1. Formic acid (HCO_2H) is secreted by ants. At equilibrium, pH is 2.7 and

$K_a = 1.8 \times 10^{-4}$. What is the concentration of formic acid at equilibrium?

	$HCO_2H_{(aq)}$	$H^{+1}_{(aq)}$	$+\ CO_2H^{-1}_{(aq)}$
I		**0**	**0**
C	**2.0 x 10^{-3} mol/L**	**2.0 x 10^{-3} mol/L**	**2.0 x 10^{-3} mol/L**
E	**x**	**$[H^+] = 10^{-pH} = 10^{-2.7} = 2.0 \times 10^{-3}$ mol/L**	**2.0 x 10^{-3} mol/L**

$$K = \frac{[H^{+1}][CO_2H^{-1}]}{[HCO_2H]} = \frac{2.0 \times 10^{-3}(2.0 \times 10^{-3})}{[HCO_2H]} = 1.8X10^{-6}$$

$[HCO_2H] = 0.022$ mol/L

2. The hypoclorite ion (OCl^{-1}) is often found in household bleaches and disinfectants. It is also the active ingredient that forms when swimming pool water is treated with chlorine. In addition, it forms weakly acidic hypochlorous acid ($HOCl$, $Ka = 3.5 \times 10^{-8}$). Calculate the pH of a aqueous solution of hypochlorious acid when concentration of $HOCl_{(aq)}$ at equilibrium is 0.100 M.

	$HOCl_{(aq)}$	$H^+_{(aq)}$	$+\ OCl^-_{(aq)}$
I		0	0
C		x	x
E	0.1	x	x

$$K = \frac{[H^{+1}][OCl^{-1}]}{[HOCl]} = \frac{x(x)}{0.1} = 3.5X10^{-8}$$

$x^2 = (3.5 \times 10^{-8})(0.100)$

$x = 5.92 \times 10^{-5}$ mol/L = $[H^+]$

pH = -log $[H^+]$ = -log $[5.92 \times 10^{-5}]$

= 4.2

3. At 25 ^{0}C, $HF_{(aq)}$ dissociates and reaches an equilibrium. The K_a of the solution is 4.7×10^{-4}. What is the concentration of $H^{+1}_{(aq)}$ in the solution when initial concentration of $HF_{(aq)}$ is 2.0 M?

0.031 moles/L

4. A 0.011 M solution of hydrocyanic acid, HCN dissociates in solution. The concentration of $H^{+1}_{(aq)}$ at equilibrium is 5.8×10^{-3} M. What is the K_a of this solution?

$K_A = (5.8 \times 10^{-3})^2/(0.011 - 5.8 \times 10^{-3}) = 0.0065$

5. In 80.0 mL solution, 0.25 mol of boric acid, H_3BO_3 dissociates into 3.4×10^{-4} mol of $H_2BO_3^{-1}{}_{(aq)}$. What is the K_a and pH of this solution?

	H_3BO_3	$H^+_{(aq)}$	$+ H_2BO_3^{-1}{}_{(aq)}$
I	0.25/0.080 L	0	0
C	3.4×10^{-4} mol/0.080 L	3.4×10^{-4} mol/0.080 L	3.4×10^{-4} mol/0.080 L
E	0.25/0.080 L – 3.4×10^{-4} mol/0.080 L	3.4×10^{-4} mol/0.080 L	3.4×10^{-4} mol/0.080 L

pH = -log (3.4×10^{-4} mol/0.080 L) = 2.37

$K_A = 5.8 \times 10^{-6}$

6. The acid dissociation constant of NH_4^{+1} is 5.6×10^{-10}. When a 0.100 M solution of NH_4^{+1} dissociates and reaches equilibrium, what is the concentration of $H^{+1}_{(aq)}$ and pOH of the solution?

$$NH_4^{+1}{}_{(aq)} \rightleftharpoons NH_{3\,(aq)} + H^{+1}_{(aq)}$$

[H+] = 7.5 X 10^{-6} M
pOH = 8.88

7. The initial concentration and pH of $NH_4OH_{(aq)}$ is 0.12 M and 10.0, respectively. What is the base dissociation constant, K_b of NH_4OH?

   K_B = 8 X10^{-8}

8. Codeine is a derivative of morphine that is used as an analgesic, narcotic, or antitussive. It was once commonly used in cough syrups but it is now available only by prescription because of its addictive properties. The molecular mass of codeine is 300.0 g/mol, and the pK_b is 6.05. Calculate the pH of a 10.0 mL solution containing 5.0 mg codeine. (Note that $pK_b = -\log K_b$ and 1 mg = 10^{-3} g)

$$\text{Codeine}_{(aq)} + H_2O_{(l)} \rightleftharpoons \text{CodeineH}^{+1}_{(aq)} + OH^{-1}_{(aq)}$$

(5 X10^{-3}/(300 g/mole)) = 1.67 X10^{-5} moles of codeine ;
[codeine] = 1.67 X 10^{-5} moles/ 0.010 L = 1.67 X 10^{-3} moles/L
$K_b = 10^{-6.05} = x^2/(1.67 \text{ X}10^{-3}-x)$
x = 3.81 X 10^{-5} moles/L = [OH^{-1}]
pOH = -log[OH^{-1}]= -log(3.81 X 10^{-5} moles/L) = 4.4
pH = 14 – pOH = 14 – 4.4 = 9.6

9. Use the information in the following table to determine which acid is the weakest and which one is the strongest. (Remember: relative strength is not based on pH alone!)

acid	Initial concentration	pH
A	0.10	3.0
B	0.000010	6.9
C	0.010	3.6

The one with the highest Ka is the strongest acid. This will not always coincide with the lowest pH. Both the initial concentration and the pH are factors in its strength.

Acid A : **Ka = $(10^{-3.0})^2/(0.10-10^{-3})$ = 1 X 10^{-5}** **STRONGEST**

Acid B : Ka = $(10^{-6.9})^2/(0.000010-10^{-6.9})$ = 2 X 10^{-9}

Acid C : Ka = $(10^{-3.6})^2/(0.010-10^{-3.6})$ = 6 X 10^{-6}