Physics 161
Lecture 7
Work and Energy

September 27, 2016
Lecture 7: learning objectives

This lecture
You will be able to calculate the work done by a force.

You will be able to define kinetic energy and apply the work-energy theorem, and categorize forces as conservative or non-conservative.

You will be able to apply the concepts of kinetic and static friction to single- and multiple-body problems.
**Work**

**Work done:**
The work done by a force, on an object, is the product of the displacement of the object and the component of the force parallel to that displacement.

\[ w = F_x \Delta x \quad w = (F \cos \theta) \Delta x \]

Work done has the same units as energy (Joules or J).

**Conservative forces:**
A force is conservative if the work the force does moving an object between two points is independent of the path taken between those points.

**Nonconservative forces:**
A force is nonconservative if the work the force does moving an object between two points depends on the path taken between those points.
Energy

**Kinetic energy:**
Energy of an object in motion, equal to half the product of the object’s mass and speed-squared.

\[ E_K = \frac{1}{2} mv^2 \]

**Work-energy theorem:**
The net work done on an object is equal to the change in the object’s kinetic energy.

\[ \mathcal{W}_{\text{net}} = \Delta E_K \]
Gravitational potential energy:
Gravitational potential energy of a system consisting of the Earth and an object near the Earth’s surface is given by the product of the object’s mass $m$, the acceleration due to gravity, $g$, and the vertical position of the object, $y$.

\[ E_P = mgy \]
Springs

Hooke's law:
The force exerted by a spring is proportional to the negative of the displacement of the spring's end.

\[ F_S = -k \Delta x \]

Elastic potential energy:
The energy associated with the spring force is given by half the product of the spring constant and the displacement-squared.

\[ E_P = \frac{1}{2} kx^2 \]
Conservation of Mechanical Energy

Conserved quantity:
A physical quantity is conserved when its numeric value is constant throughout some physical process.

Total mechanical energy:
The total mechanical energy is the sum of kinetic and potential energies of an object.

\[ E_T = E_P + E_K \]

Conservation of mechanical energy:
The total mechanical energy is conserved for isolated systems of objects interacting only through conservative forces.
Conservation of Energy

Conservation of energy:
Energy can neither be created nor destroyed, only transferred from one form to another.