

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

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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

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