REVIEW QUESTIONS
Chapter 15

For each reaction shown below, determine the Brønsted-Lowry acid and base and their conjugates:

1. H_3BO_3 + H_2O ⇔ H_3O^+ + $H_2BO_3^-$

   acid base acid base

2. HCO_3^- + OH^- ⇔ H_2O + CO_3^{2-}

   acid base acid base

3. CN^- + H_2O ⇔ HCN + OH^-

   base acid acid base

4. Identify the Brønsted-Lowry acid for each base shown below:

   a) NO_3^- **HNO_3** b) OH^- **H_2O**

   c) SO_4^{2-} **HSO_4^-** d) CH_3O^- **CH_3OH**

   e) O^{2-} **OH^-** f) HPO_4^{2-} **$H_2PO_4^-$**

5. Identify the Brønsted-Lowry base for each acid shown below:

   a) NH_3 **NH_2^-** b) H_2SO_4 **HSO_4^-**

   c) HS^- **S^{2-}** d) HClO **ClO^-**

   e) HNO_2 **NO_2^-** f) H_2O **OH^-**

6. Complete the missing information in the table below:

$[H_3O^+]$	$[OH^-]$	Acidic/Basic
1.0×10^{-12}	**1.0×10^{-2}**	**Basic**
3.8×10^{-4}	**2.6×10^{-11}**	**Acidic**
2.4×10^{-11}	4.2×10^{-4}	**Basic**
1.0×10^{-5}	1.0×10^{-9}	**Acidic**
6.5×10^{-8}	**1.5×10^{-7}**	**Basic**

Sample calculations:

$$[OH^-] = \frac{K_w}{[H_3O^+]} = \frac{1.0 \times 10^{-14}}{3.8 \times 10^{-4}} = 2.6 \times 10^{-11}$$

$$[H_3O^+] = \frac{K_w}{[OH^-]} = \frac{1.0 \times 10^{-14}}{4.2 \times 10^{-4}} = 2.4 \times 10^{-11}$$

7. Identify each of the substances below as **strong electrolyte**, **weak electrolyte** or **non-electrolyte**:

a) KCl — strong electrolyte (salt)

b) HNO_3 — strong electrolyte (strong acid)

c) CH_3OH — non-electrolyte (molecular)

d) HF — weak electrolyte (weak acid)

e) H_3PO_4 — weak electrolyte (weak acid)

8. What are the $[H_3O^+]$ and $[OH^-]$ for a solution with a pH of 4.10.

$$[H_3O^+] = \text{antilog}(-4.10) = 7.9 \times 10^{-5}\ M$$

$$[OH^-] = \frac{K_w}{[H_3O^+]} = \frac{1.0 \times 10^{-14}}{7.9 \times 10^{-5}} = 1.3 \times 10^{10} M$$

9. If 30.0 mL of 0.400 M H_2SO_4 is required to neutralize 15.0 mL of a NaOH solution, what is the molarity of NaOH?

$$H_2SO_4 + 2\ NaOH \rightarrow Na_2SO_4 + 2\ H_2O$$

$$\text{mol of acid} = 30.0\ \cancel{mL} \times \frac{1\ \cancel{L}}{1000\ \cancel{mL}} \times \frac{0.400\ mol}{1\ \cancel{L}} = 0.0120\ mol$$

$$\text{mol base} = 0.0120\ \cancel{mol\ acid} \times \frac{2\ mol\ NaOH}{1\ \cancel{mol\ acid}} = 0.0240\ mol\ NaOH$$

$$\text{molarity of base} = \frac{0.0240\ mol}{0.0150\ L} = 1.60\ M$$

10. Determine the molarity of a solution of H_3PO_4 if 25.0 mL of the acid is titrated with 14.0 mL of 0.250 M NaOH to the end point.

$$H_3PO_4 + 3\ NaOH \rightarrow Na_3PO_4 + 3\ H_2O$$

$$\text{mol of NaOH} = 14.0\ \cancel{mL} \times \frac{1\ \cancel{L}}{1000\ \cancel{mL}} \times \frac{0.250\ mol}{1\ \cancel{L}} = 0.00350\ mol$$

$$\text{mol acid} = 0.00350\ \cancel{mol\ NaOH} \times \frac{1\ mol\ acid}{3\ \cancel{mol\ NaOH}} = 0.001\underline{1}67\ mol\ acid$$

$$\text{molarity of acid} = \frac{0.001\underline{1}67\ mol}{0.0250\ L} = 0.0467\ M$$

11. Complete and balance the equations below for reactions of acids:

a) $2\ HNO_3 + Ba(OH)_2 \rightarrow Ba(NO_3)_2 + 2\ H_2O$

b) $CaCO_3 + 2\ HCl \rightarrow CaCl_2 + CO_2 + H_2O$

c) $2\ HNO_3 + Mg \rightarrow Mg(NO_3)_2 + H_2$

d) $Al(OH)_3 + 3\ HBr \rightarrow AlBr_3 + 3\ H_2O$