Lecture 2, Sep 12, 2022

Concepts and Definitions

- System: any piece of matter or region of space
  - The system is separated from the surroundings by a boundary
  - The surroundings is everything that's not the system
- Types of systems:
  - Open system/control volume: mass and energy can flow freely in and out of the system
  - Closed system/control mass: the amount of mass in the system is fixed, but energy can still cross the boundary
    - Example: A pipe open on both sides
  - Isolated system: no mass or energy crosses the system boundaries
- Property (state variable): any attribute of a system that can be measured without knowing the history of the system
  - Example: position is a property, but work is not a property since it depends on the path taken
  - For properties, infinitesimal changes are denoted by d, otherwise they are denoted by δ (e.g. $\mathrm{d}x, \delta W$)
  - Temperature is a property, but heat is not
  - Anything that crosses the system boundary is not a property (e.g. even though mass is a boundary, mass introduced to an open system is δm)
- Steady state: all properties of a system do not change with time
  - Note the system may be interacting with the surroundings (e.g. a container that is being filled and drained of water at the same rate)
- Equilibrium: when an isolated system is in steady state
  - All isolated systems tend towards equilibrium, where all properties are constant and uniform
- Quasi-equilibrium process (reversible process): when all the parts of a system are in equilibrium all the time during a process
  - e.g. pushing a piston to compress a gas, doing so infinitely slowly so that the pressure in the gas is always uniform
  - A quasi-equilibrium process does the minimum amount of work (and also gets the most work out of a system)
- Pressure, volume and temperature are related by the ideal gas law $PV = nR_uT$
  - Note P is the absolute pressure, which is equal to the gauge pressure plus atmospheric pressure