Buffers

9. $$HF_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + F^-_{(aq)}$$

a) add $HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$

the proton from HCl will combine with the conjugate base $F^-_{(aq)}$, shifting the rxn to the left to consume the added $H^+_{(aq)}$

* as long as only a small amount of $H^+_{(aq)}$ is added, pH remains relatively constant
* if a large amount of H^+ is added and all of the conjugate base, $F^-_{(aq)}$, is consumed pH will decrease

b) add $NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$

the hydroxide would combine w the hydronium to produce H_2O

$$H_3O^+_{(aq)} + OH^-_{(aq)} \rightarrow 2H_2O_{(l)}$$

more of the acid will ionize to produce more $H_3O^+_{(aq)}$

* if a small amount of NaOH is added the H_3O^+ removed can be replaced and pH will remain relatively constant
* if a large amount of NaOH is added, all of the acid will ionize and will not be able to replace the lost $H_3O^+_{(aq)}$; pH will increase

10a) $HCN_{(aq)} \rightleftharpoons H^+_{(aq)} + CN^-_{(aq)}$

$0.1 \frac{mol}{L}$ $0.1 \frac{mol}{L}$

→ buffered system as a weak acid is combined with its anion, its conjugate base

b) $NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$

→ combined a strong base with its cation

→ not a buffered system

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

$NH_4Br \rightarrow NH_4^+ + Br^-$

→ combine a weak base (NH_3) with its conjugate acid (NH_4^+)

→ buffered system

d) $NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$

$KOH_{(aq)} \rightarrow K^+_{(aq)} + OH^-_{(aq)}$

→ both are strong bases

→ not a buffered system

e) $NH_4Cl_{(aq)} \rightarrow NH_4^+{}_{(aq)} + Cl^-_{(aq)}$

$NH_4Br_{(aq)} \rightarrow NH_4^+{}_{(aq)} + Br^-_{(aq)}$

→ only the conjugate base of a weak acid, no weak acid

→ not a buffered system

(11.) $HC_2H_3O_2\,(aq) \rightleftharpoons H^+(aq) + C_2H_3O_2^-(aq)$

see question 9

(12) $HClO_4\,(aq) \longrightarrow H^+ + ClO_4^-\,(aq)$

$0.10\frac{mol}{L}$

$KClO_4\,(aq) \longrightarrow K^+(aq) + ClO_4^-\,(aq)$

$0.10\frac{mol}{L}$

$HClO_4$ is a strong acid, does not form a buffered system.

Since it ionizes completely $[H^+] = [HClO_4] = 0.1\frac{mol}{L}$

$pH = 1.00$

(13) $NH_3\,(aq) + H_2O\,(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$

$K_B = 1.8\times10^{-5}$

$$pOH = pK_B + \log\frac{[NH_4^+]}{[NH_3]}$$

$$9.00 = -\log(1.8\times10^{-5}) + \log\frac{[NH_4^+]}{[NH_3]}$$

$$\log\frac{[NH_4^+]}{[NH_3]} = 9.00 - 4.745 = 4.255$$

$$\frac{[NH_4^+]}{[NH_3]} = 10^{-4.255} = 5.56\times10^{-5}$$