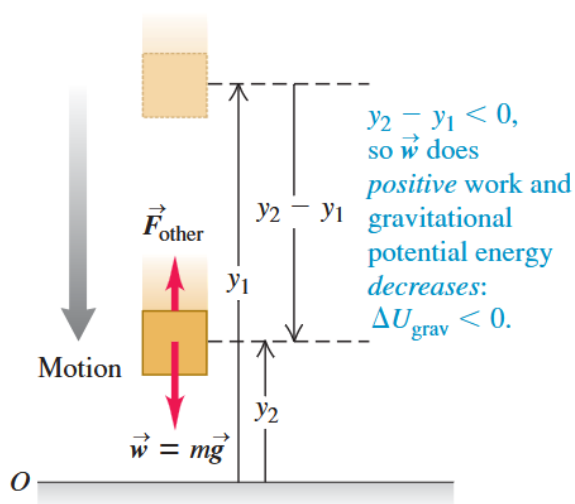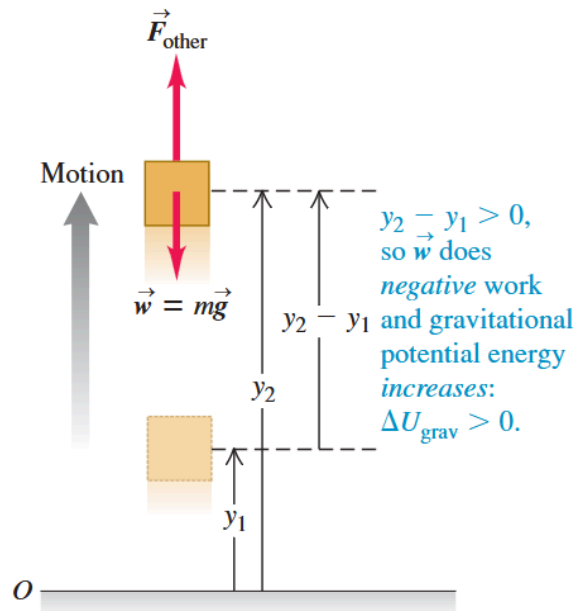# 7. Potential Energy and Energy Conservation

The energy associated with the *position* of bodies in a system is called the *potential* energy. The measurement of the *potential* or the *possibility* for work to be done. When something is raised, there is a potential for work to be done by the gravitational force.

Gravitational Potential Energy

(a) A body moves downward

$y_2 - y_1 < 0$, so $\vec{w}$ does *positive* work and gravitational potential energy *decreases*: $\Delta U_{grav} < 0$.

$\vec{F}_{other}$

$y_2 - y_1$

y_1

Motion

y_2

$\vec{w} = m\vec{g}$

O

(b) A body moves upward

$\vec{F}_{other}$

Motion

$\vec{w} = m\vec{g}$

$y_2 - y_1 > 0$, so $\vec{w}$ does *negative* work and gravitational potential energy *increases*: $\Delta U_{grav} > 0$.

$y_2 - y_1$

y_2

y_1

O

$$U_{grav} = mgy$$

Whenever the gravitational potential increases rises (lifted up), negative work is done, as the negative work is being contributed/accumulated to the potential energy. And whenever the gravitational potential energy decreases, positive work is done, as the potential energy is being converted to the work done:

$$W_{grav} = U_{grav,1} - U_{grav,2} = -\Delta U_{grav}$$

Conservation of Mechanical Energy (Gravitational Forces Only)

if only gravity does work:

$$K_1 + U_{grav,1} = K_2 + U_{grav,2}$$

the total mechanical energy (if only gravity does work) is given by:

$$E = K + U_{grav}$$

Obeying law of conservation of energy, the E will be the same throughout whole motion

When Forces other than Gravity does Work

$$K_1 + U_{grav,1} + W_{other} = K_2 + U_{grav,2}$$

Elastic Potential Energy

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

similar to gravitational potential energy, the work done by the elastic energy is negative of the potential, and vice versa

$$W_{el} = -\Delta U_{el}$$

if only the *elastic force* is present:

$$K_1 + U_{el,1} = K_2 + U_{el,2}$$

Situations where both Gravitational and Elastic Potential Energy

$$K_1 + U_1 + W_{other} = K_2 + U_2$$

The work done by all forces other than the gravitational force or elastic force equals the change in the total mechanical energy of the system $E = K + U$,

where $U = U_{grav} + U_{el}$ is the **sum of the gravitational potential energy and the elastic potential energy**.

Force and Potential Energy

$$F_x(x) = -\frac{d\,U(x)}{dx}$$