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Workshop on August 29th: Having Fun with the Routine:
Lewis Structures, Oxidation States, Nomenclature, and Stoichiometry

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STOICHIOMETRY EXERCISES

(Adapted from Zumdahl & Zumdahl; Chemistry, 8th Edition; Brooks/Cole CENGAGE Learning 2010)

- (p. 123, q. 99) Over the years, the thermite reaction has been used for welding railroad rails, in incendiary bombs, and to ignite solid-fuel rocket motors. The reaction is:
$$\text{Fe}_2\text{O}_3 (\text{s}) + 2 \text{Al} (\text{s}) \rightarrow 2 \text{Fe} (\text{l}) + \text{Al}_2\text{O}_3 (\text{s})$$
What masses of iron(III) oxide and aluminum must be used to produce 15.0 g of iron? What is the maximum mass of aluminum oxide that could be produced?
- (p. 123, q. 103) Elixirs such as Alka-Seltzer use the reaction of sodium bicarbonate with citric acid in aqueous solution to produce a fizz:
$$3 \text{NaHCO}_3 (\text{aq}) + \text{C}_6\text{H}_8\text{O}_7 (\text{aq}) \rightarrow 3 \text{CO}_2 (\text{g}) + 3 \text{H}_2\text{O} (\text{l}) + \text{Na}_3\text{C}_6\text{H}_5\text{O}_7 (\text{aq})$$
 - What mass of $\text{C}_6\text{H}_8\text{O}_7$ should be used for every 100,0 mg of NaHCO_3 ?
 - What mass of CO_2 (g) could be produced from such a mixture?
- (p. 124, q. 112) Acrylonitrile ($\text{C}_3\text{H}_3\text{N}$) is the starting material for many synthetic carpets and fabrics. It is produced by the following reaction [from propene, C_3H_6]:
$$2 \text{C}_3\text{H}_6 (\text{g}) + 2 \text{NH}_3 (\text{g}) + 3 \text{O}_2 (\text{g}) \rightarrow 2 \text{C}_3\text{H}_3\text{N} (\text{g}) + 6 \text{H}_2\text{O} (\text{g})$$
Assume that 15.0 g C_3H_6 , 10.0 g O_2 , and 5.00 g NH_3 are reacted.
 - What mass of acrylonitrile can be produced, assuming 100% yield?
 - What mass of water can be produced? Calculate the masses of excess reagents.
- (p. 174, q. 55) What mass of Na_2CrO_4 is required to precipitate all of the silver ions from 75.0 mL of a 0.100 mol/L solution of AgNO_3 ?
- (Question adapted from p.174, q. 59) What mass of solid $\text{Ca}_3(\text{PO}_4)_2$ is produced when 75.0 mL of 0,130 mol/L $\text{Ca}(\text{NO}_3)_2$ is added to 25.0 mL of 0.110 mol/L Na_3PO_4 ?

6. (Question from me!) A 32.5 mL sample of H_3PO_4 solution of unknown concentration is neutralized with 25.5 mL of 0.150 mol/L NaOH solution. What is the initial concentration of the H_3PO_4 solution?
7. (Adapted question from French Zumdahl*; p. 49, q. 47) A solution is prepared by dissolving 15.0 g of NaOH in 150.0 mL of 0.250 mol/L HNO_3 solution. Will the final solution be acidic, basic, or neutral? Calculate the concentration of each ionic species in solution, once the reaction is completed. Assume no volume change due to the addition of NaOH.

* (Zumdahl; *Chimie des solutions*, 2nd édition; CEC 1998)

OTHER APPLICATIONS IN BUFFER CHEMISTRY AND IN THERMOCHEMISTRY

8. (Adapted from p. 277, q. 43) The overall reaction in a commercial heat pack can be represented as:



How much heat is released when 10.0 g Fe and 2.00 g O_2 are reacted?

9. (Adapted from p. 737, q. 28 and 30) Calculate the pH of a solution that is 0.60 mol/L HF and 1.00 mol/L KF. Then, calculate the pH after 6.0 g of NaOH is added to 2.00 L of this buffer. Assume no volume change due to the addition of NaOH. $K_a(\text{HF}) = 7.2 \times 10^{-4}$.