Engineering Thermodynamics
MEA1110

Unit I

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Unit-I

Introduction: Basic Concepts and Definitions (Thermodynamic Systems, Properties, States, Processes, Cycles, Thermodynamic Equilibrium, Quasi-Static Process), Pressure and its Measurement, Zeroth Law of Thermodynamics, Temperature and its Measurement.

Thermodynamics

Rub your hands together for 15 seconds.

Are your hands warm?

Thermal energy

Applications of Thermal Energy

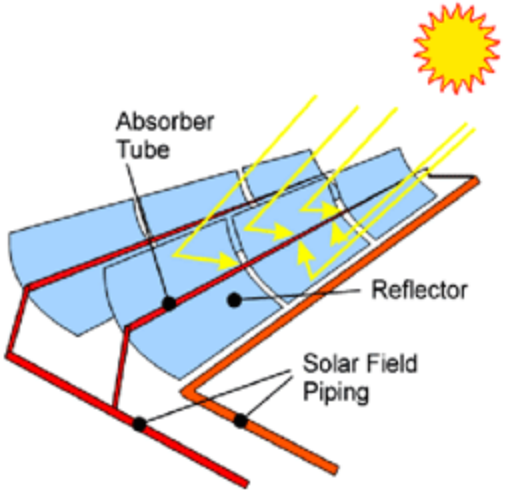
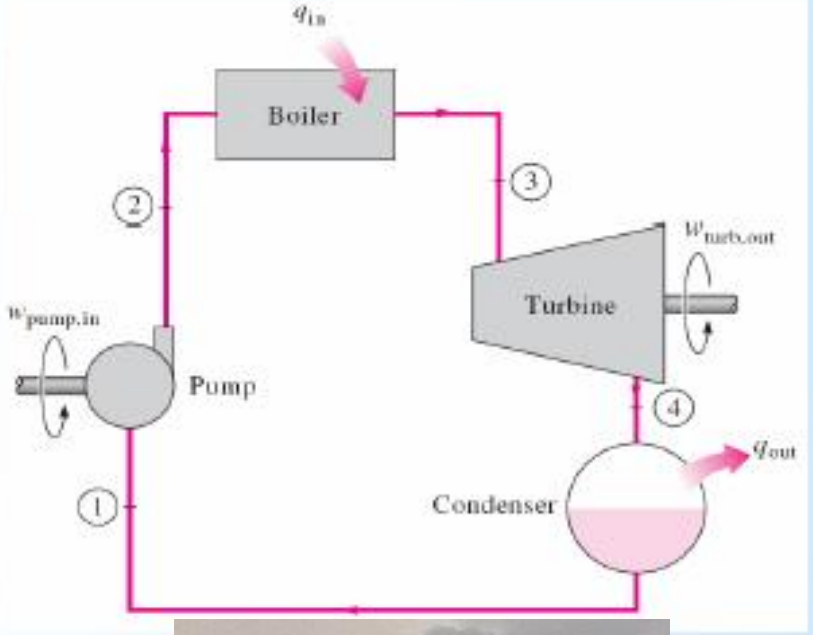


Figure 1. A solar collector assembly

http://www.nrel.gov

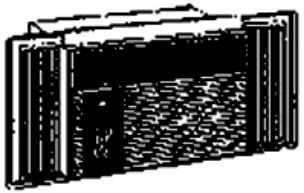
What is Thermodynamics?

- The science of energy, that concerned with the ways in which energy is stored within a body.
- Energy transformations – mostly involve heat and work movements.
- The Fundamental law is the conservation of energy principle: energy cannot be created or destroyed, but can only be transformed from one form to another.

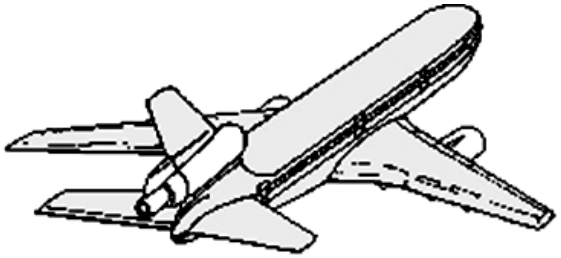


Applications of Thermodynamics

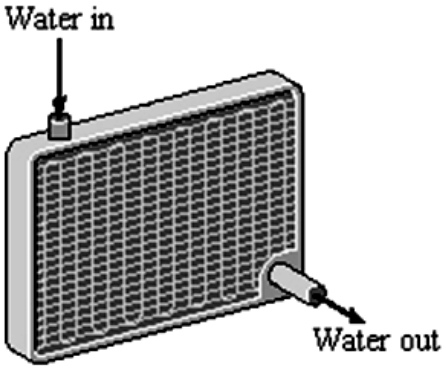
The human body



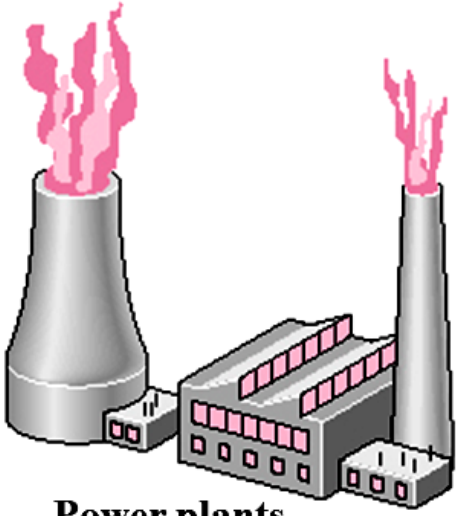
Air-conditioning systems



Airplanes



Car radiators



Power plants

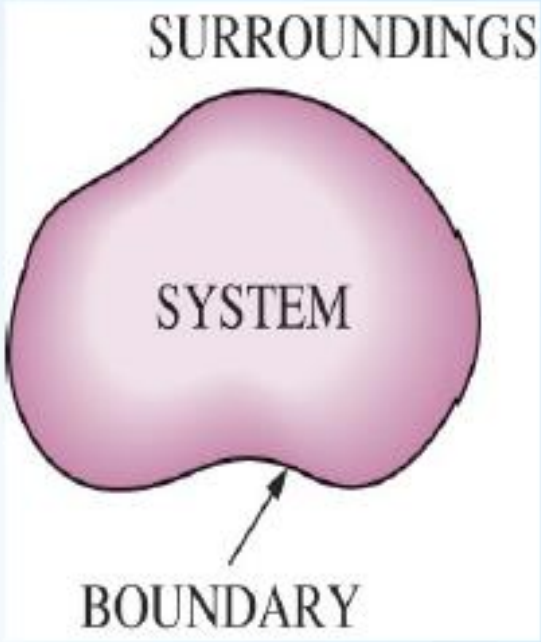
Refrigeration systems

Approaches to study thermodynamics

- Macroscopic (Classical thermodynamics)
  - study large number of particles (molecules) that make up the substance in question.
  - does not require knowledge of the behavior of individual molecules.
- Microscopic (Statistical thermodynamics)
  - concerned within behavior of individual particles (molecules)
  - study average behavior of large groups of individual particles

System, surroundings and boundary

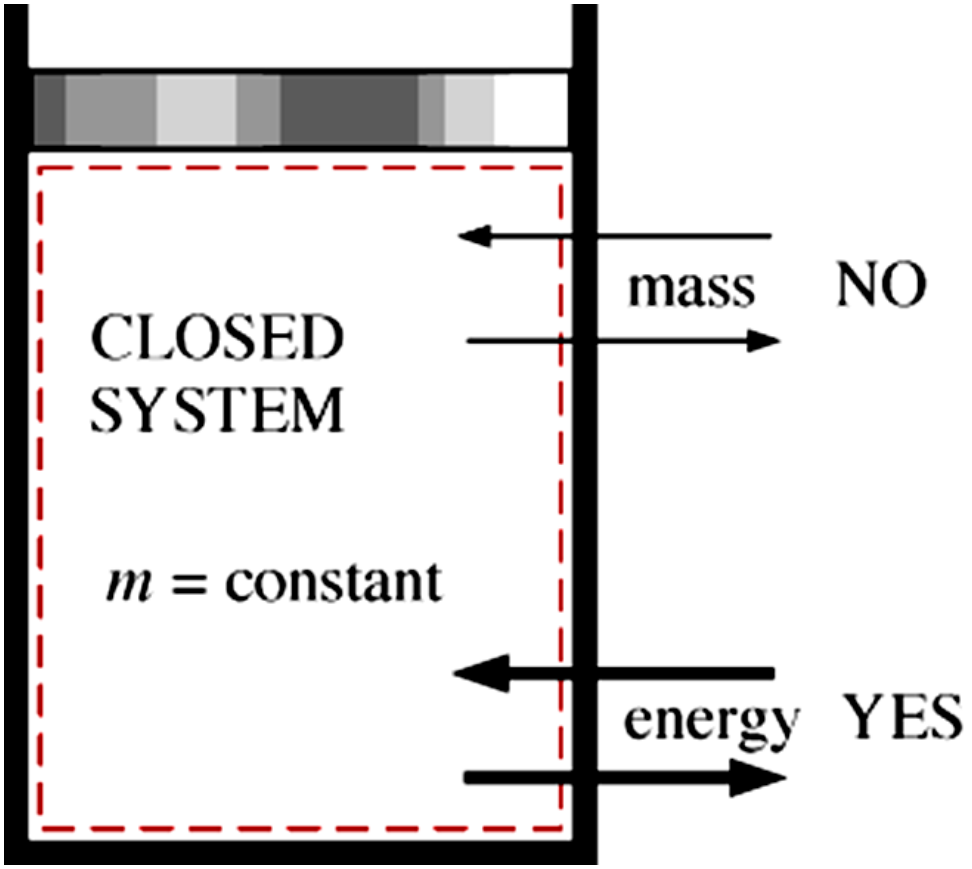
- **System**: A quantity of matter or a region in space chosen for study.
- **Surroundings**: The mass or region outside the system
- **Boundary**: The real or imaginary surface that separates the system from its surroundings.



Closed Systems (fixed masses)

Energy, not mass, crosses closed-system boundaries

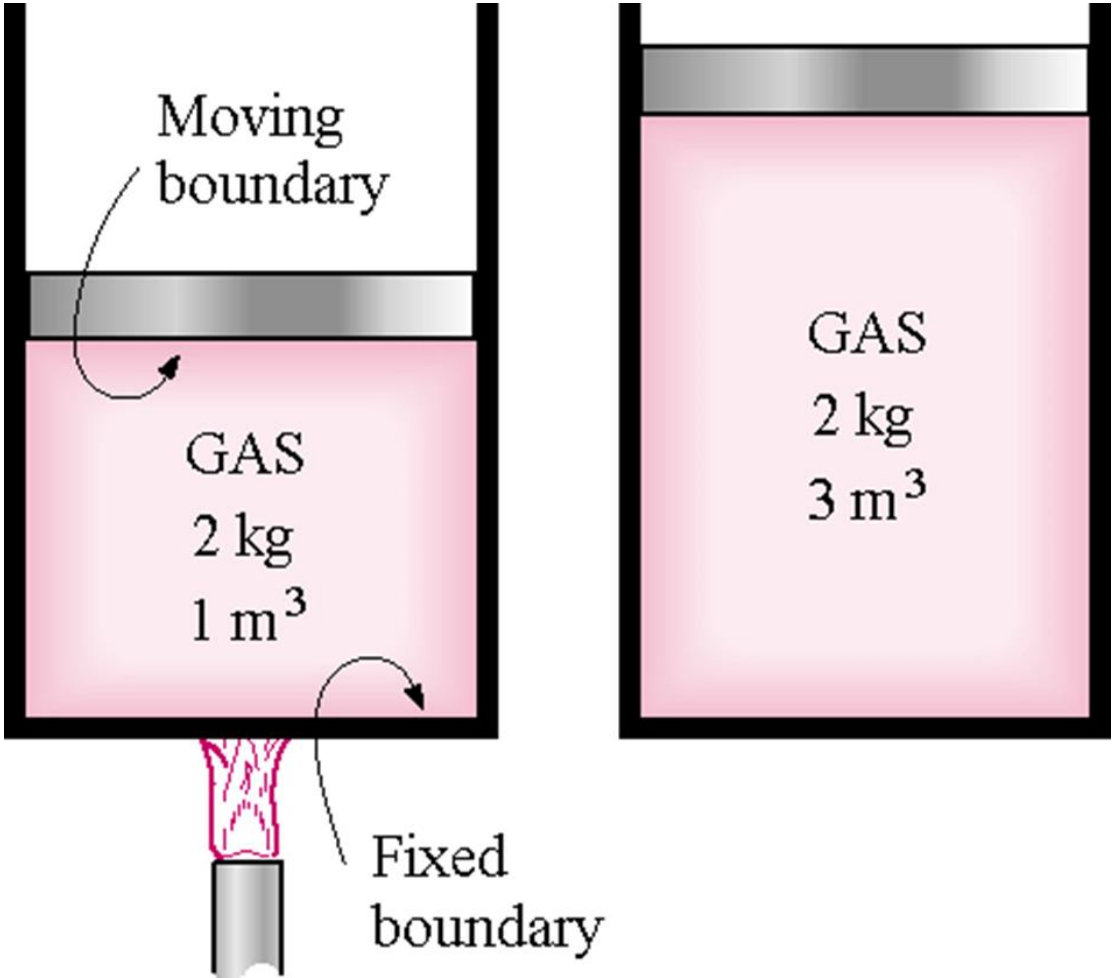
Examples: a tightly capped cup of coffee.



Closed System with Moving Boundary

One of the system boundaries is moving.

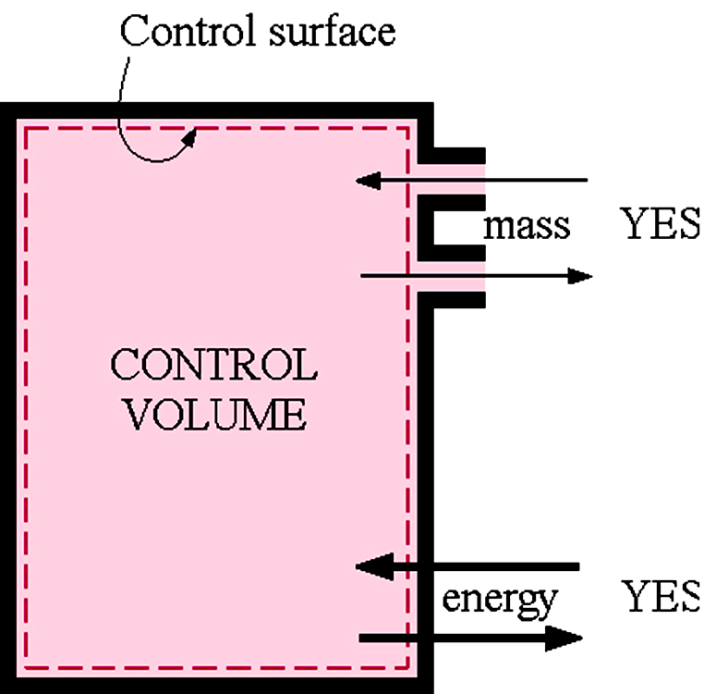
Examples: Piston-cylinder mechanism, a balloon with closed mouth

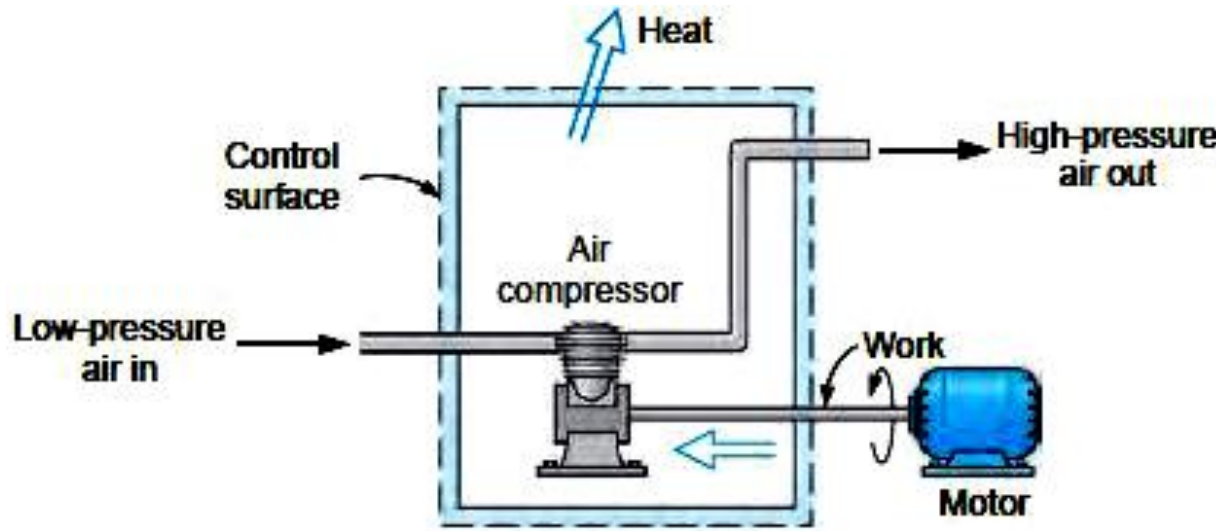


Open Systems (Control Volumes)

Mass and Energy Cross Control Volume Boundaries

Example: an open cup of coffee, an air compressor



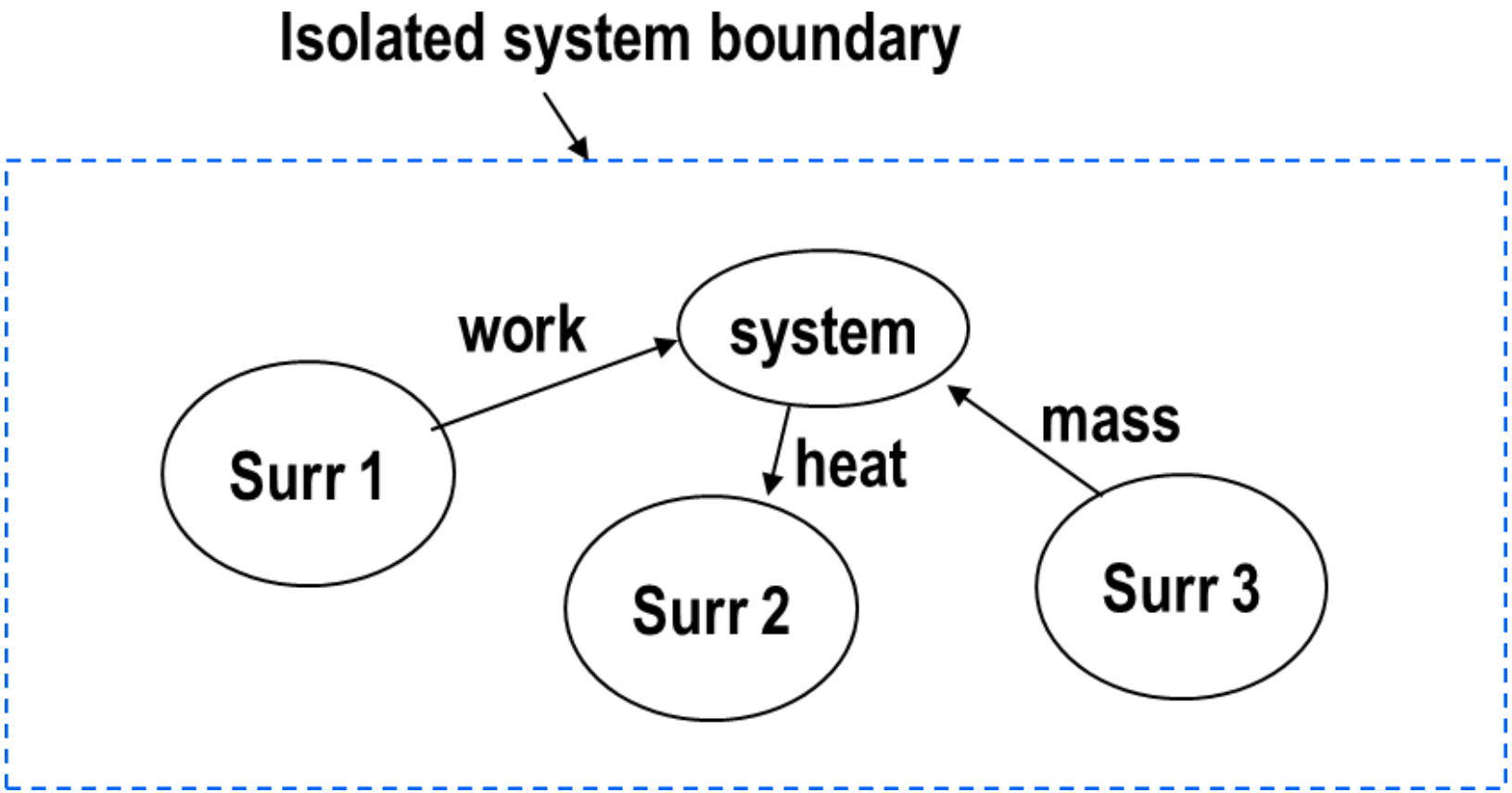


Isolated System

where no heat or work (energy) may cross the system boundary.

Example (approximate): coffee in a closed, well-insulated thermos bottle.

- typically a collection of a main system (or several systems) and its surroundings is considered an isolated system



Properties

- **Any characteristic of a system in equilibrium is called a property.**
- **Types of properties**
  - Extensive properties –

    vary directly with the size of the system

    Examples: volume, mass, total energy
  - Intensive properties –

    independent of the size of the system

    Examples: temperature, pressure, color

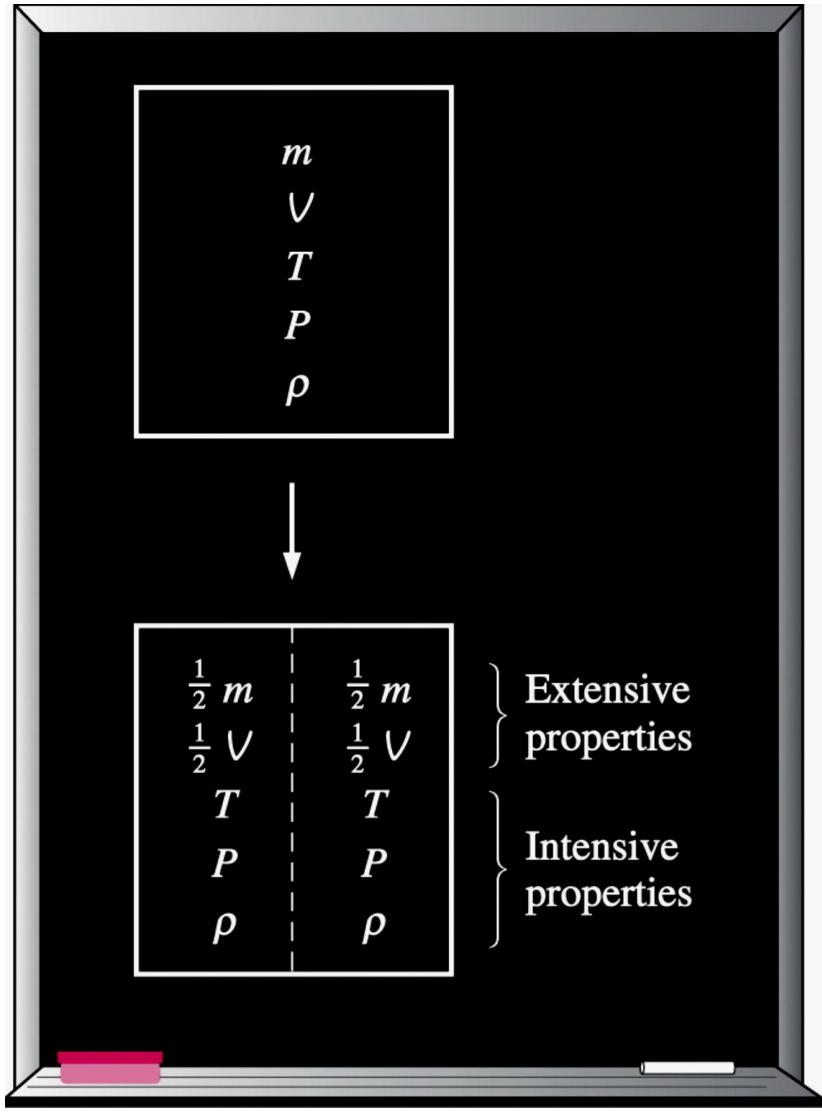
Extensive properties per unit mass are intensive properties.

For ex.

specific volume, v = Volume/Mass = V/m

density, ρ = Mass/Volume = m/V,

Specific enthalpy, specific internal energy etc.



State, Path & Process

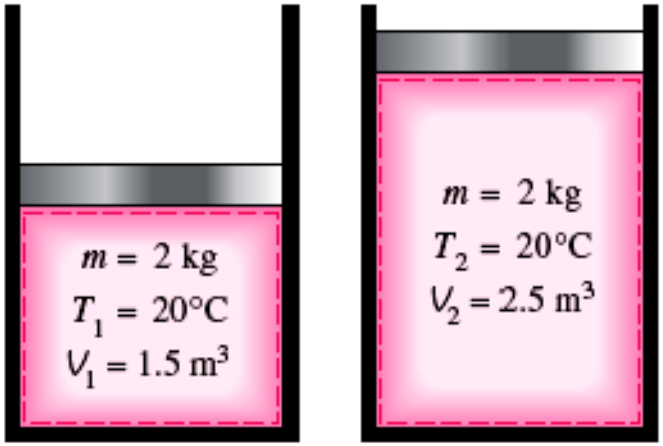
- **State of a system**

➢***State refers to the condition of a system*** as described by its properties like m, T, p, V."

➢It gives a complete description of the system.

➢At a given state, all the properties of a system have fixed values.

➢if one property changes then the state of the system changes.



(a) State 1 (b) State 2

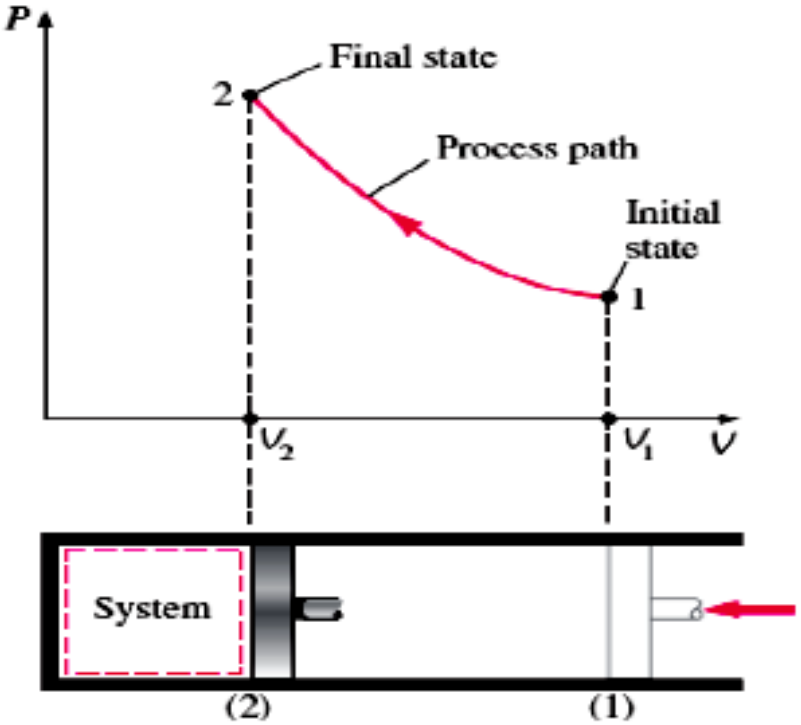
- **Process**

when a system changes from one equilibrium state to another state.

For ex. Some special processes:

- isobaric process - constant press.
- isothermal process - constant temp.
- isochoric process - constant volume
- isentropic process - constant entropy

- **Path:** series of states which a system pas through during a process



State Postulate & Cycles

- **State Postulate**
  - The thermodynamic state of a simple compressible substance is completely specified by two independent intensive properties.

- **Cycle or thermodynamic cycle**
  - A process (or a series of connected processes) with identical end states.

Example: Steam (water) that circulates through a steam power plant undergoes a cycle.