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$K_a = \frac{[H^+][F^-]}{[HF]}$

(14) .037 mol KF = mol F^-

135 mL of 0.0237 M HF

$HF \rightleftharpoons H^+ + F^-$

K_a of HF = 7.2×10^{-4}

pH = ?

$$[H^+] = K_a\left(\frac{[HF]}{[F^-]}\right) = (7.2\times10^{-4})\left(\frac{.135\,L \times .0237\,M}{.037\,mol}\right) = 6.23\times10^{-5}$$

$$pH = -\log(6.23\times10^{-5}) = \boxed{4.21}$$

(17) $NaHCO_3/Na_2CO_3$ buffer pH = 9.40

K_a of HCO_3^- = 5.6×10^{-11} $\quad [H^+] = 10^{-9.40} = 3.98\times10^{-10}\,M$

a) $[H^+] = K_a\left(\frac{[HCO_3^-]}{[CO_3^{-2}]}\right)$ $\quad \left(\frac{[HCO_3^-]}{[CO_3^{-2}]}\right) = \frac{[H^+]}{K_a} = \frac{3.98\times10^{-10}\,M}{5.6\times10^{-11}} = \frac{7.11}{1}$

b) $.225\,M\,Na_2CO_3 \times 1\,L = .225\,mol\,Na_2CO_3 = .225\,mol\,CO_3^{-2}$

$[HCO_3^-] = (7.11)(.225\,moles) = \boxed{1.60\,moles\,HCO_3^-\text{ is needed}}$

c) $.475\,L \times .336\,M\,NaHCO_3 = .1596\,moles\,NaHCO_3 = .1596\,moles\,HCO_3^-$

$\frac{.1596\,moles\,HCO_3^-}{x\,moles\,CO_3^{-2}} = 7.11$ $\quad .0224\,moles\,CO_3^{-2} = .0224\,mole \times \left(\frac{106\,g}{mole}\right) =$

$\boxed{2.48\,g\ Na_2CO_3}$

d) $.735\,L$ of $.139\,M\,Na_2CO_3 = .102\,moles\,Na_2CO_3 = .102\,mol\,CO_3^{-2}$

$\frac{x\,moles\,HCO_3^-}{.102\,mol\,CO_3^{-2}} = 7.11$ $\quad .726\,moles\,HCO_3^-\left(\frac{1\,L}{2.00\,mol}\right) = 3.63\,CO_3^-$

(20) a) 5.50 g NH_4Cl $\quad NH_4^+ \rightleftharpoons NH_3 + H^+$

.0188 mol NH_3 $\quad K_a = 5.6 \times 10^{-10}$

.155 L of Solution

$$5.50\text{ g } NH_4Cl \left(\frac{1\text{ mole } NH_4Cl}{53.5\text{ g}}\right)\left(\frac{1\text{ mole } NH_4^+}{1\text{ mole } NH_4Cl}\right) = .103\text{ mol } NH_4^+$$

$$[H^+] = K_a\left(\frac{[NH_4^+]}{[NH_3]}\right) = 5.6\times10^{-10}\left(\frac{.103\text{ mol}}{.0188\text{ mol}}\right) = 3.06\times10^{-9}$$

$$\boxed{pH = 8.51}$$

b) Buffer would have same pH as in (a) because Buffers do not rely on the volume of solution.

(25) .500 M KH_2PO_4

.317 M K_2HPO_4

$K_a = 6.2\times10^{-8}$

$$H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{-2} \qquad K_a = \frac{[H^+][HPO_4^{-2}]}{[H_2PO_4^-]} \qquad [H^+] = K_a\left(\frac{[H_2PO_4^-]}{[HPO_4^{-2}]}\right)$$

a) $$[H^+] = 6.2\times10^{-8}\left(\frac{.500\text{ M}}{.317\text{ M}}\right) = 9.78\times10^{-8}$$ $\boxed{pH = 7.00}$

$[H^+] = \frac{.05}{.600} = .0833\text{ M}$

b) moles acid = .500 M + .0833 M = .5833 M HA

moles base = .317 − .0833 M = .2336 M A^-

$$[H^+] = 6.2\times10^{-8}\left(\frac{.5833}{.2336}\right) = 1.55\times10^{-7}$$

$\boxed{pH = 6.81}$

c) $\frac{.05\text{ mol}}{.6\text{ L}} = .0833\text{ M}$

moles acid = .500 M − .0833 M = .4167 M

moles base = .317 + .0833 M = .4003 M

$$[H^+] = 6.2\times10^{-8}\left(\frac{.4167\text{ M}}{.4003\text{ M}}\right) = 6.45\times10^{-8}$$

$\boxed{pH = 7.19}$