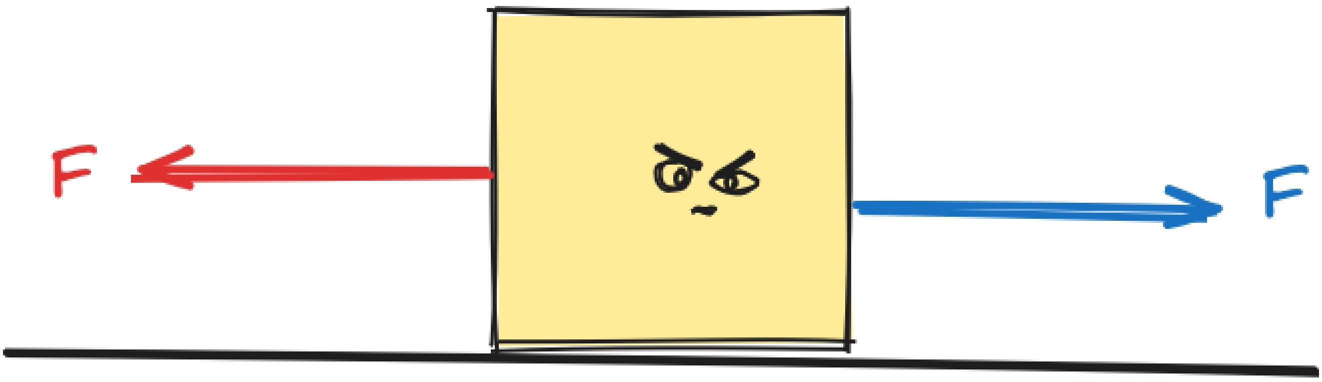
Work

Background

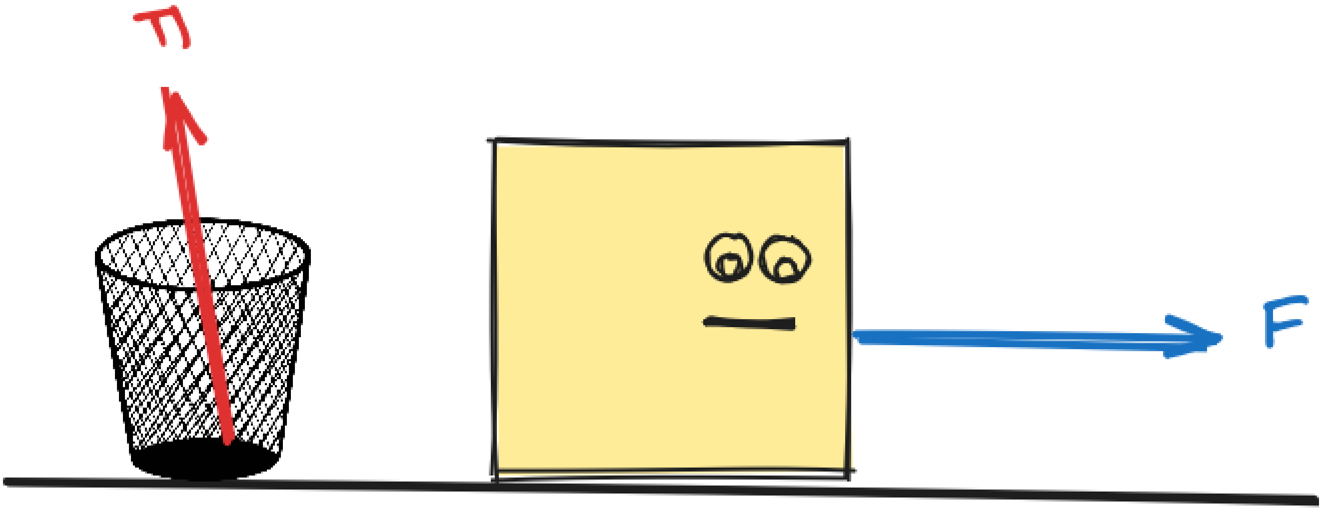
In the previous unit on Civil Engineering, we discussed the principle of **force**, and the idea that:

> When the forces acting on Mr. Box add up to zero, he will not accelerate.



With things like bridges, roads, and buildings this (usually) means the object is not moving, and will continue not to move. Trouble arises when the forces are no longer balanced, and things start to move.

But what happens when if ***do*** want Mr. Box to move? What happens when we remove one of the forces ***on purpose***?



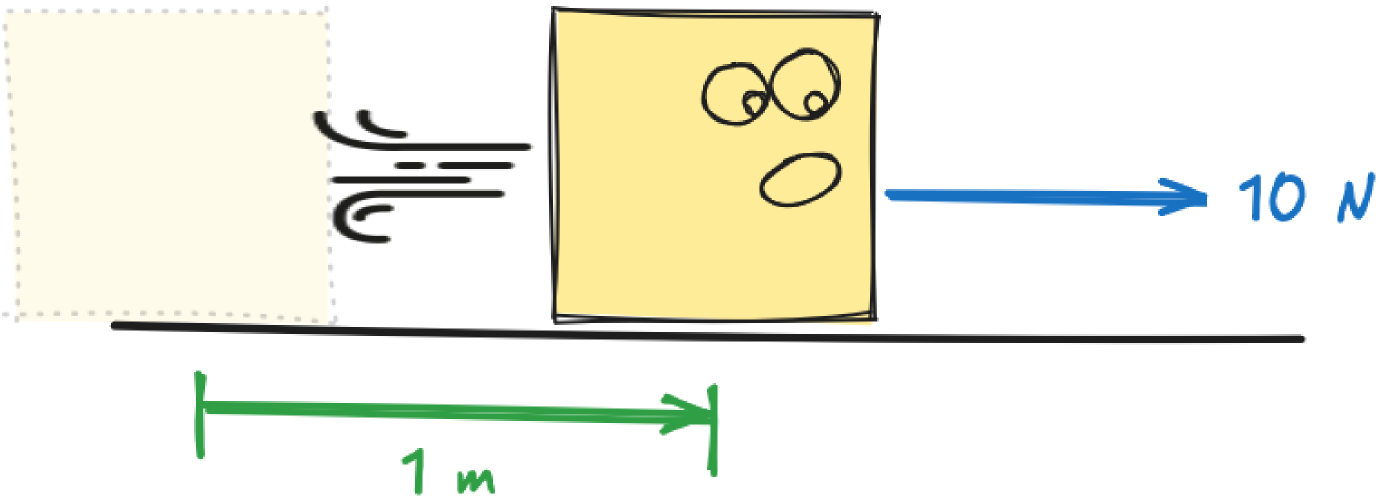
Calculating Work using Force

Now that the forces are no longer balanced, Mr. Box will be allowed to **accelerate**. How much he accelerates depends on how long (in length) the force is applied for. We call this: ***doing work on Mr. Box***. To calculate the amount of work done, we multiply the amount of force (in Newtons) by the length (in meters) the force is applied. The unit for work is Newton-meter, or **Joule**.

Work = Force × Distance

Example

If you were to pull Mr. Box with a force of **10 Newtons** for a length of **1 meter**, you will have done **10 Joules** of work on Mr. Box.



$$W = Fd$$

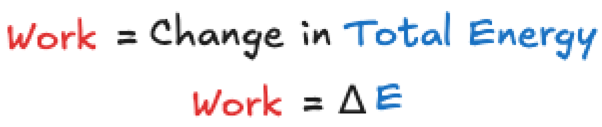
$$= 10\ N \times 1\ m$$

$$W = 10\ \text{Joules}$$

> **Note**: Similar to our working calculating Stress and Strain, it is important to always use proper units when calculating work. For example, **200 cm** should be converted to **2 m**, **2 kN** should be converted to **2,000 N**, etc.

Calculating Work using Energy

Alternatively, you may calculate the work performed on an object using its **change in total energy.**

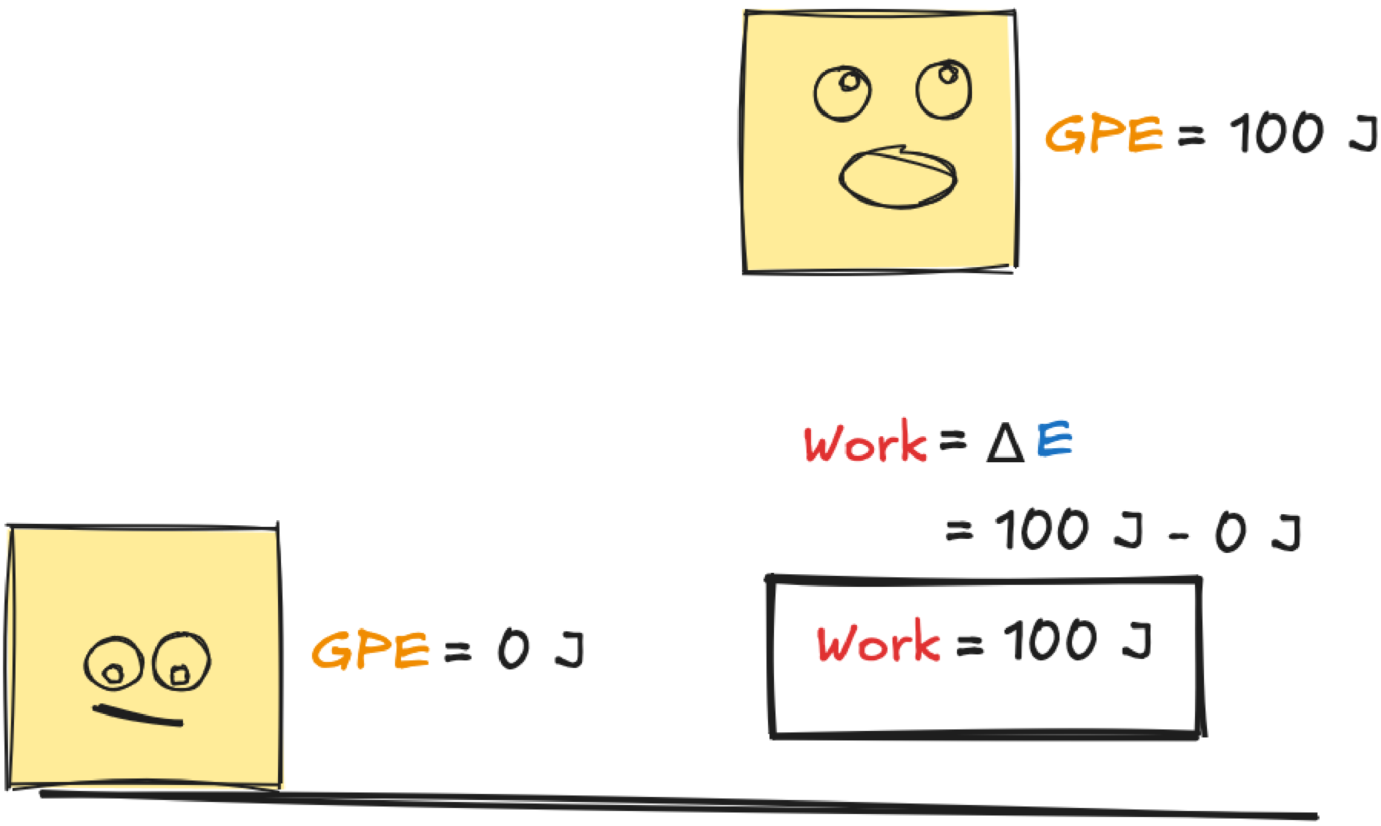


> **Note**: In math, the symbol **Δ** (or **delta**) is typically used as a shorthand to say "change in". For example, **ΔE** is a short way of saying "change in energy."

Previously, we discussed the different types of energy, such as **kinetic** and **potential.** When an object changes the total energy of another object, it is said to have done **work** on that object.

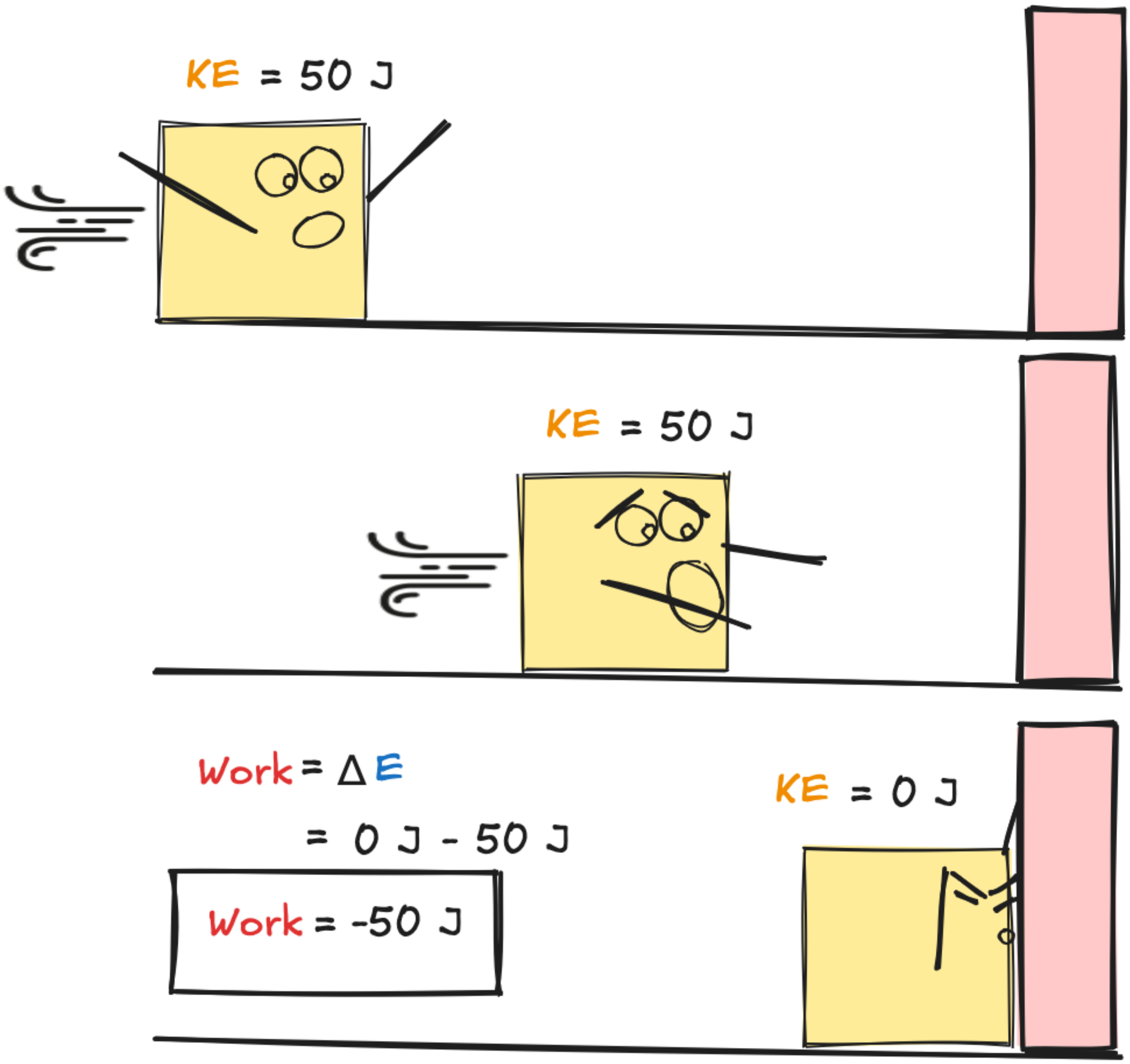
Examples

> You lift Mr. Box (10 kg) in the air. Originally his **gravitational potential energy** was **0 Joules**. By raising him in the air **0.98 meters**, you have done **100 Joules** of **work** on him.



This can also apply to changes in **kinetic energy**:

> Mr. Box is sliding with **50 Joules** of **kinetic energy**. He hits a wall that brings him to a stop (**0 Joules**). The wall did **50 Joules** of work on **Mr. Box**.



NOTE: The work is **negative** because the wall is **taking energy away** from Mr. Box.

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