Cheat Sheet for Chemical Equilibrium:

Equilibrium
- Rates are equal.
- Concentrations remain constant.

Finding Keq
- Keq = \frac{\text{products}}{\text{reactants}}
- You can have Kc, Kp, Ksp, Ka, Kb \rightarrow These are the same as Keq. They just describe specific types of reactions.
- Given: Grams. Asked for Keq and it is not clear which to use...
  - If you have a reaction of gases, solve for: Kp.
  - If you are a reaction with aqueous solutions, solve for: Kc.
- Sometimes you are asked to solve for Kc and then relate to Kp. You use Kp = Kc(RT)^\Delta n

Finding Keq when the reaction is changed:
- When a reaction is reversed, the new Keq = \frac{1}{\text{Keq}}
- When a reaction is multiplied, the new Keq = (\text{Keq})^n where n= the number the equation is multiplied by
- When more than one reaction is added together (like a Hess’s Law problem), your Keq for each reaction will be MULTIPLIED together. New Keq = (K_1)^*(K_2)

Determining The Direction a Reaction Proceeds
- K > 1: Production of the products is favored. Equilibrium lies to the right.
- K < 1: Production of the reactants is favored. Equilibrium lies to the left.
- Reaction Quotient, Q, for non-equilibrium conditions
  - Q = K, System is at equilibrium
  - Q > K, Too many products, system shifts to the Left to increase production of reactants
  - Q < K, Too many reactants, system shifts to the Right to increase production of products

ICE Charts
- Completed using Concentrations or sometimes, Partial Pressures
- Given: Initial Concentration of Reactants only- Products will be zero. Determine the change by subtracting “x” from reactants and adding “x” to products.
- Given: Initial Concentrations of Products only- Reactants will be zero. Determine the change by subtracting “x” from the products and adding “x” to reactants.
- Given: Initial Concentration of a species and Equilibrium concentration of a species: Determine the change by subtracting equilibrium concentration and initial concentration. Fill in table as appropriate.
- Don’t forget to consider mole ratios when determining the change of other species.
- Keq is determined from equilibrium values.
- All ICE charts you see on the AP exam follow the 5% rule. That means when you subtract “x” or add “x” from a concentration other than 0, you can ignore it!
Equilibrium Constant of Solubility

- The equilibrium constant for these problems is called the solubility product while the solubility is the concentration that is actually dissolved or “x”.
- The way to show the dissolving of the solid is AgI→ Ag⁺ + Cl⁻
- Since the reactants are solids, the equilibrium expression would be Ksp= [product#1][product#2]
- Given: Solubility: Determine the Ksp by setting up an ICE chart to properly deal with mole ratios.
- Given: Ksp: Determine the solubility by writing an ICE chart and solving for “x”.
- Given: Initial Concentrations and asked whether a precipitate will form: Calculate Q (no ICE chart needed) and compare with Ksp:
  - Q>Ksp, precipitate will form
  - Q=Ksp, at equilibrium
  - Q<Ksp, no precipitate formed
- Selective precipitation is the process by which metal ions are separated based on different Ksp values. They therefore need different concentrations of one anion for precipitation to occur.
- ∆G = ∆G° + RTlnQ - formula used to relate Gibbs Free Energy at standard and non-standard conditions.
- At equilibrium: ∆G° = -RTlnKeq

Le Châtelier’s Principle:

- If a system is disturbed by a change in temperature, pressure, or concentration of one of the components, the system will shift its equilibrium position so as to counteract the effect of the disturbance.
- Change in Concentration:
  - Increase Concentration- system will shift away from addition by consuming added substance.
  - Decrease Concentration- system will shift to increase the concentration of that substance.
- Change in Volume/Pressure (FOR GASES ONLY)
  - Increase Pressure/Decrease Volume- shift towards side with fewer moles of gas.
  - Decrease Pressure/Increase Volume- shift towards side with more moles of gas.
- Change in Temperature:
  - Increase Temperature- system will shift in the direction to consume heat (Just like concentration rule!).
  - Decrease Temperature- system will shift in the direction to produce heat (Just like concentration rule!).
- Common Ion Effect- The addition of an ion already involved will cause a shift away from this addition. Specifically, it will decrease the solubility of a compound.
- Addition of a Catalyst- will increase forward and reverse rates by lowering activation energy, but will have no effect on the concentrations at equilibrium. Keq NOT affected.