University Physics 1A

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October 5th, 2017

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 $\vec{F}$:

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

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

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

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

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

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