Chapter 4 – Reactions in Solutions

Michael Brodskiy
Instructor: Mr. Morgan

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- Solute gets dissolved, Solvent does the dissolving
- Molarity is (1)

$$M = \frac{\text{mol}}{\text{L}} \tag{1}$$

- Electrolytes are ionic compounds that breakup in a solution (Ex. (2))

$$\text{NaCl} \longrightarrow \text{Na}^+ + \text{Cl}^- \tag{2}$$

1. Strong Electrolyte vs. Weak Electrolyte – The more are broken up, the stronger the electrolyte
2. The Dilution Formula (3)

$$M_1V_1 = M_2V_2 \tag{3}$$

$$\begin{aligned} \text{Ca(OH)}_2\text{(s)} &\longrightarrow \text{Ca}^{2+}\text{(aq)} + 2\,\text{OH}^-\text{(aq)} \\ \text{Fe}_3\text{(PO}_4\text{)}_2 &\longrightarrow 3\,\text{Fe}^{2+}\text{(aq)} + 2\,\text{PO}_4{}^{3-}\text{(aq)} \\ \text{Cr(NO}_3\text{)}_3 &\longrightarrow \text{Cr}^{3+}\text{(aq)} + 3\,\text{NO}_3{}^-\text{(aq)} \end{aligned} \tag{4}$$

- Precipitation Reaction – Ionic compounds will either separate (soluble) or stay together (insoluble).

1. Solubility Rules – If a compound contains any of the following three, it is soluble: Sodium (Na^+), Potassium (K^+), Nitrate ($NO_3{}^-$)

2. Ex. Potassium Chromate + Barium Nitrate (5). This is an example of a molecular equation with a double replacement. (6) is named a complete ionic equation. (7) is named a net equation, and is the only one that will be on the AP exam.

$$\mathrm{K_2CrO_4(aq) + Ba(NO_3)_2(aq) \xrightarrow{K^+,\, CrO_4{}^{2-},\, Ba^{2+},\, NO_3{}^-} KNO_3(aq) + BaCrO_4(s)} \tag{5}$$

$$\begin{split}\mathrm{2\,K^+(aq) + CrO_4{}^{2-}(aq) + Ba^{2+}(aq) + 2\,NO_3{}^-(aq) \longrightarrow} \\ \mathrm{2\,K^+(aq) + 2\,NO_3{}^-(aq) + BaCrO_4(s)}\end{split} \tag{6}$$

$$\mathrm{CrO_4{}^{2-}(aq) + Ba^{2+}(aq) \longrightarrow BaCrO_4(s)} \tag{7}$$

- Acid-Base Reaction

1. Acid – Produces H^+
2. Base – Produces OH^-
3. "Arrhenius" Way of thinking
4. Strong Acid – Completely Dissociates
   (a) Examples: Hydrochloric (HCl), Sulfuric (H_2SO_4), Nitric (HNO_3), Perchloric ($HClO_4$), Hydrobromic (HBr), Hydroionic (HI)
5. Weak Acid – Does not completely dissociate. Sets up an equilibrium.
   (a) Not a strong acid.
6. Strong Base – Completely dissociates.
   (a) Hydroxides of column I and I.
7. Weak Bass – Produce OH^- with reaction with water.
   (a) It will always be explicitly stated if something is a weak base
8. Dissociation (8)

$$\begin{aligned}\text{Strong Acid: } & \mathrm{HCl \longrightarrow H^+ + Cl^-} \\ \text{Weak Acid: } & \mathrm{HF \rightleftharpoons H^+\ F^-} \\ \text{Strong Base: } & \mathrm{KOH \longrightarrow K^+ + OH^-} \\ \text{Weak Base: } & \mathrm{NH_3 + H_2O \rightleftharpoons NH_4{}^+ + OH}\end{aligned} \tag{8}$$

9. Strong Acid – H^+
10. Strong Base – OH^-
11. Weaks are represented as is

12. HCl and NaOH (9)
13. HB and KOH (10)
14. H_2SO_4 and NH_3 (11)
15. HF and CH_2NH_2 (12)

$$H^+ + OH^- \longrightarrow H_2O \tag{9}$$

$$HB + OH^- \longrightarrow B^- + H_2O \tag{10}$$

$$H^+ + NH_3 \longrightarrow {NH_4}^+ \tag{11}$$

$$HF + CH_2NH_2 \longrightarrow F^- + {CH_3NH_2}^+ \tag{12}$$

16. Titration – Adding acid to base or other way around (13)

$$M_a V_a = M_b V_b \tag{13}$$

- Oxidation/Reduction (Redox Reactions) – Transfer of electrons
- Oxidation – Loss of electrons
  1. Examples of half reactions: (??)

$$Zn \longrightarrow Zn^{2+} + 2\,e^- \tag{14}$$

- Reduction – Gain of electrons
  1. Examples of half reactions: (??)

$$Cl + e^- \longrightarrow Cl^- \tag{15}$$

- Oxidation Numbers – Used to track electrons
  1. Group 1 = +1
  2. Group 2 = +2
  3. F=-1
     (a) H is a +1; O is -2
     (b) Only one atom = to charge
     (c) Ionic Compounds = charge on atoms
     (d) Sum must be equal to overall charge
- Oxidizing Agent – Does the oxidizing, gets reduced
- Reduction Agent – Does the reducing, gets oxidized