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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?

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

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

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

$[ZnCl_2] = \frac{0.175\ mol}{0.15\ L} = \boxed{1.2\ M}$

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

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

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

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

5. Calculate the molar concentration of a solution containing 14.75 g of $Ca(NO_3)_2$ in 1.375 L

$14.75\ g \times \frac{1\ mol}{164.08\ g} = \frac{0.0899\ mol}{1.375\ L} = \boxed{0.06538\ M}$

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?

$M_1V_1 = M_2V_2$

$\frac{(6M)V_1}{6} = \frac{(0.500)(110)}{6}$

$\boxed{V = 9.2\ mL}$

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$4\ HCl\ (aq) + MnO_2\ (aq) \rightarrow MnCl_2\ (aq) + 2\ H_2O\ (l) + Cl_2\ (g)$

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?

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

9. You run this reaction with MnO_2. Using the answer from question 8, how many grams of Cl_2 do you produce?

$1300\ g\ HCl \times \frac{1\ mol}{36.458\ g} \times \frac{1\ mol}{4\ mol} \times \frac{70.9\ g}{1\ mol} = \boxed{630\ g}$

10. Using your answer from question 8, what is the volume of Cl_2 that is produced?

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

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

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

$\frac{0.866}{0.866} \rightarrow 1 \quad \frac{0.867}{0.866} \rightarrow 1 \quad \frac{1.74}{0.866}$

$\boxed{CSCl_2}$

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

$\frac{21.7}{12.01} = 1.8 \quad \frac{9.6}{16} = 0.6 \quad \frac{68.7}{19} = 3.6$

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

$\boxed{CO_3F_6}$

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

$\frac{32.79}{23} = 1.43 \quad \frac{13.02}{26.98} = 0.483 \quad \frac{(100 - 13.02 - 32.79)}{19} = 2.85$

$\frac{1.43}{0.483} \rightarrow 3 \quad \frac{0.483}{0.483} \rightarrow 1 \quad \frac{2.85}{0.483} \rightarrow 6$

$\boxed{Na_3AlF_6}$

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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:

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

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?

$2.00\text{ g } NH_3 \left(\frac{1\text{ mol}}{17.024\text{ g}}\right)\left(\frac{4\text{ NO}}{4\text{ NH}_3}\right) = 0.117\text{ mol}$ X

$2.50\text{ g}\left(\frac{1}{32}\right)\left(\frac{6}{5}\right)\left(\frac{18.02\text{ g}}{1\text{ mol}}\right) =$ **1.69 g H_2O**

$2.50\text{ g } O_2 \left(\frac{1\text{ mol}}{32\text{ g}}\right)\left(\frac{4\text{ NO}}{5\text{ O}_2}\right) = 0.0625\text{ mol}$ ↑ limiting reactant!

$\left(\frac{30}{1\text{ mol}}\right) =$ **1.875 g NO**

$0.0625\text{ mol NO}\left(\frac{4\text{ NH}_3}{4\text{ NO}}\right)\left(\frac{17.024}{1}\right) = 1.064\text{ g } NH_3$ used

$2 - 1.064 =$ **0.936 g excess**

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

$$C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$$

When 30.0 g of benzene reacts with 65.0 g of bromine, how many grams of C_6H_5Br should form?

$65.0\text{ g } Br_2\left(\frac{1}{159.8}\right)\left(\frac{1\ C_6H_5Br}{1\ Br_2}\right) = 0.407\text{ mol } C_6H_5Br$ ✓

$30.0\ C_6H_6\left(\frac{1}{78.108}\right)\left(\frac{1\ C_6H_5Br}{1\ C_6H_6}\right) = 0.384\text{ mol } C_6H_5Br\left(\frac{157}{1\text{ mol}}\right) =$ **60.3 g C_6H_5Br**

14. Given the following reaction:

$$2\ C_3H_8 + 9\ O_2 \rightarrow 6\ CO_2 + 8\ H_2O$$

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

$14.8\text{ g } C_3H_8\left(\frac{1\text{ mol}}{44.094\text{ g}}\right)\left(\frac{8}{2}\right) = 0.671\text{ mol}$ X

$3.44\text{ g } O_2\left(\frac{1\text{ mol}}{32}\right)\left(\frac{8}{9}\right) = 0.0956\text{ mol } H_2O$ ✓

$\left(\frac{18.02}{1\text{ mol}}\right) =$ **1.72 g**

15. Given the following equation:

$$Al_2(SO_3)_3 + 6\ NaOH \rightarrow 3\ Na_2SO_3 + 2\ Al(OH)_3$$

a. If 10.0 g of $Al_2(SO_3)_3$ is reacted with 10.0 g of NaOH, determine the number of moles of $Al(OH)_3$ produced 3.

$10.0\text{ g } Al_2(SO_3)_3\left(\frac{1}{294.12}\right)\left(\frac{2}{1}\right) = 0.0680\text{ mol } Al(OH)_3$ ✓

$\left(\frac{78.004}{1}\right) =$ **5.30 g**

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

X

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16. Given the following equation:

$$4\ Al_2O_3 + 9\ Fe \longrightarrow 3\ Fe_3O_4 + 8\ Al$$

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)

$$25.4\text{ g } Al_2O_3 \left(\frac{1}{101.96}\right)\left(\frac{3}{4}\right) = 0.187 \text{ mol } Fe_3O_4$$

$$10.2\text{ g Fe} \left(\frac{1}{55.85}\right)\left(\frac{3}{9}\right) = 0.0609 \text{ mol } Fe_3O_4 \left(\frac{231.55}{1}\right) = \boxed{14.1\text{ g } Fe_3O_4}$$

limiting reactant

(b)

$$0.0609\text{ mol } Fe_3O_4 \left(\frac{4\ Al_2O_3}{3\ Fe_3O_4}\right)\left(\frac{101.96}{1}\right) = 8.28\text{ g } Al_2O_3 \text{ used}$$

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