Gravitational and Elastic Potential Energy

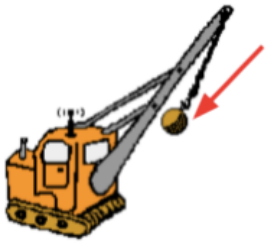
Lesson Notes

Learning Outcomes

- What is gravitational potential energy and how do you calculate it?
- What is elastic potential energy and how do you calculate it?

Potential Energy as the Energy of Position

Potential energy is the energy stored in an object as a result of its position. There are several different types of potential energy. We will focus on **gravitational potential energy** (PE_{grav}) and **elastic potential energy** ($PE_{elastic}$)

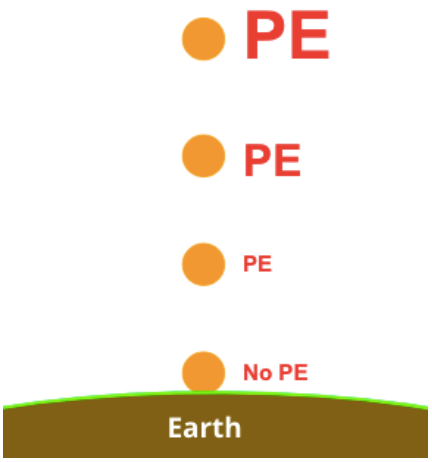


PE_{grav}: Energy is stored in the wrecking ball of a demolition machine as it is raised to a high position above its lowest point.

$PE_{elastic}$: Energy is stored in the stretched string of an archer's bow as it is drawn back from its usual *resting position*.

Gravitational Potential Energy

Gravitational potential energy (PE_{grav}) is the energy stored in an object as the result of its position within Earth's gravitational field. PE_{grav} depends upon the object mass and the object height.



Gravitational Potential Energy Equation:

The equation relating PE_{grav} to **m** and **h** is:

$$PE_{grav} = m \cdot g \cdot h$$

m = mass (kg)
h = height (m)

g = gravitational field strength = **9.8 N/kg** on Earth

Unit for PE: Joule (abbreviated J); 1 J = 1 kg•(N/kg)•m = 1 N•m

The "Zero Level"

The zero-height level is the arbitrarily assigned 0 height from which the height of any object is measured. One must assign a h=0 level before measuring heights. The most convenient choice should be made. Some choices may result in the PE being a negative value.

Using the PE_{grav} Equation in Solving Algebraic Problems

Basic Algebra: The PE_{grav} equation has three variables: **PE_{grav}**, **m**, and **h**. If you know the value of 2 variables, you can calculate the value of the 3rd variable.

Three Forms of the KE Equation

1. Solving for Potential Energy (PE_{grav}) ...

   Use **$PE_{grav} = m \cdot g \cdot h$**

2. Solving for Mass (m) ...

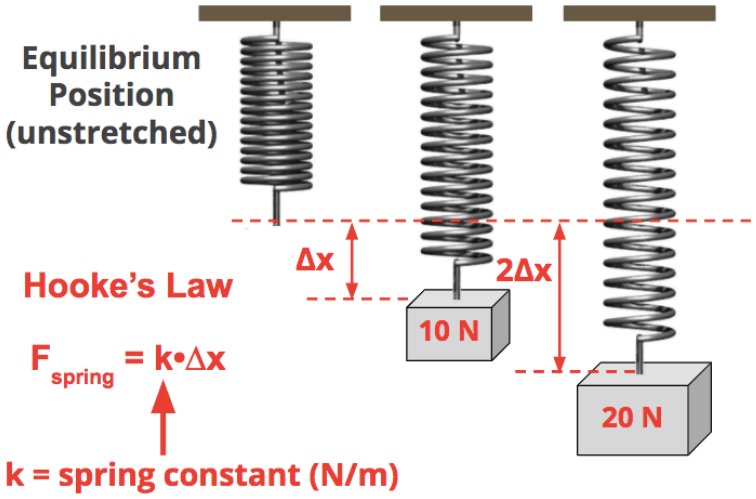
   Use **$m = (PE_{grav}) / (g \cdot h)$**

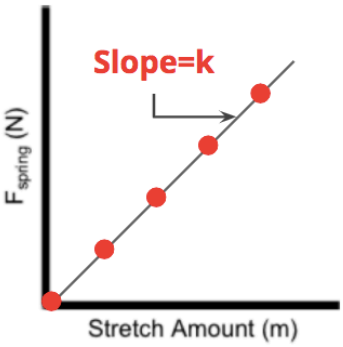
3. Solving for Height (h) ...

   Use: **$h = PE_{grav} / (m \cdot g)$**

The Spring Force

When a force is applied to a spring, its coils either stretch or compress. The amount of stretch is proportional to the amount of applied force.





Elastic Potential Energy ($PE_{elastic}$)

As a spring is stretched (or compressed) under the influence of a force, **elastic potential energy** (**$PE_{elastic}$**) is stored in the spring. The more stretch, the more **$PE_{elastic}$** that is stored. The equation for elastic potential energy is:

$$PE_{elastic} = \tfrac{1}{2} \cdot k \cdot \Delta x^2$$

Δx = stretch amount (m)

k = spring constant (N/m)

(The k value varies with the spring)