

# Gen Chem Formula Sheet

Mass #  
Atomic # X

$$1 \text{ mol} = 6.02 \times 10^{23} \text{ particles}$$

$$\text{molar mass} = \frac{\text{g}}{\text{mol}} \quad (\text{From periodic table})$$

Name ionic compounds = cation name + base anion (plus ide)

- also add in roman numerals if multiple cation forms

Name molecular = (prefix + name of first) + (prefix + (base name + ide))

- Find empirical by converting g to  $\frac{\text{g}}{100\text{g}}$  to moles, then finding mole ratios

Limiting reagent  $\rightarrow$  reactant that is consumed first

- convert to # of moles of product

- gives the theoretical yield

$$\text{percent yield} = \frac{\text{actual}}{\text{theoretical}} \times 100$$

$$\text{Molarity} = \frac{\text{amount of solute}}{\text{L of solution}} = \frac{\text{mol}}{\text{L}}$$

$$\text{Dilution} = M_1 V_1 = M_2 V_2$$

## Oxidation Rules (Numbers)

- ① Elemental atom = 0
  - ② ion = charge of ion
  - ③ sum in compound = 0 (or charge of polyatomic ion)
  - ④ Group 1A = +1      Group 2A = +2
  - ⑤ F = -1, H = +1, O = -2, group 7A = -1, 6A = -2, 5A = -3
- APPLY IN THIS ORDER

## Gas Pressure

$$P = \frac{\text{Force}}{\text{Area}} = \text{pascal}$$

$$1 \text{ ATM} = 760 \text{ mmHg}$$

$$\text{Boyle's Law} = P_1 V_1 = P_2 V_2$$

$$\text{Charles' Law} = \frac{T_1}{P_1} = \frac{T_2}{P_2}$$

$$\text{Avogadro's Law} = \frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$\text{Ideal gas law} \\ PV = nRT$$

$$R = 0.08206 \frac{\text{L} \cdot \text{ATM}}{\text{mol} \cdot \text{K}}$$

## Dalton's Law of pressure

$$P_T = P_1 + P_2 + P_x$$

$$\text{Average KE of 1 mol of gas} = \frac{3}{2} RT$$

$$\text{U root mean square (rms)} = \sqrt{\frac{3RT}{M}} \rightarrow \text{molar mass in kg}$$

$$\text{At STP } 1 \text{ mol} = 22.4 \text{ L}$$

## Graham's Law

$$\frac{\text{rate A}}{\text{rate B}} = \frac{\sqrt{M_B}}{\sqrt{M_A}}$$

## Energy Change of system

$$\Delta E = E_f - E_i \quad (\text{state function})$$

$$\Delta E_{\text{surroundings}} = -\Delta E_{\text{system}}$$

$$W = -P\Delta V$$

$$\frac{101.3 \text{ J}}{1 \text{ L} \cdot \text{atm}}$$

$$\text{heat capacity } C = \frac{q}{\Delta T}$$

$$q = C\Delta T \quad (\text{for phase change})$$

$$q = m \times C_s \times \Delta T$$

## Enthalpy

$$H = E + PV$$

$$\Delta H = q_p \quad (\text{heat at constant pressure})$$

ex: Bomb calorimeter

$$q_{\text{cal}} = C_{\text{cal}} \times \Delta T_{\text{water}}$$

$$\Delta E_{\text{rxn}} = \frac{\text{energy}}{\text{moles of substance}}$$

$$\Delta E = q_v \quad (\text{constant volume})$$

$$E = q + w$$

- enthalpy of rxn is additive

## Light

$$c = \lambda f$$

exciting gas emits light (when  $e^-$  come back down)

$$E = hf$$

$$h = 6.63 \times 10^{-34}$$

$$K_e = \frac{1}{2} m_e v^2$$

$$\lambda = \frac{h}{mv}$$

### Quantum numbers

①  $n$  (principle quantum number)

- describes energy of atoms

-  $n = 1, 2, 3, 4$       $l = s, 2 = p, 3 = d, 4 = f$

②  $l$  (angular momentum)

- orbital shape

$l = 0$  to  $(n-1)$  for a given  $n$

③  $m_l$  (magnetic quantum number)

$m_l = \pm l, 0$      so      $-l, 0, +l$

④  $m_s$  (spin)

$+\frac{1}{2}$  or  $-\frac{1}{2}$

$$\frac{1}{\lambda} = \frac{R_H}{hc} \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$R_H = 2.18 \times 10^{-18}$$

$\Psi^2 = \text{probability density} = \frac{\text{probability}}{\text{unit volume}}$

### Pauli's Exclusion Principle

- no  $e^-$  has same set of 4 quantum numbers

- 2  $e^-$  w/ opposite spins per orbital

### Aufbau's principle

- increasing energy

- fill lowest orbitals first

### Hund's rule

- single  $e^-$  in orbital (all) before doubling up

- half filled valance shell more stable than a less than full shell

- paramagnetic  $\rightarrow$  unpaired spins (magnetic)
- diamagnetic  $\rightarrow$  all filled (won't magnetize)

### Lewis Dot rules

- 1) Compute total # of  $e^-$
- 2) H + F are terminal atoms (usually)
- 3) Central atom is Carbon if it has it
- 4) Connect bonds to satisfy octet
- 5) Want one covalent bond (at least) between all atoms

$$\text{Formal charge} = (\text{total valance } e^-) - (\text{unbonded } e^-) - \left(\frac{1}{2} \times \text{shared } e^-\right)$$

### Octet exceptions

- 1) odd # of electrons  
ex: NO
- 2) octet deficient molecules  
ex:  $\text{BF}_3$
- 3) Valance shell expansion

### Shapes

2 bonding pairs	Linear	$180^\circ$
3	Trigonal planar	$120^\circ$
4	Tetrahedral	$109^\circ$
5	Trigonal bipyramidal	
6	Octahedral	

single bonds =  $\sigma$   
double bonds =  $1\sigma$   $1\pi$   
triple bonds =  $1\sigma$   $2\pi$

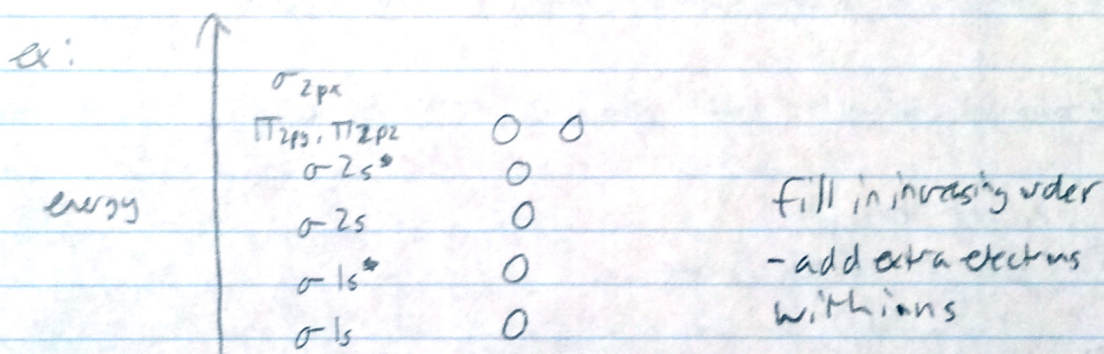
## hybridized

- $sp$  = linear
- $sp^2$  = trigonal planar
- $sp^3$  = tetrahedral
- $sp^3d$  = trigonal bipyramidal
- $sp^3d^2$  = octahedral

- Always move 1  $s e^-$  out of  $s$  and into an empty  $p$  or  $d$  orbital

## Orbital interaction

- bonding + antibonding orbitals
- Fill bonding first



## Clausius - Clapeyron Eq

$$\ln P_{\text{vap}} = \frac{-\Delta H_{\text{vap}}}{R} \times \frac{1}{T} + \ln B$$

or (2pt)

$$\ln \left( \frac{P_2}{P_1} \right) = \frac{-\Delta H_{\text{vap}}}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$$

$\Delta H_{\text{sol}} < 0$  exothermic  
 $\Delta H_{\text{sol}} > 0$  endothermic

Pressure  $\uparrow \uparrow$  Solubility

$$S_{\text{gas}} = K_H \cdot P_{\text{gas}}$$

(mol/L) (M/ATM) (ATM/L)

$$\text{Molality} = \frac{\text{moles of solute}}{\text{kg of solvent}}$$

$$\text{Mass percent} = \frac{\text{mass of solute}}{\text{mass of solution}}$$

$$\text{PPM} = \frac{\text{grams of solute}}{1 \times 10^6 \text{ g solution}}$$

$$X_A = \frac{\text{moles of A}}{\text{total moles}}$$

$$P_{\text{total}} = P_{\text{H}_2\text{O}} + P_{\text{solute}}$$

Raoult's Law

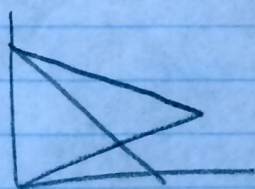
$$P_{\text{solute in solution}} = X_{\text{solute}} \cdot P_{\text{solute}}$$

Van Hoff Factor (i)

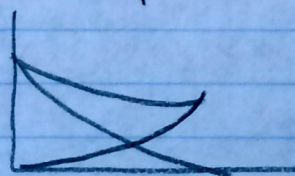
- ratio of solute particles to moles

- ex:  $\text{NaCl} \rightarrow 1 \text{ mol yields } 2 \text{ mol of ions}$

Ideal

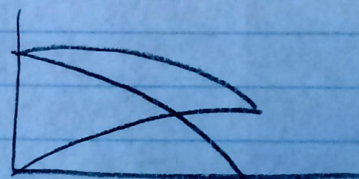


Strong solute-solvent interact  
-depressed



weak "

"



$$\text{Freezing pt depression} = \Delta T_F = m \cdot k_F \quad m = \text{molality}$$

$$\text{Boiling pt elevation} \quad \Delta T_b = m \cdot k_b$$

Osmosis

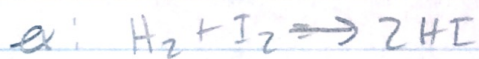
$$\pi = MRT$$

## Factors that affect rxn speed

- ① Concentration
- ② temp
- ③ Nature of reactants
- ④ Catalyst

## Rates

$$\text{Rate} = -\frac{\Delta[\text{reactant}]}{\Delta \text{time}} = +\frac{\Delta[\text{product}]}{\Delta \text{time}}$$



$$-\frac{\Delta[\text{H}_2]}{\Delta t} = -\frac{\Delta[\text{I}_2]}{\Delta t} = +\frac{\Delta[\text{HI}]}{2 \Delta t}$$

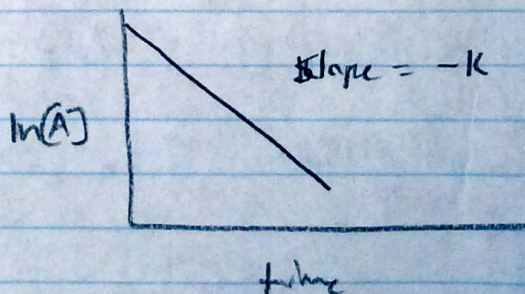
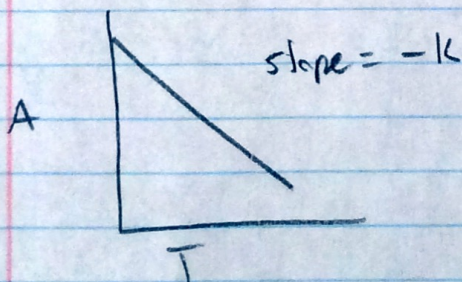
$$\text{Rate} = \frac{[\text{final}] - [\text{initial}]}{t_f - t_i}$$

$$\text{Rate} = k [\text{A}]^n \cdot [\text{B}]^m$$

$n$  and  $m$  are not the coefficients  $\rightarrow$  determined via chart  
- reaction order

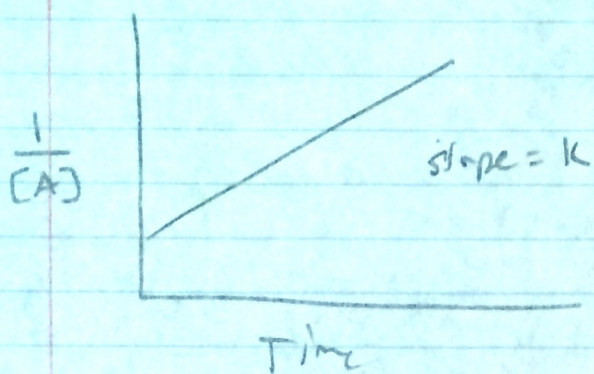
Zero-order

First order





Second order rxn



$$\ln \text{life} = e^{-k t_{1/2}}$$

$$k = A \left( e^{-E_a/RT} \right)$$

$$R = 8.314$$

$$k = p z e^{-E_a/RT}$$

$$\ln \left( \frac{k_2}{k_1} \right) = \frac{E_a}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right)$$

$E_c$  constant

$$K_{eq} = \frac{[C]^c \times [D]^d}{[A]^a \times [B]^b}$$

- only depends on temp  
- no solids / liquids

$K_{eq} > 1$  more prod than reactants  
 $K_{eq} < 1$  more react than prod

$$K_p = \frac{P_c^c \times P_d^d}{P_a^a \times P_b^b}$$

pressure of gasses

$$K_p = K_c (RT)^{\Delta n}$$

$$K_c = K_p (RT)^{-\Delta n}$$

$$Q_c = \frac{c^c \times d^d}{A^a \times B^b}$$

$Q_c < K_{eq}$  not at eq yet  
 $Q_c > K_{eq}$  past eq

$$K_a = \frac{[A_{id}^-][H_3O^+]}{[H-A_{id}]}$$

$$K_w = [OH^-][H_3O^+] = 10^{-14}$$

$$pH = -\log [H^+]$$

$$pOH = -\log [OH^-]$$

$$pH + pOH = 14$$

$$pK_a = -\log K_a$$

$$pK_b = -\log K_b$$

stronger acid = lower  $pK_a$

buffer

$$pH = pK_a + \log \left( \frac{[conjugate\ base]}{[weak\ acid]} \right)$$

$$K_{sp} = [X^n]^m [Y^m]^n$$

$$\Delta G = \Delta H - T\Delta S$$

$-\Delta G = \text{spontaneous (exergonic)}$   $T\Delta S > \Delta H$

$$\Delta G^{\circ} = -RT \ln K$$

$$\Delta G^{\circ} = -nFE^{\circ}_{\text{cell}}$$

CROAK

Cathode

Reduction

Oxidation

Anode

Konstant (no exceptions)

$$E^{\circ}_{\text{cell}} = E_{\text{ox}} + E_{\text{red}} \quad \text{so} \quad E_{\text{ox}} = -E_{\text{red}}$$

$$E_{\text{cell}} = \frac{0.0592}{N} \log K$$

$$E_{\text{cell}} = E^{\circ} - \frac{0.0592}{N} \log Q$$