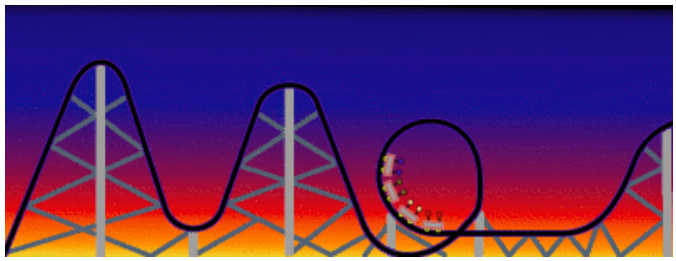
Energy

Energy is the ability to change an object or its environment.

There are different kinds of energies. Moving object have a form of **kinetic energy**. Stored energy is known as **potential energy**.

Remember that work is the transfer of energy by mechanical means.

Energy can change from one form to another. In a rollercoaster for instance, work provides potential energy that gets converted into kinetic energy.



Changing to Kinetic Energy

The kinetic energy of an object is given by the equation

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

mass velocity

This equation means that things that are heavier or going faster can carry a higher kinetic energy.

E_k, like other energies, is measured in joules.

How could you pitch a ball faster?

You could either exert a greater force or increase the distance the force is exerted (increase work!)

According to Newtons second law, F=ma, an object has constant acceleration if a constant net force is acting on it.

Work done is given by the equation:

$$W = Fd$$

Applying Newtons second law

$$W = (ma)d$$

If we assume the object was at rest originally (v_i = 0m/s) then as it accelerates:

$$v_f^2 = v_i^2 + 2ad$$

$$v_f^2 = 2ad$$

$$v^2 = 2ad$$

$$d = \frac{v^2}{2a}$$; where 'a' is constant

So, our work equation now looks like:

$$W = (ma)d$$

That is $W = E_k$; the work done equals the kinetic energy gained by the ball.

Not all object start at rest.

$$W_{net} = \Delta E_k = E_{kf} - E_{ki}$$

This equation represents the **work-energy theorem**. *The net work done on an object is equal to its change in kinetic and potential energies.*

Example

A shotputter heaves a 7.26 kg shot with a final velocity of 7.50 m/s

a) What is the kinetic energy of the shot?

b) The shot was initially at rest. How much work was done on it to give it this kinetic energy?

Try questions 1-4 on pages 221-222

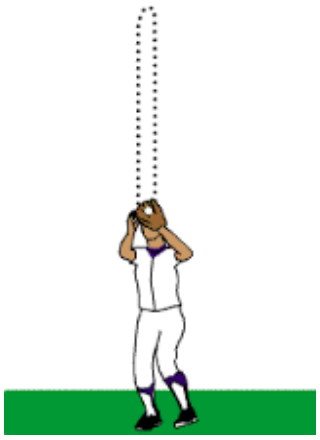
Potential Energy

If you throw a ball up in the air, you do work on it. As it leaves your hand, it has kinetic energy.

The kinetic energy you give the ball is transferred to potential energy at the top of its flight and then back to kinetic energy.

The total energy, E, can be described as the sum of the kinetic and potential energies.

$$E = E_k + E_p$$



How does potential energy depend on height?

As long as the ball is close to Earth, we can use the equation for motion with constant acceleration.

$$v_f^2 = v_i^2 + 2gh$$

where 'h' is the vertical distance measured from the launch height of the ball.

multiply each term by $\frac{1}{2}m$ gives the kinetic energy at any height, h.

$$\frac{1}{2}mv_f^2 = \frac{1}{2}mv_i^2 + mgh$$

This was E_k from earlier

At the start of the flight, h=0. The energy is all kinetic,

$$E = \frac{1}{2}mv_i^2$$

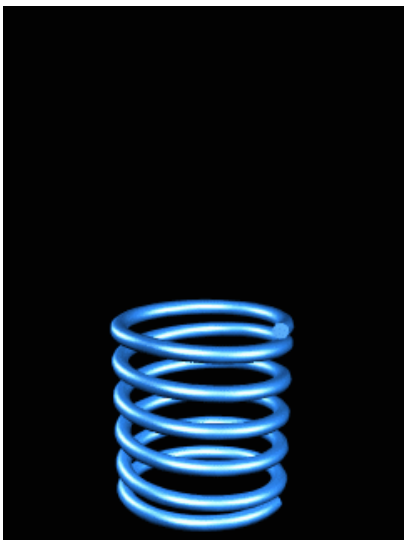
But if $E = E_k + E_p$, then E_p must be equal to the rest of the equation.

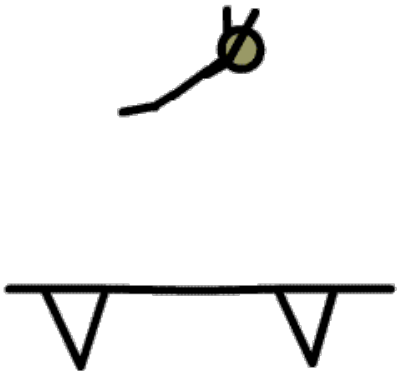
$$E_p = mgh$$

where Ep is the *gravitational* potential energy.

where 'h' is the height, it is a reference point and can be set to zero anywhere. This is called the **reference level**. Once it is set in a problem, it cannot be changed.

Energy can also be stored in the stretching or bending of an object such as metal springs, slingshots, and trampolines. These are all examples of potential energy.





Example

A 2.00 kg textbook is lifted from the floor to a shelf 2.10 meters above the floor.

a) What is the gravitational potential energy relative to the floor.

b) What is its gravitational potential energy relative to the head of a 1.65 m tall person?

Try Questions 5-8 on page 224 and 1.1-1.4 (concept review) on page 226.