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

	Acid	+	Base	⟶	Salt	+	Water
Eg	HCl	+	NaOH		NaCl	+	H_2O

Reactions of Acids and Bases

- Strong and weak acids: strength depends on concentration of $[H_3O^{+}]$ in solution.
- Strong and weak bases: strength depends on concentration of $[OH^{-}]$ in solution.

Oxidation and Reduction

Oxidation	Reduction
• Addition of oxygen	• Removal of oxygen
• Removal of hydrogen	• Addition of hydrogen
• Loss of electrons (LEO)	• Gain of electrons (GER)

Oxidizing and reducing agents

Oxidizing agent	Reducing agent
• reduced in the reaction	• oxidized in the reaction
• causes the other substance to be oxidized	• causes the other substance to be reduced
• Oxidation number decreases (as electrons are accepted)	• Oxidation number increases (as electrons are given)
• E.g.: non metals	• 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

Titrations: 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.

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

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