Energy

Energy is a scalar physical quantity which expresses the ability of an object to do work. It means that an object which possesses some energy can interact with other objects and cause changes in their positions and velocities. An object with higher energy can do more work. There are many forms of energy – kinetic, potential, thermal, chemical, nuclear etc.

1. Kinetic energy

We start with ***kinetic energy***. The ***kinetic energy*** of an object is the extra energy which it possesses due to its motion. Any moving object possesses kinetic energy. If two objects have same mass, the one with higher speed has higher energy. (I used the word "speed" instead of "velocity" because only the magnitude of velocity is important for the kinetic energy). If the speeds of two moving objects are equal, the object with higher mass will have higher kinetic energy. Kinetic energy can be calculated using the formula:

$$E_{kinetic} = \frac{m \cdot V^2}{2},$$

where ***m*** is mass, ***V*** is speed. The International System unit to measure energy is Joule (J).

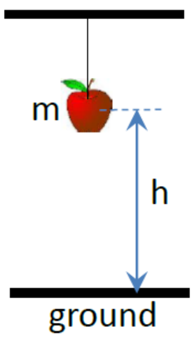
$$1J = 1\frac{kg \cdot m^2}{s^2}$$

2. Potential energy

We can think about potential energy as of the energy "stored" in the system. Unlike kinetic energy which depends on the object's *velocity*, potential energy depends on the *position* of the physical body with respect to other objects with which the body interacts. Expression of potential energy depends on the type of interaction between the objects. Here we discuss how to calculate the potential energy in case of gravity force.

Any object with mass is attracted by Earth. The higher the position of the object is over the ground, the stronger it will hit the ground when it falls. It is natural to assume that potential energy depends on the distance between the object and the ground. Potential energy corresponding to the gravity force can be calculated as:

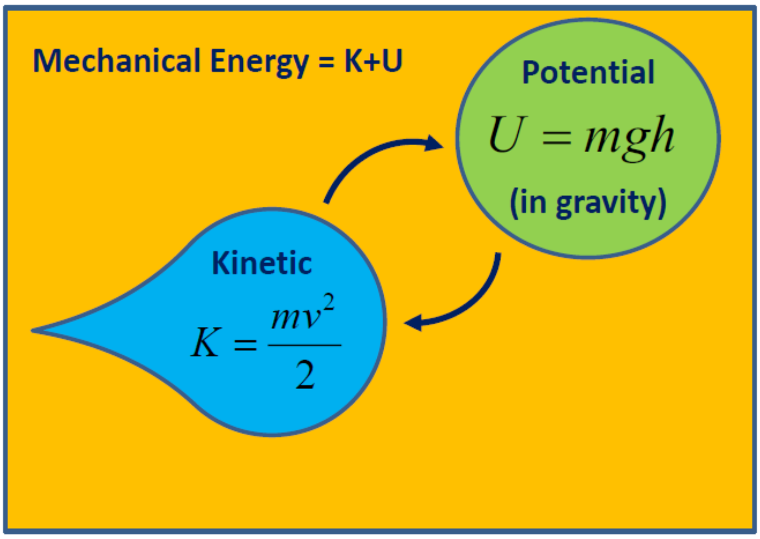
$$E_{potential} = m \cdot g \cdot h$$



Here *m* is the mass of the object; *g* is acceleration due to gravity, *h* is the distance between the object and, say, the ground.

When a stone starts falling it accelerates toward the Earth. The kinetic energy of the stone increases. At first glance it looks like the energy is created as the stone goes down. But this statement is not correct. **The total energy** of the stone **remains constant** as the stone is falling down, in full agreement with the energy conservation law. The total energy of the stone is the sum of potential and kinetic energies. In the highest point kinetic energy is zero and potential energy is maximal. At the lowest point, just before the stone hits the ground, potential energy is minimal and kinetic energy is maximal.

Now we are ready to state **the law of conservation of mechanical energy**. Energy conserves. It means that energy cannot be created or destroyed – it can only be transferred from one form into another. For example, a power plant does not create electrical energy. A power plant converts kinetic energy of water flow or chemical energy of fuel into electrical energy. When a battery of, say, a flashlight is depleted, it does not mean that the energy previously stored in the battery just disappeared. The energy was just converted into thermal energy and energy of light.



Homework:

1) Imagine that both the mass and the speed of a moving object increased 2 times. How did its kinetic energy change?

2) A 10 g bullet is sent up at a speed of 300 m s. How high will it go? Solve this problem in two ways (through kinematics and through energy conservation)

3) It is possible to use the energy of tidal waves to produce electricity. For a first glance this is an eternal (well, almost eternal – as long as the Earth and Moon exist) energy source. Is it true? Explain your answer.

4) A 50 g ball is falling down. As the ball passes a certain distance its potential energy changes by 2 J. Calculate this distance. Does this distance depend on the initial velocity of the ball?