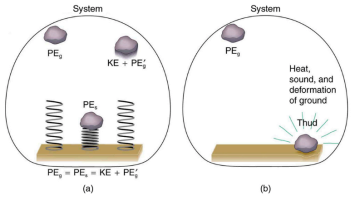
Introduction to Physical Science

Conservation of Energy

Presented by Robert Wagner

Nonconservative Forces

- Example: Frictional force
  - Work done against friction depends on the path taken
  - Friction - convert to thermal energy, removing energy from the system
- Work done by a nonconservative force can add or remove mechanical energy from a system



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Work-Energy Theorem

- Net work = change in mechanical energy of the system
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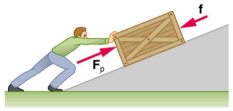
  -
- If we push a box up a ramp, it gains mechanical energy. So, the work done by the person is greater than the work done by friction.



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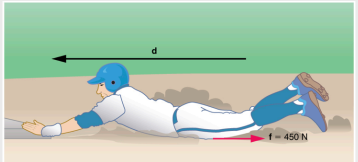
Example

- Calculate the distance a 65.0 kg baseball player slides, given that the initial speed was 6.00 m/s and the force of friction is a constant 450. N.
  - Draw a sketch
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve



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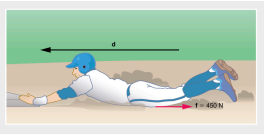
Example



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$m = 65.0\,kg\,;\; v_i = 6.00\,m/s\,;\; f = 450.\,N$

$KE_i + PE_i + W_{nc} = KE_f + PE_f$

$KE_i + W_{nc} = 0$

$\frac{1}{2}mv_i^2 - fd = 0$

$d = \frac{mv_i^2}{2f} = \frac{(65.0kg)(6.00m/s)^2}{(2)(450.N)}$

$d = 2.60\,m$

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Law of Conservation of Energy

- The total energy in any process is constant
  - The form of energy may change
  - The energy can be transferred from one system to another
- Examples of different forms of energy
  - Kinetic and Potential energy
  - Electrical energy, Chemical energy, Radiant energy, Nuclear energy, Thermal energy

Problem Solving Strategies for Energy

- Determine the system and the quantity to be calculated - make a sketch
- Examine all forces involved
  - Conservative forces?
  - Nonconservative forces?
- Eliminate terms when possible
  - Ex: Choose initial or final height to be 0
- Check that the answer is reasonable
  - Does the velocity make sense?

Transformation of Energy

- Conversion takes place all the time
  - Chemical energy in food —> Thermal energy
  - Photosynthesis: Light energy —> Chemical energy
  - Boiler: Chemical energy —> Thermal energy —> Mechanical energy —> Electrical energy
  - Solar cell: Light energy —> Electrical energy

Efficiency

- The output of useful energy will always be less than the energy input
  -
  - Examples:
    - Gasoline engine = 30%
    - Gas heater = 98%
    - Swimming = 4%
    - Steam engine = 17%

Summary

- Nonconservative forces can add or remove mechanical energy from a system
- Friction is a common example of a nonconservative force
- The efficiency of the transfer of energy conversion varies, but is always less than 100%