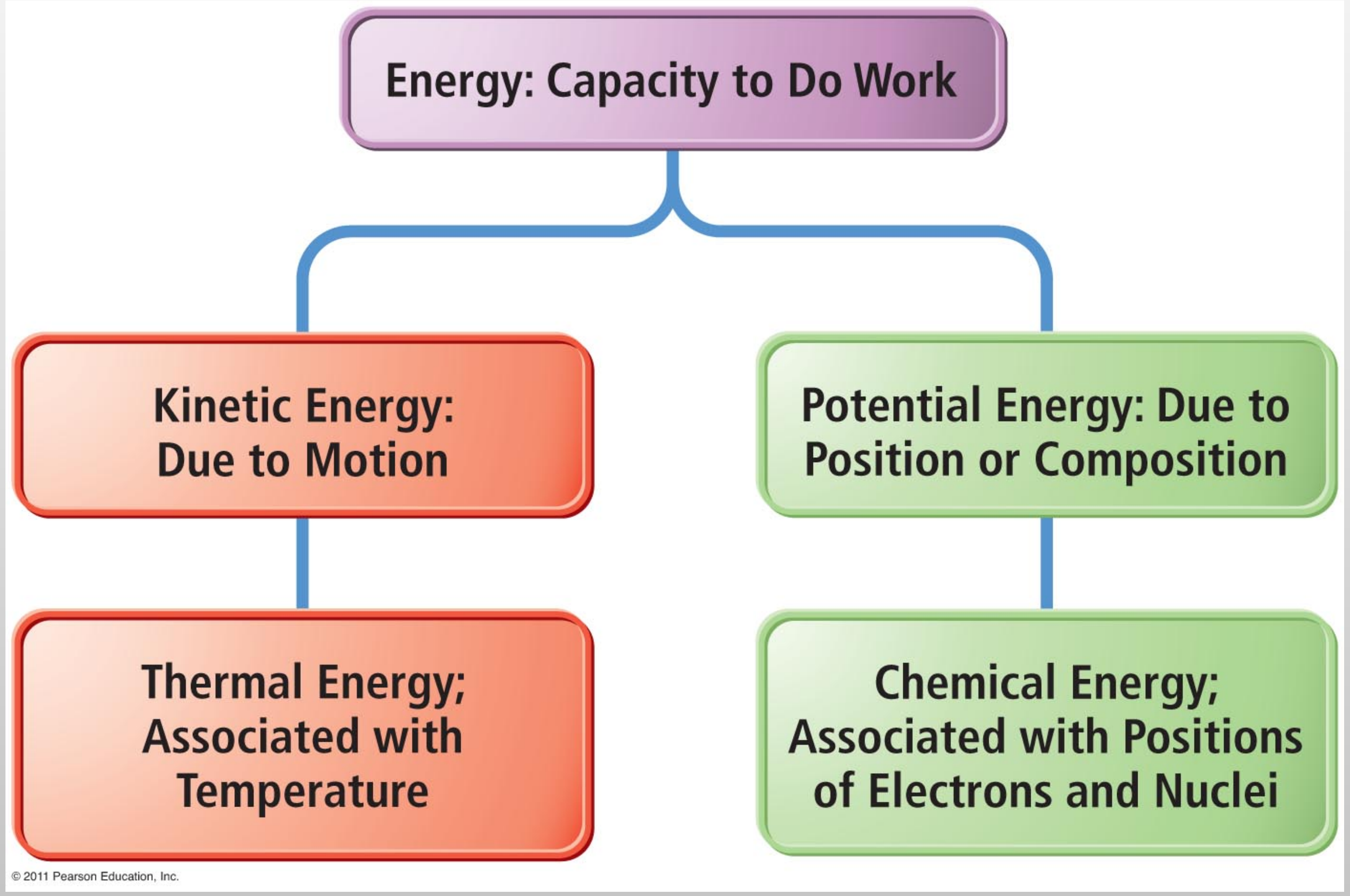
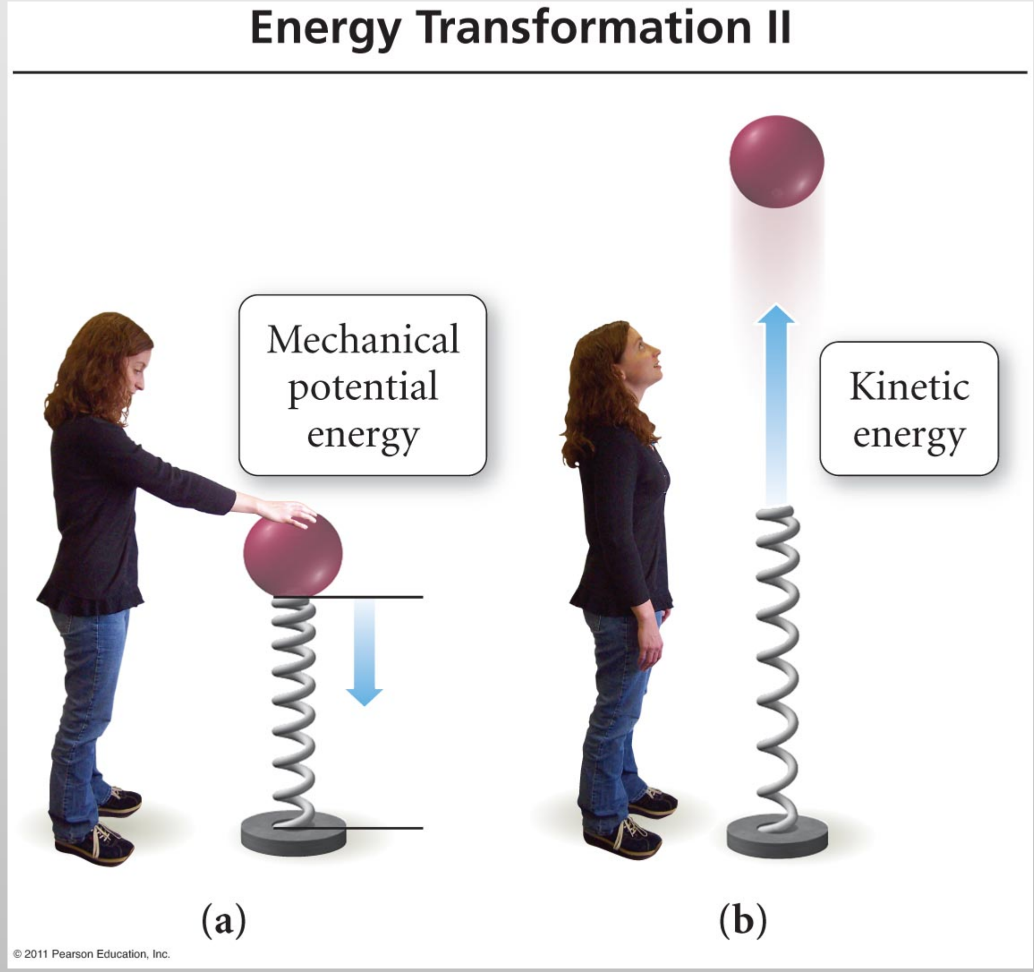
Forms of Energy



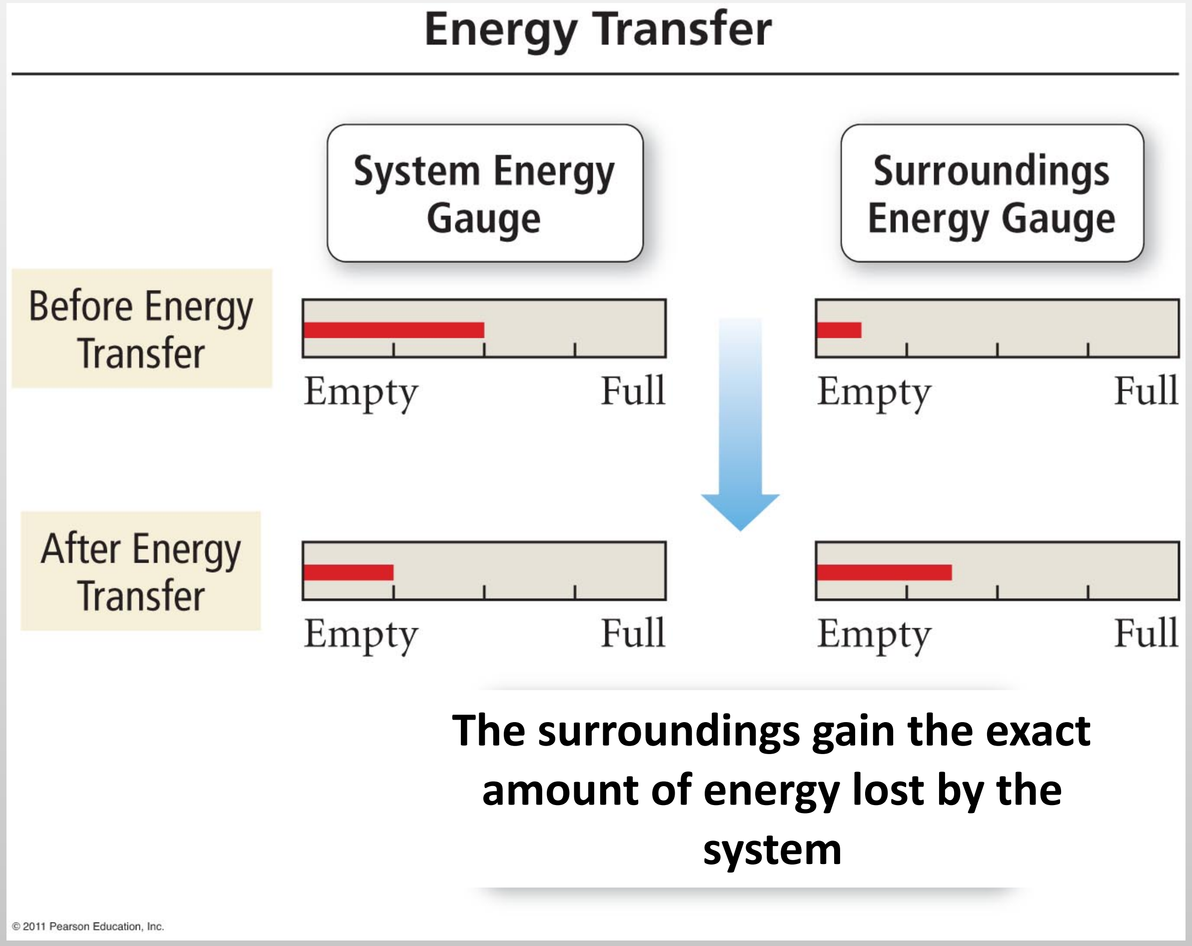
First Law of Thermodynamics
(Law of Conservation of Energy)

The energy in the universe is constant

" Energy cannot be created or destroyed, it can only be transformed from one form to another"



Energy Transfer



Unit of energy

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

$kg(ms^{-1})^2$

very often use

$1000\,J = 1\,kJ$

$1\,kg\,m^2s^{-2} = 1\,J$ (Joule)

$1\,kWh = 3.60 \cdot 10^6\,J$

another unit: $1\,cal = 4.184\,J$

Gericke eats 48000 kJ

recommended intake 2550 Cal

1 Cal (nutritional) = 1000 cal

food intake $= 48000\,kJ \cdot \frac{1\,cal}{4.184\,J} \cdot \frac{1000\,J}{1\,kJ} = 11\,472\,275\,cal$

nutritional Cal $= 11\,472\,275\,cal \cdot \frac{1\,Cal}{1000\,cal} = 11472\,kcal$

Internal Energy

Internal energy is the sum of the kinetic and potential energies of all particles that compose the system

Internal energy is <u>a state function</u>

state function: value depends only on the state of the system and not on how it arrived at the state

change in altitude:
611 m − 159 m = 452 m

pot. E. change = pot. E.$_{wach.}$ − pot. E.$_{WPI}$

$$= m \cdot g \cdot h$$

$$= 60\,kg \cdot 9.81\,ms^{-2} \cdot 452\,m$$

$$= 266\,04\,kg\,m^2 s^{-2} = 266\,04\,J = 26.6\,kJ$$

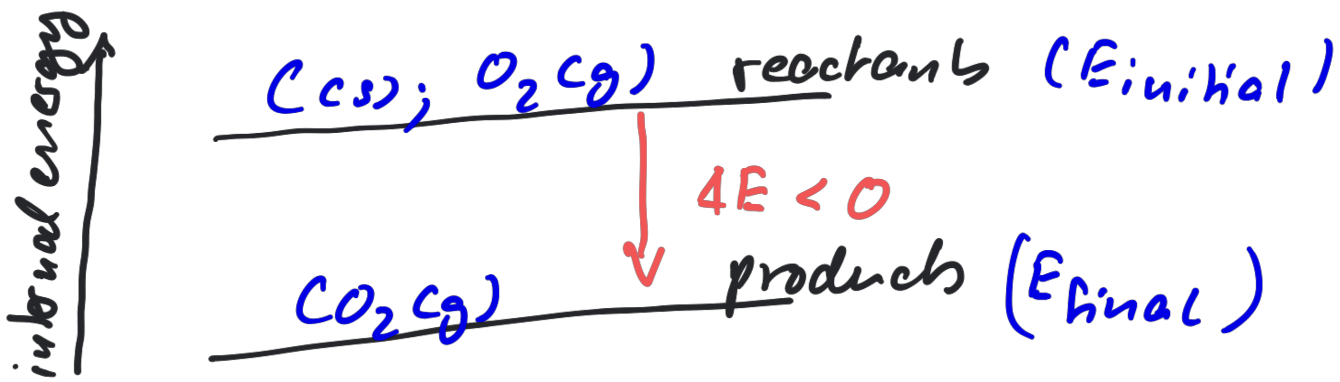
Internal energy change:

$$\Delta E = E_{final} - E_{initial}$$

chemical system:

final state: products
initial state: reactants

$$C(s) + O_2(g) \longrightarrow CO_2(g)$$



$$\Delta E = E_{final} - E_{initial}$$

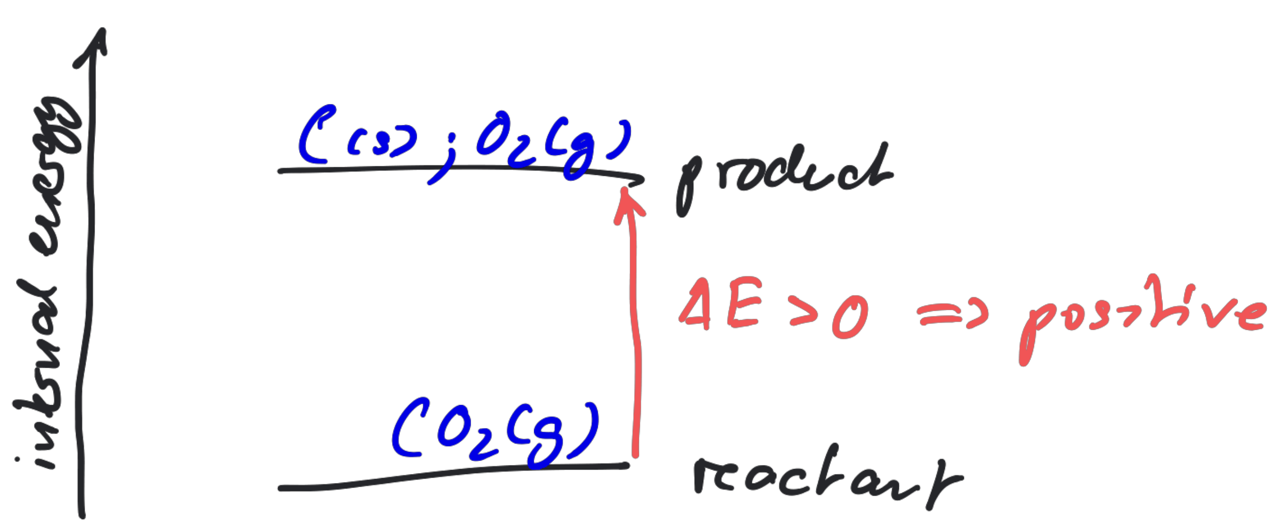
$E_{final} < E_{initial} \Rightarrow \Delta E$ is negative where does the energy go lost by the reactants ?

system $\xrightarrow{\text{energy flow}}$ surroundings

$\Delta E_{sys.} < 0$ $\quad\quad$ $\Delta E_{surr} > 0$

$$\Downarrow$$

$$\Delta E_{sys.} = -\Delta E_{surr}$$



Sign Conventions for Heat, Work and Internal Energy Change

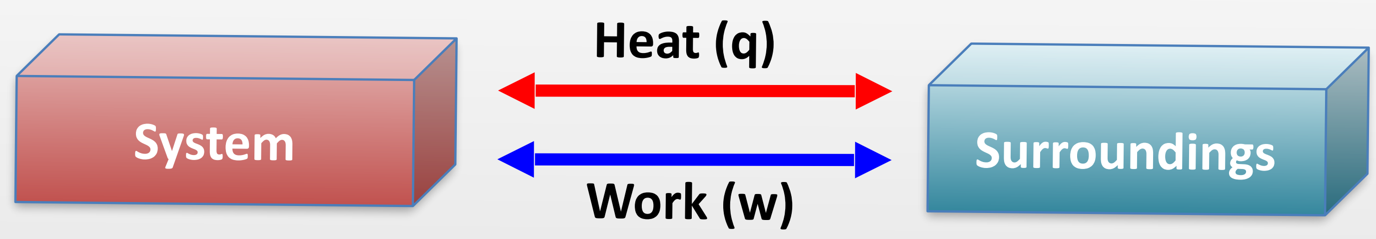
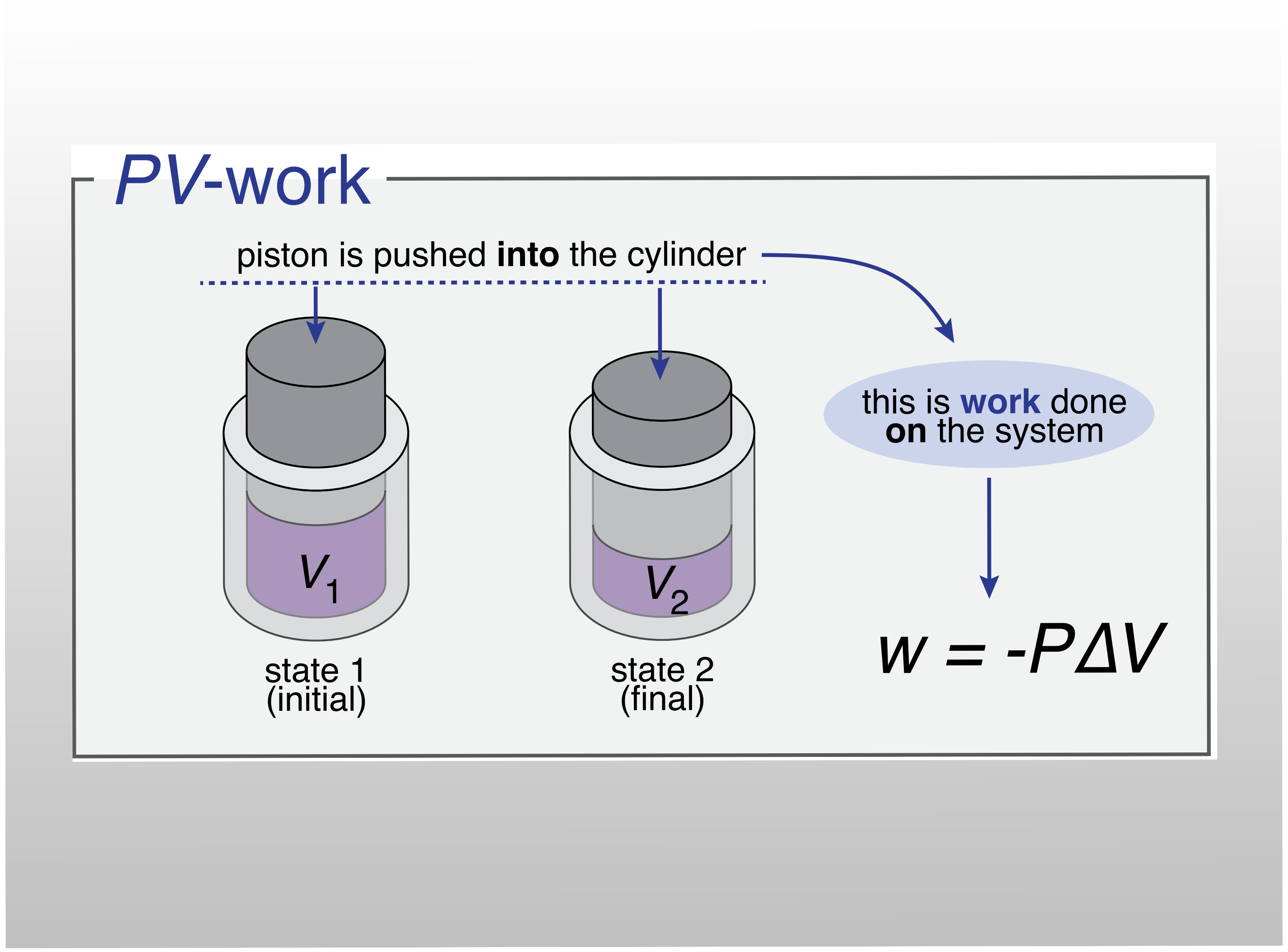


TABLE 6.3 Sign Conventions for q, w, and ΔE

q (heat)	+ system *gains* thermal energy	− system *loses* thermal energy
w (work)	+ work done *on* the system	− work done *by* the system
ΔE (change in internal energy)	+ energy flows *into* the system	− energy flows *out* of the system

Exothermic Process: q is negative
Endothermic Process: q is positive



Goal : Calculate work associated with a volume change

$w = F \times D$

$P = \frac{F}{A}$ or $F = P \cdot A$

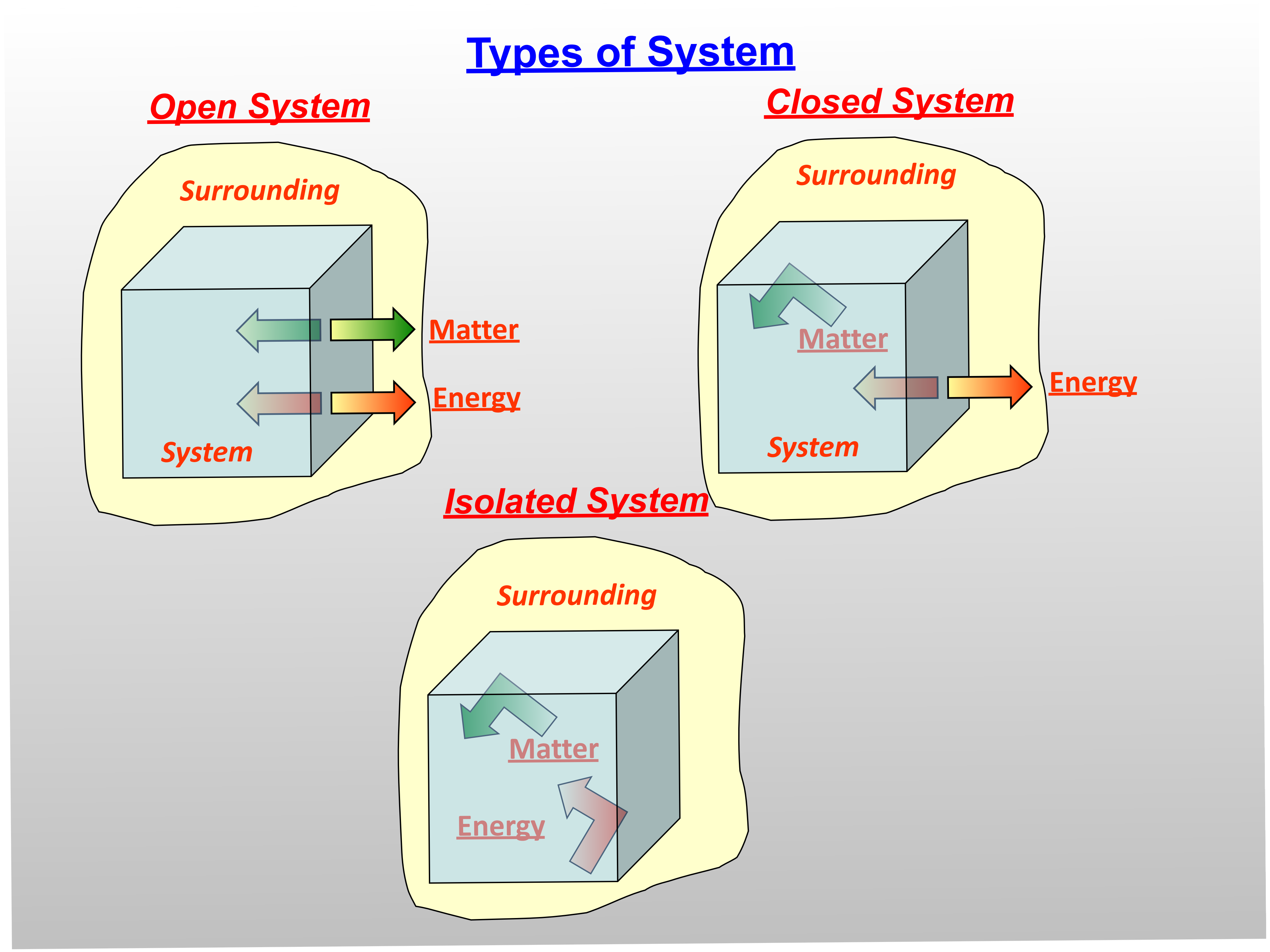
$\Rightarrow w = P \cdot A \cdot D$

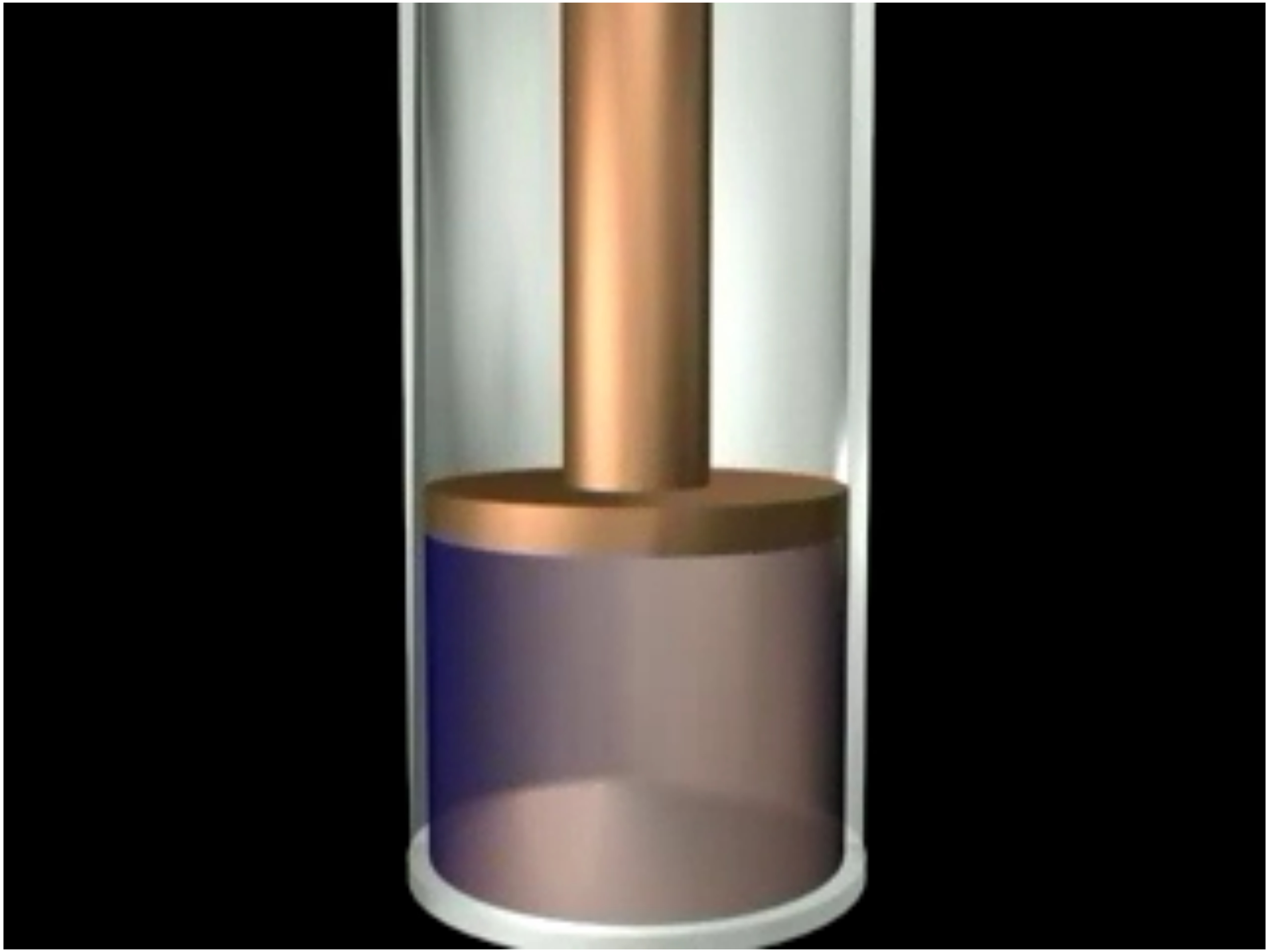
$w = P \cdot \underbrace{A \cdot \Delta h}$

$w = P \cdot \Delta V$

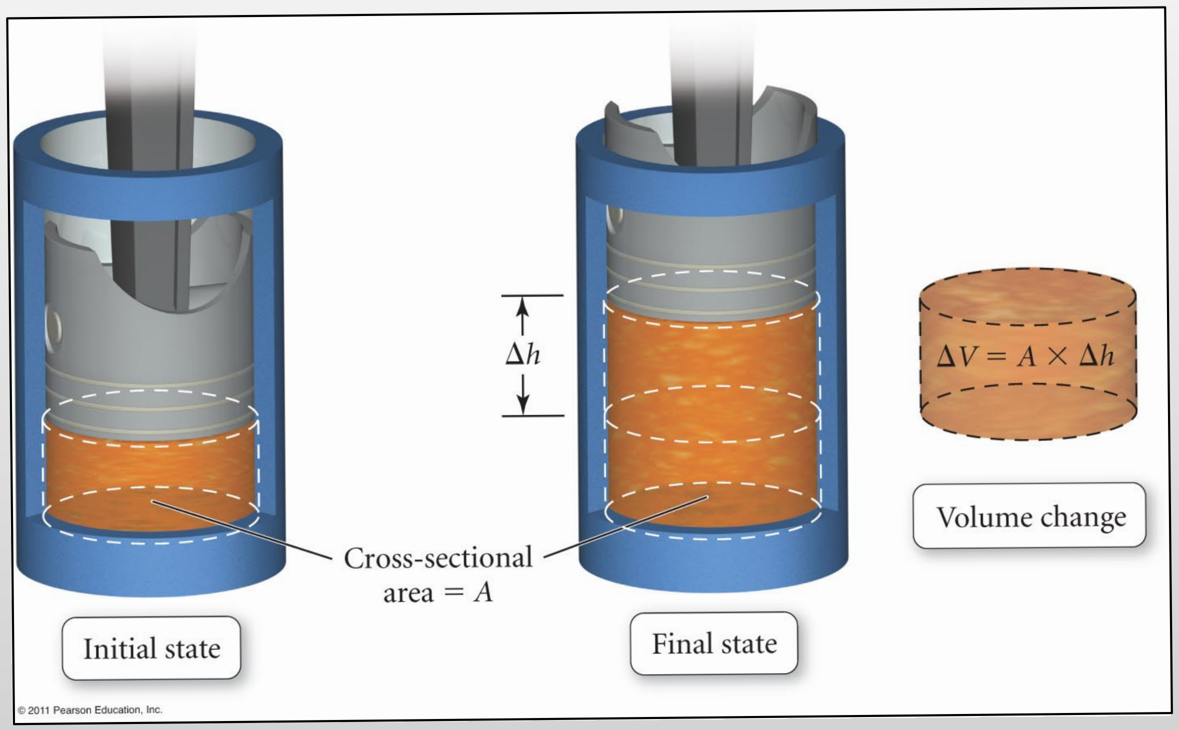
$\Delta V > 0$ (volume increases)

$\Rightarrow w = -P\Delta V$


Types of System
Open System
Surrounding
Matter
Energy
System
Closed System
Surrounding
Matter
Energy
System
Isolated System
Surrounding
Matter
Energy



Pressure –Volume Work:
Moving of a Piston against External Pressure



$w = F \cdot D$

$P = F / A$ or $F = P \cdot A$

$\Rightarrow w = P \cdot A \cdot D$

$w = P \cdot A \cdot \Delta h$

$w = P \cdot \Delta V$

The system is “doing” work, i.e., w must be negative

$w = - P \cdot \Delta V$