Conservation of Energy

- We can define a quantity which is conserved in all physical processes: Energy
- Power: Only consider initial and final states
- There are different manifestations of that quantity
- e.g. Kinetic Energy: $K = \frac{1}{2} m v^2$

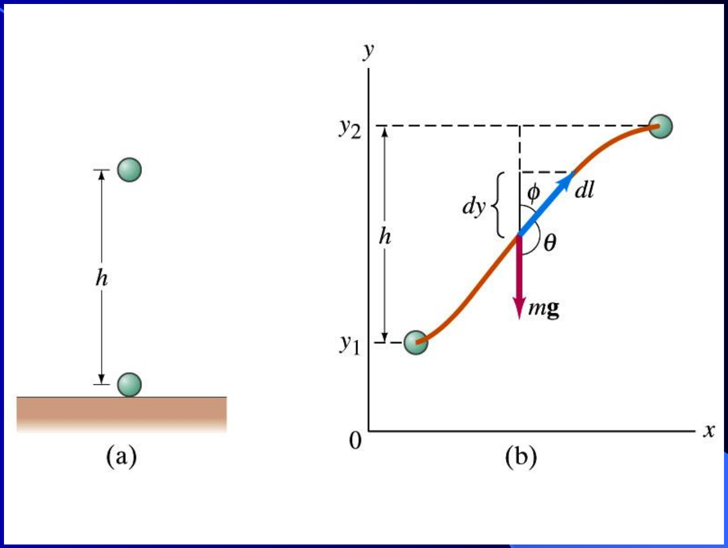
Conservation of Energy: The total Energy is neither increased nor decreased in any process. Energy can be transformed from one form to another, and transferred from one body to another, but the total amount remains constant.

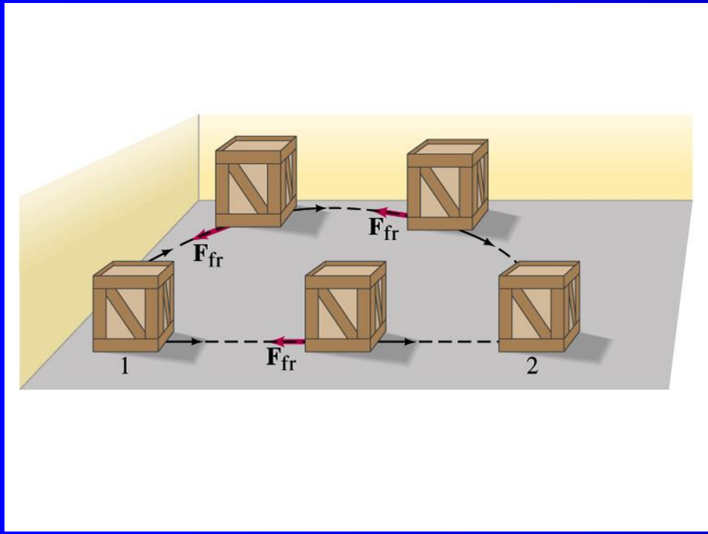
• To better define energy let’s first look at forces

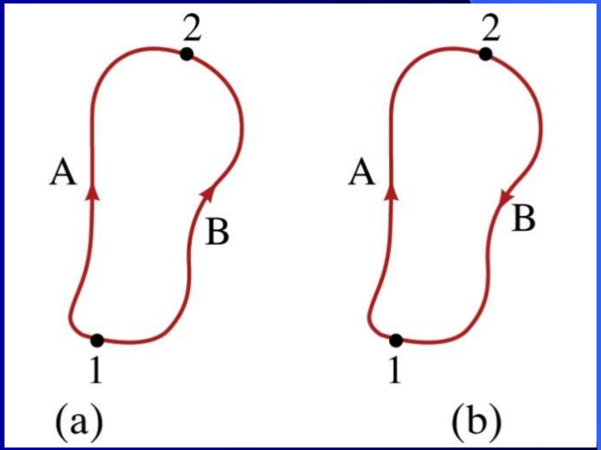
(Non)Conservative Forces

- There are two types of forces:

- Conservative Forces:
  Work is path independent
- Nonconservative Forces:
  Work is path dependent

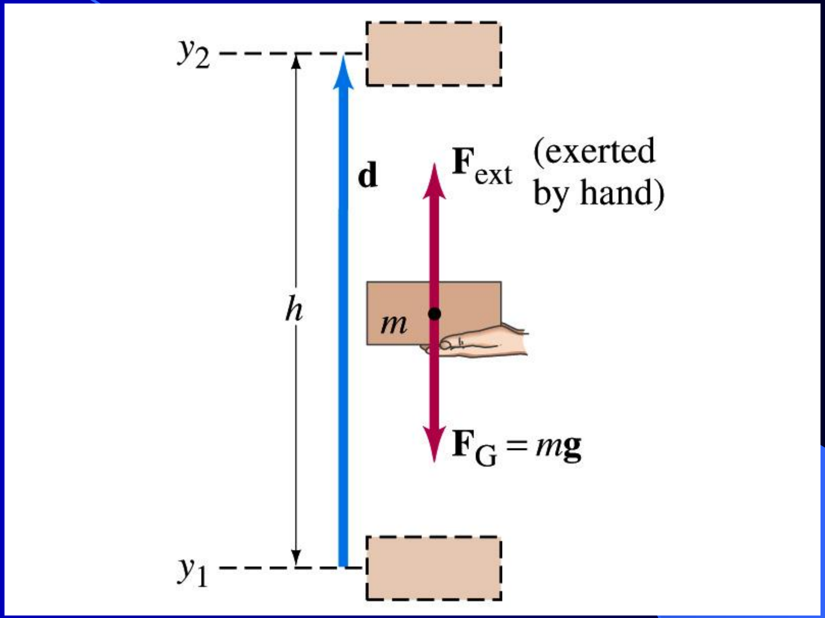






Potential Energy

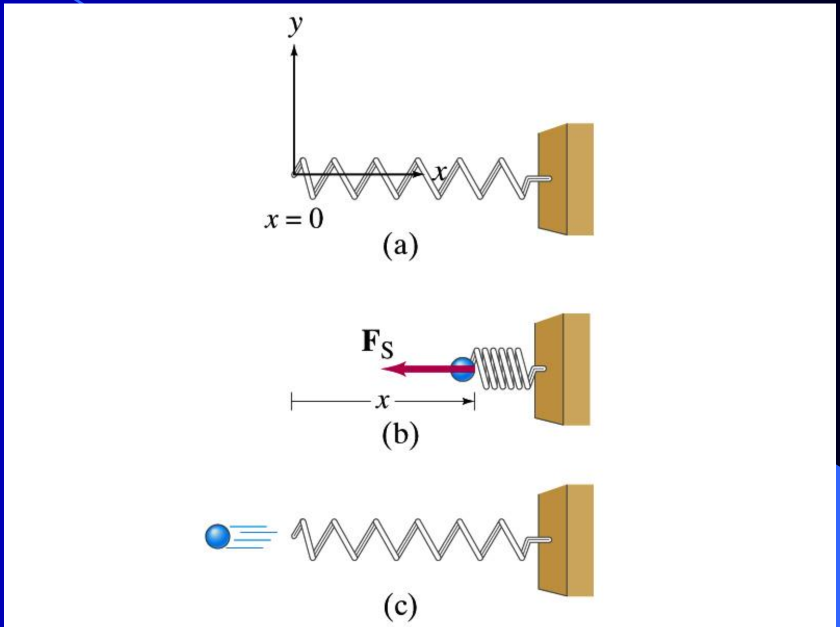
- $W_{ext} = \mathbf{F_{ext}}\ \mathbf{d} = mg\ h \cos 0° = mgh = mg\ (y_2 - y_1)$
- Same work done if path is different
- Conservative Force



- $W_{ext} = mg\ (y_2 - y_1) = mgy_2 - mgy_1 = U_2 - U_1 = \Delta U$
- Define potential energy: U=mgy (or U=mgy+C)

Potential Energy

- $\Delta U = -W_G$ (= $-\int \mathbf{F}_G\, d\mathbf{l}$)
- $\Delta U = U_2 - U_1$ (= $-\int \mathbf{F}\, d\mathbf{l} = -W$)
- Only for conservative forces
- Spring: $\Delta U = U(x) - U(0) =$
  (= $-\int \mathbf{F}\, d\mathbf{l} = -\int (-kx)\, dx$ =) $\frac{1}{2} k x^2$



- $U(x) = \frac{1}{2} k x^2$
- $E = K + U$, E = const., $E_1 = K_1 + U_1 = K_2 + U_2 = E_2$
- Determine force and do problems