# Energy Storage Mechanisms

## Kinetic Energy ($E_k$)

$$E_k = \frac{1}{2} m v^2$$

$m$ = mass (kg)
$v$ = speed (m/s)

- Energy stored in a moving object
- object is included in system

## Dissipated Energy ($E_{diss}$)

- Work done by the friction force
- surface is included in the system
- later we will call this internal energy in the thermodynamics chapters
  - Energy stored as random molecular motion
  - This energy can only <u>increase</u>

## Gravitational Energy ($E_g$)

$$E_g = mgh$$

$m$ = mass (kg)
$g = 9.8 \frac{N}{kg}$
$h$ = height (m)

- Energy stored as position in a gravitational field
- Earth or gravitation source is included in system

## Elastic Energy ($E_{el}$)

$$E_{el} = \frac{1}{2}kx^2$$

$k$ = spring constant ($\frac{N}{m}$)

$x$ = distance from equilibrium (m)

- Energy stored in an ideal spring.
- Spring is included in system.

Other energy storage mechanisms exist, but this is all we need for mechanical motion.

## Energy Diagrams

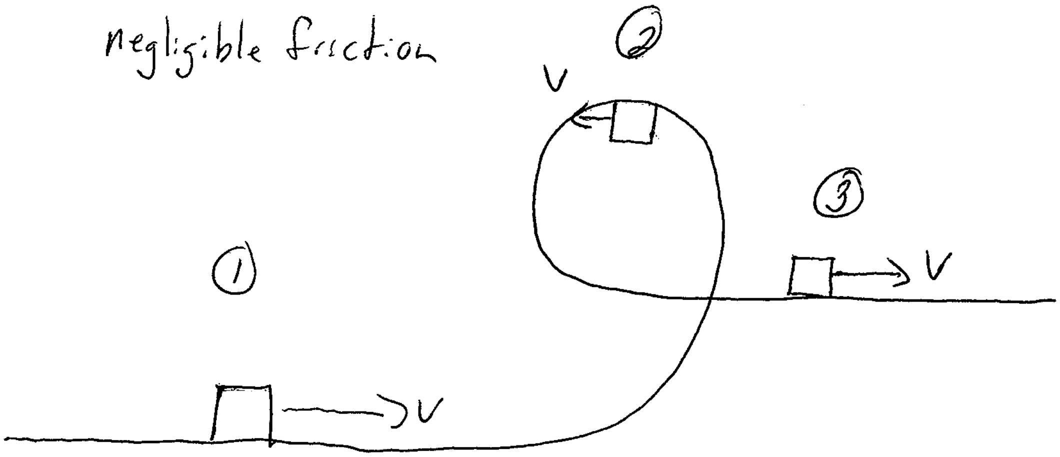
- Pie chart that shows how energy is stored in a system.
- The system is an object or collection of objects that are of interest.

* Choice of a system will involve how we would like to store energy.

# Energy Diagram Example

Each snapshot in time is (①, ②, 3) characterized by a unique energy diagram.

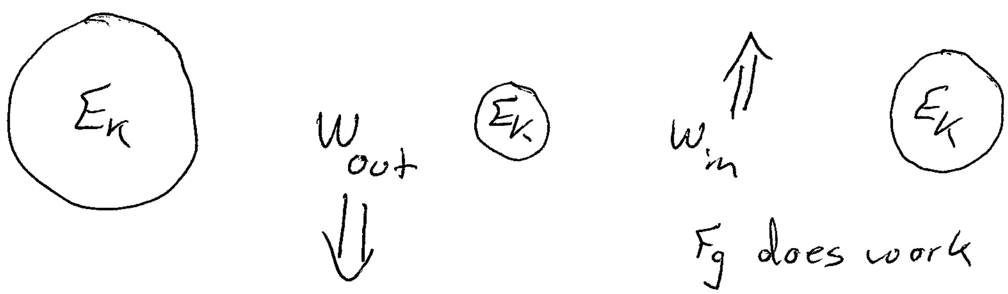
negligible friction




System

box

① ② ③

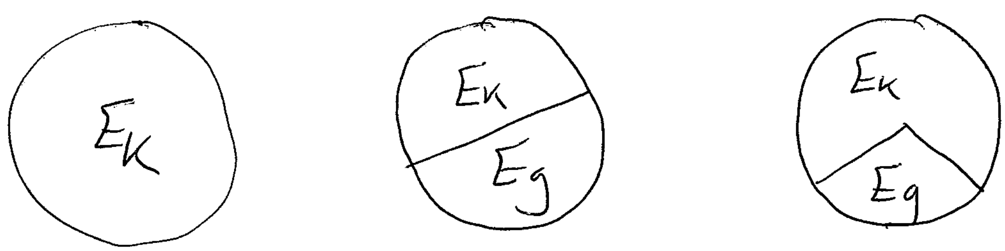



$F_g$ does work transferring energy out of box

$F_g$ does work transferring energy into box

box

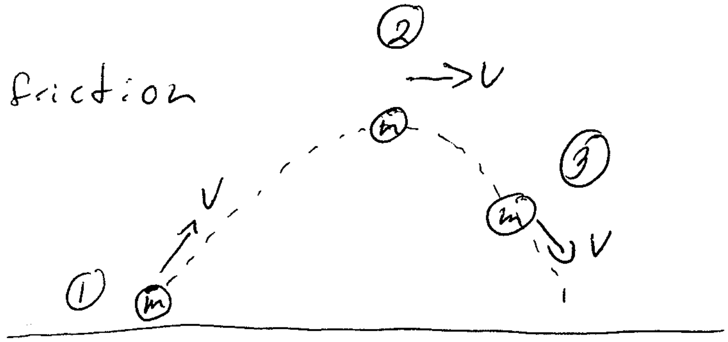
Earth



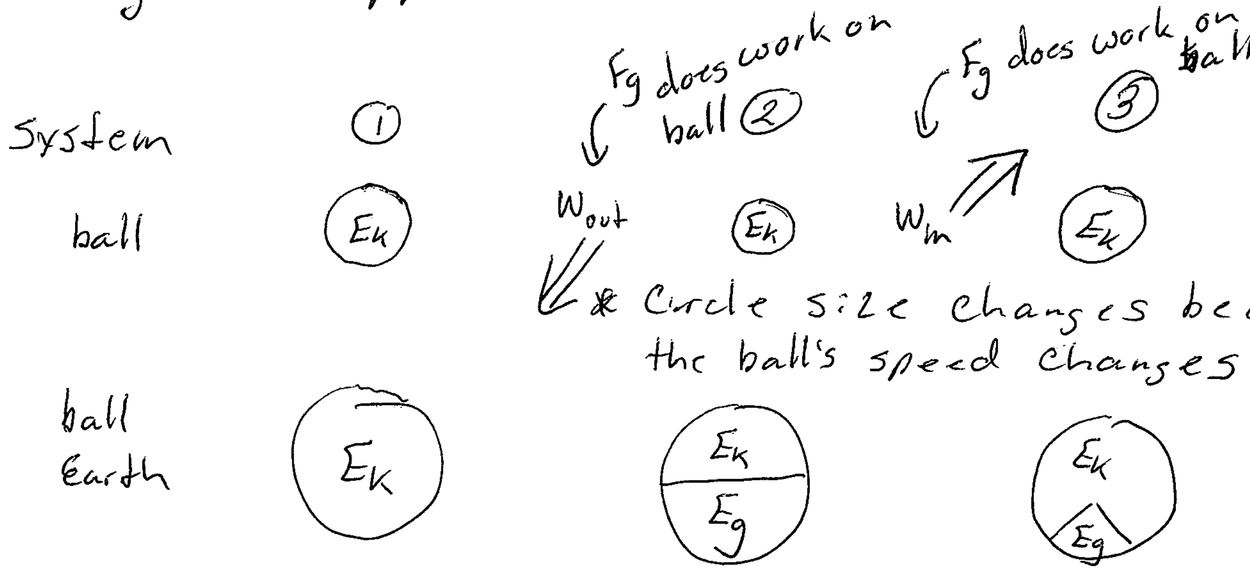

System is large enough so that all energy transfers are internal to the system.

# Energy Diagram Examples

negligible/no friction with air




Each snapshot in time (1, 2, 3) shows the system in a different state. An energy diagram applies to only one state.




* Circle size changes because the ball's speed changes

* Circle size is constant because the system is large enough to account for all energy transfers that occur during the motion

# Conservation of Energy

- Concept that is useful for analyzing the energy states of a system.

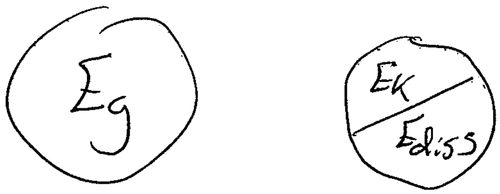
- If the "correct" system is chosen all energy transfers are internal to the system.

In such a case we say that system energy is constant or conserved.

* When circle sizes are the same we can equate energy equations associated with the diagrams


$$E_g = E_K$$

$$mgh = \frac{1}{2} m v^2$$




$$E_g = E_k + E_{diss}$$

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

This is why it is most useful to choose a system where all energy transfers are internal.

Another way to state energy conservation

$$\Delta E_{Total} = 0$$

$$\Delta E_{Total} = \Delta E_k + \Delta E_g + \Delta E_{el} + \Delta E_{diss} = 0$$