

Macro-Scale Energy

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What is Energy?

Energy is the ability to do stuff.

It is scalar (has no direction)

It is conserved (like matter is)

It is measured in Joules (J)

Macro-scale → Mechanical Energy

Law of Conservation of Energy

The total energy is neither increased nor decreased in any process. Energy can be transformed from one form to another, and transferred from one body to another, but the total amount remains constant

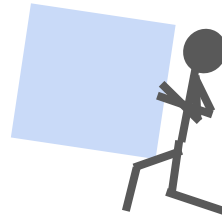
What is Work?

Work is the energy needed to enact a force through some displacement.

$$W = \int \mathbf{F} \cdot d\mathbf{r}$$

work equals force integrated over distance

As long as the box doesn't move no work is done even though effort is being put in.

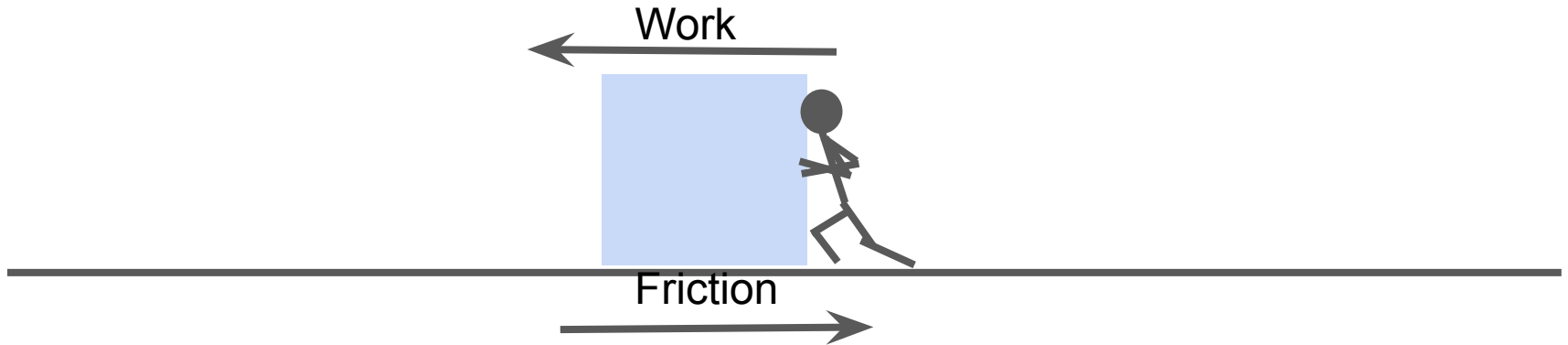


Negative Energy

Forces Against Energy (Friction) do negative work.

Energy put into a system is positive.

Energy taken out of the system is negative.



Kinetic Energy

Kinetic Energy is the energy of motion.

$$KE = \frac{1}{2} mv^2$$

the kinetic energy of an object equals half the object's mass multiplied by the square of its velocity

$$W_{\text{net}} = \Delta KE$$

The net work done on an object is equal to the change in its Kinetic Energy

Potential Energy

Potential Energy is the energy of position or configuration.

$$PE_g = mgh$$

The gravitational potential energy of an object is equal to the product of the object's weight and height.

Potential Energy is independent of the path taken to get to a certain position.

Energy Transformation

Mechanical Energy: Kinetic & Potential

Potential Energy \rightarrow Kinetic Energy (by motion)

Kinetic Energy \rightarrow Potential Energy (by gravity or elasticity)

- Follows Law of Conservation of Energy
- Energy can be taken out of the system through negative energy (like friction)
- Input $>$ Out (due to negative energy)

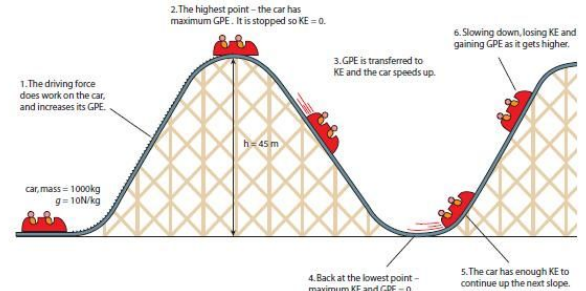


Fig. 9.16 Transferring energy from GPE to KE and back again.

Example

Running \rightarrow KE

Flex the pole \rightarrow PE_E (+ KE)

Lift off the ground \rightarrow PE_E + KE (+ PE_g)

Projectile through air \rightarrow KE + PE_g

Land \rightarrow Sound and heat



Power

Power is the average rate at which work is done or the rate at which energy is transformed.

It is measured in Watts (W) \rightarrow 1 Watts = 1 Joule/Second

$$P = dW/dt$$

power is the rate at which **work** is done over **time**

Something can have very high power w/o using a lot of energy if it releases the energy very quickly.