

Name _____ Date _____

MORE REVIEW

1. Calculate the pH of each of the following solutions in water.

- 0.10 M HCl
- 5.0 M HCl
- 1.0×10^{-11} M HCl



a) $\text{pH} = -\log(0.10) = 1$

b) $\text{pH} = -\log(5.0) = -0.70$

c) $\text{pH} = -\log(1.0 \times 10^{-11}) = 11$

2. Calculate the pH of each of the following solutions in water.

- 0.10 M NaOH
- 5.0 M NaOH
- 1.0×10^{-11} M NaOH



a) $\text{pOH} = -\log(0.10) = 1$ $\text{pH} = 13$

b) $\text{pOH} = -\log(5.0) = -0.70$ $\text{pH} = 14.7$

c) $\text{pOH} = -\log(1.0 \times 10^{-11}) = 11$ $\text{pH} = 3$

3. A solution is prepared by adding 50.0 ml of 0.050 M HCl to 150.0 ml of 0.10 M HNO₃. Calculate the concentrations of all species in this solution.

$$\text{HCl} \quad \mu = \frac{\text{moles}}{\text{L}}$$

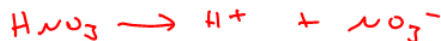
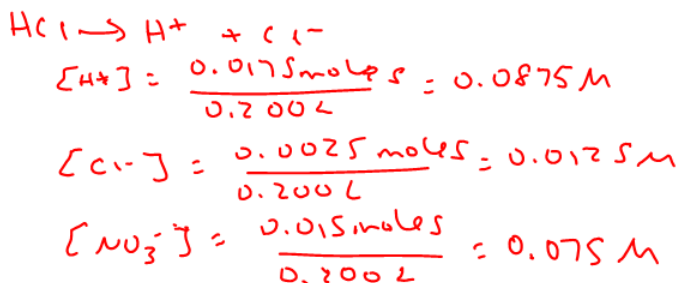
$$0.050 \text{ M} = \frac{x}{0.050 \text{ L}}$$

$$x = 0.0025 \text{ moles HCl}$$

$$\text{HNO}_3 \quad \mu = \frac{\text{moles}}{\text{L}}$$

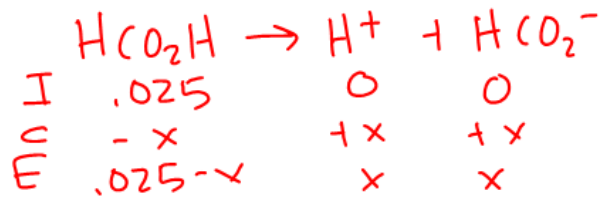
$$0.10 \text{ M} = \frac{x}{0.150 \text{ L}}$$

$$x = 0.015 \text{ moles HNO}_3$$



4. Formic acid (HCO_2H) is secreted by ants. Calculate $[\text{H}^+]$ and the pH of a 0.025 M solution of formic acid ($K_a = 1.8 \times 10^{-4}$)

$$K_a = \frac{[\text{H}^+][\text{HCO}_2^-]}{[\text{HCO}_2\text{H}]}$$



$$1.8 \times 10^{-4} = \frac{x^2}{.025-x}$$

$$x = .00212$$

5% ✓
 $.05(.025) = .00125$

FAILS!

∩

$$1.80 \times 10^{-4} (.025-x) = x^2$$

$$4.5 \times 10^{-6} - 1.80 \times 10^{-4} x - x^2 = 0$$

$$x^2 + 1.80 \times 10^{-4} x - 4.5 \times 10^{-6} = 0$$

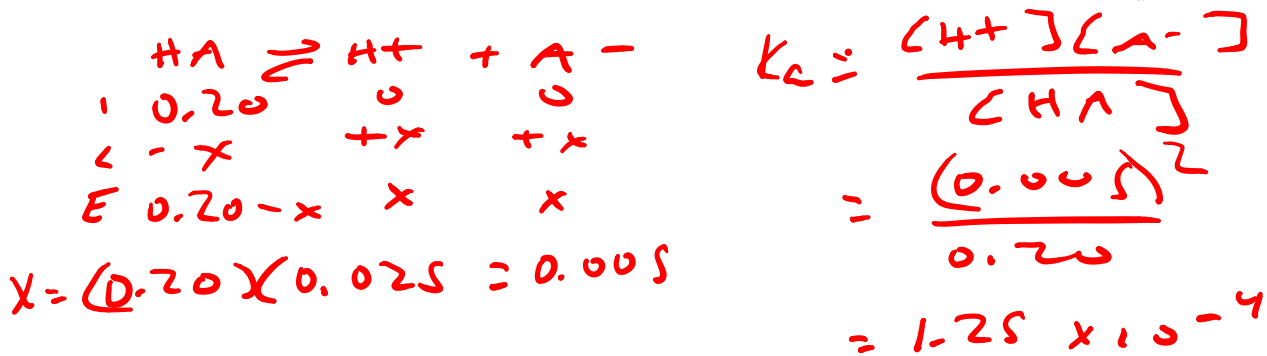
$$\frac{- (1.80 \times 10^{-4}) \pm \sqrt{(1.80 \times 10^{-4})^2 - 4(1)(-4.5 \times 10^{-6})}}{2}$$

$$\frac{-1.8 \times 10^{-4} \pm 0.00425}{2}$$

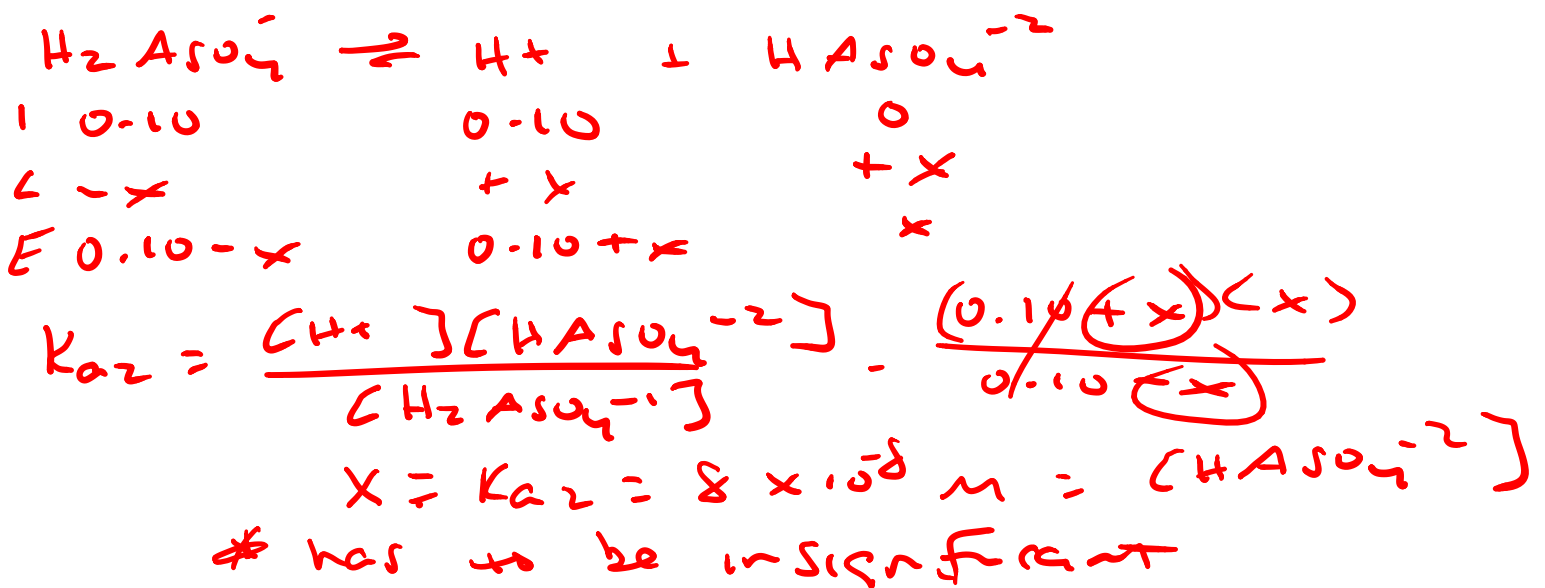
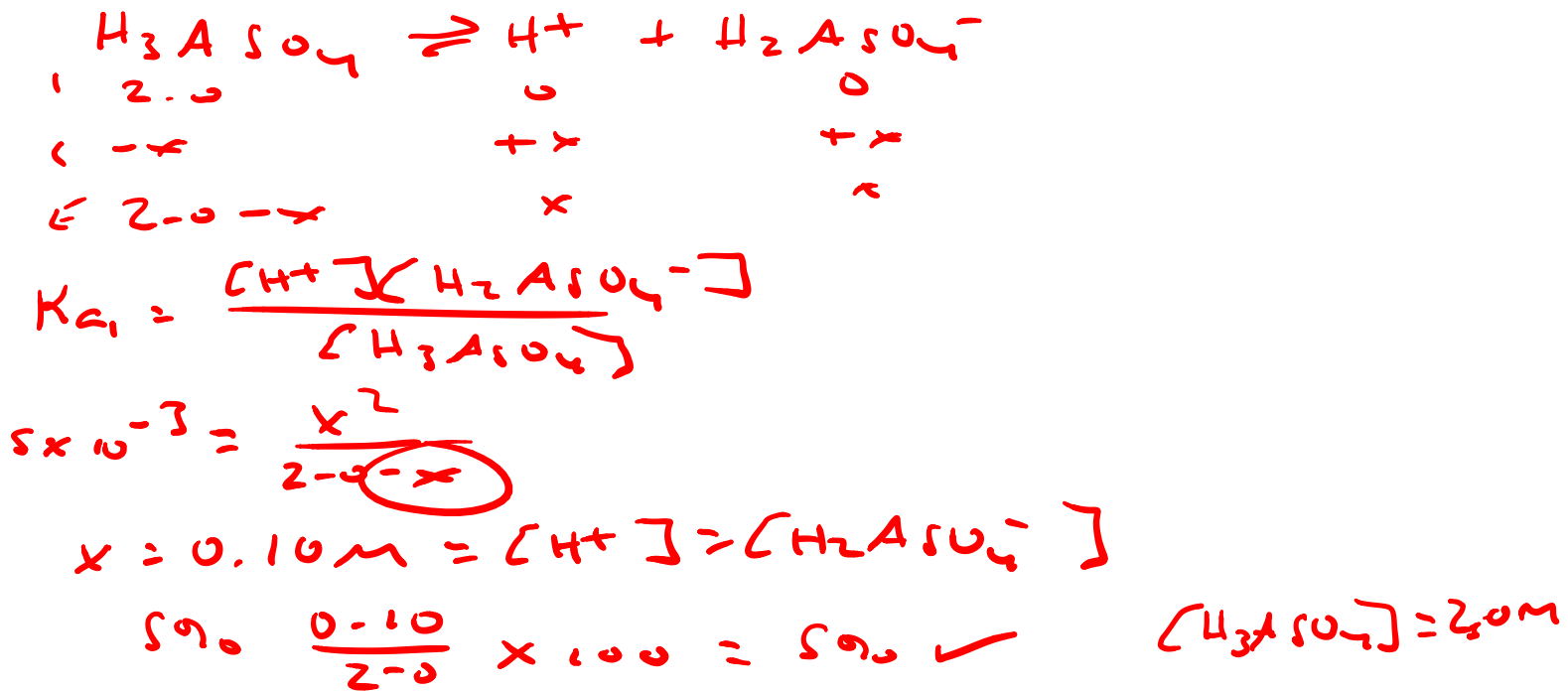
$$x = 2.04 \times 10^{-3}$$

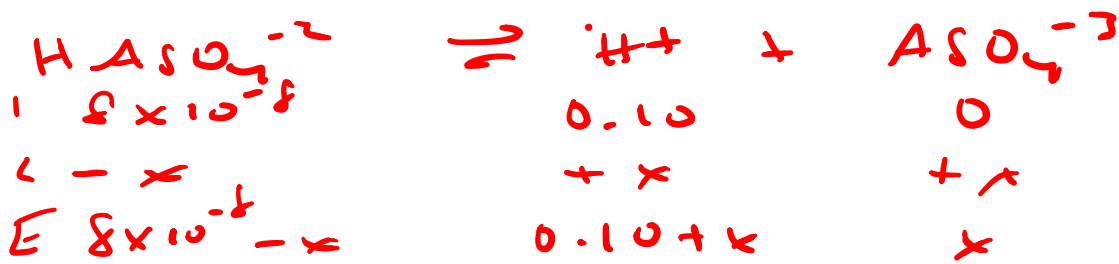
$$\text{pH} = -\log(2.04 \times 10^{-3}) = 2.69$$

5. A 0.20 M solution of a weak acid is 2.5% dissociated. Calculate the K_a .



6. Arsenic acid (H_3AsO_4) is a triprotic acid with $K_{a1} = 5 \times 10^{-3}$, $K_{a2} = 8 \times 10^{-8}$, and $K_{a3} = 6 \times 10^{-10}$. Calculate $[\text{H}^+]$, $[\text{OH}^-]$, $[\text{H}_3\text{AsO}_4]$, $[\text{H}_2\text{AsO}_4^-]$, $[\text{HAsO}_4^{2-}]$ and $[\text{AsO}_4^{3-}]$ in a 2.0 M arsenic acid solution.





$$K_{a2} = \frac{[\text{H}^+][\text{AsO}_4^{3-}]}{[\text{HAsO}_4^{2-}]}$$

$$6 \times 10^{-10} = \frac{(0.10 + x)(x)}{8 \times 10^{-8} - x}$$

$$x = 4.8 \times 10^{-16} \text{ M} = [\text{AsO}_4^{3-}]$$

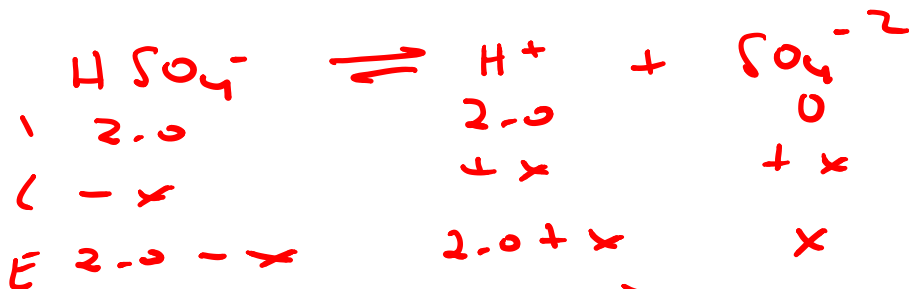
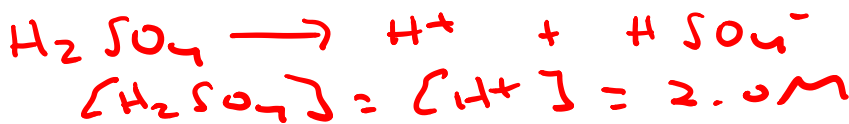
x has to be insignificant

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$[\text{OH}^-] = \frac{1 \times 10^{-14}}{0.10}$$

$$= 1 \times 10^{-13} \text{ M}$$

7. Calculate the pH of a 2.0 M H_2SO_4 solution.



$$K_a = \frac{[\text{H}^+][\text{SO}_4^{2-}]}{[\text{HSO}_4^-]} = 1.2 \times 10^{-2}$$

$$= \frac{(2.0 + x)(x)}{2.0 - x}$$

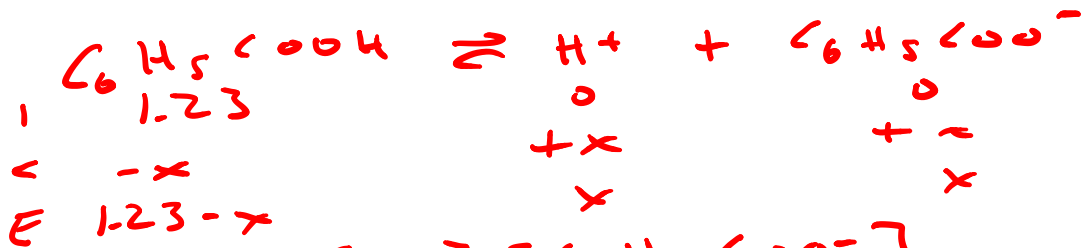
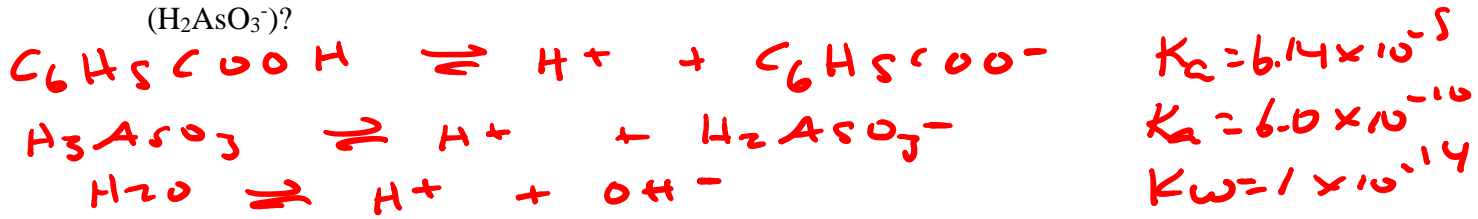
$$x = 1.2 \times 10^{-2}$$

$$\text{Solve } \frac{1.2 \times 10^{-2}}{2.0} x \approx 0.6\%$$

$$[\text{H}^+] = 2.0 \text{ M}$$

$$\text{pH} = -\log(2.0) = -0.30$$

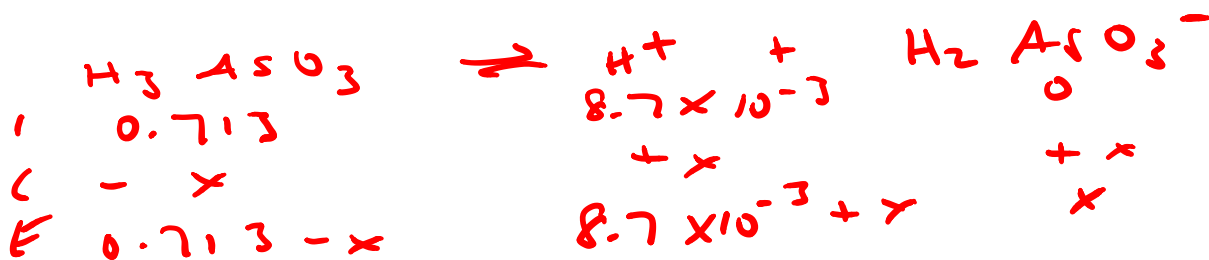
8. Calculate the pH of a solution that contains 1.23 M benzoic acid, C_6H_5COOH ($K_a = 6.14 \times 10^{-5}$) and .713 M arsenious acid H_3AsO_3 ($K_a = 6.0 \times 10^{-10}$). What is the concentration of the benzoate ion ($C_6H_5COO^-$), hydroxide ion (OH^-) and arsenite ion ($H_2AsO_3^-$)?



$$K_a = \frac{[H^+][C_6H_5COO^-]}{[C_6H_5COOH]}$$

$$6.14 \times 10^{-5} = \frac{x^2}{1.23 - x}$$

$$x = 8.7 \times 10^{-3} M = [H^+] = [C_6H_5COO^-]$$



$$K_a = \frac{[H^+][H_2AsO_3^-]}{[H_3AsO_3]}$$

$$6.0 \times 10^{-10} = \frac{(8.7 \times 10^{-3} + x)(x)}{(0.713 - x)}$$

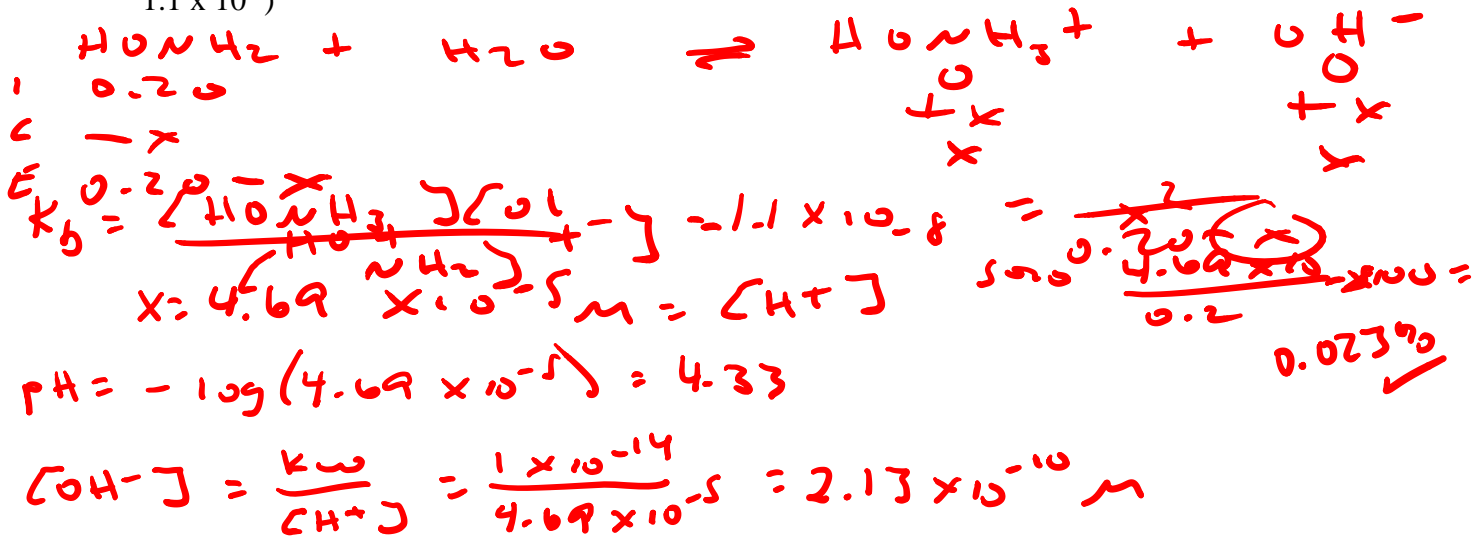
$$x = 4.9 \times 10^{-8} M = [H_2AsO_3^-]$$

$$\% \text{ ionized} = \frac{4.9 \times 10^{-8}}{0.713} \times 100 = 6.9 \times 10^{-6} \% \checkmark$$

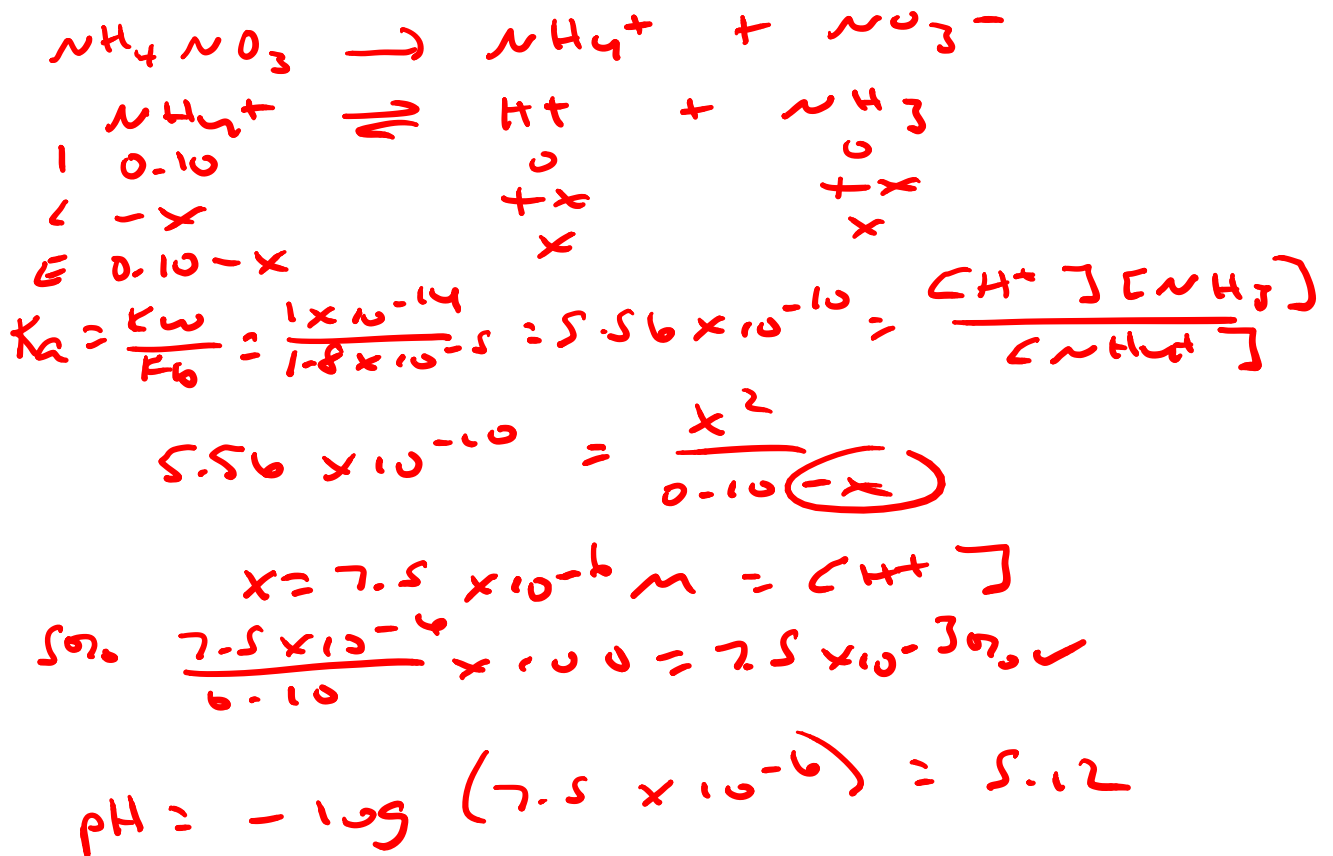
$$[OH^-] = \frac{1 \times 10^{-14}}{8.7 \times 10^{-3}} = 1.15 \times 10^{-12} M$$

$$pH = -\log(8.7 \times 10^{-3}) = 2.06$$

9. Calculate the $[OH^-]$, $[H^+]$ and the pH of 0.20 M solution of hydroxylamine ($HONH_2$, $K_b = 1.1 \times 10^{-8}$)



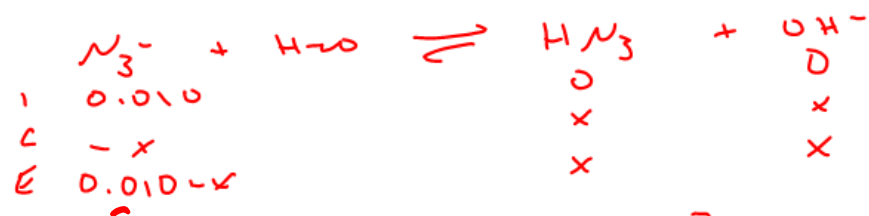
10. Calculate the concentration of all species and the pH of a 0.10 M NH_4NO_3 solution. The K_b for ammonia is 1.8×10^{-5}



11. Calculate the concentration of all species and the pH in a 0.010 M solution of NaN_3 . The K_a for hydrozoic acid (HN_3) is 1.9×10^{-5} .



$$K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{1.9 \times 10^{-5}} = 5.3 \times 10^{-10}$$



$$K_b = \frac{[\text{HN}_3][\text{OH}^-]}{[\text{N}_3^-]} = 5.3 \times 10^{-10} = \frac{x^2}{0.010-x}$$

$$x = 2.3 \times 10^{-6} \text{ M} = [\text{OH}^-]$$

$$0.05(0.010) = 5 \times 10^{-4} \quad \checkmark$$

$$[\text{HN}_3] = [\text{OH}^-] = 2.3 \times 10^{-6} \text{ M}$$

$$[\text{Na}^+] = 0.010 \text{ M}$$

$$[\text{N}_3^-] = 0.010$$

$$[\text{H}^+] = \frac{1.0 \times 10^{-14}}{2.3 \times 10^{-6}} = 4.3 \times 10^{-9} \text{ M}$$