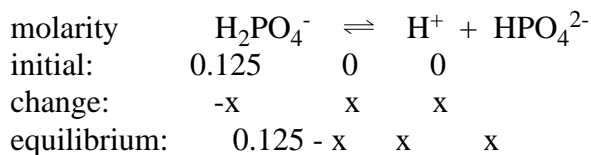


1.  $[\text{NaH}_2\text{PO}_4] = [\text{H}_2\text{PO}_4^-] = 0.125 \text{ M}$



$$K_a = \frac{[\text{H}^+][\text{HPO}_4^{2-}]}{[\text{H}_2\text{PO}_4^-]} = \frac{6.2 \times 10^{-8}}{0.125 - x} = \frac{x^2}{0.125 - x}$$

Since  $K_a$  is small,  $x$  is small, and  $0.125 - x \approx 0.125$

$$x^2 = \frac{6.2 \times 10^{-8}}{0.125} \quad x^2 = 7.75 \times 10^{-9}$$

$$x = 8.8 \times 10^{-5} = [\text{H}^+]$$

$$\text{pH} = 4.1$$

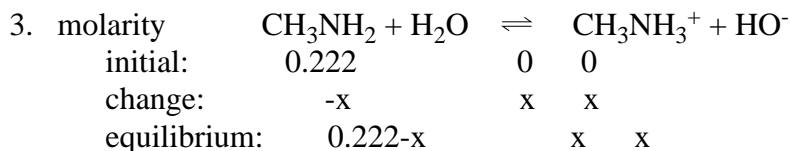
$$\text{Error in approximation} = \frac{8.8 \times 10^{-5}}{0.125} \times 100 = 0.070\%$$

2. For a buffer,  $[\text{H}^+] = K_a \times \frac{[\text{Acid}]}{[\text{Conjugate base}]}$

The acid is  $\text{H}_3\text{PO}_4$  and the conjugate base is  $\text{H}_2\text{PO}_4^-$

$$K_a = \frac{K_w}{K_b} = \frac{1.0 \times 10^{-14}}{1.3 \times 10^{-12}} = 7.7 \times 10^{-3}$$

$$[\text{H}^+] = 7.7 \times 10^{-3} \times \frac{0.30}{0.20} = 1.2 \times 10^{-2} \quad \text{pH} = 1.9$$



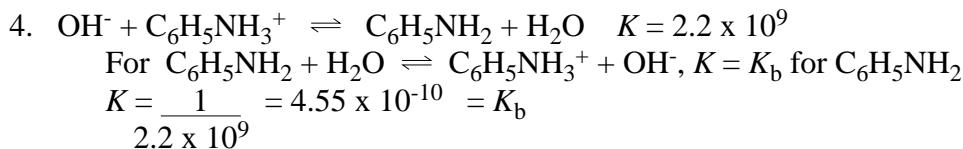
$$K_b = \frac{[\text{CH}_3\text{NH}_3^+][\text{HO}^-]}{[\text{CH}_3\text{NH}_2]} = \frac{x^2}{0.222 - x} = 5.0 \times 10^{-4}$$

Since  $K_b$  is small,  $x$  is small, and  $0.222 - x \approx 0.222$

$$x^2 = \frac{5.0 \times 10^{-4}}{0.222} \quad x^2 = 1.11 \times 10^{-4}$$

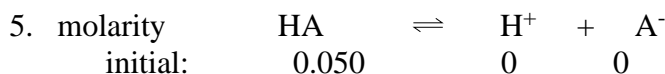
$$x = 1.05 \times 10^{-2} = [\text{HO}^-]$$

$$\text{pOH} = 2.0 \quad \text{pH} = 14 - \text{pOH} = 12.0$$



The conjugate acid of  $\text{C}_6\text{H}_5\text{NH}_2$  is  $\text{C}_6\text{H}_5\text{NH}_3^+$

$$\text{Therefore, } K_a \text{ for } \text{C}_6\text{H}_5\text{NH}_3^+ = \frac{1.0 \times 10^{-14}}{4.55 \times 10^{-10}} = 2.2 \times 10^{-5}$$



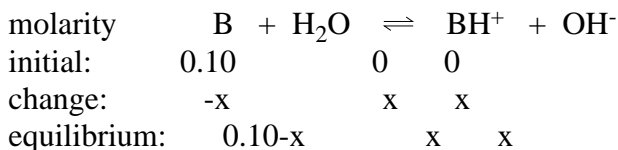
$$\text{change: } -\frac{3.5 \times 0.050}{100} = -0.000175 \quad +0.000175 \quad +0.000175$$

$$\text{equilibrium: } 0.050 - 0.000175 = 0.0498 \quad 0.000175 \quad 0.000175$$

$$\text{(i) } [\text{H}^+] = 1.75 \times 10^{-4} \quad \text{pH} = 3.8$$

$$\text{(ii) } K_a = \frac{(1.75 \times 10^{-4})^2}{0.0498} = 6.1 \times 10^{-7}$$

6.  $\text{p}K_b = 5.4 \quad K_b = 4.0 \times 10^{-6}$



$$K_b = \frac{[\text{BH}^+][\text{OH}^-]}{[\text{B}]} = \frac{x^2}{0.10-x} = 4.0 \times 10^{-6}$$

Since  $K_b$  is small,  $x$  is small, and  $0.10-x \approx 0.10$   
 $x^2 = \frac{4.0 \times 10^{-6}}{0.10} \quad x^2 = 4.0 \times 10^{-7} \quad x = 6.3 \times 10^{-4}$

$$\text{Percent dissociation} = \frac{6.3 \times 10^{-4}}{0.10} \times 100 = 0.63\%$$

7. The solution of  $\text{HOC}_6\text{H}_5$  and  $\text{NaOC}_6\text{H}_5$  is a buffer solution.

$$[\text{H}^+] = K_a \times \frac{[\text{HOC}_6\text{H}_5]}{[\text{NaOC}_6\text{H}_5]} = K_a \times \frac{\text{moles HOC}_6\text{H}_5}{\text{moles NaOC}_6\text{H}_5}$$

$$= 1.6 \times 10^{-10} \times \frac{2.5/94}{3.5/116} = 1.4 \times 10^{-10}$$

$$\text{pH} = 9.85$$

8. The solution of  $\text{CH}_3\text{COONa}$  and  $\text{CH}_3\text{COOH}$  is a buffer solution.

$$[\text{H}^+] = K_a \times \frac{[\text{CH}_3\text{COOH}]}{[\text{CH}_3\text{COONa}]} = K_a \times \frac{\text{moles CH}_3\text{COOH}}{\text{moles CH}_3\text{COONa}}$$

$$\text{moles CH}_3\text{COOH} = 0.750 \text{ L} \times 0.64 \text{ mole/L} = 0.480$$

$$\text{moles CH}_3\text{COONa} = 75.0 \text{ g} \times \frac{1 \text{ mole}}{82.0 \text{ g}} = 0.915$$

$$[\text{H}^+] = 1.8 \times 10^{-5} \times \frac{0.480}{0.915} = 9.44 \times 10^{-6} \quad \text{pH} = 5.0$$

9.  $[\text{H}^+] = K_a \times \frac{\text{moles CH}_3\text{COOH}}{\text{moles CH}_3\text{COONa}} \quad \text{pH} = 6.0 \quad [\text{H}^+] = 1.0 \times 10^{-6}$

$$\text{moles CH}_3\text{COOH} = 0.0500 \text{ L} \times 0.50 \text{ mole/L} = 0.025$$

$$1.0 \times 10^{-6} = 1.8 \times 10^{-5} \times \frac{0.025}{\text{moles CH}_3\text{COONa}}$$

$$\text{moles CH}_3\text{COONa} = \frac{1.8 \times 10^{-5} \times 0.025}{1.0 \times 10^{-6}} = 0.45$$

$$\text{mass CH}_3\text{COONa} = 0.45 \text{ mole} \times 82.0 \text{ g/mole} = 37 \text{ g}$$



$$\text{moles NaOH} = 0.0172 \text{ L} \times 0.155 \text{ mole/L} = 2.67 \times 10^{-3}$$

$$\text{moles HF} = 0.0250 \text{ L} \times 0.200 \text{ mole/L} = 5.00 \times 10^{-3}$$

$$\text{moles NaF formed} = 2.67 \times 10^{-3}$$

$$\text{moles HF left over} = (5.00 - 2.67) \times 10^{-3} = 2.33 \times 10^{-3}$$

A solution of NaF and HF is a buffer solution

$$[\text{H}^+] = K_a \times \frac{[\text{HF}]}{[\text{NaF}]} = K_a \times \frac{\text{moles HF}}{\text{moles NaF}} = 7.2 \times 10^{-4} \times \frac{2.33 \times 10^{-3}}{2.67 \times 10^{-3}}$$

$$= 6.28 \times 10^{-4} \quad \text{pH} = 3.2$$