

Chapter 4: Reactions in Aqueous Solutions

Electrical Properties of Aqueous Solutions

Electrolytes:

- Arrhenius theory: non, weak, strong (depending on ionization in solution)
- Most ionic compounds are strong electrolytes.
- Some molecular acids are strong electrolytes.
- Most molecular compounds and organic compounds are weak or non electrolytes.

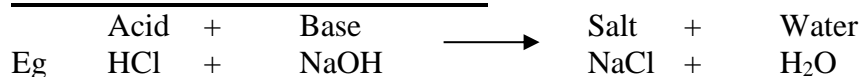
Precipitation Reactions

Solubility rules

Soluble		Insoluble
Group I salts		
Ammonium salts		
Nitrates		
Acetates		
Perchlorates		
Halides	except	Pb^{2+} , Ag^+ , Hg_2^{2+}
Sulfates	except	Sr^{2+} , Ba^{2+} , Ca^{2+} , Pb^{2+} , Hg_2^{2+} , Ag^+
Except Groups II salts		Carbonates
		Phosphates
Ca^{2+} , Ba^{2+}		Hydroxides
Except Groups II salts		Sulfides

- Writing and predicting products of reactions

Acid base reaction – neutralization



Reactions of Acids and Bases

- Strong and weak acids: strength depends on concentration of $[\text{H}_3\text{O}^+]$ in solution.
- Strong and weak bases: strength depends on concentration of $[\text{OH}^-]$ in solution.

Oxidation and Reduction

Oxidation

- Addition of oxygen
- Removal of hydrogen
- Loss of electrons (LEO)

Reduction

- Removal of oxygen
- Addition of hydrogen
- Gain of electrons (GER)

Oxidizing and reducing agents

Oxidizing agent

- reduced in the reaction
- causes the other substance to be oxidized
- Oxidation number decreases (as electrons are accepted)
- E.g.: non metals

Reducing agent

- oxidized in the reaction
- causes the other substance to be reduced
- Oxidation number increases (as electrons are given)
- E.g. metals as they give electrons

Oxidation Numbers: charge on any ion

Rules for determining oxidation number:

Neutral species e.g. metals and bimolecular compounds (Cl_2 , O_2 etc) have 0

For ions the Oxdn # is the charge on the ion e.g. Cr^{6+} is +6 and SO_4^{2-} is -2

Group I is always +1

Group II is always +2

Fluorine is always -1

Hydrogen is always +1

Oxygen is mostly -2

In group binary compounds VII are -1 (e.g. NaCl , Cl is -1)

VI are -2 (e.g. K_2S)

V are -3 (NaN_3)

- Identify the species getting oxidized or reduced in a reaction. (Redox reactions)
- First see if oxygen or hydrogen is gained or lost and then check for electron transfer.
- Balancing redox reactions.

Practical Applications

- 1) batteries
- 2) organic chemistry: alcohol
- 3) industrial processes
- 4) household chemicals e.g. H_2O_2 , benzyl peroxide, bleach
- 5) food and nutrition: energy from aerobic oxidation of carbohydrate and vitamin C as antioxidant.

Solutions

Solution = solute + solvent (the larger quantity)

Saturated, concentrated and dilute solutions.

Unless specified most solutions will be made in water.

Molar concentration (molarity)

Molarity (M) = mol/L (also the units)

Dilution of solutions

$$M_1V_1 = M_2V_2$$

Initial values = final values

(since number of actual mols of solute does not change only amount of solvent changes)

Solutions in chemical reactions: acid base titration

Titration: Quantitative neutralization reactions.

Calculations of titration: e.g. how much acid of a known concentration will it take to neutralize a base of unknown concentration? (One of the chemicals has to have known concentration)

Calculation set up similar to stoichiometry in chapter 3.

$$\left(\frac{\text{vol Acid}}{1} \times \frac{\text{molarity of Acid}}{1} \right) \times \left(\frac{\text{mol base}}{\text{mol acid}} \right) \times \frac{1}{\text{vol base}} = \text{molarity of base}$$

(to calculate mols of acid used) (from balanced equation)