

Acid Base Worksheet No. 4

1a) $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$

$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = \frac{K_w}{K_a(\text{NH}_4^+)} = \frac{1.00 \times 10^{-14}}{5.6 \times 10^{-10}} = 1.79 \times 10^{-5}$$

let $[\text{OH}^-] = x$, then $[\text{NH}_4^+] = x$
 and $[\text{NH}_3] = 0.30\text{M} - x \approx 0.30\text{M}$ if x is small

$$1.79 \times 10^{-5} = \frac{x^2}{0.30} \quad x = [\text{OH}^-] = \underline{2.3 \times 10^{-3}\text{M}}$$

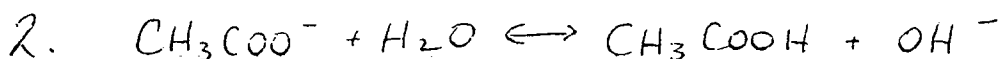
b) $\text{pOH} = -\log(2.3 \times 10^{-3}\text{M}) = 2.636$

$\text{pH} = \text{pK}_w - \text{pOH} = 14.000 - 2.636 = \underline{11.36}$

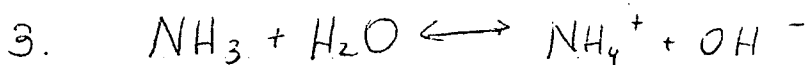
c) $[\text{H}_3\text{O}^+] = \text{antilog}(-\text{pH}) = \text{antilog}(-11.36) = \underline{4.3 \times 10^{-12}\text{M}}$

d) $[\text{NH}_3] = 0.30\text{M} - 2.3 \times 10^{-3}\text{M} = \underline{0.30\text{M}}$

e) % dissociation = $\frac{2.3 \times 10^{-3}\text{M}}{0.30\text{M}} \times 100 = \underline{0.77\%}$



$$K_b = \frac{[\text{CH}_3\text{COOH}][\text{OH}^-]}{[\text{CH}_3\text{COO}^-]} = \frac{K_w}{K_a(\text{CH}_3\text{COOH})} = \frac{1.00 \times 10^{-14}}{1.8 \times 10^{-5}} = \underline{5.6 \times 10^{-10}}$$



$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = \frac{K_w}{K_a(\text{NH}_4^+)} = \frac{1.00 \times 10^{-14}}{5.6 \times 10^{-10}} = 1.79 \times 10^{-5}$$

let $[\text{OH}^-] = x$, then $[\text{NH}_4^+] = x$ and $[\text{NH}_3] = 1.0\text{M} - x$
 $[\text{NH}_3] \approx 1.0\text{M}$ if x is small

$$1.79 \times 10^{-5} = \frac{x^2}{1.0}$$

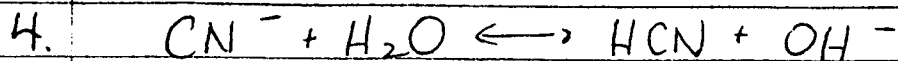
$$x = [\text{OH}^-] = 4.23 \times 10^{-3}\text{M}$$

$$[\text{H}_3\text{O}^+] = \frac{K_w}{[\text{OH}^-]} = \frac{1.00 \times 10^{-14}}{4.23 \times 10^{-3}} = 2.36 \times 10^{-12}\text{M}$$

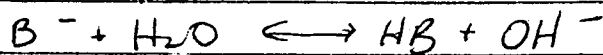
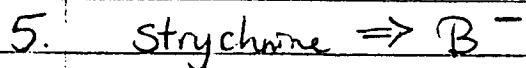
$$\text{pH} = -\log(2.36 \times 10^{-12})$$

$$\underline{\underline{\text{pH} = 11.63}}$$

Acid Base Worksheet No. 4



$$K_b = \frac{[\text{HCN}][\text{OH}^-]}{[\text{CN}^-]} = \frac{K_w}{K_a(\text{HCN})} = \frac{1.00 \times 10^{-14}}{4.9 \times 10^{-10}} = \underline{2.0 \times 10^{-5}}$$



$$K_b = \frac{[\text{HB}][\text{OH}^-]}{[\text{B}^-]} = 1.8 \times 10^{-6}$$

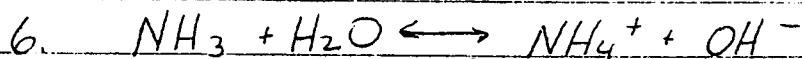
let $x = [\text{OH}^-]$, then $[\text{HB}] = x$ and $[\text{B}^-] = 0.15\text{M} - x$

$\approx 0.15\text{M}$ if x is small

$$1.8 \times 10^{-6} = \frac{x^2}{0.15}$$

$$x = [\text{OH}^-] = 5.20 \times 10^{-4}\text{M} \quad \text{pOH} = -\log 5.20 \times 10^{-4} = 3.284$$

$$\text{pH} = \text{p}K_w - \text{pOH} = 14.000 - 3.284 = \underline{10.72}$$



$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = \frac{K_w}{K_a} = \frac{1.00 \times 10^{-14}}{5.6 \times 10^{-10}} = 1.79 \times 10^{-5}$$

let $x = [\text{OH}^-]$, then $[\text{NH}_4^+] = x$ and $[\text{NH}_3] = 0.10\text{M} - x \approx 0.10$

if x is small

$$1.79 \times 10^{-5} = \frac{x^2}{0.10\text{M}} \quad x = [\text{OH}^-] = 1.34 \times 10^{-3}\text{M}$$

$$\% \text{ dissociation} = \frac{1.34 \times 10^{-3}}{0.10\text{M}} \times 100 = \underline{1.3\% \text{ dissociation}}$$

7. $\text{p}K_b = -\log K_b = -\log (2.0 \times 10^{-5}\text{M}) = \underline{6.70}$



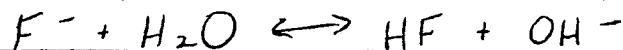
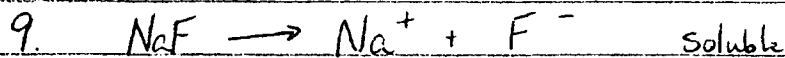
$$K_b = \frac{[\text{CH}_3\text{COOH}][\text{OH}^-]}{[\text{CH}_3\text{COO}^-]} = \frac{K_w}{K_a} = \frac{1.00 \times 10^{-14}}{1.8 \times 10^{-5}} = \underline{5.56 \times 10^{-10}}$$

let $x = [\text{OH}^-]$, then $[\text{CH}_3\text{COOH}] = x$ and $[\text{CH}_3\text{COO}^-] = 0.25 - x \approx 0.25\text{M}$ if x is small

$$5.56 \times 10^{-10} = \frac{x^2}{0.25} \quad x = [\text{OH}^-] = 1.18 \times 10^{-5} \quad \text{pOH} = 4.929$$

$$\text{pH} = 14.000 - 4.929 = 9.07$$

Acid Base Worksheet No. 4

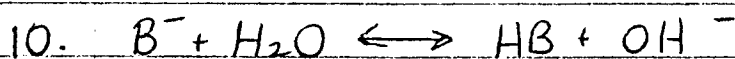


$$K_b = \frac{[\text{HF}][\text{OH}^-]}{[\text{F}^-]} = \frac{K_w}{K_{a(\text{HF})}} = \frac{1.00 \times 10^{-14}}{3.5 \times 10^{-4}} = 2.86 \times 10^{-11}$$

Let $[\text{OH}^-] = x$, then $[\text{HF}] = x$ and $[\text{F}^-] = 0.50\text{M} - x \approx 0.50\text{M}$ if x is small

$$2.86 \times 10^{-11} = \frac{x^2}{0.50} \quad [\text{OH}^-] = x = 3.78 \times 10^{-6}\text{M}$$

$$\text{pOH} = -\log [\text{OH}^-] = -\log (3.78 \times 10^{-6}) = \underline{\underline{5.42}}$$



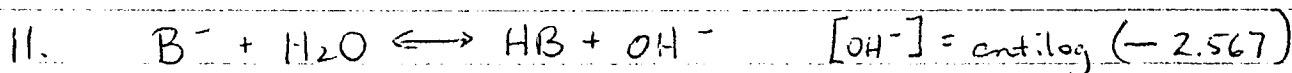
$$K_b = \frac{[\text{HB}][\text{OH}^-]}{[\text{B}^-]} \quad [\text{OH}^-] = \text{antilog}(-(\text{pOH} - \text{pK}_b))$$

$$= 4.17 \times 10^{-3}\text{M}$$

$$[\text{HB}] = [\text{OH}^-] = 4.17 \times 10^{-3}\text{M}$$

$$K_b = \frac{(4.17 \times 10^{-3})^2}{9.58 \times 10^{-2}} = 1.81 \times 10^{-4} \quad [\text{B}^-] = 0.10\text{M} - 4.17 \times 10^{-3}\text{M} = 9.58 \times 10^{-2}$$

$$K_a = \frac{K_w}{K_b} = \frac{1.00 \times 10^{-14}}{1.81 \times 10^{-4}} = \underline{\underline{5.5 \times 10^{-11}}}$$



$$[\text{OH}^-] = \text{antilog}(-2.567)$$

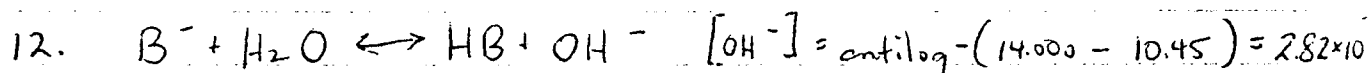
$$= 2.710 \times 10^{-3}\text{M}$$

$$K_b = \frac{[\text{HB}][\text{OH}^-]}{[\text{B}^-]}$$

$$[\text{HB}] = [\text{OH}^-] = 2.710 \times 10^{-3}\text{M}$$

$$[\text{B}^-] = 0.250 - 2.710 \times 10^{-3}\text{M} = 0.2473$$

$$K_b = \frac{(2.710 \times 10^{-3})^2}{0.2473} = 2.97 \times 10^{-5}$$



$$[\text{OH}^-] = \text{antilog}-(14.000 - 10.45) = 2.82 \times 10^{-4}$$

$$[\text{HB}] = [\text{OH}^-] = 2.82 \times 10^{-4}\text{M}$$

$$K_b = \frac{[\text{HB}][\text{OH}^-]}{[\text{B}^-]}$$

$$[\text{B}^-] = 0.20\text{M} - 2.82 \times 10^{-4}\text{M} = 0.200\text{M}$$

$$K_b = \frac{(2.82 \times 10^{-4})^2}{0.200} = 4.0 \times 10^{-7}$$