

# University Physics 1A

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## Potential Energy

Any path from A to B has the same work by the force of gravity. The work around a closed path is 0. This is called a “conservative” force. For a conservative force  $\vec{F}$ :

$$\int \vec{F} \cdot d\vec{s} = 0$$

on any closed path. We can define a potential function  $u$  which is a function of position.

$$\begin{aligned}\Delta u &= u_B - u_A \\ &= - \int_A^B \vec{F} \cdot d\vec{s} \\ &= -W_{A \text{ to } B} \\ &= - \int_A^B mg \, ds \cos(180) \\ &= mg \int_A^B ds \\ &= mgh \\ &= \text{gravitational potential energy of the mass } m\end{aligned}$$

For a frictionless spring where equilibrium is position 0, compression distance is  $x_B$ , and the force by the spring is  $-kx$ :

$$\begin{aligned}\Delta u &= u_B - u_A \\ &= - \int_0^{x_B} \overrightarrow{F_{spring}} \cdot \vec{dx} \\ &= - \int_0^{x_B} |-kx| |dx| \cos(180^\circ) \\ &= \int_0^{x_B} x \, dx \\ &= \left. \frac{1}{2} kx^2 \right]_0^{x_B} \\ &= \frac{1}{2} kx_B^2 \\ &= \text{potential energy of the spring at } x = x_B\end{aligned}$$

You can find all my notes at <http://omgimanerd.tech/notes>. If you have any questions, comments, or concerns, please contact me at [alvin@omgimanerd.tech](mailto:alvin@omgimanerd.tech)