Physics 161

Lecture 7

Work and Energy

September 26, 2017

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.

$$w = F_x \Delta x \qquad w = (F\cos\theta)\Delta x$$

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.

$$E_{\mathrm{K}} = \frac{1}{2}mv^2$$

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

$$w_{\mathrm{net}} = \Delta E_{\mathrm{K}}$$

Potential Energy

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.

$$E_{\mathrm{P}} = mgy$$

Springs

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

$$F_{\mathrm{S}} = -k\Delta x$$

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

$$E_{\mathrm{P}} = \frac{1}{2}kx^2$$

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.

$$E_{\mathrm{T}} = E_{\mathrm{P}} + E_{\mathrm{K}}$$

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.