Heat

and Thermal Expansion

Heat and Temperature

- Heat
  - the thermal energy transmitted from one body to another
- Temperature
  - the physical property that determines the direction in which heat will flow.

Temperature Scales

- Fahrenheit (F^o)
  - Originally based on an salt/water combination and the temperature of the human body
- Celsius (^oC)
  - based on the freezing point (0^oC) and the boiling point (100^oC) of water
- Kelvin (K)
  - based on the theoretical temperature that molecular energy is at a minimum. (0 K)

Temperature Scale Conversions

- Celsius to Fahrenheit

$$T_F = \frac{9}{5}T_C + 32$$

- Fahrenheit to Celsius

$$T_C = \frac{5}{9}(T_F - 32)$$

- Celsius to Kelvin

$$T_K = T_C + 273.15$$

Thermal Expansion

- Linear
  - The change in length of a solid dependant on the material of the solid and the change in temperature

$$\Delta L = \alpha L_0 \Delta T$$

  - α = the coefficient of linear expansion
  - ΔT can be in Celsius or Kelvin
  - See Table 10.1 on p.351
- NOTE: this expansion occurs in all 3 dimensions

Thermal Expansion

- Volumetric
  - The change in volume of a liquid dependant on the liquid and the change in temperature

$$\Delta V = \beta V_0 \Delta T$$

  - β = the coefficient of volumetric expansion
  - ΔT can be in Celsius or Kelvin
  - See Table 10.1 on p.351

Thermal Expansion

- Charles Law
  - All gases expand as the are heated.
  - All gases have approximately the same coefficient of expansion($3.663 \times 10^{-3}/^{o}C$)
  - The coefficient of expansion is nearly constant at all temperatures
  - The volume of a gas is directly proportional to the Kelvin temperature of the gas , at constant pressure. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Thermal Expansion

- Boyle's Law
  - The volume of a gas varies inversely with the pressure on the gas, at a constant temperature

$$p_1 V_1 = p_2 V_2$$

Pressure

- Units
  - 1 atmosphere (atm)
    - the average atmospheric pressure
  - Pascal (Pa)
    - SI Unit of pressure
    - $1atm = 1.01 \times 10^5$ Pa

Standard Temperature and Pressure (STP)

- The ideal situation for gas laws
  - Temperature = 0°C
  - Pressure = 1 atm or 1.01×10^5 Pa

Combined Gas Equation

- Combination of Boyle's and Charles' Laws
- Used to find how a gas changes under certain conditions

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

or

$$PV = nRT$$

Return to Honors Physics Notes