Física A para Engenharia Ambiental - 2020

Vídeo-aula 11 – Trabalho e energia

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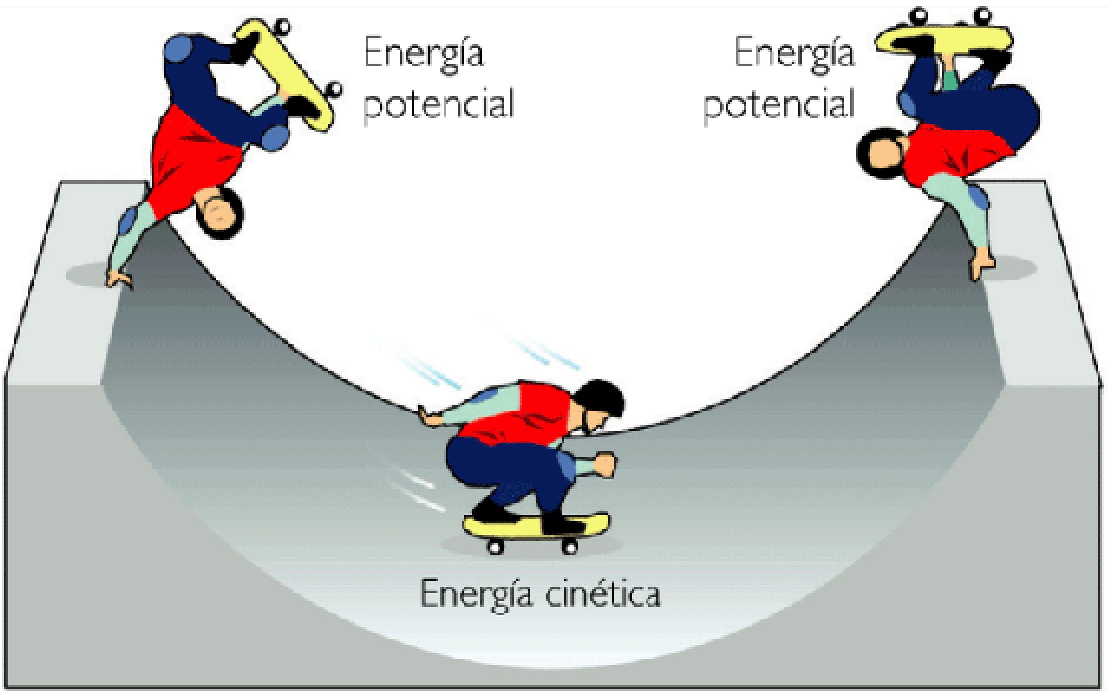
Na última aula

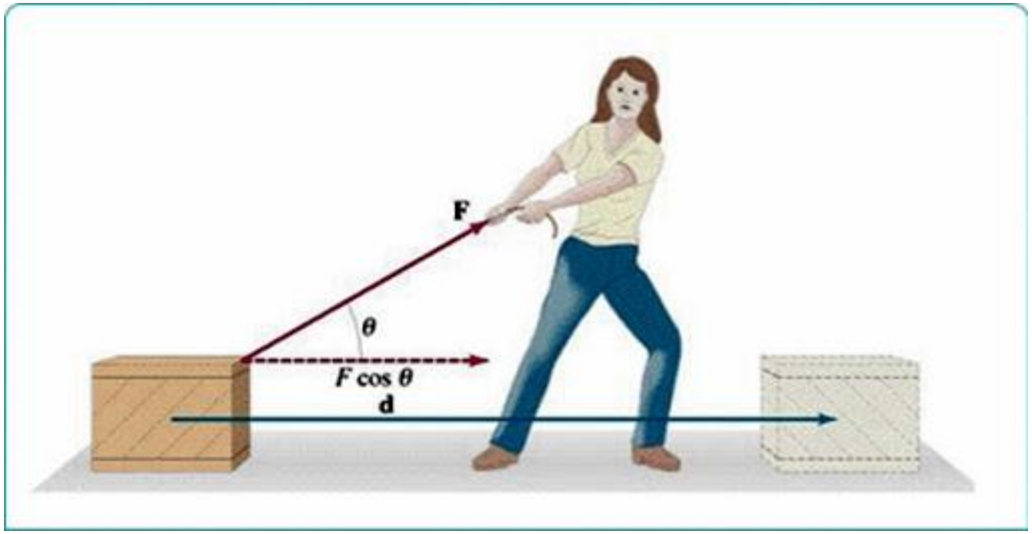


$$U = mgh$$

$$K = \frac{1}{2}mv^2$$

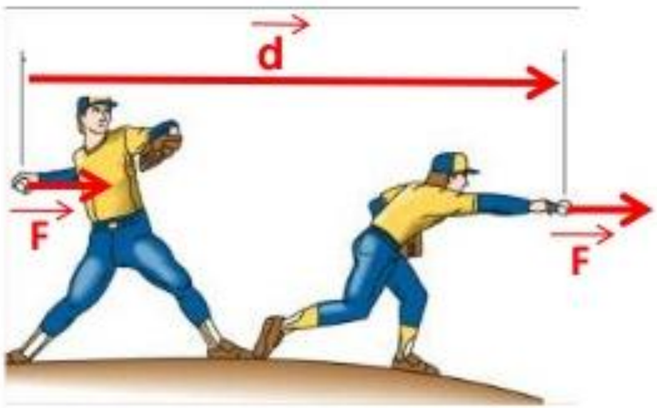
$$E_{total} = K + U = cte$$

Trabalho de uma força constante



$$W = \vec{F} \cdot \Delta\vec{r}$$

Teorema da Energia Cinética



$$F_x = ma_x$$

$$v^2 = v_0^2 + 2a_x\Delta x$$

$$v^2 = v_0^2 + 2\frac{F_x}{m}\Delta x$$

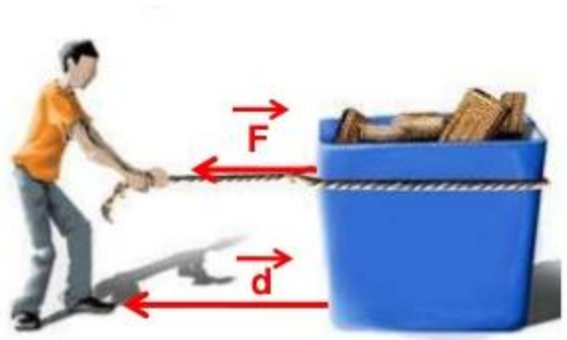
$$F_x\Delta x = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$$

$$W = \vec{F}\cdot\Delta\vec{r} = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$$

Conceito

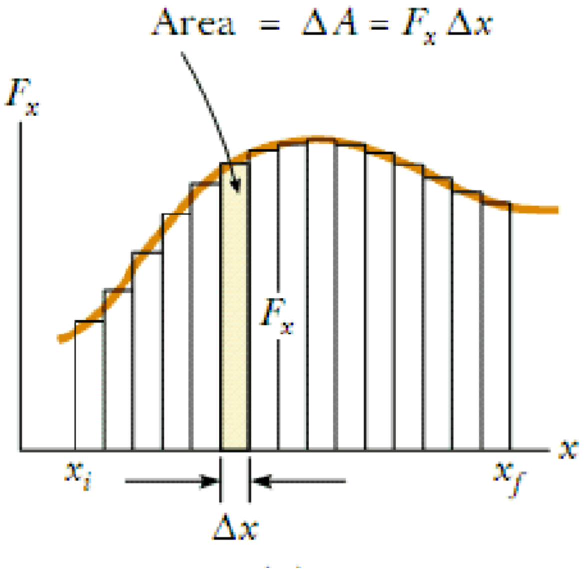
MEDIDA DA TRANSFORMAÇÃO/ VARIAÇÃO/TRANSFERÊNCIA DE ENERGIA

Quem ganhou energia: recebeu trabalho
Quem perdeu energia: realizou trabalho



TRABALHO foi realizado pela pessoa sobre a caixa: pessoa perde energia química (processos biológicos internos) e caixa ganha energia cinética e energia térmica por causa do atrito.

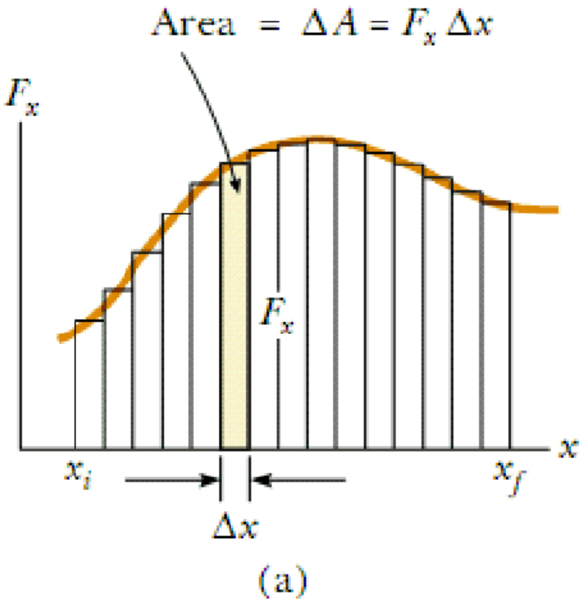
Trabalho de uma força variável

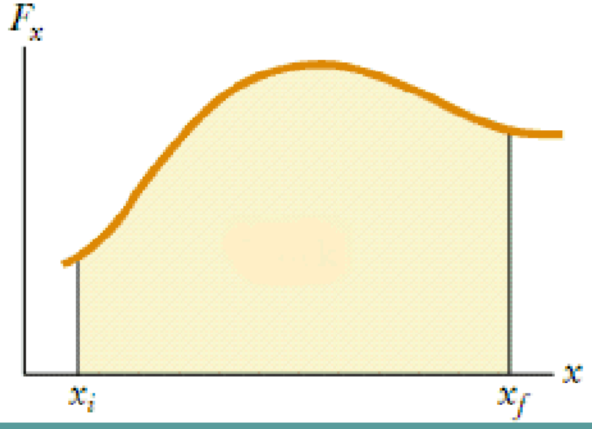


$$W = F_x \Delta x$$

$$W = \sum_{x_i}^{x_f} F_x \Delta x$$

Trabalho de uma força variável





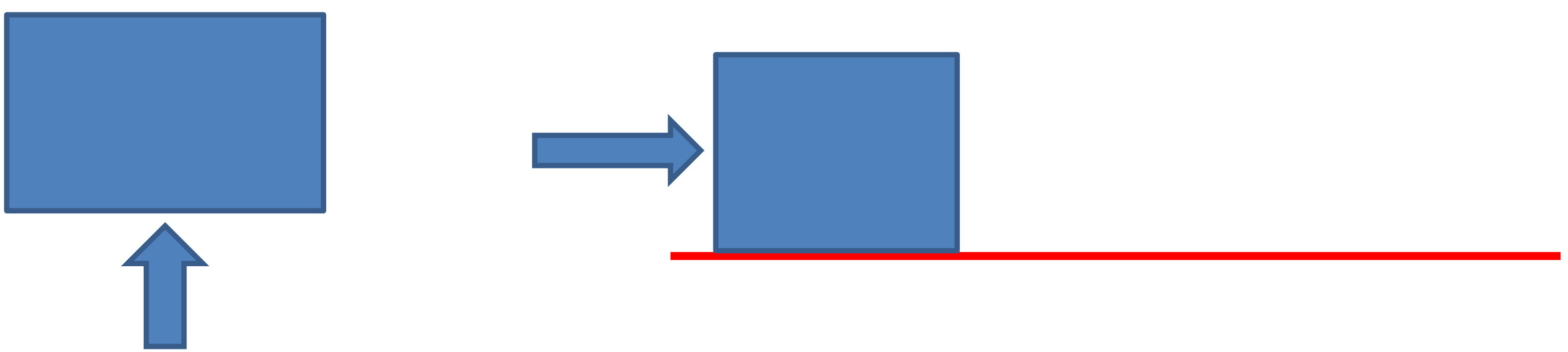
$$W = F_x \Delta x$$

$$W = \sum_{x_i}^{x_f} F_x \Delta x$$

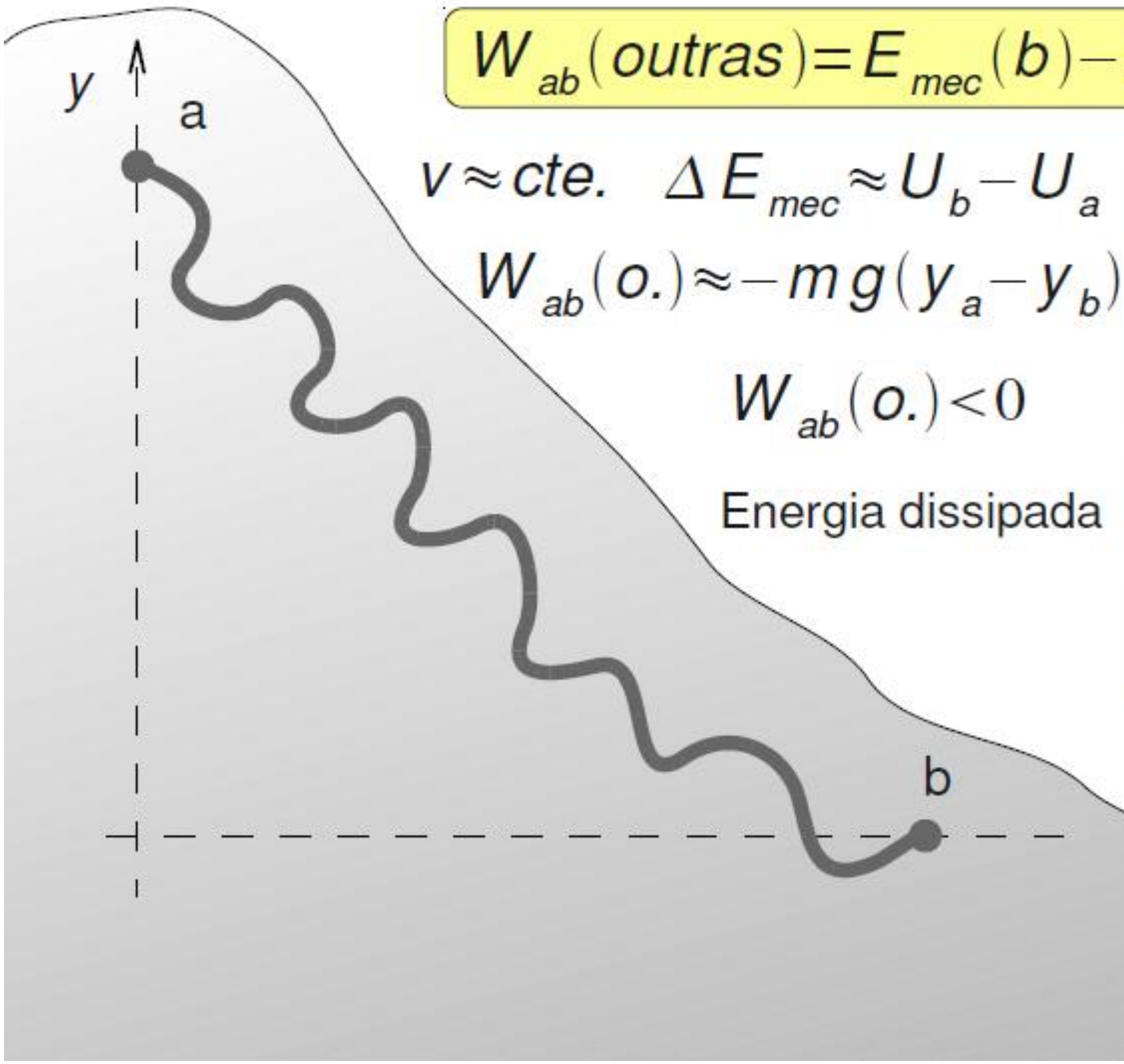
$$\lim_{\Delta x \to 0} \sum_{x_i}^{x_f} F_x \Delta x = \int_{x_i}^{x_f} F_x dx$$

$$W = \int_{x_i}^{x_f} F_x dx$$

Forças conservativas e não-conservativas



Energia dissiada



$$W_{ab}(outras) = E_{mec}(b) - E_{mec}(a)$$

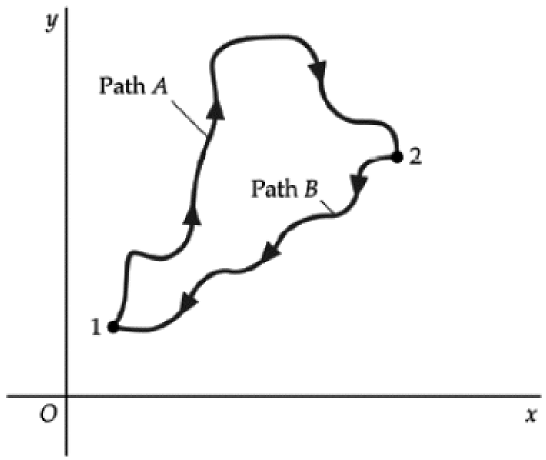
$$v \approx cte. \quad \Delta E_{mec} \approx U_b - U_a$$

$$W_{ab}(o.) \approx -mg(y_a - y_b)$$

$$W_{ab}(o.) < 0$$

Energia dissipada

Trabalho com forças conservativas

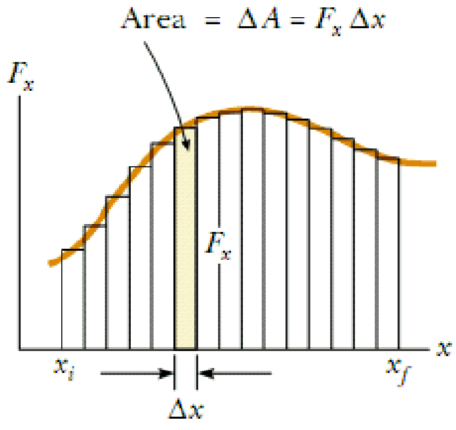


$$E = K_i + U_i = K_f + U_f$$

$$K_f - K_i = U_i - U_f$$

$$W = -\Delta U$$

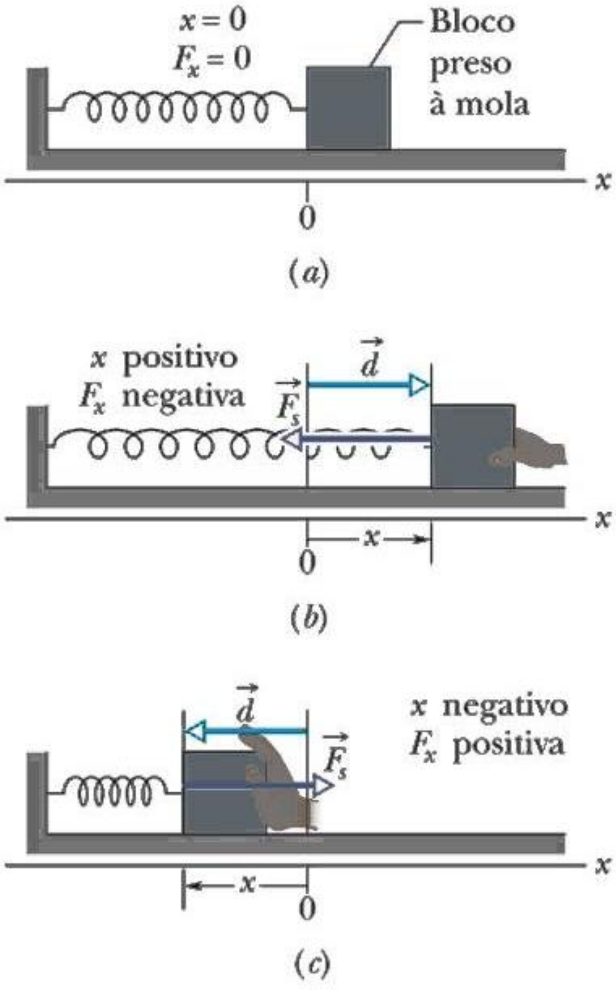
O trabalho de uma força conservativa é igual à variação da energia potencial associada à força.



$$dW = -dU$$

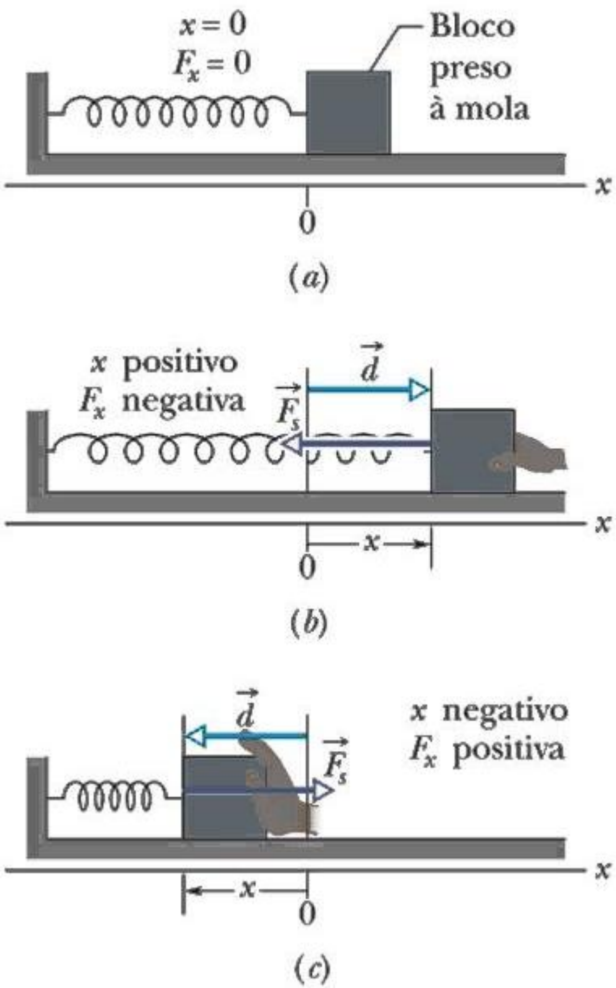
$$W = -\int_a^b dU = \int_{x_a}^{x_b} F(x)dx \Rightarrow \Delta U = -\int_{x_a}^{x_b} F(x)dx$$

Exemplo de força variável
Sistema massa-mola

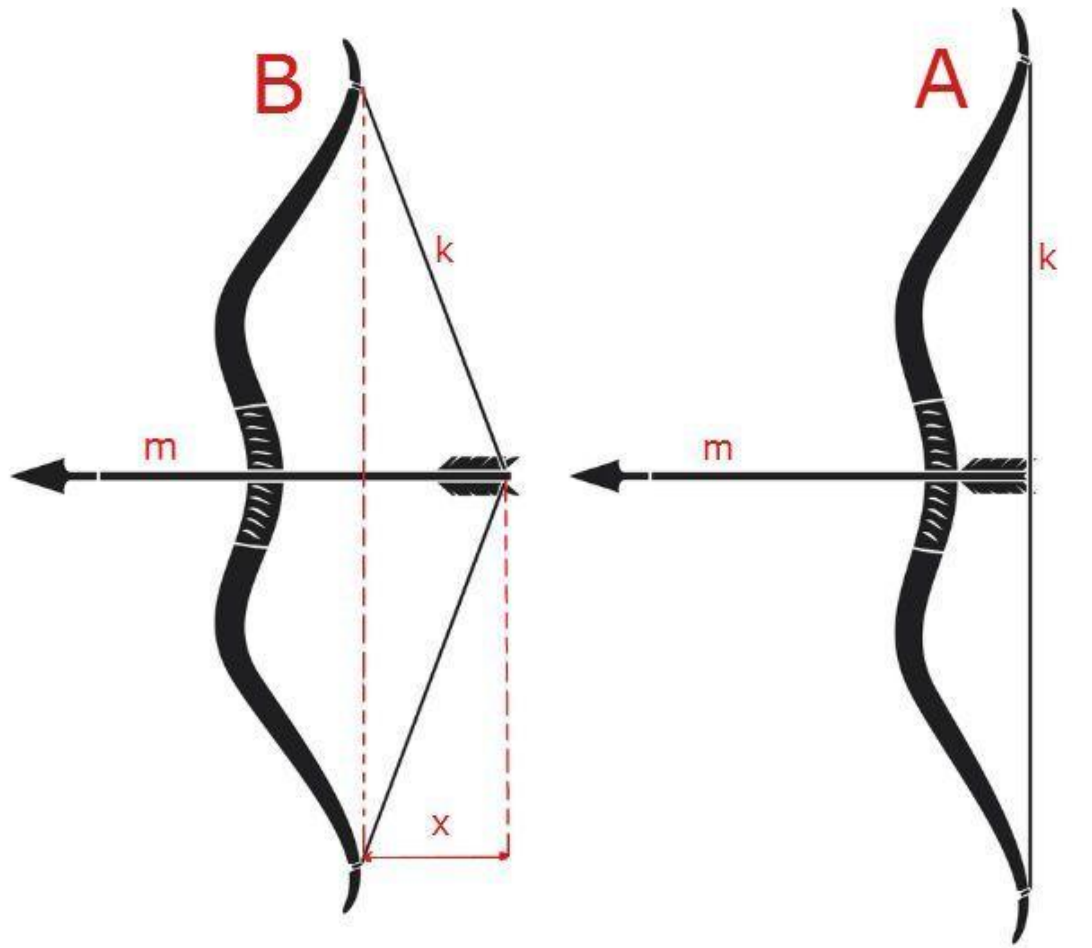


$$F_m = k.\Delta x$$

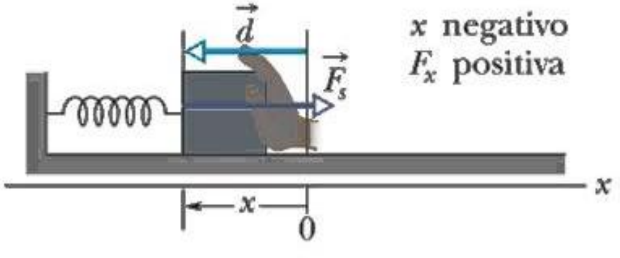
Exemplo de força variável
Sistema massa-mola



$$F_m = k.\Delta x$$



Energia potencial elástica



(c)

$$F = -kx$$

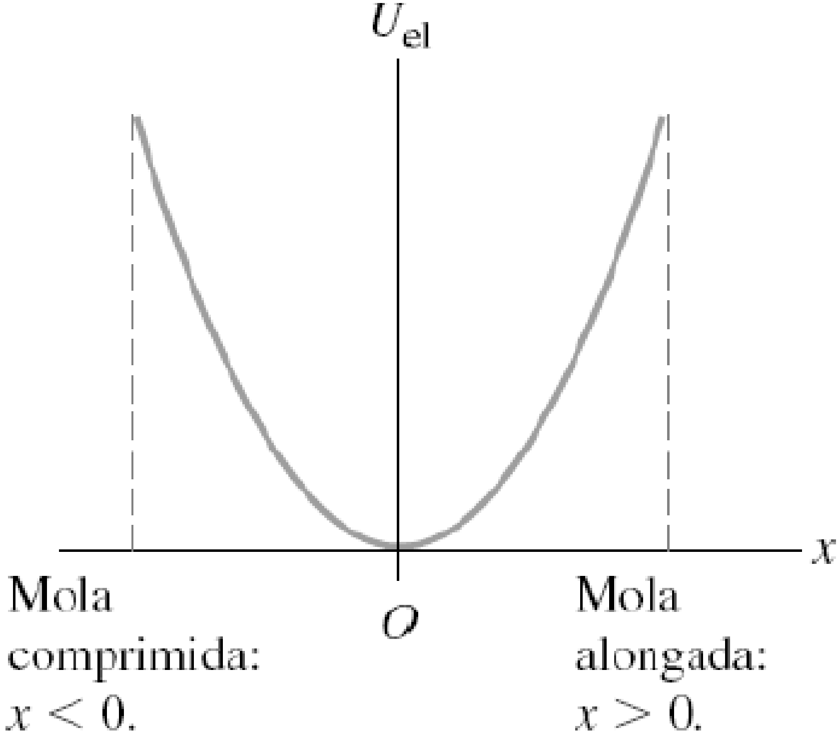
$$W = \int_0^x -kx\,dx$$

$$\Delta U = U - U_0 = -\int_0^x -kx\,dx \quad \Rightarrow \quad U = -\int_0^x -kx\,dx$$

$$U = \frac{1}{2}kx^2\Big]_0^x$$

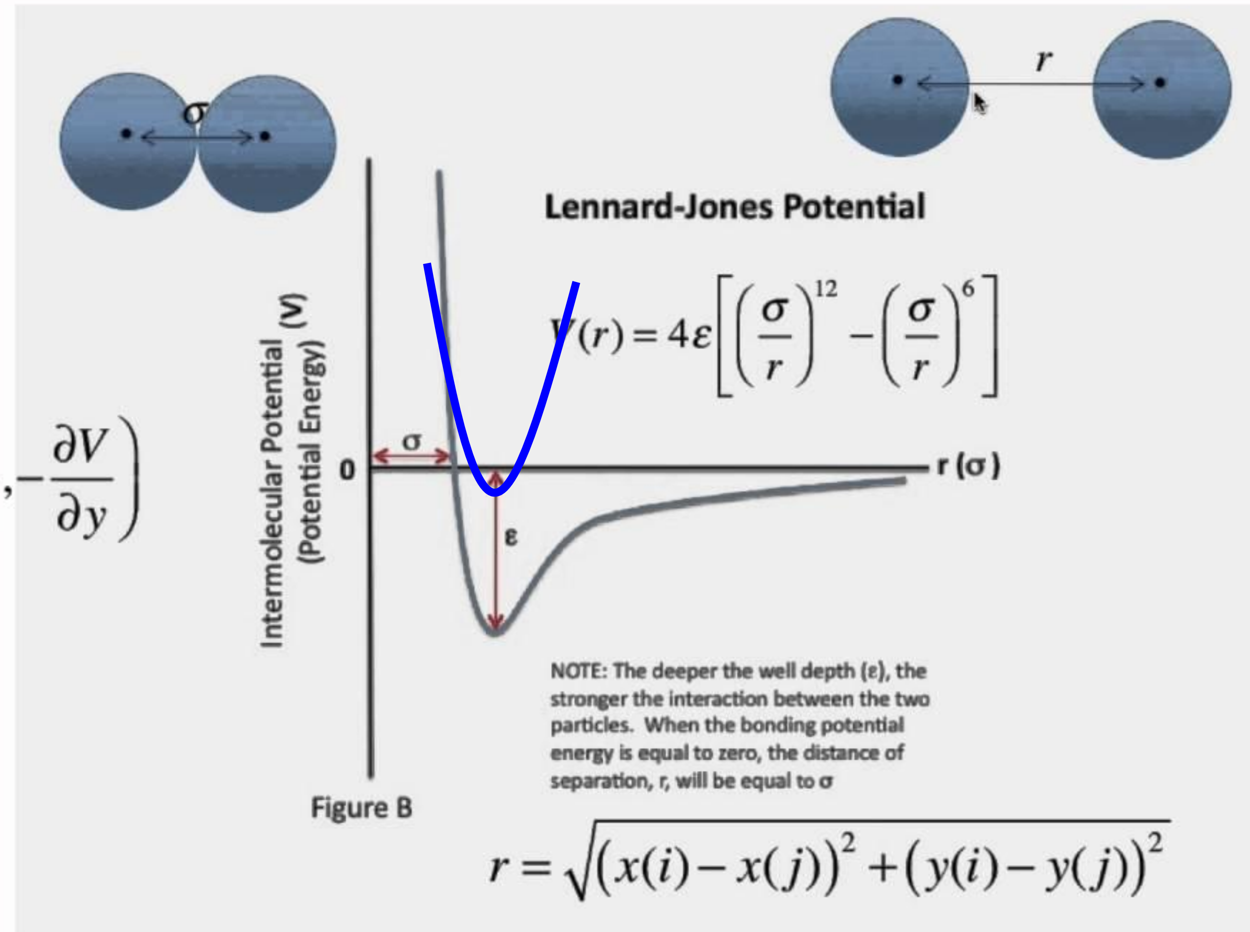
$$\boxed{U = \frac{1}{2}kx^2}$$

Gráfico energia elástica



Aproximação de sistemas físicos para o sistema massa-mola

$$\mathbf{F} = \left(-\frac{\partial V}{\partial x}, -\frac{\partial V}{\partial y} \right)$$



http://chemwiki.ucdavis.edu/Core/Physical_Chemistry/Physical_Properties_of_Matter/Atomic_and_Molecular_Properties/Intermolecular_Forces/Specific_Interactions/Lennard-Jones_Potential

Potência

P → Taxa temporal de realização de trabalho por uma força

$$P = \frac{dW}{dt} \xrightarrow{dW = \vec{F} \cdot d\vec{r}} P = \frac{d}{dt}\left(\vec{F} \cdot d\vec{r}\right) = \vec{F} \cdot \vec{v}$$

$$P = F_x v_x$$

$$P = m a_x v_x$$

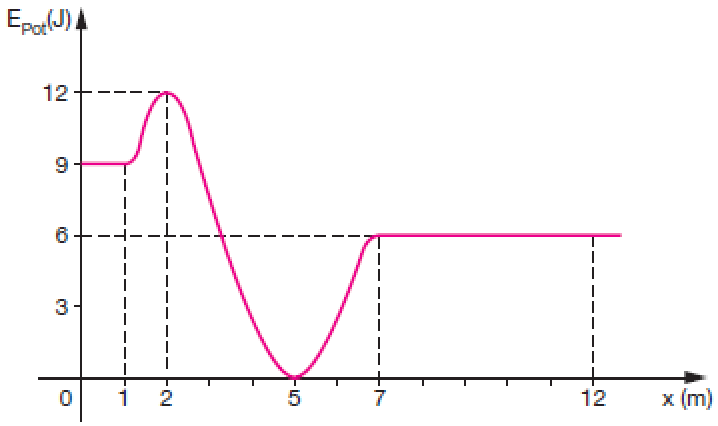
$$a_x = \frac{m v_x}{P}$$

$$P = m a_x v_x = m v_x \frac{d v_x}{dt} = \frac{d}{dt}\left(\frac{1}{2} m v_x^2\right) = \frac{dK}{dt}$$

$$P = \frac{dK}{dt}$$

Alguns exemplos

193 (UFGO) A energia potencial de um carrinho em uma montanha-russa varia, como mostra a figura a seguir.



Sabe-se que em x = 2 m, a energia cinética é igual a 2 J, e que não há atrito, sobre o carrinho, entre as posições x = 0 e x = 7 m. Desprezando a resistência do ar, determine:

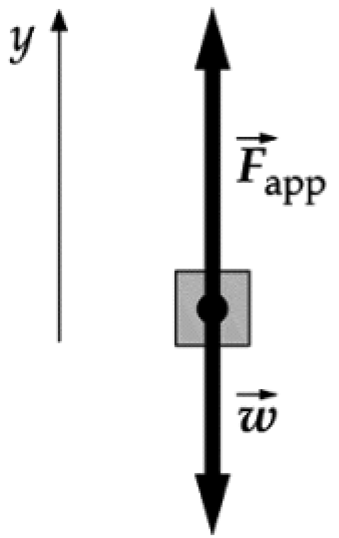
a) a energia mecânica total do carrinho

b) a energia cinética e potencial do carrinho na posição x = 7 m

c) a força de atrito que deve atuar no carrinho, a partir do posição x = 7 m, para levá-lo ao repouso em 5 m

Alguns exemplos

A truck of mass 3000 kg is to be loaded onto a ship by a crane that exerts an upward force of 31 kN on the truck. This force, which is just strong enough to get the truck started upward, is applied over a distance of 2 m. Find (*a*) the work done by the crane, (*b*) the work done by gravity, and (*c*) the upward speed of the truck after 2 m.



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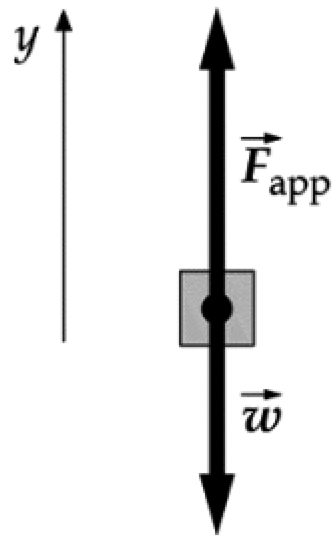


$$W_{app} = F_{app} \cos 0^\circ \, \Delta y = (31\text{ kN})(1)(2\text{ m}) = 62\text{ kJ}$$

$$W_g = mg \cos 180^\circ \, \Delta y$$
$$= (3000\text{ kg})(9.81\text{ N/kg})(-1)(2\text{ m}) = -59\text{ kJ}$$

$$K_f = \frac{1}{2} m v_f^2$$

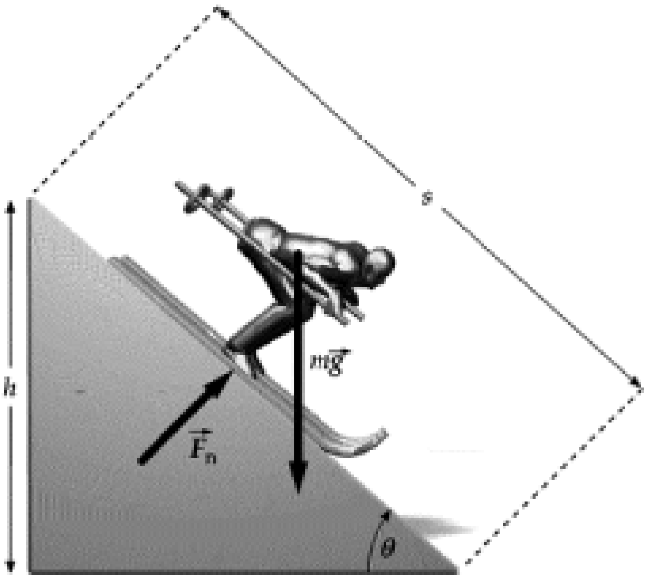
$$v_f = \sqrt{\frac{2K_f}{m}}$$

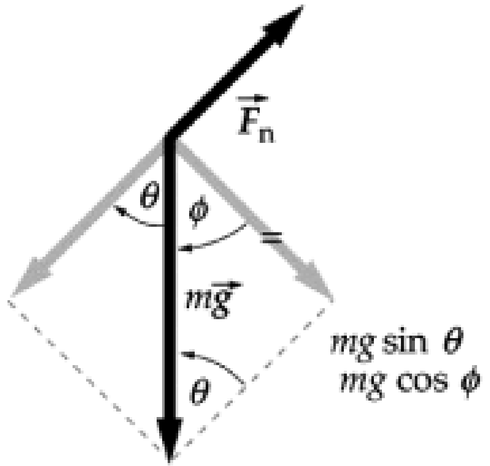
$$W_{total} = \Delta K = K_f - K_i = K_f$$

$$W_{total} = W_{app} + W_g = 62\text{ kJ} - 59\text{ kJ} = 3.0\text{ kJ}$$

Alguns exemplos

You ski downhill on waxed skis that are nearly frictionless. (*a*) What work is done on you as you ski a distance *s* down the hill? (*b*) What is your speed on reaching the bottom of the run? Assume the length of the ski run is *s*, its angle of incline is θ, and your mass is *m*. The height of the hill is then $h = s \sin \theta$.





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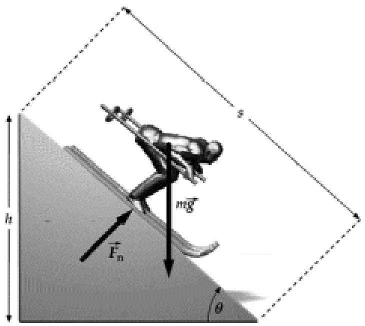

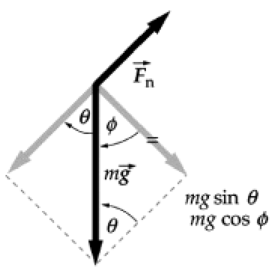

$$W = m\vec{\mathbf{g}} \cdot \vec{\mathbf{s}} = mgs\cos\phi = mgs\sin\theta$$

$$\sin\theta = \frac{h}{s}$$

$$W = mgh$$

$$W = mgh = \frac{1}{2}mv^2 - 0 \quad \text{or} \quad v = \sqrt{2gh}$$

Alguns exemplos

(Fuvest) No desenvolvimento do sistema amortecedor de queda de um elevador de massa m, o engenheiro projetista impõe que a mola deve se contrair de um valor máximo d, quando o elevador cai, a partir do repouso, de uma altura h, como ilustrado na figura a seguir. Para que a exigência do projetista seja satisfeita, a mola a ser empregada deve ter constante elástica dada por