

Chapter 4

Sample Calculations



For each problem below, write a NET IONIC EQUATION to represent the reaction. Base your stoichiometry calculations on this net ionic equation. Show all work carefully on separate lined paper.

1. How many grams of $\text{Mg}(\text{OH})_2$ are required to neutralize 50.0 ml of a 3.00 M HCl solution?
2. A piece of copper metal weighing 1.50 grams is placed in 250.0 mL of 0.200-M silver nitrate solution. The two will react in a 'single-replacement' reaction, which is really a type of oxidation-reduction reaction.
 - (a) Show the reaction in a NET IONIC FORM. Identify the oxidizing agent and reducing agent.
 - (b) Will the piece of copper be completely consumed? Show calculations to support your answer.
 - (c) Determine the concentration of the metal ions after the reaction is complete.

3. (adapted from the 2001 AP exam)

Answer the following questions about *acetylsalicylic acid*, the active ingredient in aspirin.

- (a) The amount of acetylsalicylic acid in a single aspirin tablet is 325 mg, yet the tablet has a total mass of 2.00 grams. Calculate the mass percent of acetylsalicylic acid in the tablet. (*Yes, it's easy.*)
- (b) The elements contained in acetylsalicylic acid are carbon, hydrogen and oxygen. The combustion of a 3.000-gram sample of the compound produces 1.200 grams of water and 3.72 L of carbon dioxide gas measured at 750. mm Hg and 25° C. (Review: $PV = nRT$; $R = 62.4$)
 - (i) Determine the mass of each element in the 3.00-gram sample.
 - (ii) Determine the empirical formula of the compound.
(Hint: use the best possible whole-number ratio)
- (c) A student dissolved 1.625 grams of pure acetylsalicylic acid in distilled water and titrated the resulting solution to the endpoint using 88.43 mL of 0.102 M sodium hydroxide solution. Assume that acetylsalicylic acid is a weak monoprotic acid represented by the formula HAsp. Write a net ionic equation to represent the titration reaction and use the titration data to determine the formula mass of acetylsalicylic acid.
- (d) Based on the results of parts (b) and (c), what is the molecular formula for acetylsalicylic acid?

4. The iron content of iron ore can be determined by titration with potassium permanganate solution. The iron ore is dissolved in acid and all of the iron is converted to iron (II) ions. The acidic solution is then reacted with potassium permanganate solution, producing iron (III) and manganese (II) ions.

- (a) Give the balanced net-ionic form of this reaction. (*It's a redox reaction.*)
- (b) If it required 41.95 mL of 0.0205 M potassium permanganate solution to completely titrate the iron from a 0.6128-gram ore sample, what is the mass percent of iron in the ore?

5. Saccharin is an artificial sweetener with the chemical formula $\text{C}_7\text{H}_5\text{NO}_3\text{S}$. Ten saccharin tablets with a total mass of 0.5894 g were dissolved in water and the sulfur in the tablets was completely converted to sulfate ion, which was precipitated by adding excess barium chloride solution. The mass of barium sulfate obtained was 0.5032 g. Determine the average mass of saccharin per tablet.

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ANSWERS

- 4.37 grams magnesium hydroxide
- $$\text{Cu(s)} + 2 \text{Ag}^+(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2 \text{Ag(s)}$$

Oxidizing agent: silver ion Ag^+
Reducing agent: copper metal Cu
 - YES (There is enough silver to react with 1.587 grams of copper)
 - $[\text{Cu}^{2+}] = 0.0945 \text{ M}$ $[\text{Ag}^+] = 0.0112 \text{ M}$
- 16.25%
 - 1.80 g C; 0.133 g H; 1.067 g O
 - $\text{C}_9\text{H}_8\text{O}_4$
 - FM = 180 g/mol
 - also $\text{C}_9\text{H}_8\text{O}_4$
- $$\text{MnO}_4^-(\text{aq}) + 5 \text{Fe}^{2+}(\text{aq}) + 8 \text{H}^+ \rightarrow 5 \text{Fe}^{3+}(\text{aq}) + \text{Mn}^{2+}(\text{aq}) + 4 \text{H}_2\text{O}$$
 - 39.15% iron in the ore
- 39.5 mg saccharin per tablet