AP CHEMISTRY

TOPIC 7: ACIDS & BASES, PART A

Day 75:

- Nature of Acids and Bases
- Acid Strength
- Water as an acid and a base

---

1. Define the following using the Arrhenius model.

   a) Strong acid : ***An Acid that dissociates 100% in water***

   b) Strong base : ***A Base that dissociates 100% in water***

   c) Weak acid : ***An Acid that dissociates very little in water (typically around 1 – 20%)***

   d) Weak base : ***A Base that dissociates very little in water (typically around 1 – 20%)***

2. Write the balanced equation that describes the following reactions.

   a) The dissociation of perchloric acid in water. $HClO_{4\,(aq)} + H_2O_{\,(l)} \longrightarrow ClO_4^{\,-1}{}_{(aq)} + H_3O^{\,+1}{}_{(aq)}$

   OR

   $HClO_{4\,(aq)} \longrightarrow ClO_4^{\,-1}{}_{(aq)} + H^{\,+1}{}_{(aq)}$

   b) The dissociation of ammonium ion in water. $NH_4^{\,+1}{}_{(aq)} + H_2O_{\,(l)} \leftrightarrow NH_{3\,(aq)} + H_3O^{\,+1}{}_{(aq)}$

   OR

   $NH_4^{\,+1}{}_{(aq)} \leftrightarrow NH_{3\,(aq)} + H^{\,+1}{}_{(aq)}$

3. Write the dissociation reaction and the corresponding K_a equilibrium expression for each of the following acids in water.

   a) HNO_2 : $HNO_{2\,(aq)} \leftrightarrow NO_2^{\,-1}{}_{(aq)} + H^{\,+1}{}_{(aq)}$; $K_a = \dfrac{[H^+][NO_2^-]}{[HNO_2]}$

   OR

   $HNO_{2\,(aq)} + H_2O_{(l)} \leftrightarrow NO_2^{\,-1}{}_{(aq)} + H_3O^{\,+1}{}_{(aq)}$; $K_a = \dfrac{[H_3O^+][NO_2^-]}{[HNO_2]}$

   b) HCN : $HCN_{\,(aq)} \leftrightarrow CN^{\,-1}{}_{(aq)} + H^{\,+1}{}_{(aq)}$; $K_a = \dfrac{[H^+][CN^-]}{[HCN]}$

   OR

   $HCN_{\,(aq)} + H_2O_{(l)} \leftrightarrow CN^{\,-1}{}_{(aq)} + H_3O^{\,+1}{}_{(aq)}$; $K_a = \dfrac{[H_3O^+][CN^-]}{[HCN]}$

3c) $HC_2H_3O_2$: $\boldsymbol{HC_2H_3O_{2\,(aq)} \leftrightarrow C_2H_3O_2{}^{-1}{}_{(aq)} + H^{+1}{}_{(aq)}}$; $K_a = \dfrac{[\,H^+\,][\,C_2H_3O_2^-\,]}{[\,HC_2H_3O_2\,]}$

OR

$\boldsymbol{HC_2H_3O_{2\,(aq)} + H_2O_{(l)} \leftrightarrow C_2H_3O_2{}^{-1}{}_{(aq)} + H_3O^{+1}{}_{(aq)}}$; $K_a = \dfrac{[\,H_3O^+\,][\,C_2H_3O_2^-\,]}{[\,HC_2H_3O_2\,]}$

4. For each of the following reactions, identify the acid, the base, the conjugate base, and the conjugate acid.

a) $HF_{(aq)} + H_2O_{(aq)} \leftrightarrow H_3O^+{}_{(aq)} + F^-{}_{(aq)}$

$HF_{(aq)}$	+	$H_2O_{(aq)}$	$\leftrightarrow$	$H_3O^+{}_{(aq)}$	+	$F^-{}_{(aq)}$
A		B		CA		CB

b) $H_2SO_{4\,(aq)} + H_2O_{(aq)} \leftrightarrow HSO_4{}^-{}_{(aq)} + H_3O^+{}_{(aq)}$

$H_2SO_{4\,(aq)}$	+	$H_2O_{(aq)}$	$\leftrightarrow$	$HSO_4{}^-{}_{(aq)}$	+	$H_3O^+{}_{(aq)}$
A		B		CB		CA

c) $HSO_4{}^-{}_{(aq)} + H_2O_{(aq)} \leftrightarrow SO_4{}^{-2}{}_{(aq)} + H_3O^+{}_{(aq)}$

$HSO_4{}^-{}_{(aq)}$	+	$H_2O_{(aq)}$	$\leftrightarrow$	$SO_4{}^{-2}{}_{(aq)}$	+	$H_3O^+{}_{(aq)}$
A		B		CB		CA

5. Calculate [H^+] or [OH^-] as required for each of the following solutions at 25 ^{0}C, and state whether the solution is neutral, acidic, or basic.

$$K_w = 1.00\times10^{-14} = [\,H^+\,][\,OH^-\,]$$

a) $1.4 \times 10^{-3}\,M$ [OH^-] : $[\,H^+\,] = \dfrac{1.00\times10^{-14}}{1.4\times10^{-3}} = 7.14\times10^{-12}$ ***Basic***

b) $4.3 \times 10^{-7}\,M$ [OH^-] : $[\,H^+\,] = \dfrac{1.00\times10^{-14}}{4.3\times10^{-7}} = 2.33\times10^{-8}$ ***Basic***

c) $9.7 \times 10^{-11}\,M$ [H^+] : $[\,OH^-\,] = \dfrac{1.00\times10^{-14}}{9.7\times10^{-11}} = 1.03\times10^{-4}$ ***Basic***

d) $2.4 \times 10^{-6}\,M$ [H^+] : $[\,OH^-\,] = \dfrac{1.00\times10^{-14}}{2.4\times10^{-6}} = 4.17\times10^{-9}$ ***Acidic***

e) $3.9 \times 10^{-3}\,M$ [OH^-] : $[\,H^+\,] = \dfrac{1.00\times10^{-14}}{3.9\times10^{-3}} = 2.56\times10^{-12}$ ***Basic***