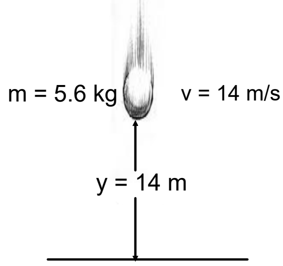
AP Phys 1 Unit 7.5 Notes - Conservation of Energy

7.5 – Conservation of Energy

1. Review and Lead-In!

Consider this picture:



A. How much kinetic energy does the ball have?

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

$= \frac{1}{2} \bullet 5.6kg \bullet (14m/s)^2 = 550J$

B. How much gravitational potential energy?

$\Delta U_g = mg\Delta y$

$= 5.6kg \bullet 9.81m/s^2 \bullet 14m = 770J$

C. How much total energy? $550J + 770J = 1320J$

Total Mechanical Energy (Symbol = E)

The sum of kinetic and potential energy of a system is its Mechanical Energy.

E = K + U	K = kinetic energy (J) U = potential energy (J)

Note 1: Potential energy could be from any source (gravitational, spring, etc.).

Note 2: This works in a conservative system (no friction).

Force Types

Conservative force: work done is independent of the object's path.

Ex: gravity. Under frictionless conditions, work done by gravity: W = ΔU

Nonconservative: work done depends on path length.

Ex: friction. The longer the path, the more work it'll take to move: W = Fd

Conservation of Energy

Energy is transferred within systems (non-conservative, and conservative), not created or destroyed.

Transfers can be complex, but total energy is equal when measured at an initial and final condition.

One upshot: the energy in the universe is constant.

Total Energy: Conservative Systems

Mechanical energy is the same at any point of a conservative process:

$E_1 = E_2$	E_1 = initial energy E_2 = final energy

By finding kinetic and potential energy (initial and final), you can calculate other parameters.

2. Conservative System Example

A dropped 2.0 kg ball falls 16 meters.
How fast is it when it hits the ground?

Hint: initial gravitational potential = final kinetic energy:

$$E_1 = E_2$$

$$\Delta U_g = K$$

$$mg\Delta y = \frac{1}{2}mv^2$$

$$g\Delta y = \frac{1}{2}v^2$$

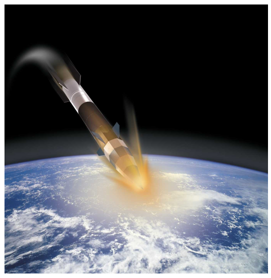
$$v = \sqrt{2g\Delta y} = \sqrt{2 \bullet 9.81\,m/s^2 \bullet 16\,m} = 17.7\,m/s$$

Energy: Non-conservative Systems

In a non-conservative (nc) system (with friction), some mechanical energy is lost as heat.

Work done by friction equals energy change:

$$W_{nc} = \Delta E = E_2 - E_1$$

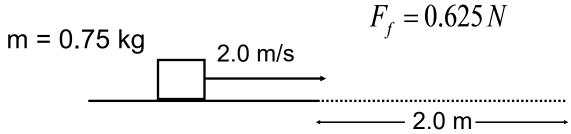


3. Non-Conservative Example

A 0.75 kg block sliding at 2.0 m/s travels 2.0 m over a rough surface, experiencing a frictional force of 0.625 N.

How fast is the block going after that?

$$F_f = 0.625\,N$$



3. Non-Conservative Example

Friction work equals total mechanical energy change.

A. Calculate initial kinetic energy:

$$K_1 = \frac{1}{2}mv_1^2$$

$$= \frac{1}{2} \bullet 0.75\,kg \bullet (2.0\,m/s)^2 = 1.5\,J$$

3. Non-Conservative Example

B. Calculate frictional work (will be negative):

$$W_f = F_f \bullet d$$

$$= 0.625\,N \bullet 2.0\,m = -1.25\,J$$

C. Mechanical energy = kinetic energy in this problem (no elevation change); subtract frictional work from initial energy to get final kinetic energy:

$$W_f = \Delta K = K_2 - K_1$$

$$K_2 = \Delta K + K_1$$

$$= -1.25\,J + 1.5\,J = 0.25\,J$$

3. Non-Conservative Example

D. Final velocity:

$$K_2 = \frac{1}{2}mv_2^2$$

$$v_2 = \sqrt{\frac{2 \bullet K_2}{m}} = \sqrt{\frac{2 \bullet 0.25\,J}{0.75\,kg}} = 0.82\,m/s$$

Homework

Read 5.6 in your book
7.5 Problems in your Booklet
Due: next class