**Dougherty Valley HS** **AP Chemistry**

**Equilibrium: A Dynamic Process**

**A BLUFFER’S GUIDE**

*Inspired by Paul Groves*

1. aA +bB + . . .  rR +sS + . . .

Law of Mass Action:  
Kc = 

and for gases:

Kp = 

1. K > 1 Products Favored

K < 1 Reactant Favored

1. Excluded: solids, liquids including water in aqueous solutions.   
   Why: because their [ ]’s don’t change
2. Convert Kc to Kp  
   Kp = Kc(RT)∆nWhere ∆n =   
   mol of (g) products – mol of (g) reactants
3. Typical question: Given Kc and the starting concentrations of reactants, find concentrations of products at equilibrium.

Example: Kc for acetic acid = 1.8 x 10-5.

What is the equilibrium concentration of [H+] in a 0.100 M solution of the acid?

1. Relationship between modifying a chemical equation and the value of K
   * Reverse a rxn = 1/Kforward
   * Multiplying by a number “n” = Kn
   * Adding rxns = Koverall = K1 x K2 x ...
2. Le Chatelier’s Principle: effect of changes in concentration, pressure and temperature. Equilibrium always “shifts” away from what you add and towards what you remove. “Stress” means too much or too little: chemical, heat, or volume.

*Based on a handout by William Bond, Snohomish HS*

Good for solving quadratic, cubic, etc for ICE Tables if no graphing calculator <https://www.mathpapa.com/equation-solver/>

1. If NOT at equilibrium (or you don’t know if at equilibrium or not): Calculate Q, the reaction quotient.
   * Set up the same way as if calculating K
   * If K < Q
     + Numerator too large  
       Denominator too small
     + Too many products  
       Not enough reactants
     + Reverse rxn is favored to reach equilib.
     + “Shift left”
   * If K > Q
     + Numerator too small  
       Denominator too large
     + Not enough products  
       Too many reactants
     + Forward rxn is favored to reach equilib.
     + “Shift right.”
2. ICE Box  
   Example: A  2B + C

|  |  |  |  |
| --- | --- | --- | --- |
|  | **A** | **B** | **C** |
| *initial* | 5.0 M | 0 M | 0 M |
| *change* | -x | +2x | +x |
| *equilibrium* | 5.0-x | 2x | x |

“C” row follows the stoichiometry of the rxn

1. The 5% rule allows us to approximate
   * K must be < 1
   * Usually able to be used if K is at least 1000 times smaller than [ ]initial
   * x must be ≤ 5% of the [ ]initial
   * If 5% rule doesn’t work then use quadratic equation *(not often seen on AP Exam)*

ax2 + bx + c = 0

x = 

1. “Perfect Squares” are another way math is sometimes simplified.   
   3x10-6 = (x)(x) / 0.1 take √ of both sides and you get 1.73 x 10-3 = x / 0.316 now solving for x is super easy.

**R-23**