Potential Energy

Potential energy is energy that is Stored

For example:

food, an object at a height

The type of potential energy we will most focus on is gravitational

This is the energy which is stored due to being at a height above a reference point.

Gravitational potential energy = mgh ← height; mass; $9.8\ m/s^2$

Example: A 2.0 kg object sitting on a table 1.0 m above the floor is lifted 0.5 m. How much gravitational potential energy does it have

a) With respect to the table

$2kg \times 9.8 m/s^2 \times 0.5m$

$= 9.8 \frac{kg \cdot m^2}{s^2} = 9.8J$

b) With respect to the floor

$2kg \times 9.8 \frac{m}{s^2} \times 1.5m$

$= 29.4J$

Example: What is ΔE_p when a 50 kg object is dropped from a height of 20m to 10m?

E_p final $-$ E_p initial

$50 \times 9.8 \times 10 - 50 \times 9.8 \times 20$

$= -4900J$

Practice:

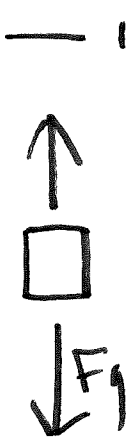
1. How much gravitational potential energy does a 1500 kg car have if a hoist lifts it up to a height of 2.0 m above the floor?

$$E_p = mgh$$
$$= 1500\,kg \times 9.8\,\frac{m}{s^2} \times 2.0\,m$$
$$= 2.9 \times 10^4\,J$$

2. A book of mass 1.2 kg drops from a height of 2.6 m to a height of 0.4 m. What is the value of ΔEp?

$$\Delta E_p = E_{p\,final} - E_{p\,initial} = mgh_f - mgh_i$$
$$= 4.7 - 30.6 = mg(h_f - h_i)$$
$$= -26\,J$$

3. It takes 90J of work to lift an object to a height of 1.2m. What is the mass of the object?



$$W = Fd = F_g d$$
$$= mgd$$

$$90J = mgd$$
$$90J = m \cdot 9.8 \cdot 1.2$$
$$\frac{90J}{9.8 \times 1.2} = m$$
$$7.7kg = m$$

Kinetic Energy

Kinetic Energy is the energy of motion. The faster an object is moving the more energy it has.

Kinetic energy = $\frac{1}{2}mv^2$

Note that energy is not a vector, it does not matter what direction the object is moving.

Example: A 2.0 kg object is moving at 25 m/s. How much kinetic energy does it have?

$E_K = \frac{1}{2}(2kg)\left(25\frac{m}{s}\right)^2 = 625\ J$

$\approx 630\ J$

Example: What is the mass of an object if it has 250 J of kinetic energy and is moving at 5.0m/s?

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

$2E_K = mv^2$

$\frac{2E_K}{v^2} = m$

$\frac{2(250J)}{\left(5.0\frac{m}{s}\right)^2} = 20kg$

Example: What is the velocity of an object if it has 5600 J of kinetic energy and has a mass of 29kg?

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

$2E_K = mv^2$

$\frac{2E_K}{m} = v^2$

$\pm\sqrt{\frac{2E_K}{m}} = v$

$\pm\sqrt{\frac{2\times 5600}{29}}$

$= \pm 19.65\ m/s$

Practice:

1. A 14 object is moving at 276 m/s. How much kinetic energy does it have?

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

$5.3 \times 10^5 J$

2. What is the velocity of an object if it has 840 J of kinetic energy and has a mass of 29kg?

$V = \sqrt{\frac{2E_K}{m}}$

$\pm 7.6 \text{ m/s}$

3. What is the mass of an object if it has 195 J of kinetic energy and is moving at 2.5m/s?

$m = \frac{2E_K}{v^2}$

62 kg

Conservation of Energy

A fundamental law of the universe is the law of conservation of energy:

Energy can not be created nor destroyed, only change forms.

Give an example of a technology which transforms energy from:

Electrical energy into kinetic energy: Electric motor

Electrical energy into light energy: Light bulb

Chemical energy into kinetic energy: Riding a bike

Chemical energy into electrical energy: Battery

Example: A 20.0 kg rock is dropped from a height of 5.0m. It hits the ground at 8.5 m/s. How much heat energy was generated?

E_p it starts with: $mgh = 980\,J$

E_K at end $= \frac{1}{2}mv^2 = 722.5\,J$

E_p at end $= 0$

$E_{heat} = 980J - 722.5J = 260\,J$

Thermal Energy

Thermal energy is the _____ of the molecules and atoms in a substance.

As a substance "heats up" the molecules and atoms that make up the substance move and vibrate more, thus increasing their kinetic energy.

Temperature is the _____ kinetic energy of a substance.

Thermal energy, like all energy is measured in _____

Temperature is measured in degrees Fahrenheit or Celsius or in Kelvin.

Kelvin is based on absolute zero which is the lowest possible temperature, at 0K there is _____.

0 K = _____ $°C$

Specific Heat Capacity

The amount of energy needed to raise the temperature of a substance depends on the chemical structure of that substance. For instance, if you applied 5000 J of heat energy to 1kg of water, copper iron or concrete.