



$$W_{\text{res}} = W_{\text{either}} + W_g = \Delta K \quad \text{or} \quad W_{\text{either}} = \Delta K + \Delta U = (K_2 + U_2) - (K_1 + U_1) = \Delta E_{\text{mech}}$$
$$W_g = -\Delta U$$

## Elastic Potential Energy

elastic body: returns to original shape and size after being deformed

$$F_s = -kx$$

$$W_s = \int_{x_i}^{x_f} F_s dx = -\frac{k}{2}(x_f^2 - x_i^2) = -\Delta U_{el} = \Delta K = K_f - K_i$$

$$\Rightarrow K_f + U_{el,f} = K_i + U_{el,i}$$

gravitational potential energy, elastic potential energy, other forces

$$W_g + W_{el} + W_{other} = \Delta K$$

$$U_{g,f} - U_{g,i} + U_{el,f} - U_{el,i} + W_{other} = K_f - K_i$$

chg in total mechanical energy of the system (mass, Earth, spring)

$$W_{other} = (K_f + U_{g,f} + U_{el,f}) - (K_i + U_{g,i} + U_{el,i}) = \Delta E_{mech}$$

## Law of Conservation of Energy

chg in internal energy

$$\Delta K + \Delta U + \Delta U_{int} = 0$$

$$\Delta U_{int} = -W_{other}$$

"energy is never created or destroyed, it only changes form"

## Force and Potential Energy

so far, we've started w/ description of force, calculated work, defined potential energy.

if instead we are given a potential energy function of position, how to find corresponding force?

Ex: motion along x-axis, under conservative force  $F_x(x)$ , pot. en  $U(x)$ .

$$W = -\Delta U$$

$$\text{For small displacements } \Delta x, \Delta W = F_x(x) \Delta x = -\Delta U \Rightarrow F_x(x) = -\frac{\Delta U}{\Delta x}$$

$$\Rightarrow F_x(x) = \lim_{\Delta x \rightarrow 0} \frac{-\Delta U}{\Delta x} = -\frac{dU}{dx}$$