CONCEPT: Ka AND Kb

- **Ka and Kb** are equilibrium _____ for acids and bases, respectively.
  - Ka and Kb are used to measure the _____ of weak acids and bases

Equilibrium Constant (K)	Example Equilibrium Expressions	Acid-Base Strength
Ka: acid dissociation (ionization) constant	$HF\ (aq) + H_2O\ (l) \rightleftharpoons F^-\ (aq) + H_3O^+\ (aq)$ $K_a = \frac{\text{products}}{\text{reactants}} = \frac{\quad}{\quad} = 6.3 \times 10^{-4}$	• Stronger Acid: ____ Ka • Weak Acid: Ka 1 • Strong Acid: Ka 1
Kb: base dissociation (ionization) constant	$NH_3\ (aq) + H_2O\ (l) \rightleftharpoons NH_4^+\ (aq) + OH^-\ (aq)$ $K_b = \frac{\text{products}}{\text{reactants}} = \frac{\quad}{\quad} = 1.8 \times 10^{-5}$	• Stronger Base: ____ Kb • Weak Base: Kb 1 • Strong Base: Kb 1

  - _____ acids and bases have a dissociation constant associated with them as well

EXAMPLE: Identify the strongest acid from the following list of weak acids based on their K_a values. Assume temp is 25°C.

a) HCN $K_a = 4.9 \times 10^{-10}$ b) H_2O $K_a = 1.0 \times 10^{-14}$ c) HNO_2 $K_a = 4.6 \times 10^{-4}$ d) $HC_3H_5O_3$ $K_a = 1.4 \times 10^{-4}$

PRACTICE: Hypobromous acid ($K_a = 2.8 \times 10^{-9}$) and hydrocyanic acid ($K_a = 4.9 \times 10^{-10}$) are both weak acids. Determine if reactants or products are favored in the following reaction.

$$HBrO\ (aq) + CN^-\ (aq) \rightleftharpoons BrO^-\ (aq) + HCN\ (aq)$$

a) reactants b) products c) both directions are favored equally d) neither direction is favored

PRACTICE: Identify a Bronsted-Lowry acid with **weakest** conjugate base.

a) H_3BO_3 $K_a = 5.4 \times 10^{-10}$

b) HF $K_a = 3.5 \times 10^{-4}$

c) HNO_2 $K_a = 4.6 \times 10^{-4}$

d) HClO $K_a = 2.9 \times 10^{-8}$

CONCEPT: Ka AND Kb

Ka & Kb Relationship

● Ka and Kb are related through the following formulas and can only be used for _____ pairs

Ka & Kb Formulas	
Kw = Ka x Kb	14 = pKa + pKb

pKa & pKb		
Acids	pKa = - log ___ Ka = 10 ———	□ Stronger Acid: __ Ka, __ pKa ● Strong Acid: Ka 1; pKa 1 ● Weak Acid: Ka 1; pKa 0
Bases	pKb = - log ___ Kb = 10 ———	□ Stronger Base: __ Kb, __ pKb ● Strong Base: Kb 1; pKb 1 ● Weak Base: Kb 1; pKb 0

EXAMPLE: Aspirin, also known as acetylsalicylic acid ($Ka = 3.3 \times 10^{-4}$), is a medication used to reduce pain, fever, and inflammation. Calculate the Kb of acetylsalicylate ($C_9H_7O_4^-$).

PRACTICE: Identify which of the compounds is the strongest species.

a) Iodic acid pKa = 0.80 b) Acetic acid pKb = 9.24 c) Formic acid pKa = 3.75 d) Ammonium pKb = 4.75

PRACTICE: Determine the pK_a given the Kb of the following bases:

i) NH_3 $K_b = 1.76 \times 10^{-5}$; NH_4^+ pK_a = _____

ii) $C_6H_5NH_2$ $K_b = 3.9 \times 10^{-10}$; $C_6H_5NH_3^+$ pK_a = _____