AP Physics Study Guide

Work and Energy

From Simple Studies, https://simplestudies.edublogs.org & @simplestudiesinc on Instagram

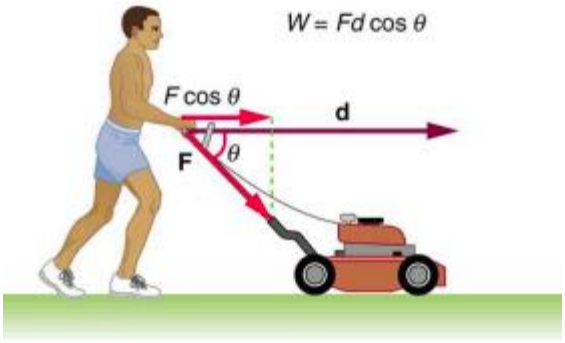
All images are from the Openstax college physics textbook

Conservation of energy is the principle that energy can neither be created nor destroyed

- **Energy** is the ability to do work
- Even as scientists discovered new forms of energy, conservation of energy has always been found to apply

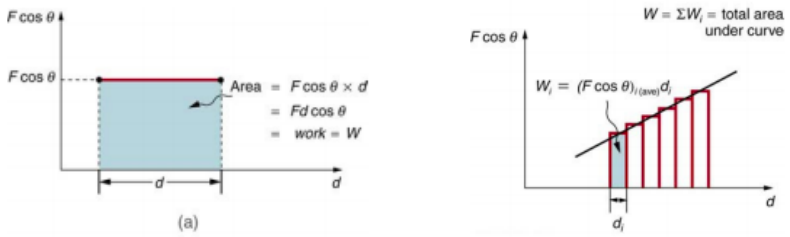
The **work** done on a system by a constant force is defined as the product of the component of the force in the direction of motion times the distance through which the force acts

- $W = Fd\ cos\theta$
  - F is the magnitude of force on the system
  - d is the magnitude of the displacement of the system
  - $\theta$is the angle between the force vector and the displacement vector
- Work and energy are measured in **newton-meters**



Net work is the work done by the net external force F_{net}

- $W_{net} = F_{net} d\ cos\theta$
    - If $\theta = 0$(so cos = 1) then $W_{net} = mad$
        - This eventually leads to $W = .5mv^2 - .5mv_0^2$
            - This expression is called the **work-energy theorem**

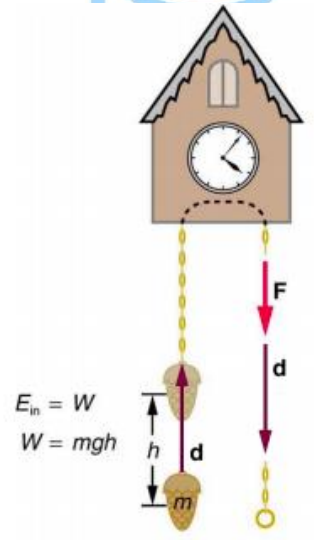


Kinetic energy is the energy an object has by reason of its motion

- $KE = .5mv^2$

Gravitational potential energy is the energy an object has due to its position in a gravitational field

- $PE_g = mgh$
    - This applies for any path that has a change in height

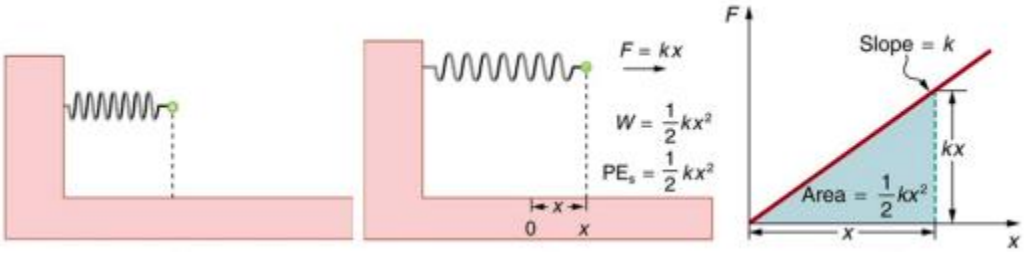


A **conservative force** is one in which work done by or against it depends only on the starting and ending points of a motion and not on the path taken

- **Potential energy** is the energy a system has due to position, shape, or configuration

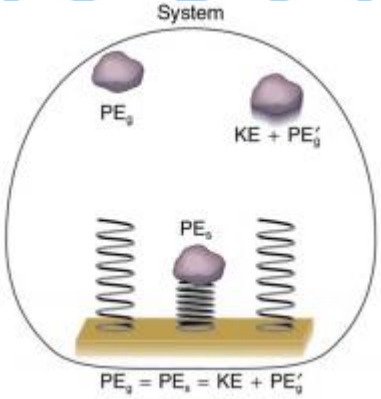
- It is stored energy that is completely recoverable

- The **potential energy of a spring** is the stored energy of a spring as a function of its displacement
  - $PE_s = .5kx^2$
    - x is the distance the spring is compressed or extended
    - k is the spring constant



Conservation of mechanical energy is the rule that the sum of the kinetic energies and potential energies remains constant only if conservative forces act on and within a system

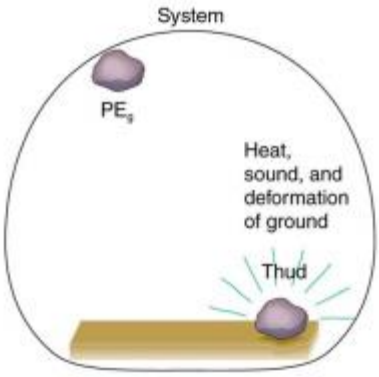
- $KE_i + PE_i = KE_f + PE_f$
- **Mechanical energy** is the total kinetic plus potential energy of a system (KE+PE)



A **nonconservative force** is one in which work depends on the path taken

- It adds or removes mechanical energy from the system

- Ex: Friction causes **thermal energy** that removes energy from the system



Efficiency is a measure of the effectiveness of the input of energy to do work

- $Eff = W_{out}/E_{in}$
  - W_{out} is the useful energy or work output
  - E_{in} is the total energy input

Power is the rate at which work is done

- $P = W/t$
- The unit for power is the **watt**