

Show all work to receive credit. $pH = pK_a + \log(\text{"base"/"acid"})$

1. (3 Pts) A buffer of pH 4.1 is to be prepared from a weak acid and its salt. The best acid from which to prepare the buffer is

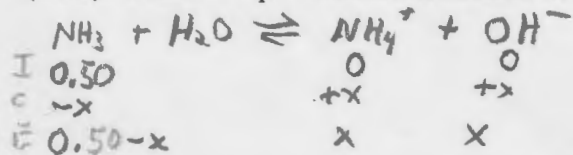
(A) phthalic acid, $K_1 = 1.3 \times 10^{-3}$ (first ionization)

(B) hydrogen phthalate, $K_2 = 3.9 \times 10^{-5}$ (second ionization of phthalic acid)

(C) benzoic acid, $K = 6.3 \times 10^{-5}$ $-\log(6.3 \times 10^{-5}) = 4.2$ closest to 4.1

(D) hydrocyanic acid, $K = 4 \times 10^{-10}$

2. (4 Pts) What is the pH in a 0.50 M solution of $NH_3(aq)$? $K_b = 1.8 \times 10^{-5}$

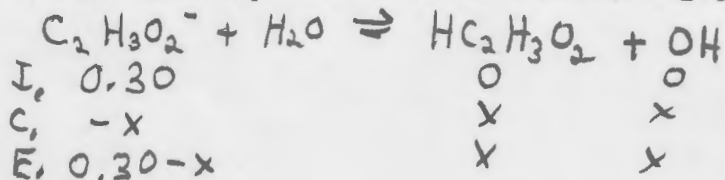


$$K_b = 1.8 \times 10^{-5} = \frac{x^2}{0.50-x} \leftarrow 5\% \text{ rule}$$

$$x = [OH^-] = 0.003$$

$$pOH = 2.52 \quad pH = 11.48$$

3. (5 Pts) What is the pH of a 0.30 M sodium acetate, $NaC_2H_3O_2$ solution? $K_a = 1.8 \times 10^{-5}$



$$K_b = \frac{10^{-14}}{1.8 \times 10^{-5}} = 5.56 \times 10^{-10}$$

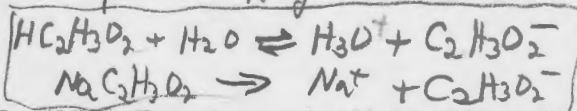
$$5.56 \times 10^{-10} = \frac{x^2}{0.30-x} \leftarrow 5\% \text{ rule}$$

$$x = [OH^-] = 1.29 \times 10^{-5} \quad pOH = 4.89 \quad pH = 9.11$$

4. (4 Pts) What is the $[H^+]$ of a solution which is 0.2 M in $NaC_2H_3O_2$ and 0.1 M in $HC_2H_3O_2$? $K_a = 1.8 \times 10^{-5}$

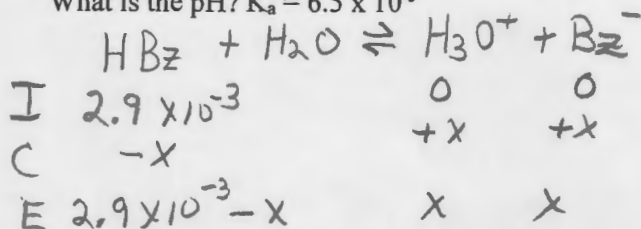
Buffer solution use Henderson-Hasselbalch equation

$$pH = -\log(1.8 \times 10^{-5}) + \log \frac{0.2}{0.1} = 5.046$$



$$[H_3O^+] = 10^{-pH} = 9.0 \times 10^{-6}$$

5. (5 Pts) Enough water is added to 0.35 g of benzoic acid (molar mass = 122 g/mol) to make 1000 mL of solution. What is the pH? $K_a = 6.5 \times 10^{-5}$



$$6.5 \times 10^{-5} = \frac{x^2}{2.9 \times 10^{-3} - x} \leftarrow 25\% \text{ rule}$$

$$x = 4.3 \times 10^{-4} = [H_3O^+]$$

$$pH = 3.36 \quad \text{should use Quad. Eq, but told not to.}$$

6. (4 Pts) What is the $[OH^-]$ of a solution which is 0.18 M in ammonium chloride (NH_4Cl) and 0.10 M in ammonia (NH_3)? $K_b = 1.8 \times 10^{-5}$

Buffer solution

$$pH = -\log\left(\frac{10^{-14}}{1.8 \times 10^{-5}}\right) + \log \frac{0.10}{0.18}$$

$$pH = 9.0 \quad pOH = 5 \quad [OH^-] = 10^{-5}$$

