Types of Chemical Reactions & Solution Chemistry

Chapter 4

4.4 Types of Chemical Reactions

- Precipitation reactions
- Acid-Base reactions
- Oxidation-reduction reactions (Redox)

Precipitation Reactions

- When two solutions are mixed, an insoluble solid sometimes forms (precipitate)
- Example:
  - Barium nitrate reacts with potassium chromate
    - What are the products?
    - Which product is the precipitate?

Solubility Rules

- Learn the first three rules on pg 150!!!

Exercise 4.8

- Using the solubility rules predict what will happen when the following pairs of solutions are mixed:
- A. Potassium nitrate & Barium Chloride
- B. Sodium sulfate & Lead (II) nitrate
- C. Potassium hydroxide & iron (III) nitrate

Answers

- A. No reaction
- B. Lead (II) sulfate
- C. Iron (III) hydroxide

4.6 Describing Reactions in Solutions

- Molecular equation: shows reactants and products
- Complete Ionic equation: represents the actual forms of the reactants and products in solution
- Net Ionic equation: includes only those solution components directly involved in the reaction.

Exercise 4.9: Writing Equations for Reactions

- Write the molecular equation, the complete ionic equation, and the net ionic equation

- A. Aqueous potassium chloride is added to aqueous silver nitrate to form a silver chloride precipitate plus aqueous potassium nitrate.

Exercise 4.9 Con't

- B. Aqueous potassium hydroxide is mixed with aqueous iron(III) nitrate to form a precipitate of iron(III) hydroxide and aqueous potassium nitrate.

4.7 Stoichiometry of Precipitation Reactions

- Calculate the mass of solid NaCl that must be added to 1.50L of a 0.100M $AgNO_3$ solution to precipitate all the Ag^+ ions in the form of AgCl.

Answer

- 8.77g NaCl

Another one…

- When aqueous solutions of Na_2SO_4 and $Pb(NO_3)_2$ are mixed, $PbSO_4$ precipitates. Calculate the mass of $PbSO_4$ formed when 1.25L of 0.0500M $Pb(NO_3)_2$ and 2.00L of 0.0250M Na_2SO_4 are mixed.

Answer

- 15.2g $PbSO_4$

Neutralization Reactions

write balanced neutralization reactions

Stoichiometry of Acid-Base Reactions

What volume of 0.50M sulfuric acid is required to neutralize 50.0mL of 1.45M aluminum hydroxide?

Answer: 220mL

Stoichiometry of Acid-Base reactions

What mass of chloric acid would be needed to completely neutralize 50.0g of magnesium hydroxide?

Answer: 51.1g

Definitions

- Oxidation: Loss of elections
- Reduction: Gain of electrons.
- Redox reaction: reaction involving transfer of electrons. One substance is oxidized by losing electrons, and the other substance is reduced by gaining electrons.
- Oxidation number: Apparent charge on an atom.

Oxidation Number Rules

- 1. ON of an uncombined element = 0
- 2.a) Sum of the ON in a neutral compound = 0
- b) Sum of the ON in an ion = charge on the ion.
- 3. In compounds:
- a) Group 1 = 1+
- b) Group 2 = 2+

Oxidation Number Rules

- 4. In compounds: H = 1+ and F = 1-
- 5. In compounds: O = 2-
- 6. In binary compounds with metals:
- a) Group 15 = 3-
- b) Group 16 = 2-
- c) Group 17 = 1-

Oxidation Numbers

- Assign oxidation numbers to each element in the following.
- CO_2 — C = 4+; O = 2-
- NO_3^- — N = 5+; O = 2-
- H_2SO_4 — H = 1+; S = 6+; O = 2-
- Fe_2O_3 — Fe = 3+; O = 2-
- Fe_3O_4 — Fe = 8/3+; O = 2-

Redox Reactions

- Transfer electrons, so the oxidation states change.
- Oxidation is the loss of electrons.
- Reduction is the gain of electrons.
- OIL RIG
- LEO GER

Redox Reactions

- Assign Oxidation Numbers

0 0 1+ 1--

- Na + $2Cl_2 \rightarrow 2NaCl$
- Na goes from 0 to 1+; It loses electrons. It is oxidized and is called the reducing agent
- Cl goes from 0 to 1-. It gains electrons. It is reduced and is called the oxidizing agent.

Redox Reactions

- Assign Oxidation Numbers

4-	1+	0	4+	2-	1+	2-

- $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
- C goes from 4- to 4+; It loses electrons. It is oxidized and is called the reducing agent
- O goes from 0 to 2-. It gains electrons. It is reduced and is called the oxidizing agent.

Practice

- $Fe\,(s) + O_2(g) \rightarrow Fe_2O_3(s)$
- Oxidizing agent O
- Reducing agent Fe
- Substance oxidized Fe
- Substance reduced O

Practice

- $Fe_2O_3(s) + 3\ CO(g) \rightarrow 2\ Fe(l) + 3\ CO_2(g)$
- Oxidizing agent Fe
- Reducing agent C
- Substance oxidized C
- Substance reduced Fe

Half-Reactions

- All redox reactions can be thought of as happening in two halves.
- One produces electrons - Oxidation half.
- The other requires electrons - Reduction half.
- Write the half reactions for the following.
- $Na + Cl_2 \rightarrow Na^+ + Cl^-$
- $SO_3^{2-} + MnO_4^- \rightarrow SO_4^{2-} + Mn^{+2}$

Balancing Redox Equations in acidic solutions

1. Write separate half reactions
2. For each half reaction balance all reactants except H and O
3. Balance O using H_2O
4. Balance H using H^+
5. Balance charge using e^-
6. Multiply equations to make electrons equal

7. Add equations and cancel identical species

8. Check that charges and elements are balanced.

Practice

The following reaction occurs in acidic solution. Balance it.

1. $Mn^{+2} + NaBiO_3 \rightarrow Bi^{+3} + MnO_4^-$

Balancing Redox Reactions in Basic Solution

Follow same steps as acidic and then…

1. Add the same number of OH^- to both sides of the reaction as there are H^+.
2. $H^+ + OH^- = H_2O$, combine them and then reduce H_2O.
3. It's balanced!!

Practice

Balance the following reaction in basic solution:

$Cu + NO_3^- \rightarrow Cu^{+2} + NO(g)$