2. Calculate the pH of a 0.30 *M* NaF solution. The K_a value for HF is 7.2×10^{-4}.

NaF → NaOH: SB (no hydrolysis); HF: WA

$F^-_{(aq)} + H_2O_{(l)} \rightleftharpoons HF_{(aq)} + OH^-_{(aq)}$

↑ acting as a weak base ⇒ need $K_b = \frac{K_w}{K_a} = \frac{1E-14}{7.2E-4} = 1.4E-11$

$K_b = \frac{[HF][OH^-]}{[F^-]} = \frac{x^2}{0.30 - x} \approx \frac{x^2}{0.30} = 1.4E-11$

$K_b \ll 1$, x negligible

$x = [OH^-] = \sqrt{(0.30)(1.4E-11)} = 2.0E-6\ M$

$pOH = -\log(2.0E-6) = 5.69 \Rightarrow pH = 14 - 5.69 = \boxed{8.31}$

Multiple Choice Practice

NaOH: SB HCN: WA

3. What is the pH of a 1.0×10^{-2} M solution of NaCN? (For HCN, $K_a = 1.0 \times 10^{-10}$).

   a. between 0 and 3
   b. between 3 and 7
   c. between 7 and 10
   (d.) between 10 and 14

$K_b(CN^-) = \frac{1E-14}{1E-10} = 1E-4$

$K_b = \frac{x^2}{1E-2} = 1E-4 \Rightarrow x = [OH^-] = \sqrt{(1E-2)(1E-4)} = \sqrt{1E-6} = 1E-3$

$\Rightarrow pOH = 3$

$pH = 14 - 3 = 11$

favored = weaker!

$650\ kJ + HCO_3^-(aq) + HC_2O_4^-(aq) \leftrightarrow CO_3^{2-}(aq) + H_2C_2O_4(aq)$

A B CB CA

4. If K > 1, all of the following statements are true about the reaction above EXCEPT:

   (a.) $HC_2O_4^-$ is a weaker base than CO_3^{2-}.
   b. HCO_3^- and $H_2C_2O_4$ are both acting as acids in the reaction.
   c. The reaction lies far to the right (favors products).
   d. Lowering the temperature of the solution will decrease the value of K.

5. Which of the following would form a basic solution when dissolved in water?

   a. HCl — SA!
   b. LiCl → LiOH (SB) + HCl (SA) ⇒ neutral
   c. NH_4Cl → NH_3 (WB) + HCl (SA) ⇒ acidic
   (d.) $NaC_2H_3O_2$ → NaOH (SB) + $HC_2H_3O_2$ (WA)

6. Estimate the pH of a 1.0×10^{-5} M solution of the weak base $C_6H_5NH_2$? ($K_b = 4.0 \times 10^{-10}$).

a. between 0 and 3 c. between 7 and 10

(b.) between 3 and 7 d. between 10 and 14

$$K_b = \frac{x^2}{1E\text{-}5} = 4E\text{-}10 \Rightarrow x = [OH^-] = \sqrt{4E\text{-}15} = 2E\text{-}7.5 \approx 1E\text{-}7.5$$

$$\Rightarrow pOH = 7.5 \Rightarrow pH = 14 - 7.5 = 6.5$$

7. Which of the following would a solution with the lowest pH?

a. NaOH — SB

b. LiCl — $LiOH$ (SB) + HCl (SA) $\Rightarrow$ neutral

(c.) $HClO_4$ — SA

d. $NaC_2H_3O_2$ — $NaOH$ (SB) + $HC_2H_3O_2$ (WA) $\Rightarrow$ basic

8. A solution of a monoprotic acid, HA, has a pH of 5.00. Calculate the acid dissociation constant for the weak acid if the solution has a molar concentration of 0.50 M.

a. 2.0×10^{-11} (b.) 2.0×10^{-10} c. 2.0×10^{-7} d. 2.0×10^{-6}

$$x = [H_3O^+] = 10^{-5} \qquad K_a = \frac{x^2}{[HA]} = \frac{(1E\text{-}5)^2}{0.5} = \frac{1E\text{-}10}{1/2} = 2E\text{-}10$$

9. Which of the following can act as an amphoteric species?

I. SO_4^{2-}
II. HCO_3^-
III. NH_4^+

a. I only (b.) II only c. II and ~~III~~ only d. I, II, and III

10. What is the equilibrium expression for the hydrolysis of NH_4Cl?

$$NH_4^+_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + NH_{3(aq)}$$

a. $K = \frac{[HCl][OH^-]}{[Cl^-]}$ c. $K = \frac{[Cl^-]}{[HCl][OH^-]}$

(b.) $K = \frac{[NH_3][H_3O^+]}{[NH_4^+]}$ d. $K = \frac{[NH_4^+]}{[NH_3][H_3O^+]}$

11. The pH of a 0.10 M KOH solution is:

a. 0.10 b. 1.00 (c.) 13.00 d. 14.00

$$pOH = -\log(1E\text{-}1) = 1$$

$$pH = 14 - 1 = 13$$