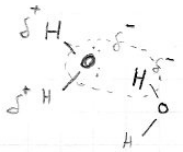
CHEMISTRY

STATES OF MATTER

GAS
- MOLECULES ARE RELATIVELY FAR APART
- LITTLE OR NO STRUCTURE
- MOVE RELATIVE TO EACH OTHER → LOTS OF COLLISIONS

LIQUID
- MOLECULES ARE RELATIVELY CLOSE TOGETHER / CLOSE SPACING
- SOME MOTION BETWEEN MOLECULES (FLUID)
- WEAK BONDS BETWEEN MOLECULES
  - ↳ LONDON, VAN DER WAAL'S
  - ↳ DIPOLE
  - ↳ HYDROGEN BONDING



RELATIVE TO OTHER MOLECULES OF SIMILAR MOLECULAR WEIGHT, WATER HAS HIGH BOILING POINT AND MELTING POINT

SOLID
- MOLECULES ARE WELL ORGANIZED AND DO NOT MOVE MUCH RELATIVE TO EACH OTHER (SOMETIMES CRYSTALLINE)
- NOT FLUID BUT WILL DEFORM

ATOMIC STRUCTURE

3 BASIC COMPONENTS

⊕ PROTON, NEUTRON } SIMILAR MASS >> MASS OF e^-

⊖ ELECTRON

ATOMS HAVE NEUTRAL CHARGE → SAME # OF PROTONS AND ELECTRONS

NUCLEUS → CONTAINS PROTONS AND NEUTRONS

NAME ATOM IS DETERMINED BY NUMBER OF PROTONS (ATOMIC NUMBER)

ISOTOPES → ATOMS WITH DIFFERENT # OF NEUTRONS

^{35}Cl, ^{37}Cl

$17_p, 18_n$ $17_p, 20_n$ NATURAL ABUNDANCE RATIO $^{35}Cl : ^{37}Cl \approx 3:1$

IDEAL GAS LAW

$PV = nRT$

- P = PARTIAL PRESSURE
- V = VOLUME
- n = # OF MOLES
- R = GAS CONSTANT = $0.08205 \frac{L \cdot atm}{K\ mol}$
- T = ABS TEMP

EXAMPLE: IF n, R, T FIXED → $P_1V_1 = P_2V_2$ OR P, V ARE INVERSELY RELATED

$n = \frac{PV}{RT} \Rightarrow An = \frac{PVA}{RT}$ A = AVAGADRO'S # $\approx 6.02 \times 10^{23}$ $\frac{\text{molecules / atoms / ions}}{\text{mole}}$

PERIODIC TABLE

ROWS = PERIODS

COLUMNS = GROUPS

IN GENERAL, ELEMENTS MOVE FROM METALLIC → NON METALLIC AS WE MOVE LEFT → RIGHT

HEAVIER ELEMENTS TEND TO BE MORE METALLIC

ATOM RADIUS DECREASES FROM LEFT TO RIGHT

ATOM RADIUS INCREASES FROM TOP TO BOTTOM

IONIZATION POTENTIAL = ENERGY REQUIRED TO REMOVE AN e^- FROM A GASEOUS ATOM OR ION

IONIZATION POTENTIAL INCREASES FROM LEFT TO RIGHT, DECREASES FROM TOP TO BOTTOM

IMPORTANT GROUPS

- GROUP IA - ALKALI METALS (M^+)
- GROUP IIA - ALKALINE EARTH METALS (M^{2+})
- GROUP VIIA - HALOGENS (X^-)
- GROUP VIIIA - NOBLE GASES

REACTION STOICHIOMETRY / EQUILIBRIA / KINETICS

GENERAL REACTION: $aA + bB \underset{K_R}{\overset{K_F}{\rightleftharpoons}} cC + dD$

a, b, c, d = STOICHIOMETRIC COEFFICIENTS – DEFINES MOLAR QUANTITIES OF REACTANTS, PRODUCTS

$r_{FORWARD} = K_F [A]^a [B]^b$ $\quad$ [i] : MOLAR CONCENTRATION OR ACTIVITY OF i

$r_{REVERSE} = K_R [C]^c [D]^d$

WHEN $r_{FORWARD} = r_{REVERSE}$ ∴ CHEMICAL EQUILIBRIUM

$K_{EQ} = \frac{K_F}{K_R} = \frac{[C]^c [D]^d}{[A]^a [B]^b}$

Le CHATTLIER'S PRINCIPLE: IF WE STRESS A SYSTEM IN EQUILIBRIUM, IT WILL RESPOND BY MOVING TO ANOTHER EQUILIBRIUM CONDITION.

ACID/BASE EQUILIBRIA

$HA \rightleftharpoons H^+ + A^-$

ACID $\quad$ CONJUGATE BASE

K_a = ACID DISSOCIATION CONSTANT $\quad K_a = \frac{[H^+][A^-]}{[HA]}$

$pX = -\log_{10} X$

$pK_a = pH - \log_{10} \frac{[A^-]}{[HA]} \Rightarrow pH - pK_a = +\log_{10} \frac{[A]}{[HA]}$

WHEN $pH = pK_a \rightarrow [HA] = [A^-]$

$pH < pK_a \rightarrow [HA] > [A^-]$

$pH > pK_a \rightarrow [HA] < [A^-]$

WATER AS AN ACID/BASE

$H_2O \rightleftharpoons H^+ + OH^-$ $\quad K = \frac{[H^+][OH^-]}{[H_2O]} \Rightarrow K_w = [H^+][OH^-] \approx 10^{-14}$

$pK_w = pH + pOH \approx 14$

PRECIPITATION / DISSOLUTION

$A_a B_{b(s)} \underset{\text{PRECIPITATION}}{\overset{\text{DISSOLUTION}}{\rightleftharpoons}} aA + bB$ $\quad K_{eq} = \frac{[A]^a [B]^b}{[A_a B_{b(s)}]} \Rightarrow K_{sp}$ = SOLUBILITY PRODUCT = $[A]^a [B]^b$

A, B CONSTITUENT IONS

OXIDATION / REDUCTION e^- TRANSFER

OXIDATION : INCREASE IN OXIDATION STATE → LOSS OF e^-
REDUCTION : DECREASE IN OXIDATION STATE → GAIN OF e^-

OXIDIZING AGENT → PROMOTES OXIDATION → IS ITSELF REDUCED $Cl_2 + 2e^- \rightarrow 2Cl^-$
REDUCING AGENT → " " REDUCTION → " " OXIDIZED