CHAPTER 10: GASES

GASES AND PRESSURE

- CHARACTERISTICS OF GASES
  - physical characteristics
    - mainly nonmetallic elements
    - low molecular masses
  - in equations
    - often reactants or products
    - large volumes of high pressure gas have a highly destructive explosive power
  - properties
    - expand to fill containers
    - highly compressible
    - very low densities
    - mixtures of gases is homogenous
  - determinants of state
    - temperature
    - volume
    - amount of gas (moles)
    - pressure
- PRESSURE
  - FORCE APPLIED TO AN AREA
  - P = F/A
  - standard pressure = 1 atm
  - units
    - SI = Pascal (Pa)
    - interconversions — 1 atm = 760 mmHg = 760 torr = 101325 kPa
    - other units
      - 1 bar = 100kPa
      - 1 Torr = 1 mmHg
      - 1 atm = 760 mmHg
- ATMOSPHERIC PRESSURE AND THE BAROMETER
  - atmospheric pressure = weight exerted by air per unit area
    - at sea level = 760 mmHg
    - ybung = 640 mmHg
  - barometer
    - used to measure and calculate atmospheric pressure
    - (h) - measure of difference in height — h changes as atmospheric pressure changes
- PRESSURE OF ENCLOSED GASES AND MANOMETERS
  - manometer
    - measures pressure difference between atmospheric air and enclosed gas
    - (h) = height difference between the two tubes
  - enclosed gas pressure
    - Pgas < Patm — Pgas = Patm - Ph
    - Pgas > Patm — Pgas = Patm + Ph

GAS LAWS

- THE GAS LAWS
  - gas laws = equations that express the relationships between variables affecting gas
  - variables (symbol)
    - pressure (P)
    - volume (V)
    - temperature (T)
    - amount of gas (n)
- BOYLE'S LAW
  - pressure-volume
  - the volume of a fixed quantity of gas at constant temperature is inversely proportional to the pressure of that gas
  - PxV = P2V2
- CHARLES LAW
  - temperature-volume
  - the volume of a fixed amount of gas at constant pressure is directly proportional to its absolute temperature
  - V/T = V2/T2
- AVOGADRO'S LAW
  - derived from gay-lussac's law
  - the volume of a gas at constant temperature and pressure is directly proportional to the number of moles of the gas
  - at STP one mole of any gas occupies 22.4 litres of space
  - V/n = V2/n2

GAS CALCULATIONS

- IDEAL GAS
  - hypothetical gas
  - obeys the gas laws at all temperatures
  - based on assumptions
    - ideal gas molecules do not react with each other
    - ideal gas molecules do not take up space
  - in real life
    - molecules do react (IMF)
    - molecules occupy space (finite volume)
    - real gases are similar to ideal gases
- GAS MIXTURES AND PARTIAL PRESSURES
  - DALTONS LAW OF PARTIAL PRESSURES — if 2 gases that don't react are combined in a container, they act as if they are alone in container
  - total pressure = sum of partial pressures each gas would exert if present alone
  - P(T) = P1 + P2 + P3 + ...(n times)
  - P(T) = nt x (RxT)/V = n2 x (RxT)/V
- PARTIAL PRESSURES AND MOLE FRACTIONS
  - mole fractions
    - demonstrates how many moles of a gas relates to the ratio of moles of substance to total moles in a mixture (X)
    - X(1) = n(1)/n(t)
  - pressure-mole fraction relationship
    - relate amount in mixture to partial pressure because each gas acts as though it is alone
    - P1 = (n1/nT)(T) = X1P(T)
    - P(1) = X(1) x P(T)
- COLLECTING GASES OVER WATER
  - gas collected includes gas and water vapor
  - subtract water vapor pressure from total pressure to get the pressure of the gas alone

IDEAL GAS EQUATION

- WHAT IS IT?
  - ideal gas equation is a combination of the gas laws
  - constant of proportionality (R)
  - value for (R) depends on units used for pressure
    - [atm] R = 0.0821 L·atm·mol⁻¹·K⁻¹
    - [Pa] R = 8.314
    - [bar] R = 0.0831 L·bar·mol⁻¹·K⁻¹
    - R = 62.364 L·Torr·mol⁻¹·K⁻¹
- RELATING IDEAL GAS EQUATION TO GAS LAWS
  - (P1V1)/T1 = (P2V2)/T2 — combined gas law
  - because the ideal gas equation is a combination of all three gas laws
- APPLICATIONS OF THE IDEAL GAS EQUATION
  - the ideal gas equation can be used to relate gas laws or quantify an unknown
  - can also be applied to gas density calculations
- GAS DENSITIES AND MOLAR MASS
  - density
    - need
      - molar mass
      - pressure
      - temperature
    - d = MP/RT — derived by combining the ideal gas equation with stoichiometric equations for mass
  - molar mass
    - need
      - mass
      - volume
      - temperature
    - M = mRT/PV — derived by combining the ideal gas equation with stoichiometric calculations of mass

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