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Weightlifting – Stoichiometry Practice Problems

Stoich Review

1. The average human male has a total blood volume of 5.0 L. If a concentration of sodium ion in this average individual is 0.135 M, what is the mass of sodium ion circulating in the blood?

$$[\text{Na}^+] = 0.135 \frac{\text{mol}}{\text{L}}$$

$$5 \text{ L} \times 0.135 \frac{\text{mol}}{\text{L}} \times \frac{22.99 \text{ g}}{1 \text{ mol}} = \boxed{16 \text{ g}}$$

2. Calculate the molarity of a solution that contains 0.175 mol of ZnCl_2 dissolved in 150 mL of solution

$$[\text{ZnCl}_2] = \frac{0.175 \text{ mol}}{0.15 \text{ L}} = \boxed{1.2 \text{ M}}$$

3. How many moles of HCl are present in 35.0 mL of 4.50 M solution?

$$0.035 \text{ L} \times 4.50 \frac{\text{mol}}{\text{L}} = \boxed{0.158 \text{ mol}}$$

4. Calculate the number of grams of solute in 0.240 L of 0.175 M KBr

$$0.240 \text{ L} \times 0.175 \frac{\text{mol}}{\text{L}} \times \frac{119 \text{ g}}{1 \text{ mol}} = \boxed{5.00 \text{ g}}$$

5. Calculate the molar concentration of a solution containing 14.75 g of $\text{Ca}(\text{NO}_3)_2$ in 1.375 L

$$14.75 \text{ g} \times \frac{1 \text{ mol}}{164.08 \text{ g}} = \frac{0.0899 \text{ mol}}{1.375 \text{ L}} = \boxed{0.0653 \text{ M}}$$

6. How many mL of stock solution of 6.0 M HNO_3 would you have to use to prepare 110 mL of 0.500 M HNO_3 ?

$$M_1 V_1 = M_2 V_2$$
$$\frac{(6 \text{ M}) V_1}{6} = \frac{(0.500)(110)}{6} \rightarrow \boxed{V = 9.2 \text{ mL}}$$

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7. Balance the chemical reaction above. What type of reaction is it (acid/base, redox, etc.)? **Redox**

8. You begin with 2.3 L of 15.2 M HCl (super dangerous, so be careful!), how many grams of HCl will you be starting this reaction with?

$$2.3 \text{ L} \times 15.2 \frac{\text{mol}}{\text{L}} \times \frac{36.458 \text{ g}}{1 \text{ mol}} = 1274.6 \text{ g} = \boxed{1300 \text{ g}}$$

9. You run this reaction with MnO₂. Using the answer from question 8, how many grams of Cl₂ do you produce?

$$1300 \text{ g HCl} \times \frac{1 \text{ mol}}{36.448 \text{ g}} \times \frac{1 \text{ mol}}{4 \text{ mol}} \times \frac{70.9 \text{ g}}{1 \text{ mol}} = \boxed{630 \text{ g}}$$

10. Using your answer from question 8, what is the volume of Cl₂ that is produced?

$$630 \text{ g} \times \frac{1 \text{ mol}}{70.9} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 199 = \boxed{200 \text{ L}}$$

Empirical Formulas

11. Determine the empirical formulas for of the compounds with the following compositions by mass:

a. 10.4% C, 27.8% S, and 61.7% Cl

$$\frac{10.4 \text{ g}}{12.01} = 0.866 \quad \frac{27.8}{32.06} = 0.867 \quad \frac{61.7}{35.45} = 1.74 = 2$$

b. 21.7% C, 9.6% O, and 68.7% F

$$\frac{21.7}{12.01} = 1.8$$

$$\frac{9.6}{16} = 0.6$$

$$\frac{68.7}{19} = 3.6$$

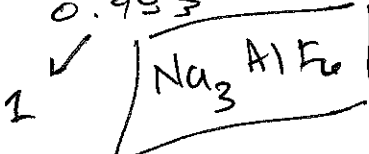
$$\frac{0.6}{0.6} = 1 \quad \frac{1.8}{0.6} = 3 \quad \frac{3.6}{0.6} = 6$$

c. 32.79% Na, 13.02% Al, and the remainder is F

$$\frac{32.79}{23} = 1.43$$

$$\frac{13.02}{26.98} = 0.483$$

$$\frac{13.02}{26.98} = 0.483 \quad (100 - 13.02 - 32.79) = 54.19$$



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Limiting Reactants

12. One of the steps in the commercial process for converting ammonia to nitric acid is the conversion of NH_3 to NO :
 $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$

In a certain experiment, 2.00 g of NH_3 reacts with 2.50 g of O_2 . How many grams of NO and H_2O form? How many grams of excess reactant remain after the completion of the reaction?

$$2.00 \text{ g NH}_3 \left(\frac{1 \text{ mol}}{17.024 \text{ g}} \right) \left(\frac{4 \text{ NO}}{4 \text{ NH}_3} \right) = 0.117 \text{ mol} \times$$

$$2.50 \text{ g} \left(\frac{1}{32} \right) \left(\frac{6}{5} \right) \left(\frac{18.02 \text{ g}}{1 \text{ mol}} \right) = \boxed{1.69 \text{ g H}_2\text{O}}$$

$$2.50 \text{ g O}_2 \left(\frac{1 \text{ mol}}{32 \text{ g}} \right) \left(\frac{4 \text{ NO}}{5 \text{ O}_2} \right) = 0.0625 \text{ mol} \left(\frac{30}{1 \text{ mol}} \right) = \boxed{1.875 \text{ g NO}}$$

↑
limiting reactant!

13. When benzene reacts with bromine, bromobenzene is obtained:



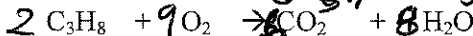
When 30.0 g of benzene reacts with 65.0 g of bromine, how many grams of $\text{C}_6\text{H}_5\text{Br}$ should form?

$$65.0 \text{ g Br}_2 \left(\frac{1}{159.8} \right) \left(\frac{1 \text{ C}_6\text{H}_5\text{Br}}{1 \text{ Br}_2} \right) = 0.407 \text{ mol C}_6\text{H}_5\text{Br}$$

$$30.0 \text{ C}_6\text{H}_6 \left(\frac{1}{78.108} \right) \left(\frac{1 \text{ C}_6\text{H}_5\text{Br}}{1 \text{ C}_6\text{H}_6} \right) = 0.384 \text{ mol C}_6\text{H}_5\text{Br} \left(\frac{157}{157.03} \right) = \boxed{60.3 \text{ g C}_6\text{H}_5\text{Br}}$$

$2 - 1.064 = \boxed{0.936 \text{ g excess}}$
 $0.0625 \text{ mol NO} \left(\frac{4 \text{ NH}_3}{4 \text{ NO}} \right) \left(\frac{17.024}{1} \right) = 1.064 \text{ g NH}_3 \text{ used}$

14. Given the following reaction:

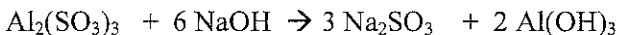


If you start with 14.8 g of C_3H_8 and 3.44 g of O_2 , determine the number of grams of H_2O produced

$$14.8 \text{ g C}_3\text{H}_8 \left(\frac{1 \text{ mol}}{44.094 \text{ g}} \right) \left(\frac{8}{2} \right) = 0.671 \text{ mol} \times$$

$$3.44 \text{ g O}_2 \left(\frac{1 \text{ mol}}{32} \right) \left(\frac{8}{9} \right) = 0.0956 \text{ mol H}_2\text{O} \left(\frac{18.02}{1 \text{ mol}} \right) = \boxed{1.72 \text{ g}}$$

15. Given the following equation:



a. If 10.0 g of $\text{Al}_2(\text{SO}_4)_3$ is reacted with 10.0 g of NaOH , determine the number of moles of $\text{Al}(\text{OH})_3$ produced 3.

$$10.0 \text{ g Al}_2(\text{SO}_4)_3 \left(\frac{1}{294.12} \right) \left(\frac{2}{1} \right) = 0.0680 \text{ mol Al}(\text{OH})_3 \left(\frac{78.004}{78.004} \right) = \boxed{5.30 \text{ g}}$$

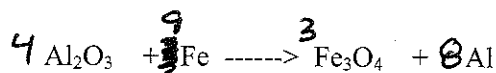
$$10.0 \text{ g NaOH} \left(\frac{1}{40} \right) \left(\frac{2}{6} \right) = 0.0833 \text{ mol Al}(\text{OH})_3$$

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16. Given the following equation:



- a. If 25.4 g of Al_2O_3 is reacted with 10.2 g of Fe, determine the number of grams of Fe_3O_4 produced
b. Determine the number of grams of excess reagent left over in the reaction

(a)

$$25.4 \text{ g Al}_2\text{O}_3 \left(\frac{1}{101.96} \right) \left(\frac{3}{4} \right) = 0.187 \text{ mol Fe}_3\text{O}_4$$

$$10.2 \text{ g Fe} \left(\frac{1}{55.85} \right) \left(\frac{3}{9} \right) = 0.0609 \text{ mol Fe}_3\text{O}_4$$

limiting reagent

$$0.0609 \text{ mol Fe}_3\text{O}_4 \left(\frac{231.55}{1} \right) = 14.1 \text{ g Fe}_3\text{O}_4$$

(b)

$$0.0609 \text{ mol Fe}_3\text{O}_4 \left(\frac{4 \text{ Al}_2\text{O}_3}{3 \text{ Fe}_3\text{O}_4} \right) \left(\frac{101.96}{1} \right) = 8.28 \text{ g Al}_2\text{O}_3 \text{ used}$$

$$25.4 - 8.28 = 17.1 \text{ g excess}$$