



Chapter 6: Work and Energy

Essential Concepts and Summary

Work Done by a Constant Force

- ◆ Work is related to force and displacement
- ◆ The force and displacement must be in same direction, or else no work is done
- ◆ Work is a scalar quantity

$$W = (F \cos \theta)s$$

Work-Energy Theorem and Kinetic Energy

- ◆ Kinetic energy KE is related to mass and square of speed
- ◆ Work-energy theorem states the work W done by net external force equals the difference in the objects' kinetic energy
- ◆ Work is positive when KE difference is positive, and negative when KE difference is negative

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

$$W = KE_f - KE_i$$

$$F \cdot s = \Delta KE$$

Gravitational Potential Energy

- ◆ Work done by force of gravity on object m is related to mass, acceleration of gravity, and the change in height of the object
- ◆ Gravitational Potential Energy is energy due to object's position; h is the height of the object relative to **arbitrary** zero level

$$W_{gravity} = mg(h_0 - h_f)$$

$$PE = mgh$$

Conservative vs Non-Conservative Forces

- ◆ Conservative force is one doing same work in moving an object between two points, **independent of the path taken.**
- ◆ A force is conservative when the work done in moving an object around a closed path is zero
- ◆ A force is non-conservative if the work done **is** dependent on the path taken

Conservation of Mechanical Energy

- ◆ Mechanical energy E is the sum of kinetic and potential energy
- ◆ Principle of conservation of mechanical energy states total mechanical energy E remains constant, provided net work done by external non-conservative forces is zero.
- ◆ When object falls, gravitational potential energy is converted to kinetic energy

$$E = KE + PE$$

$$W_{nc} = E_f - E_0$$

$$E_i = \frac{1}{2}mv^2 + mgh = mgh$$

$$E_f = \frac{1}{2}mv^2 + mgh = \frac{1}{2}mv^2$$

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

$$v = \sqrt{2gh}$$

Power

- ◆ Average power is the work done per unit time
- ◆ It is also the rate at which energy changes
- ◆ When a force acts on an object with an average speed, the average power is direct multiplication of the force and speed

$$\bar{P} = \frac{\Delta Work}{\Delta Time}$$

$$\bar{P} = \frac{\Delta Energy}{\Delta Time}$$

$$\bar{P} = F \bar{v}$$

Other Forms of Energy and the Conservation of Energy

- ◆ Energy exists in many forms, such as kinetic, potential, chemical, heat, etc...
- ◆ Principle of Conservation of Energy tells us **Energy can neither be created nor destroyed, but can only be converted from one form to another**

Work Done by a Variable Force

- ◆ Work done by a variable force in moving an object is equal to the area under a graph of $F \cos(\theta)$ vs s

