Energy

Energy is something that is found all over the physical and life sciences. **Thermal Energy** is what you experience when you burn your hand on the stove (again). **Chemical Energy** is what causes that (safely contained) explosion in chemistry class. In this section, we will focus solely on **mechanical energy**, or energy due to the movement (or potential movement) of an object.

Types of Mechanical Energy

Kinetic

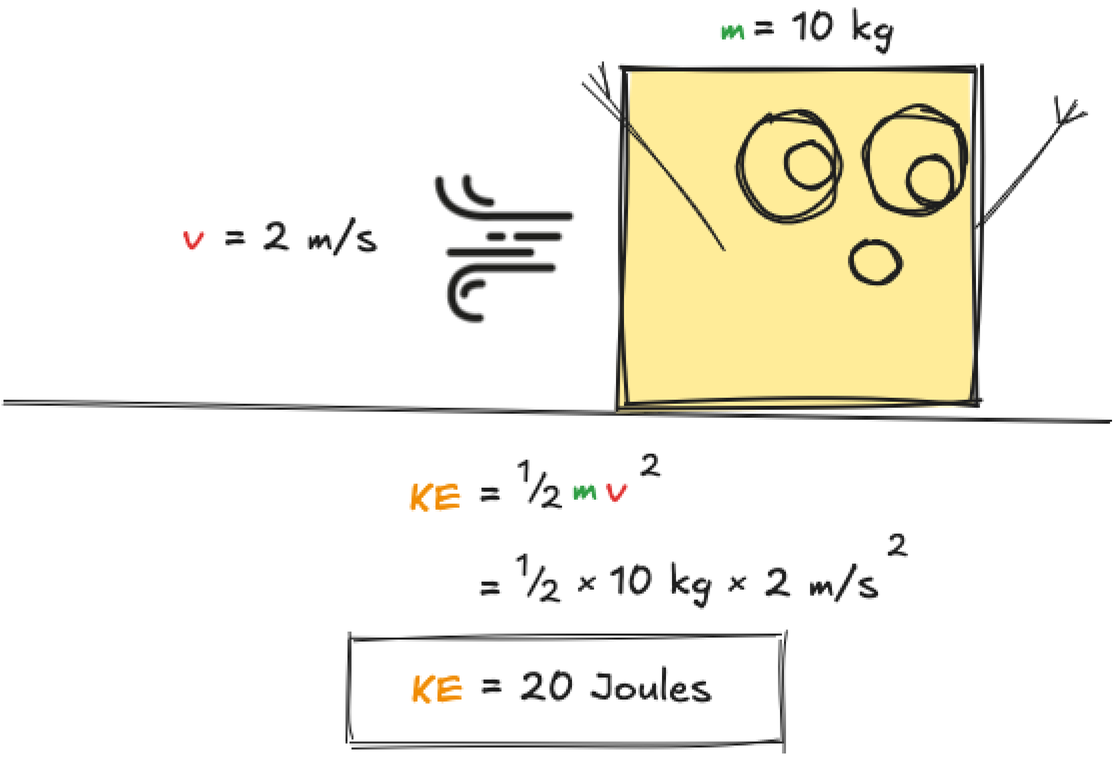
Kinetic energy is the amount of energy an object has due to its movement (**velocity**).

$$\text{Kinetic Energy} = \frac{1}{2} \times \text{Mass} \times \text{Velocity}^2$$

$$\boxed{KE = \frac{1}{2} m v^2}$$

Example

> Mr. Box, who has a mass of **10 kilograms (kg)**, is sliding on a patch of ice at **2 meters per second (m/s)** of velocity. How much **kinetic energy** would he have?



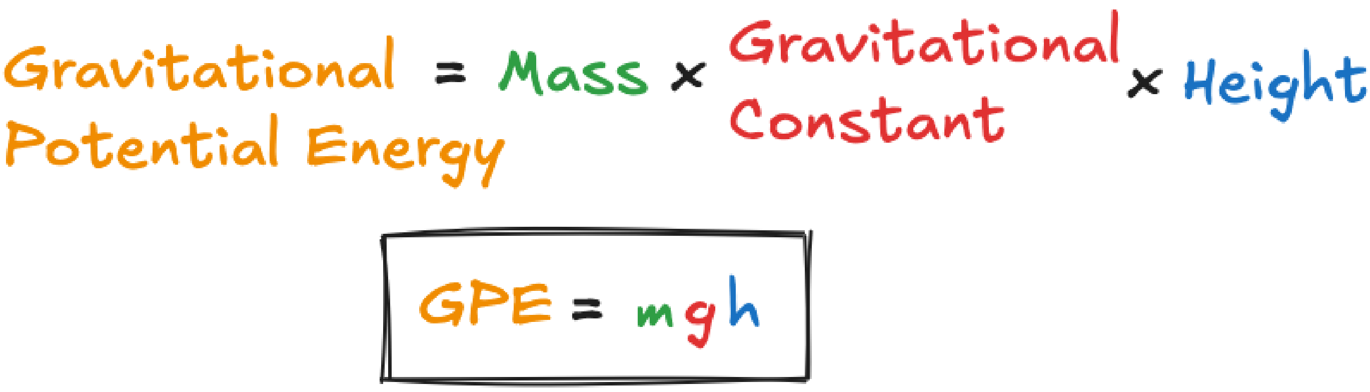
> Mr. Box would have **20 Joules** of **Kinetic Energy**.

Potential

Potential energy is the energy of an object or system due to its position relative to other objects.

Gravitational

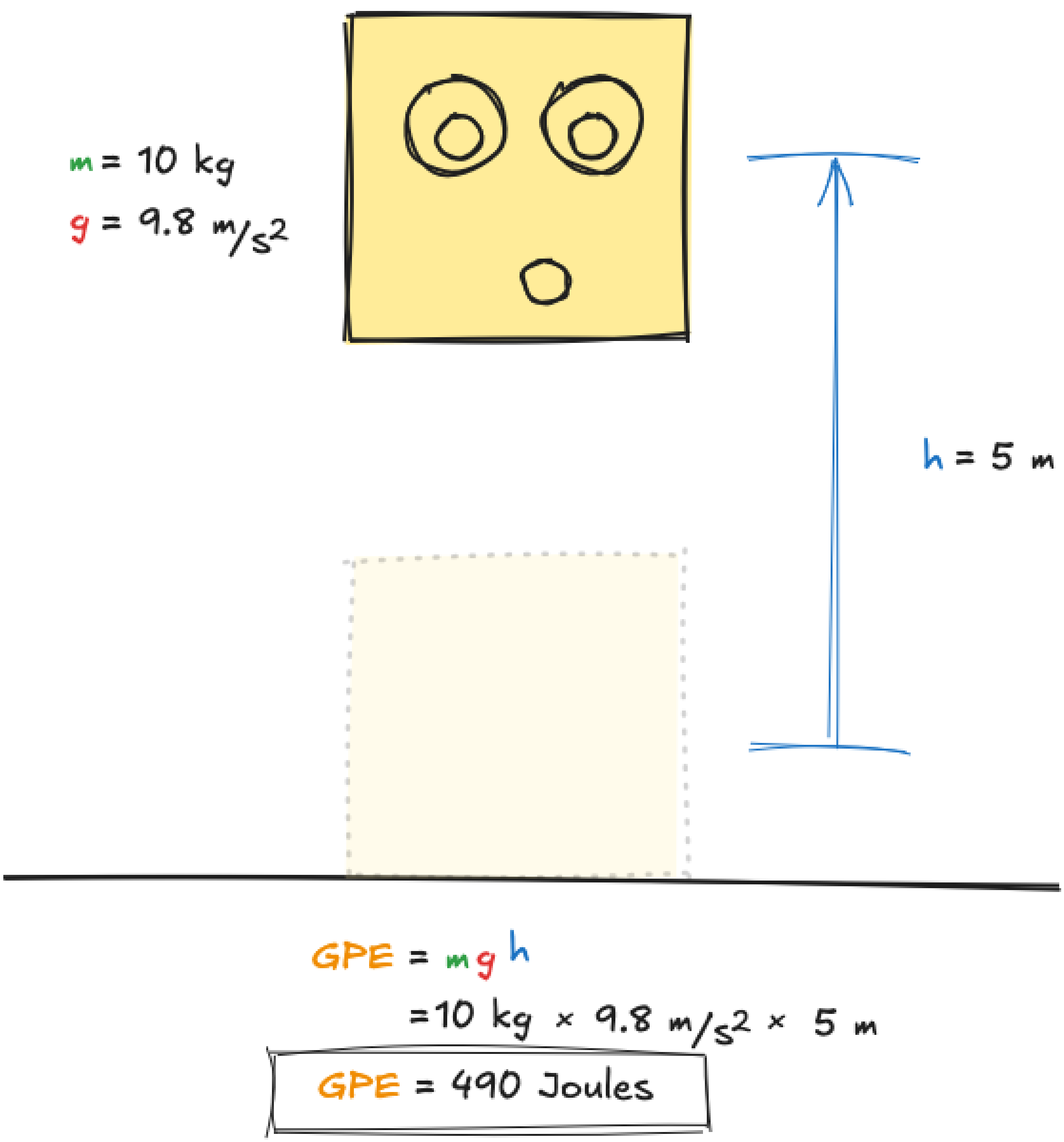
Gravitational potential energy is calculated using an object's position within a gravitational field. Typically, this is considered to be the **height** (**h**) above the surface of the earth, which provides a constant **gravitational acceleration** (**g**) of around 9.8 meters per second squared.



Example

>

Mr. Box, who has a **mass** of **10 kg**, is lifted **5 meters** into the air above the surface of the Earth, which provides a**gravitational acceleration** of **9.8 meters per second squared**. How much **gravitational potential energy** would Mr. Box have?



Mr. Box would have **490 Joules** of **gravitational potential energy**.

Elastic Potential

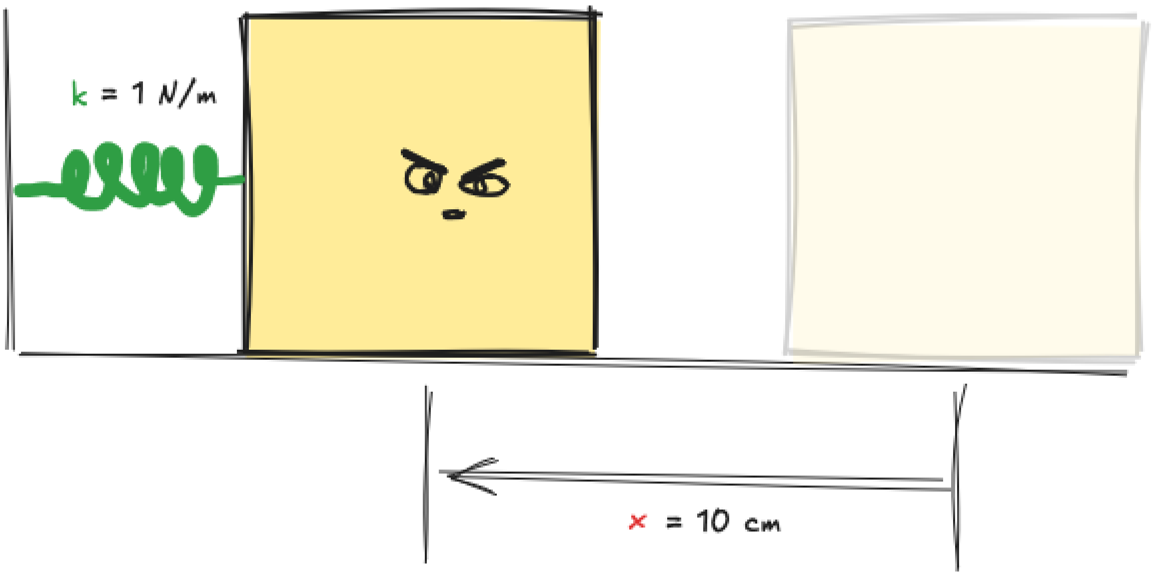
Although similar to gravitational potential energy, **elastic potential energy** instead deals with the energy provided by a spring (or elastic) rather than gravity. A spring's constant (**k**), also known as "stiffness", is determined by its **shape** and **material**.

$$\text{Elastic Potential Energy} = \frac{1}{2} \times \text{Spring Constant} \times \text{Displacement}^2$$

$$EPE = \frac{1}{2} k x^2$$

Example

Mr. Box (**mass** of **10 kg**) is pressed against a spring with a spring constant of **1 N/m** for **10 centimeters** (or **0.1 meters**). How much **elastic potential energy** does Mr. Box now have?



$$EPE = \frac{1}{2} k x^2$$

$$= \frac{1}{2} \times 1\ N/m \times 0.1\ m^2$$

$$EPE = 0.005\ J$$

Mr. Box would have an **elastic potential energy** of **0.005 Joules**.

Conservation of Energy

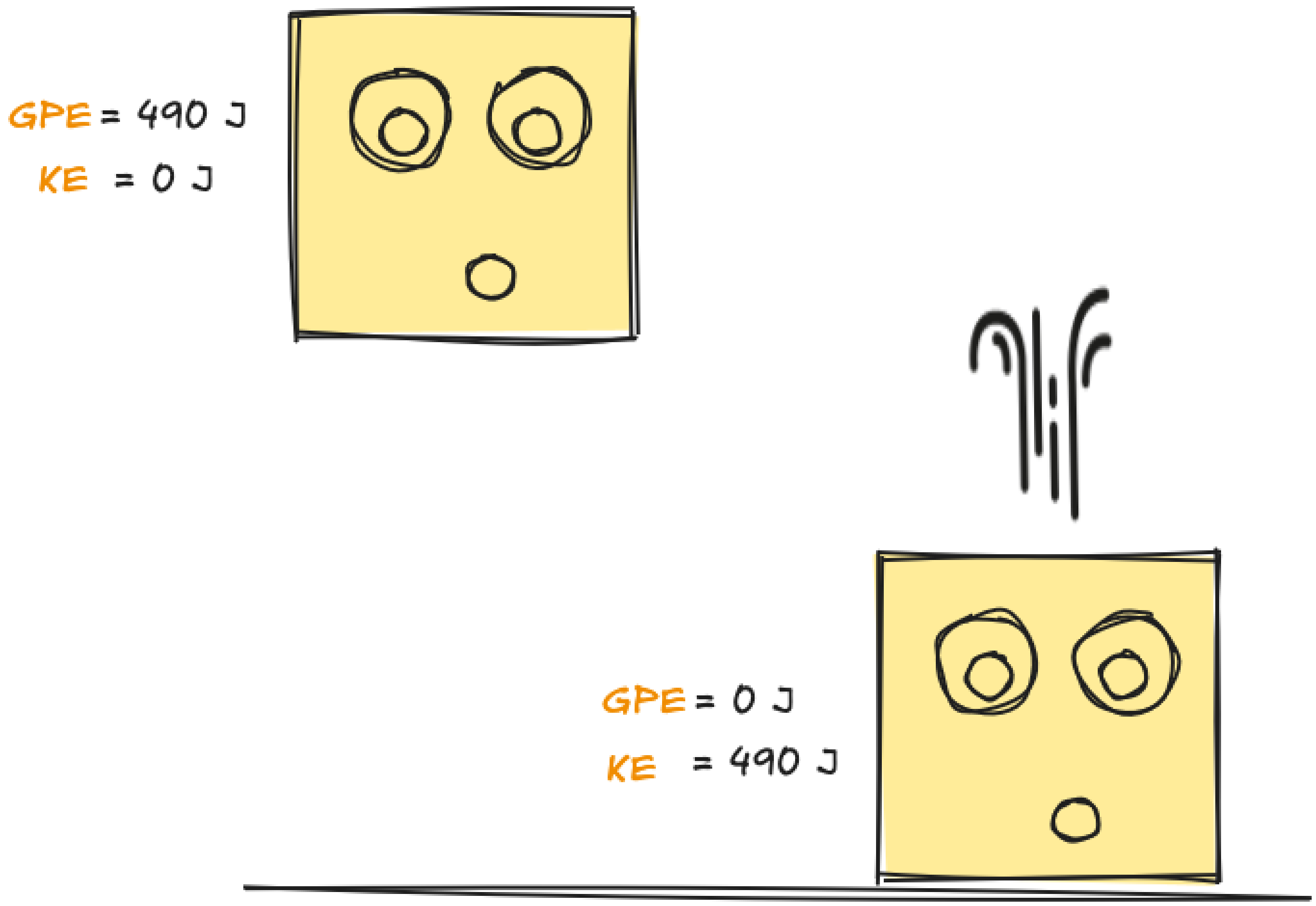
The conservation of energy is a fundamental principle of physics, which states:

> The **total energy** of an isolated system is **constant** despite internal changes.

What this means within the context of our work in mechanical engineering is that the **type of energy** a system experiences may change, but the total amount of energy in that system will not.

For example:

> In a previous question, we lifted Mr. Box (mass of **10 kg**) to a height of **5 meters,** which gave him a gravitational potential energy of **490 Joules**. Dropping him from that height would begin to **convert** the **potential energy** into **kinetic energy**. When Mr. Box gets back to the ground (height of **0 meters**) his potential energy will have been entirely converted to kinetic energy.



> How much **velocity** is he moving with when he hits the ground (**GPE = 0 J, KE = 490 J**)?

$$KE = \frac{1}{2} m v^2$$

$$490\ J = \frac{1}{2} \times 10\ kg \times v^2$$

$$\boxed{v = 9.9\ m/s}$$

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