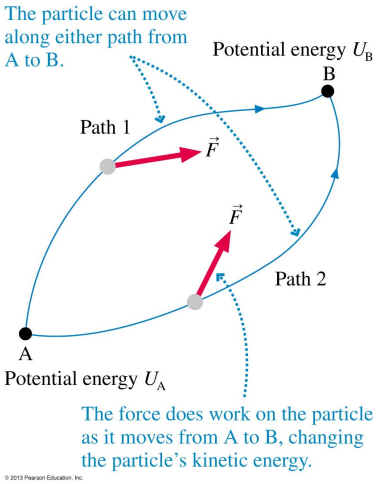
Conservative and Non-conservative Forces



A force for which the work done on a particle is independent of the path is called a **conservative force**.

There is a **potential energy** associated with the force.

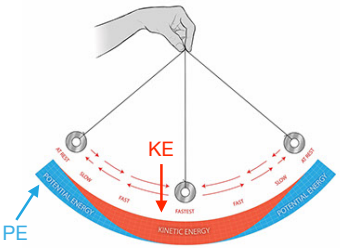
→ Stored energy; we may retrieve it later.

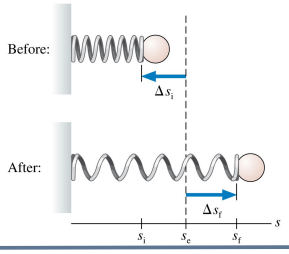
The potential energy is transformed into **kinetic energy**.

$$\Delta K = -\Delta U$$

$$K_i + U_i = K_f + U_f$$

Example:
gravitational force,
springs/elastics.





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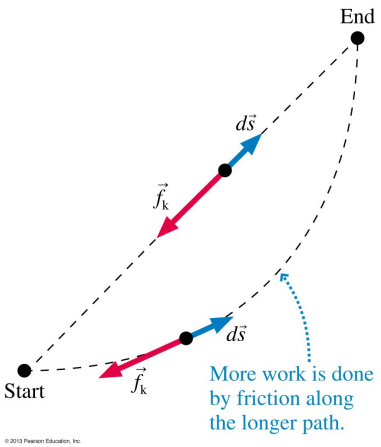


A force for which the work done on a particle is **not** independent of the path is called a **nonconservative force**.

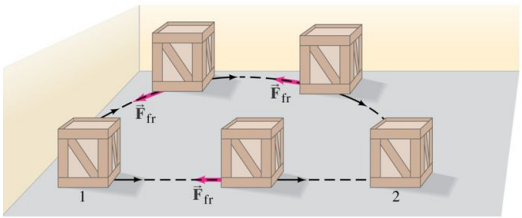
For example: work by friction (if constant):

$$W_{\text{fric}} = \boldsymbol{f} \cdot \Delta \boldsymbol{s} = f_k \, \Delta s \cos \alpha$$

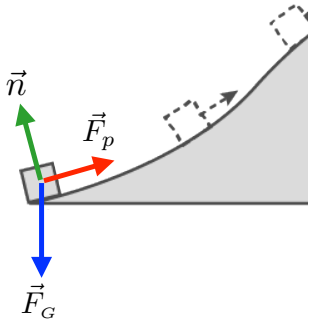
$$W_{\text{fric}} = \mathbf{f} \cdot \Delta \boldsymbol{s} = -f_k \, \Delta s$$

The work done by friction depends on Δs, the distance traveled.

The work done by friction is usually dissipated as heat; it is not possible to define a potential energy for a non-conservative force.



Conservative and Non-conservative Forces



Work-Energy Theorem

$$W_{\text{net}} = K_{\text{f}} - K_{\text{i}} = \Delta K$$

$$(W_{\text{grav}} + W_{\text{sp}}) + W_{\text{other}} = K_{\text{f}} - K_{\text{i}}$$

gravitational W_{grav}
elastic (spring) W_{sp}

$$W_{\text{cons}} = -\Delta U$$

nonconservative, e.g. friction, external forces

$$W_{\text{other}} = \int \vec{F}_{\text{other}} \cdot d\vec{s}$$

Considering conservative and nonconservative forces, we get:

$$-\Delta U + W_{\text{other}} = \Delta K$$

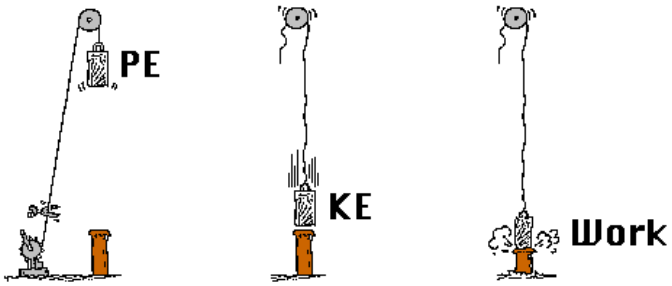
$$K_i + U_i + W_{\text{other}} = K_f + U_f$$

Conservation of Energy

Law of Conservation of Energy: Energy cannot be created or destroyed; it may be transformed from one form into another through interactions, but the total amount of energy never changes.

$$K_i + U_i + W_{\text{other}} = K_f + U_f$$

where $U = U_{\text{grav}} + U_{\text{sp}} = mgy + \frac{1}{2}k(\Delta s)^2$



Do work → lift ram → giving it PE

Release ram, PE → KE

This KE transfer to the piling.

(force of impact x distance piling penetrates into ground = work done)