Water (H₂O) is considered the universal solvent. Water is a covalent compound (electrons are shared between atoms) but the electrons in the hydrogen-oxygen bonds are not shared equally – makes water a polar molecule. This polarity gives water the ability to dissolve some ionic compounds and polar covalent compounds. Solute: substance dissolved in water. When ionic compounds dissolve in water they break into their respective ions. Cations are attracted to the negative ends of water molecules and anions are attracted to the positive ends of water molecules.

\[
\text{NH}_4\text{NO}_3 (s) \xrightarrow{\text{H}_2\text{O} (l)} \text{NH}_4^+ (aq) + \text{NO}_3^- (aq)
\]

Solubility of ionic compounds depends on the relative attractions of the ions for each other versus the attractions of the ions for water (Figure 4.2).

Solubility Rules

1. Most nitrate (NO₃⁻) salts are soluble.
2. Most salts containing the alkali metals ions (Li⁺, Na⁺, K⁺, Cs⁺, Rb⁺) and the ammonium ion (NH₄⁺) are soluble.
3. Most chloride, bromide, and iodide salts are soluble. Notable exceptions are salts containing the ions Ag⁺, Pb²⁺, and Hg₂²⁺.
4. Most sulfate salts are soluble. Notable exceptions are BaSO₄, PbSO₄, Hg₂SO₄, and CaSO₄.
5. Most hydroxide salts are insoluble. The important soluble hydroxides are NaOH and KOH. The compounds Ba(OH)₂, Sr(OH)₂, and Ca(OH)₂ are marginally soluble.
6. Most sulfide (S²⁻), carbonate (CO₃²⁻), chromate (CrO₄²⁻), and phosphate (PO₄³⁻) salts are insoluble. Notable exceptions are salts of alkali metals and ammonium cations are soluble.

* You do not need to memorize solubility rules but you should know how to use them.
Electrolytes – solutions which contain dissolved ions which conduct electricity.

Strong Electrolytes: when dissolved in solution if ions dissociate completely they produce strong electrolytes. Strong electrolytes include soluble ionic compounds (equation a), strong acids (equation b) (HCl, HBr, HI, HNO₃, HClO₄, H₂SO₄) and strong bases (equation c) (soluble metal hydroxide salts (Group 1A, Ca, Sr, Ba).

(a) \[ \text{Zn(NO}_3\text{)}_2 (s) \xrightarrow{\text{H}_2\text{O} (l)} \text{Zn}^{2+} (aq) + 2 \text{NO}_3^- (aq) \]

(b) \[ \text{HI} (aq) \xrightarrow{\text{H}_2\text{O} (l)} \text{H}^+ (aq) + \text{I}^- (aq) \]

(c) \[ \text{Sr(OH)}_2 (s) \xrightarrow{\text{H}_2\text{O} (l)} \text{Sr}^{2+} (aq) + 2\text{OH}^- (aq) \]

Weak Electrolytes: only some ions present; conducts electricity but only slightly, compounds which are not 100% ionized. These compounds include weak acids (HC₂H₃O₂, HF, HCN, H₂S, HNO₂, H₂SO₃ and H₃PO₄) and weak bases.

Nonelectrolytes: no ions present in solutions, does not conduct electricity. These compounds include covalent compounds such as sugar (C₁₂H₂₂O₁₁) or ethanol (C₂H₅OH). These substances undergo a dissolution reaction:

\[ \text{C}_1\text{2H}_2\text{2O}_1\text{1} (s) \xrightarrow{\text{H}_2\text{O} (l)} \text{C}_1\text{2H}_2\text{2O}_1\text{1} (aq) \]

Concentration: refers to the number of moles of compound per unit volume. Molarity = number of moles/volume = mol/L.

Question: Calculate the concentration of all ions present in each of the following solutions of strong electrolytes:

(a) 0.100 mole of Ca(NO₃)₂ in 100.0 mL of solution.
Dilution: the process of adding solvent to lower the concentration of solute in a solution. Usually utilized in order to work with more useful quantities in the laboratory. During the dilution process the concentration changes but not the number of moles of solute.

\[ M_1V_1 = M_2V_2 \]

**Question:** We want to prepare 500 mL of 1.00 M acetic acid (HC\(_2\)H\(_3\)O\(_2\)) from a 17.4 M stock solution of acetic acid. What V of stock solution is required?

Precipitation Reactions:
- Solubility rules are used to predict precipitates.
- Called double displacement reactions – the cations and anions of the two reacting salts switch.
- The result is the formation of a solid precipitate.
- Generally two soluble compounds are mixed and an insoluble compound precipitates.

**Question:** What happens when barium nitrate and ammonium sulfate are mixed?
Solution Stoichiometry

**Question:** What volume of a 0.050 M Na₃PO₄ solution is needed to react completely with 30 mL of 0.10 M AgNO₃?

**Question:** What mass of precipitate would form from 30.0 mL of 0.10 M AgNO₃ using excess Na₃PO₄ solution?