Chapters 1 and 2
A Review

- System of Units

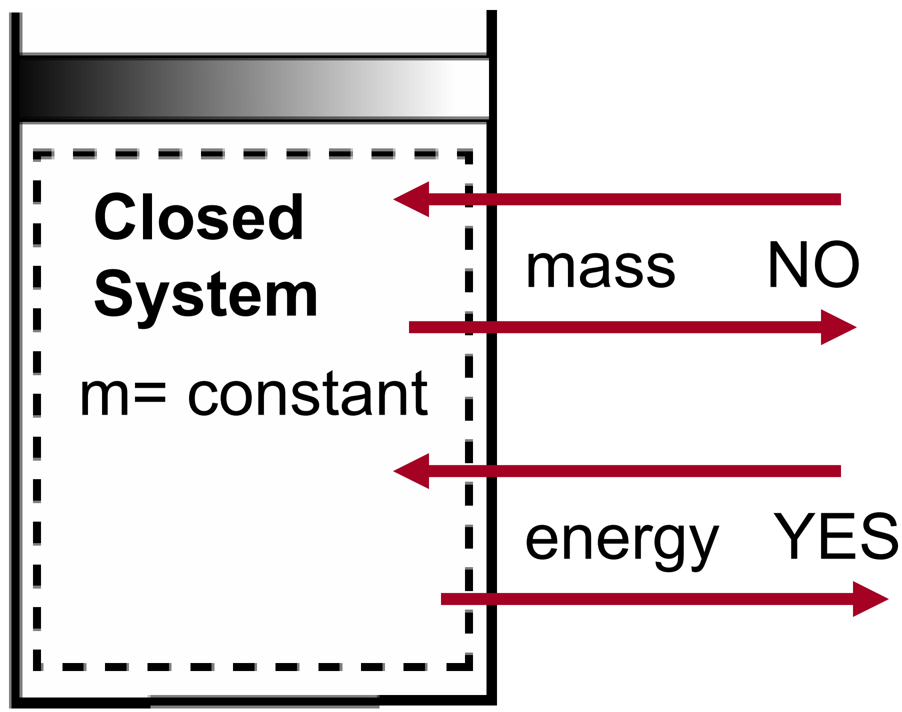
  - SI
  - English

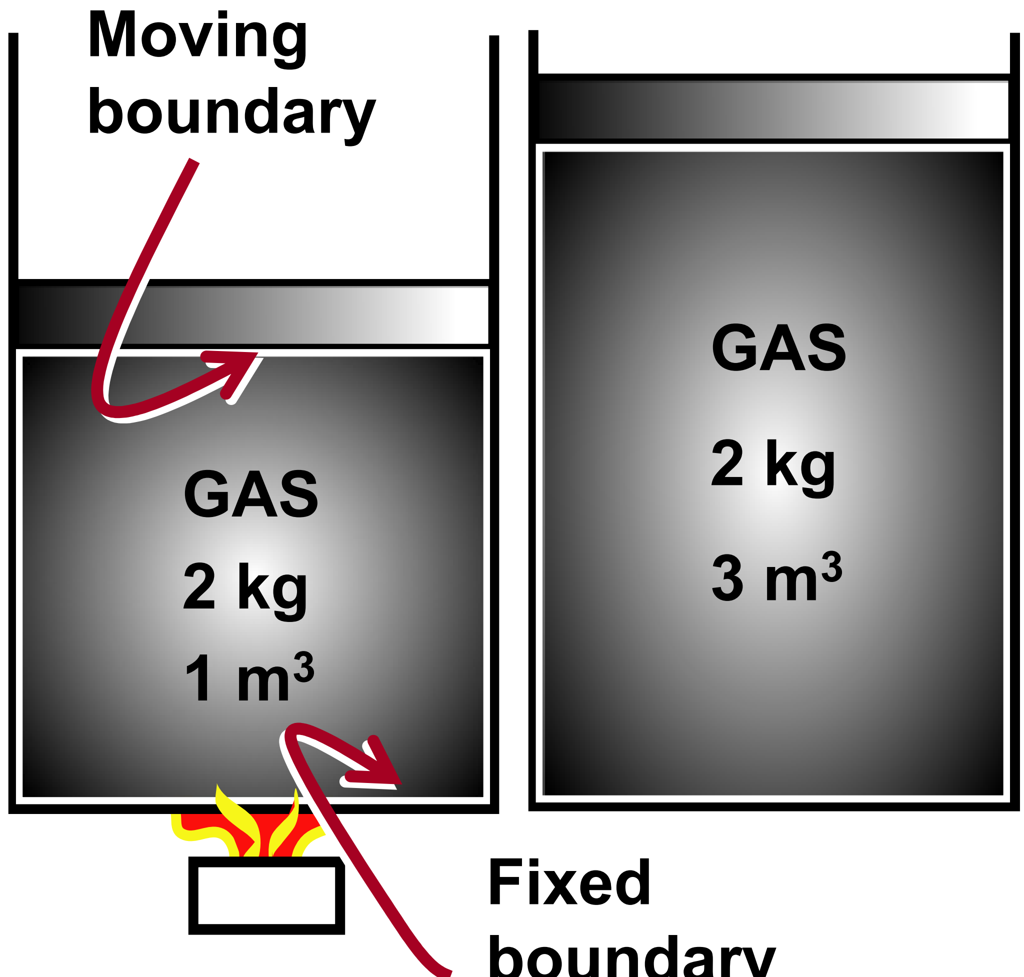
- Thermodynamic System

  - Concept used to establish frame of reference with respect to surroundings

- Two major categories of systems

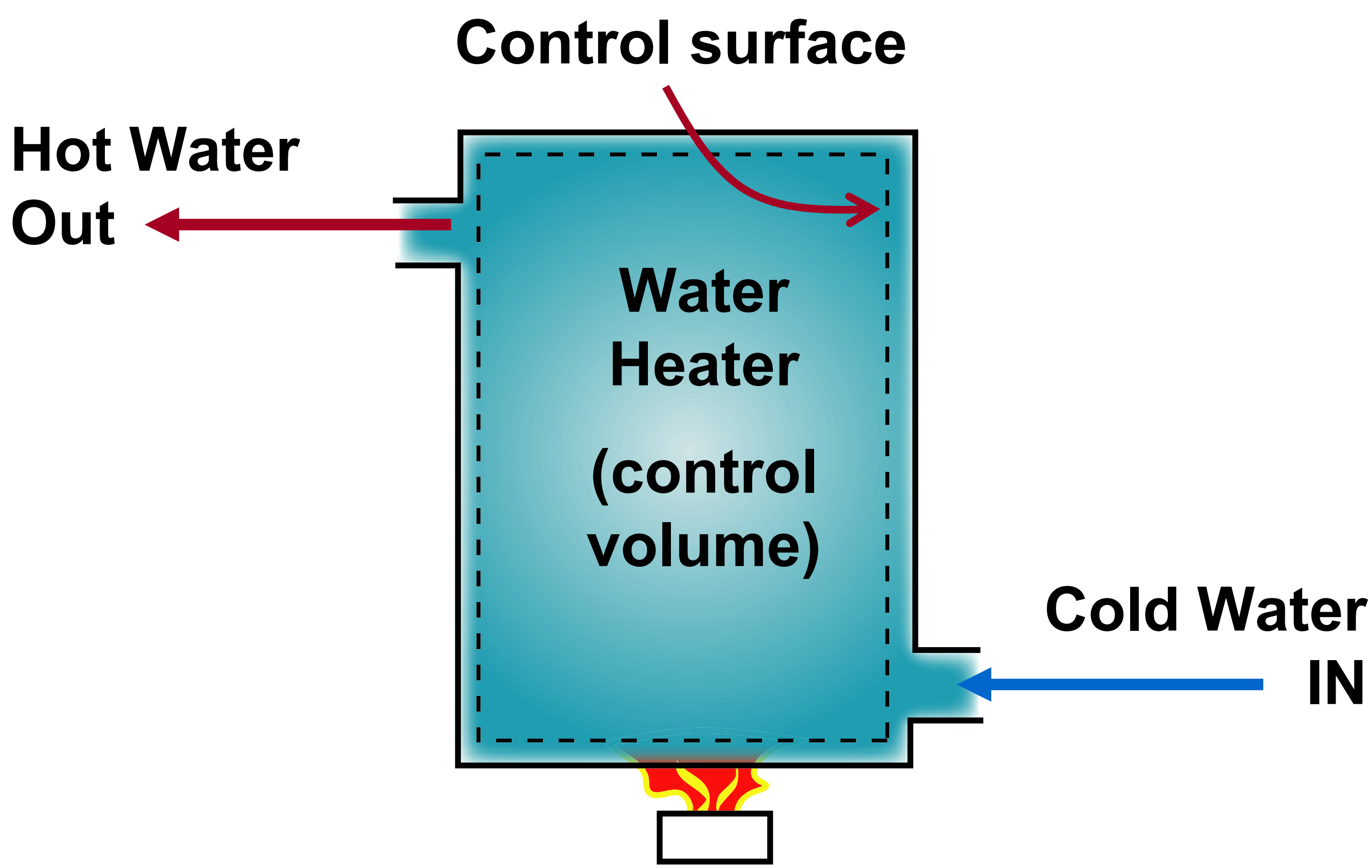
(a) Closed system (control mass)





Moving boundary
GAS
2 kg
1 m3
Fixed boundary
GAS
2 kg
3 m3

(b) Open system: control volume



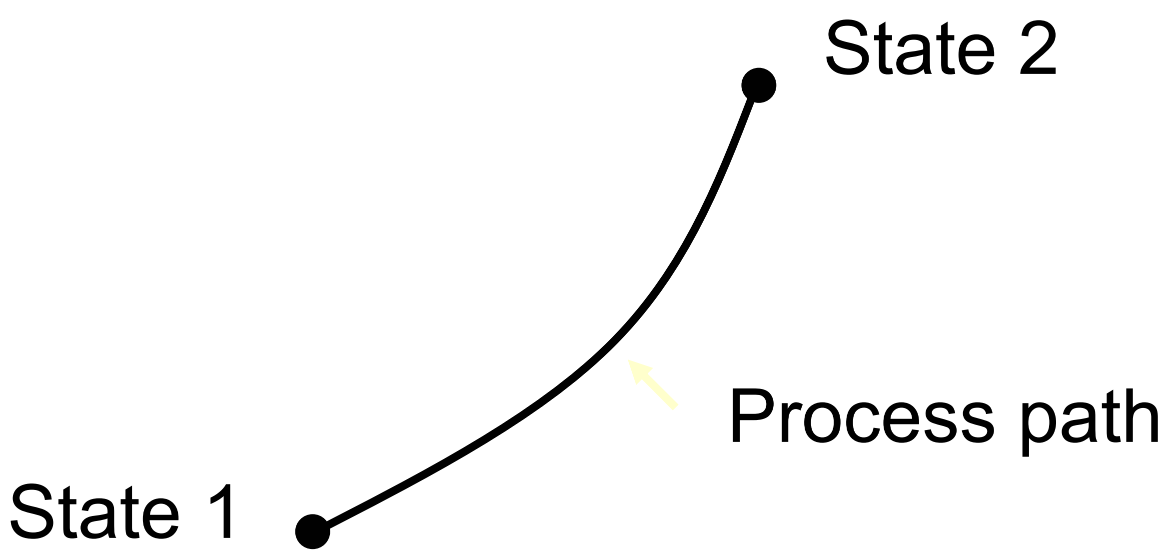
- Classification of properties
  (a) intensive properties
  (b) extensive properties

- Thermodynamic state of equilibrium
  - All driving potentials are balanced
  - Properties do not change with time

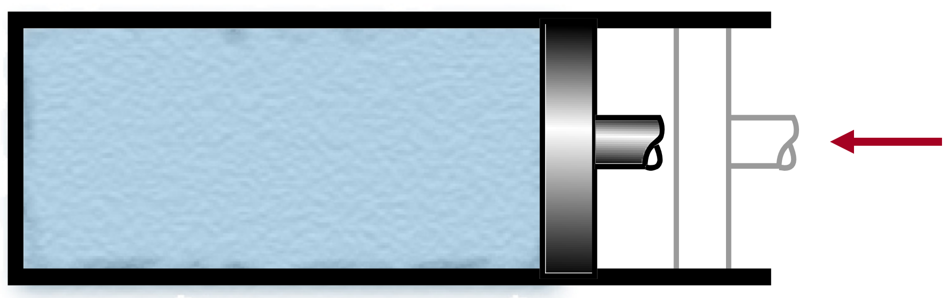
- Thermodynamic processes

  - Any change from one equilibrium state to another is called process

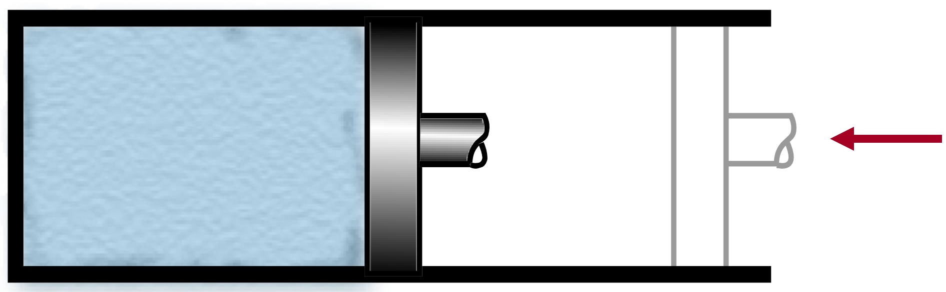
  - Series of intermediate states defines ***path*** of the process



- Quasi-equilibrium process

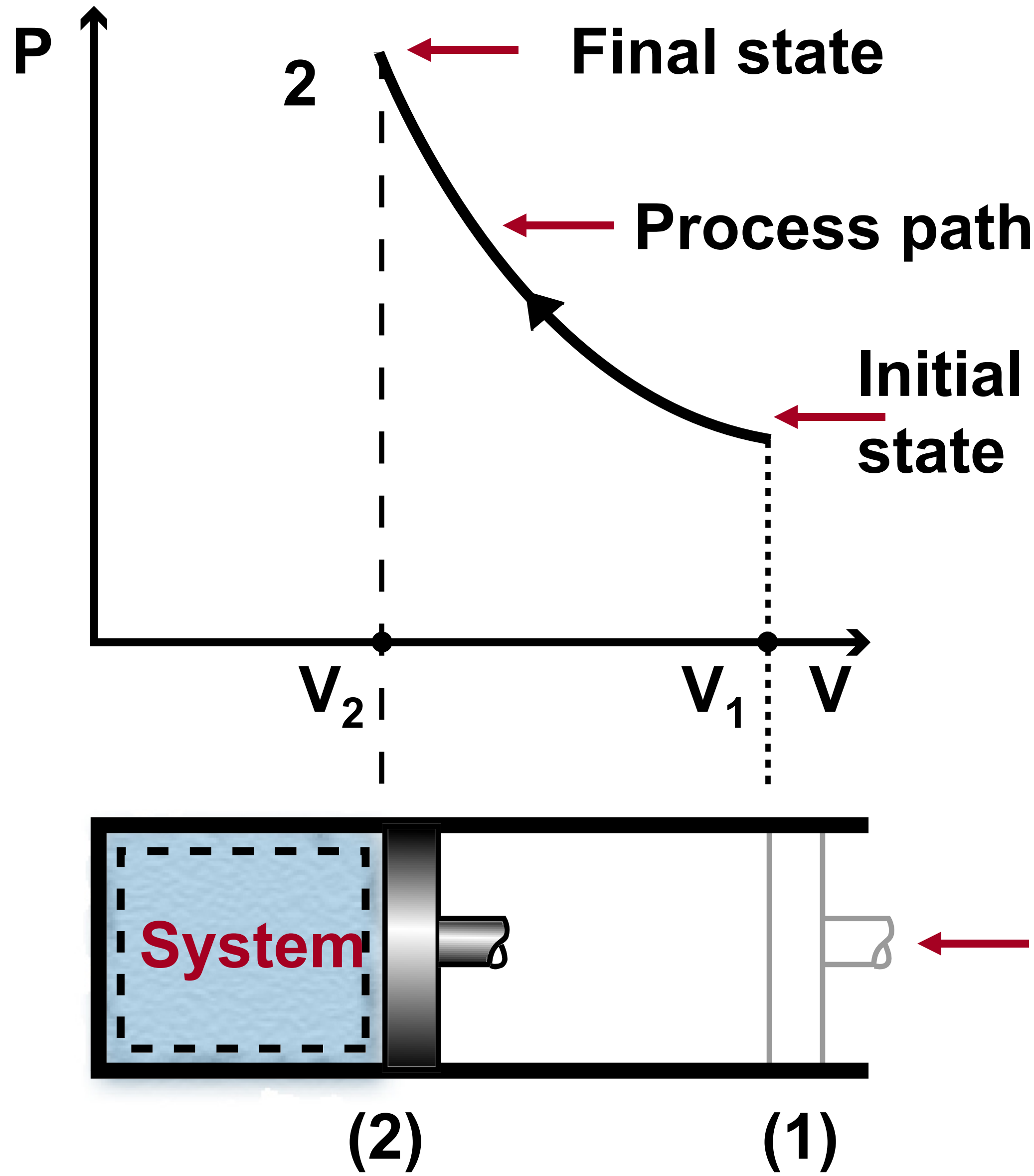


(a) Slow compression (quasi-equilibrium)



(a) Very fast compression (non-quasi-equilibrium)

- Process formulation using thermodynamic properties



First Law of Thermodynamics

- Total energy

$$\Delta E = \Delta KE + \Delta PE + \Delta U$$

$$= (KE_2 - KE_1) + (PE_2 - PE_1) + (U_2 - U_1)$$

- Specific energy

$$e = \frac{E}{m} = \frac{U}{m} + \frac{KE}{m} + \frac{PE}{m} = u + ke + pe$$

$$\Delta KE = KE_2 - KE_1 = \frac{1}{2} m (V_2^2 - V_1^2)$$

$$\Delta PE = PE_2 - PE_1 = mg(z_2 - z_1)$$

First Law of Thermodynamics (cont'd)

- Work

$$W = \int_{t_1}^{t_2} \dot{W} dt = \int_{t_1}^{t_2} F.V dt = \int_{s_1}^{s_2} F.\frac{ds}{dt} dt$$

$$W = \int_{s_1}^{s_2} F.ds$$

- Exp./Comp. Work

$$W = \int_{V_1}^{V_2} p dV$$

- Heat Rate

$$\dot{Q} = \frac{Heat}{Time} = \frac{dQ}{dt}$$

First Law of Thermodynamics (cont'd)

Change in Total Energy = Net Heat Transfer In – Net Work Out

$$E_2 - E_1 = \Delta KE + \Delta PE + \Delta U = Q - W$$

Or

$$dE = \delta Q - \delta W$$

$W > 0$: work done *by* the system

$W < 0$: work done *on* the system

$Q > 0$: heat transfer *to* the system

$Q < 0$: heat tranfer *from* the system

Heat Transfer Modes

Fourier's Law:

Conduction

$$\dot{Q}_c = hA(T_b - T_f)$$

Newton's Law of Cooling

Convection

$$\dot{Q}_x = -kA\frac{dT}{dx}$$

Radiation

Boltzmann's Law:

$$\dot{Q}_e = \varepsilon\sigma A T_b^4$$

- Thermodynamic cycle
  - Process as a result of which a system returns to its original state