Gas laws and absolute temperatures

- Volume of a gas depends very much on the pressure as well as on the temperature
- Equation of state
    - only considered at equilibrium states
        - when pressure and temperature are the same throughout and are not changing in time

Temperature

- At 0°C the states are in equilibrium
- Absolute zero (-273.15°C)
- Basis of absolute or Kelvin scale (K)
- $T(K) = t(°C) + 273.15$

Boyle's Law

- Volume is inversely proportional to the pressure applied to it at constant temperature
- $V \propto (\frac{1}{P})$ [Constant T]
    - P is absolute Pressure
- $P * V = P * V$
- If pressure is doubled, volume is one half

Charles' Law

- Constant pressure, volume increases with temperature at a nearly constant rate
- $V \propto T$ [Constant pressure]

$$\frac{V}{T} = \frac{V}{T}$$

Gay-Lussac

- $P \propto T$ [constant V]
- $\frac{P}{T} = \frac{P}{T}$

Combination of Proportionalities

- $PV \propto T$
- 1 mold is the number of grams of a substance numerically equally to the molecular mass of the substance
- 1 mole of $H_2 = 2\ g$
- 1 mole of $CO_2 = (12 + 2(16)) = 44\ g$
- N = mass/molecular mass = moles
- R is universal gas constant
- $R = 8.135\ J/mol\ K$
- $R = .0821\ (L * atm)/(mol * K)$ [atm & liters]
- STP
- P = 1 atm; T = 273.15 K

1 mol at $STP\ V = \left(\frac{nRT}{P}\right) = \frac{(1)(.0821)(273.15)}{1}$

Thermodynamic energy changes (via heat & work)

Internal Energy (U)

- Full definition on pg 333 in book
- energies associated with atoms and molecules in a material
- For a monatomic gas
    - U=(3/2)*nRT
    - U=(3/2)*PV

Heat - Joules (Q)

- Energy transferred due to temperature differences between a system and its environment
- calories [not KCal] (definition pg. 334)
- 1 cal = 4.186 J
- $Q = mc\Delta T$ - c is specific heat (pg 335)

Work (W)

- The other way to transfer energy in thermodynamic systems
- Work done on the gas
    - $W = (-P)\Delta V$
    - Constant pressures only!

always be found from the area under a PV diagram

First law of thermodynamics

- The change in internal energy of a system is equal to the sum of the energy transferred across the system boundary by heat and the energy transferred by work.
- $\Delta U = Q + W$
- $= \left(\frac{3}{2}\right) nR\Delta T$
- See Worksheet

Isothermal

- $\Delta T = 0$
- $\Delta U = 0$
- $W = (-Q)$

Isobaric

- $W = -P\Delta V$
- No change in P
- $\Delta U = Q + W$

Isometric

- W=o
- No change in V
- $\Delta U = Q$

Adiabatic

- No change in Q
- $\Delta U = W$