

## Important TD Definitions

### • Systems

#### – System

finite portion of matter or a restricted portion of space upon which attention is focused, e.g., gas in a cylinder or inside of a pipe and whatever happens to be in it at the moment

#### – Surroundings /Environment

everything outside the system (which has a direct bearing on its behavior)

#### – Enclosure/ Control Surface

real or imaginary surface which separates system from its surroundings (can identify a control mass - *finite portion of matter* - or control volume - *restricted portion of space*)

#### – Isolated System

system that exchanges no energy (heat or work) or matter with its surroundings

#### – Closed System

system which may exchange energy but not mass with its surroundings (similar to a **Control Mass**)

#### – Open System

system which may exchange both energy and mass with its surroundings (related to a **Control Volume**)

#### – Reference Frame

coordinate system against which motion of the system is measured; in inertial reference frame, free particles move at constant velocity

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## Important TD Definitions

### • Equilibrium

#### – Equilibrium

exists if there is no tendency for a system to undergo **spontaneous** (and macroscopically observable) change; different types of equilibrium can be defined

*In terms of isolated systems, different types of equilibrium can be described as:*

#### – Mechanical

exists when there is no unbalanced force (electrostatic forces not included typically) in the interior of the system (leads to the mechanical-thermodynamic concept of pressure)

#### – Thermal

exists when all parts of the system are at the same temperature, or equivalently when there is no tendency for energy transfer as heat within the system; basis of thermodynamic concept of temperature

#### – Chemical

exists when the system has no tendency to undergo a spontaneous change in chemical composition (or phase) - no matter how slow

#### – Electro- static

exists when there is no unbalanced electrostatic force or equivalently no tendency for charge flow in the system

#### – Thermo- dynamic

exists when the system is in equilibrium with respect to all of the relevant possible changes above

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## Important TD Definitions

### • Properties and State

- **Property** any characteristic or attribute of a system that can be quantitatively evaluated, what matter has (e.g., volume, mass, energy, pressure, polarization) - not work or heat (these are done on or to a system)
- **Extensive Property** depends on size or extent of the system and are additive - value of the property of the total system is the sum of the values of all the constituent parts (e.g., volume  $V$  and mass  $m$ ); generally definable regardless whether the system is in an equilibrium state or not
- **Intensive Property** independent of size of system and not additive (e.g., temperature  $T$  and pressure  $p$ ; and can define intensive versions of extensive properties, e.g., mass specific volume  $v=V/m=1/\rho$ ); in absence of equilibrium, some intensive properties have no meaning or may vary from point to point in larger system if subsystems considered to be in “local” equilibrium
- **State** the condition of a system, as described by a list of the values of its properties; some minimum number of relevant properties are required to uniquely define a state

## Important TD Definitions

### • Mixtures

- **Mixture** any collection of matter
- **Constituent/ Species** each part of mixture (or group of particles in a microscopic sense) which is distinguishable from the rest by virtue of its chemical structure
- **Component** those constituents whose amounts can be varied independently (from the other constituents); for example in mixture of two inert gases, both constituents would be components
- **Phase** a quantity of matter which is homogeneous in chemical composition and physical structure (note: a single phase can consist of several components)
- **Homogeneous** mixture where composition is (macroscopically) uniform throughout, so can contain only one phase
- **Pure Substance** has same chemical structure in all states but may have several distinguishable phases (e.g., water is chemically  $H_2O$  but can exist in gaseous, liquid and solid phases)
- **Independent Substance** its thermodynamic properties are not functions of the other constituents in the mixture