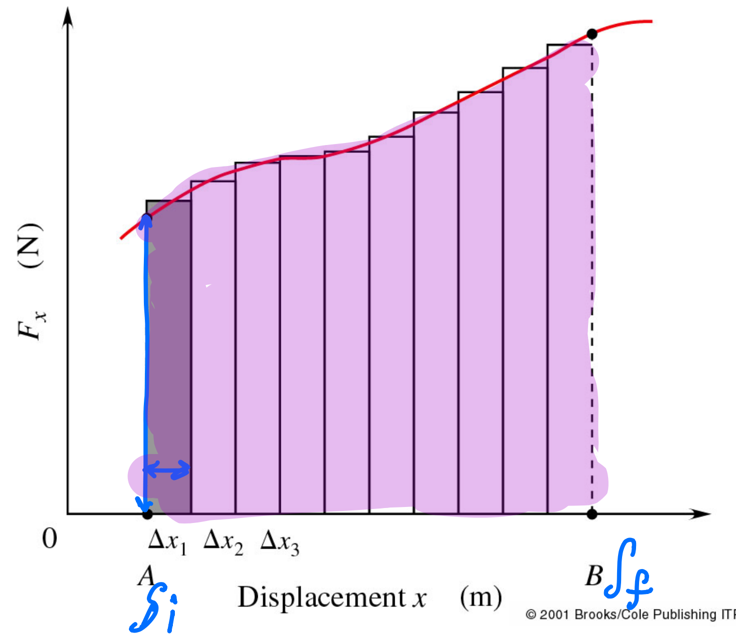


TRAVAIL D'UNE FORCE VARIABLE

$$W = \int_{s_i}^{s_f} \vec{F} \cdot d\vec{s}$$

$$\left(W = \vec{F} \cdot \vec{l} \right)$$

$$W = \sum_i W_i = \sum_i \vec{F}_i \, \Delta \vec{l}_i$$



TRAVAIL ET ÉNERGIE CINÉTIQUE

$$W = F\cdot x = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$\vee$$

$$f(m,v)$$

$$W = E_c^f - E_c^i$$

$$\boxed{W = \Delta E_c}$$

$$W = F\cdot x = ma\cdot x$$

MRVA (rappel)

$$v_f^2 - v_i^2 = 2ax$$

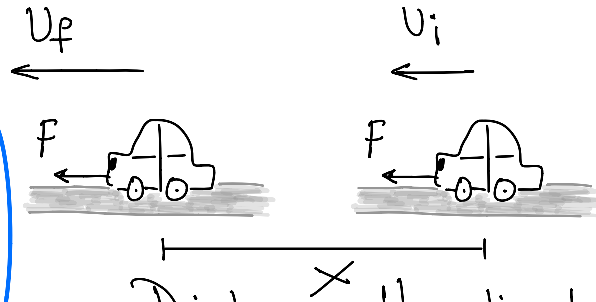
$$\vee$$

$$\left.\begin{array}{l} W = max \\ ax = \frac{1}{2}(v_f^2 - v_i^2) \end{array}\right\} \Rightarrow W = \frac{1}{2}m(v_f^2 - v_i^2) \Rightarrow$$

$$\Rightarrow W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$\Rightarrow \boxed{W = \Delta E_c}$$

Theorème Energie Cinétique



Distance d'application de la Force F

EXEMPLE

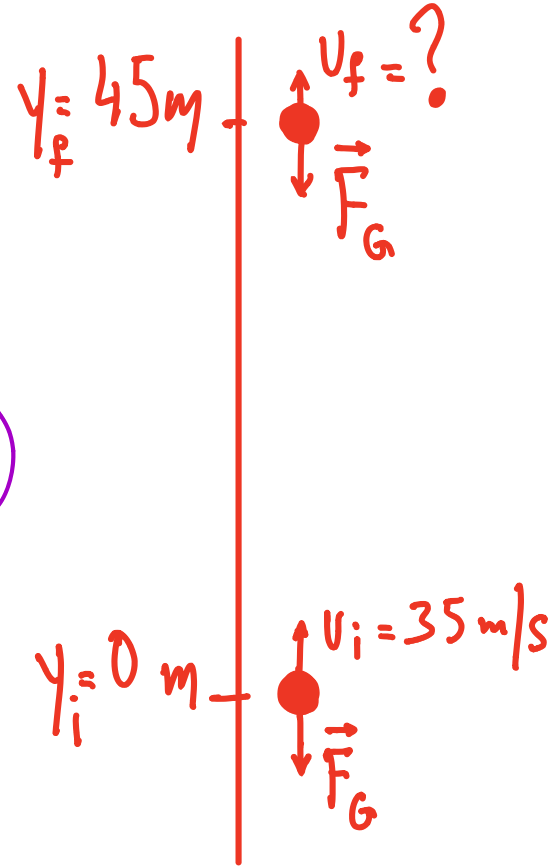
$$W = \Delta E_c \Rightarrow$$

$$F_y \cdot \Delta y = E_c^{\,f} - E_c^{\,i} \Rightarrow$$

$$-mgh = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 \Rightarrow$$

$$\frac{1}{2} \cancel{m} v_f^2 = \frac{1}{2} \cancel{m} v_i^2 - \cancel{m} g h \qquad (v_f < v_i)$$

$$\Rightarrow \boxed{v_f^2 = v_i^2 - 2gh} \Rightarrow \dots \Rightarrow v_f = 18\ \text{m/s}$$



EXEMPLE

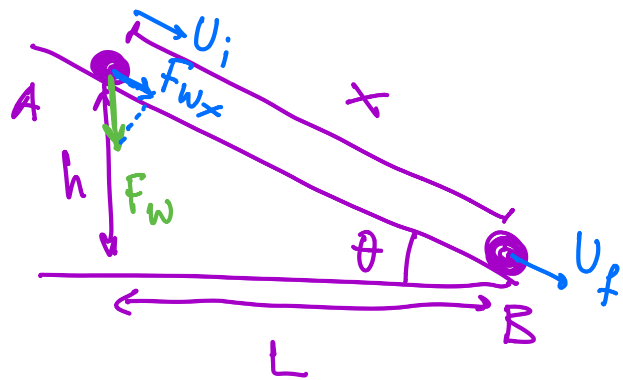
Un skieur de 70 kg glisse à 2 m/s quand il commence à descendre à une pente de 50 m de longueur et 10º. Quelle est la vitesse au bas de la pente?

$$W = \Delta E_c = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

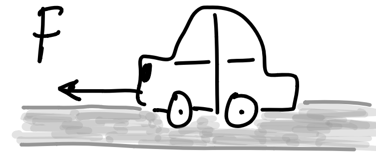
$$W = \vec{F} \cdot \vec{l}$$

$$= F_w \cdot h$$

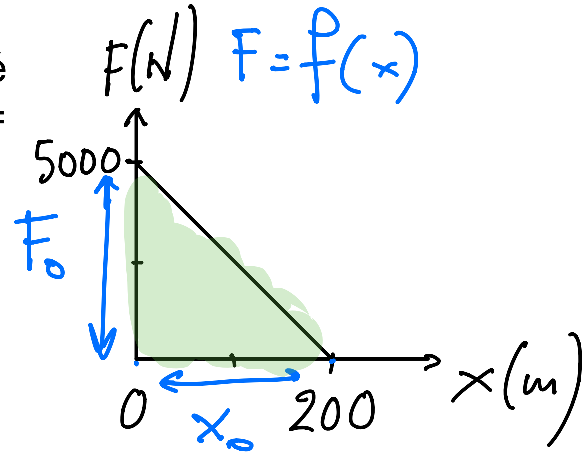
$$= F_{w_x} \cdot X$$



EXEMPLE



On tire une voiture de 1500 kg avec une force le module de la quelle est démontré sur la figure à coté (pas de changement de direction). Si la vitesse à x = 0 m est zero, quelle est la vitesse à x = 200 m?



$$W = \Delta E_c = \frac{1}{2} m v^2 \Rightarrow$$

$$\frac{1}{2} F_0 x_0 = \frac{1}{2} m v^2 \Rightarrow$$

$$\frac{1}{2} 5000\,N \cdot 200\,m = \frac{1}{2} 1500\,kg \cdot v^2$$

$$\Rightarrow v = \ldots\ m/s$$

$\cancel{W = F \cdot l}$! puisque F variable

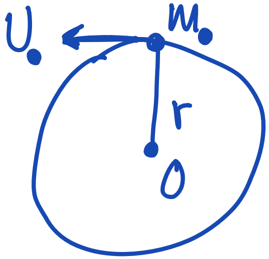
$$W = \int_0^x F\,dx$$

UNE ÉNERGIE RÉLATIVE

$$E_c = \frac{1}{2} m v^2$$

RELATIVE

ÉNERGIE CINÉTIQUE DE ROTATION



$$E_{\bullet c} = \frac{1}{2} m_\bullet v_\bullet^2$$

$$E_c = \sum_\bullet \frac{1}{2} m_\bullet v_\bullet^2$$

$$v_\bullet = r\omega$$

$\Rightarrow \dots \quad E_c = \frac{1}{2} I \omega^2$

$$E_c = \frac{1}{2} m v^2$$

Transl	Rotation
$\vec{F} = m\vec{a}$	$\vec{\tau} = I\vec{\alpha}_{ang}$
$\vec{p} = m\vec{v}$	$\vec{L} = I\vec{\omega}$
$\frac{d\vec{p}}{dt} = \vec{F}$	$\frac{d\vec{L}}{dt} = \vec{\tau}$
$E_c = \frac{1}{2} m v^2$	$E_c = \frac{1}{2} I \omega^2$

ÉNERGIE POTENTIELLE GRAVITATIONNELLE

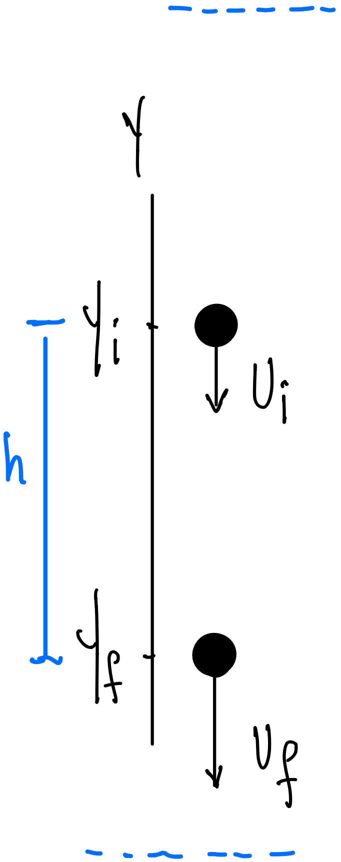
$$W = \Delta E_c \Rightarrow$$

$$F \cdot h = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 \Rightarrow$$

$$mg(y_i - y_f) = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 \Rightarrow$$

$$\underbrace{mg y_i + \frac{1}{2} m v_i^2}_{f_i} = \underbrace{mg y_f + \frac{1}{2} m v_f^2}_{f_f}$$

$$E_{pot}^{i} + E_{cin}^{i} = E_{pot}^{f} + E_{cin}^{f}$$



ÉNERGIE MÉCANIQUE ET SA CONSERVATION

$$E_{MEC} = E_c + E_p$$