

# Chemistry – Solutions Unit Review

## Equations

$$\text{concentration} = \frac{\text{moles}}{\text{volume (in liters)}}$$

$$\% \text{ mass} = \frac{\text{mass of solute}}{\text{mass of solute} + \text{mass of solvent}} \times 100$$

$$\% \text{ volume} = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100$$

$$C_1 V_1 = C_2 V_2$$

$$\% \text{ Yield} = \frac{\text{experimental yield}}{\text{theoretical yield}} \times 100$$

$$\% \text{ Error} = \frac{\text{theoretical} - \text{experimental}}{\text{theoretical}} \times 100$$

$$K_w = [\text{H}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at } 25^\circ\text{C}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+], [\text{H}_3\text{O}^+] = 10^{-\text{pH}}$$

$$\text{pOH} = -\log[\text{OH}^-], [\text{OH}^-] = 10^{-\text{pOH}}$$

$$\text{pH} + \text{pOH} = 14$$

## Key Terms

**Solution:** Solvent + Solute

**Dissolving:** Process by which a solute moves into the spaces between the solvent.

**Crystallizing:** Opposite of dissolving. Process by which the dissolved molecules crystallize.

**Volumetric analysis:** is a technique that involves precise volume measurements in order to determine the concentration of an unknown solution, the most common type is an acid-base titration; this involves the neutralisation reaction between an acid and a base. This technique may also be used to determine the molar mass of a substance, and the percent composition of a substance.

**Volumetric Flask:** For making solutions, the volume is known to the nearest one-tenth of a mL.

**Volumetric Pipette:** for transferring precise and very accurate volumes of solutions.

**Erlenmeyer flask:** (aka: conical flask), is the reaction vessel used in a titration, (why does an erlenmeyer flask have sloped sides?).

**Burette:** is a device for dispensing very precise volumes of solutions, (adjusting the rate of flow of the liquid with the ...). Suggest why the volume reading on a burette have a 0.00 mL at the top and are read downward.

**Titration:** an experimental procedure in order to determine the concentration of an unknown solution.

**End Point:** the change in the colour of an indicator in a titration, i.e. the point at which neutralisation is complete.

**Equivalence (or stoichiometric) point:** is when the precise number of moles are added from the burette needed to react completely with the reagent in the flask. This is when chemically equivalent quantities of reactant are present.

**Gravimetric analysis:** involves precise mass measurements, usually accomplished by precipitating an insoluble compound.

**Dilution:** The process by which it is possible to lower the concentration of a concentrated solution, and the solution with the lower concentration is referred to as a dilute solution. Note, that the terms "concentrated" and "dilute" are relative terms, and refer to the number of moles of solute in a solvent.

**Proton:** Hydrogen Ion,  $\text{H}^+_{(\text{aq})}$ , however exists as the hydronium ion,  $\text{H}_3\text{O}^+_{(\text{aq})}$ , by means of a coordinate covalent (aka: dative), bond.

**Dative (Co-ordinate Covalent) Bond:** When one of the atom in the covalent bond to be formed provides both of the electrons.

**Oxidation:** Loss of electrons, (OIL), is also the reducing agent in the reaction.

**Reduction:** Gain of electrons, (RIG), is also the oxidizing agent in the reaction.

**Redox Reaction:** When oxidation and reduction occur simultaneously in a reaction.

**Electrolyte:** Conducts electricity, due to mobile ions or delocalised electrons.

**Mobile Electrons:** Delocalized electrons free to move, as in metals.

**Strong Electrolyte:** 100% Ionization / Dissociation, a solution in which all of the compound is present as ions.

**Weak Electrolyte:** <5% ionization / Dissociation, a solution in which the major proportion of the compound is in molecular form

**Ionization:** Covalent compounds dissolve in H<sub>2</sub>O to form ions.

**Dissociation:** Ionic compounds dissolve in H<sub>2</sub>O (100% ionized)

**Polar Bond:** Due the difference in electronegativity of the atoms involved in a bond, there is unequal sharing of electrons, the electron cloud thus becomes distorted, hence a polar molecule results, i.e. a positive and negative end of the molecule.

**Amphiprotic:** when a species can either be a proton donor (i.e. an acid), or a proton acceptor (i.e. a base).

**Standardizing:** the technique to determine the concentration of a solution.

**Aqueous Ammonia (NH<sub>3</sub>):** NH<sub>4</sub><sup>+</sup> OH<sup>-</sup>

## Key Concepts

### **Arrhenius Definition of:**

**Acid:** Substance that produces H<sub>3</sub>O<sup>+</sup> ions in aqueous solution.

**Base:** Substance that produces OH<sup>-</sup> ions in aqueous solution.

### **Bronsted-Lowry Definition of: hydrogen-ion exchange reactions or proton transfer reactions**

**Acid:** is any molecule or ion that can give up a hydrogen ion, i.e. Proton donor in solution.

**Base:** is any molecule or ion that can combine with a hydrogen ion, i.e. Proton acceptor in solution.

**Conjugate acid:** every base has a corresponding acid

**Conjugate base:** every acid has a corresponding base.

### **Lewis Definition of Acid – Base**

**Lewis Acid:** is an electron pair acceptor

**Lewis Base:** is an electron pair donor

- Acid + Base → Water + Salt of the acid (exothermic reaction)
- Acid + metal → salt of the acid + H<sub>2(g)</sub>
- Acid + metal carbonate → salt of the acid + CO<sub>2(g)</sub> + H<sub>2O(l)</sub>
- Metal Oxides: Bases in solution
- Non-metal Oxides: Acids in solution
- Covalent compounds may conduct (100 % or partially)
- All acids and bases conduct, i.e. are electrolytes.

### **pH of solution formed by mixing an acid and a base**

### **Titration Curve:**

#### **Rules to Remember**

#### **Solution Stoichiometry**

Step 1: Grams to moles

Step 2: Moles to moles

Step 3: Moles to grams

#### **Titration**

Step 1: n<sup>o</sup> moles (n=m/m<sub>R</sub> or n=cv)

Step 2: mole to mole ratio

Step 3: concentration (c=n/v)