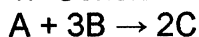


Additional Stoichiometry Review Problems

Name Key Period

Interpreting a Chemical Equation

1. Consider the general chemical equation:



a. If 10.0g of A reacts with exactly 15.0g of B, what is the mass of C produced?

Conservation of mass

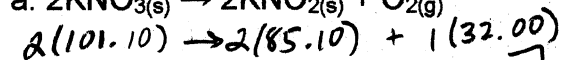
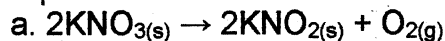
$$\text{mass of C produced} = 15.0g + 10.0g = \boxed{25.0g C}$$

b. If 50.0g of A reacts to produce 75.0g of C, what is the mass of B used?

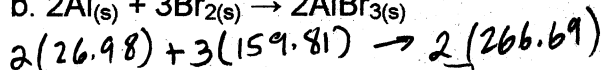
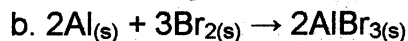
Conservation of mass again

$$50.0g + x = 75.0g \quad x = \boxed{25.0g B}$$

2. Verify the conservation of mass law using the molar masses of reactants and products for each substance in the following balanced equations.



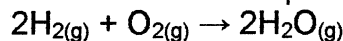
$$\boxed{202.20g = 170.20g + 32.00g}$$



$$\boxed{53.96 + 479.43 = 533.39}$$

Mole - Mole Relationships

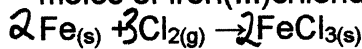
3. Given the balanced equation, calculate the moles of oxygen gas that react with 0.500mol of hydrogen gas. How many moles of water are produced?



$$0.500 \text{ mol } H_2 \left(\frac{1 \text{ mol } O_2}{2 \text{ mol } H_2} \right) = \boxed{0.250 \text{ mol } O_2}$$

$$0.500 \text{ mol } H_2 \left(\frac{2 \text{ mol } H_2O}{2 \text{ mol } H_2} \right) = \boxed{0.500 \text{ mol } H_2O}$$

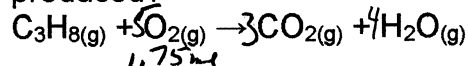
4. How many moles of chlorine gas react with 0.333mol of metallic iron? How many moles of iron(III)chloride are produced?



$$0.333 \text{ mol } Fe \left(\frac{3 \text{ mol } Cl_2}{2 \text{ mol } Fe} \right) = .4995 = \boxed{0.500 \text{ mol } Cl_2}$$

$$0.333 \text{ mol } Fe \left(\frac{2 \text{ mol } FeCl_3}{2 \text{ mol } Fe} \right) = \boxed{0.333 \text{ mol } FeCl_3}$$

5. How many moles of propane gas, C₃H₈, react with 1.75mol of oxygen gas? How many moles of carbon dioxide are produced?

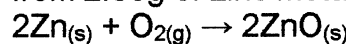


$$1.75 \text{ mol } O_2 \left(\frac{1 \text{ mol } C_3H_8}{5 \text{ mol } O_2} \right) = \boxed{0.35 \text{ mol } C_3H_8}$$

$$1.75 \text{ mol } O_2 \left(\frac{3 \text{ mol } CO_2}{5 \text{ mol } O_2} \right) = \boxed{1.05 \text{ mol } CO_2}$$

Mass - Mass Problems

6. Given the balanced equation, calculate the mass of product that can be prepared from 2.36g of zinc metal.

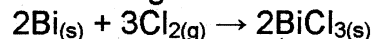


$$\textcircled{1} g \rightarrow \text{mol} \quad 2.36g \left(\frac{1 \text{ mol } Zn}{65.39g} \right) = .0361 \text{ mol } Zn$$

$$\textcircled{2} \text{ mole ratios} \quad .0361 \text{ mol } Zn \left(\frac{2 \text{ mol } ZnO}{2 \text{ mol } Zn} \right) = .0361 \text{ mol } ZnO$$

$$\textcircled{3} \text{ mol} \rightarrow g \quad .0361 \text{ mol } ZnO \left(\frac{81.39g}{1 \text{ mol } ZnO} \right) = 2.9381g = \boxed{2.94g ZnO}$$

7. Given the balanced equation, calculate the mass of product that can be prepared from 3.45g of bismuth metal.

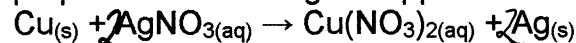


$$\textcircled{1} 3.45g Bi \left(\frac{1 \text{ mol } Bi}{208.98g} \right) = .0165 \text{ mol } Bi$$

$$\textcircled{2} .0165 \text{ mol } Bi \left(\frac{2 \text{ mol } BiCl_3}{2 \text{ mol } Bi} \right) = .0165 \text{ mol } BiCl_3$$

$$\textcircled{3} .0165 \text{ mol } BiCl_3 \left(\frac{315.34g}{1 \text{ mol } BiCl_3} \right) = \boxed{5.20g BiCl_3}$$

8. What is the mass of silver that can be prepared from 0.615g of copper metal?

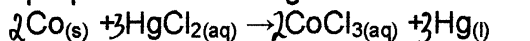


$$\textcircled{1} 0.615g Cu \left(\frac{1 \text{ mol } Cu}{63.55g} \right) = .00968 \text{ mol } Cu$$

$$\textcircled{2} .00968 \text{ mol } Cu \left(\frac{2 \text{ mol } Ag}{1 \text{ mol } Cu} \right) = .0194 \text{ mol } Ag$$

$$\textcircled{3} .0194 \text{ mol } Ag \left(\frac{107.9g}{1 \text{ mol } Ag} \right) = \boxed{2.09g Ag}$$

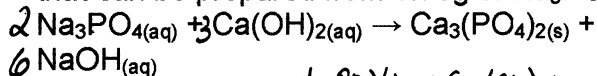
9. What is the mass of mercury that can be prepared from 1.25g of cobalt metal?



$$1.25\text{g Co} \left(\frac{1\text{mol Co}}{58.93\text{g}} \right) \left(\frac{3\text{mol Hg}}{2\text{mol Co}} \right) \left(\frac{200.6\text{g Hg}}{1\text{mol Hg}} \right)$$

$$= \boxed{6.38\text{g Hg}}$$

10. What is the mass of calcium phosphate that can be prepared from 1.78g of Na_3PO_4 ?

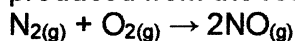


$$1.78\text{g Na}_3\text{PO}_4 \left(\frac{1\text{mol Na}_3\text{PO}_4}{163.94\text{g}} \right) \left(\frac{1\text{mol Ca}_3(\text{PO}_4)_2}{2\text{mol Na}_3\text{PO}_4} \right)$$

$$\left(\frac{310.18\text{g Ca}_3(\text{PO}_4)_2}{1\text{mol}} \right) = \boxed{1.68\text{g Ca}_3(\text{PO}_4)_2}$$

The Limiting Reactant Concept

11. If 1.00mol of nitrogen gas and 1.50mol of oxygen gas react, what is the limiting reactant and how many moles of NO are produced from the reaction?

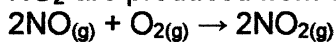


$$1.00 \quad 1.50$$

Since they are in a 1:1 ratio N_2 limits

$$1.00\text{mol N}_2 \left(\frac{2\text{mol NO}}{1\text{mol N}_2} \right) = \boxed{2.00\text{mol NO}}$$

12. If 1.00mol of nitrogen monoxide gas and 1.00mol of oxygen gas react, what is the limiting reactant and how many moles of NO_2 are produced from the reaction?

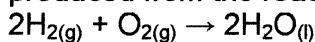


$$1.00\text{mol} \quad 1.00\text{mol}$$

Since NO reacts with O_2 in a 2:1 ratio,

$$\text{NO limits} \quad 1.00\text{mol NO} \left(\frac{2\text{mol NO}_2}{2\text{mol NO}} \right) = \boxed{1.00\text{mol NO}_2}$$

13. If 5.00mol of hydrogen gas and 5.00mol of oxygen gas react, what is the limiting reactant and how many moles of water are produced from the reaction?

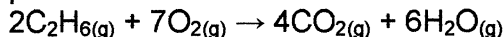


$$5.00\text{mol} \quad 5.00\text{mol}$$

Since H_2 reacts with O_2 in a 2:1 ratio H_2 limits.

$$5.00\text{mol H}_2 \left(\frac{2\text{mol H}_2\text{O}}{2\text{mol H}_2} \right) = \boxed{5.00\text{mol H}_2\text{O}}$$

14. If 1.00mol of ethane gas and 5.00mol of oxygen gas react, what is the limiting reactant and how many moles of water are produced from the reaction?

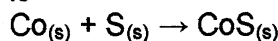


$$1.00\text{mol} \quad 5.00\text{mol}$$

since oxygen reacts with ethane in a 7:2 ratio you only need $1.00 \left(\frac{7}{2} \right) = 3.50\text{mol}$ of O_2 to use up all of the ethane therefore ethane limits. The reaction produces

$$1.00\text{mol C}_2\text{H}_6 \left(\frac{6\text{mol H}_2\text{O}}{2\text{mol C}_2\text{H}_6} \right) = \boxed{3.00\text{mol H}_2\text{O}}$$

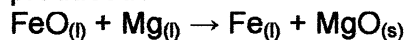
15. Cobalt metal can react with sulfur to give cobalt(II)sulfide. Complete the following table by stating the moles of Co, S and CoS after the reaction is complete. The balanced equation for the chemical reaction is



Experiment	mol Co	mol S	mol CoS
1. Before reaction	1.50	2.00	0.00
2. After reaction	0.00	0.50	1.50
1. Before reaction	3.00	2.00	0.00
2. After reaction	1.00	0.00	2.00

Limiting Reactant Problems

16. If 40.0g of molten iron(II)oxide reacts with 10.0g of magnesium according to the following equation, what is the mass of iron produced?



$$40.0\text{g} \quad 10.0\text{g}$$

$$\text{mol FeO} = \frac{40.0\text{g}}{71.84\text{g/mol}} = .557\text{mol FeO}$$

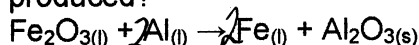
$$\text{mol Mg} = \frac{10.0\text{g}}{24.31\text{g/mol}} = .411\text{mol Mg}$$

Since FeO & Mg react in a 1:1 ratio Mg limits (Fewer moles)

$$.411\text{mol Mg} \left(\frac{1\text{mol Fe}}{1\text{mol Mg}} \right) \left(\frac{55.85\text{g Fe}}{1\text{mol Fe}} \right) = 22.954$$

$$\boxed{23.0\text{g Fe}}$$

17. If 175g of molten iron(III)oxide reacts with 37.5g of aluminum according to the following equation, what is the mass of iron produced?

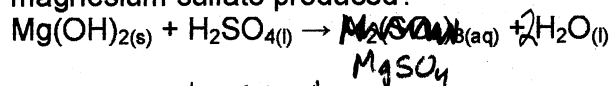


$$175\text{g Fe}_2\text{O}_3 = 175\text{g} \left(\frac{1\text{mol}}{159.69\text{g}} \right) = 1.10\text{mol} \leftarrow \begin{array}{l} \text{needs to} \\ \text{be 1:2} \\ \text{ratio} \\ \text{Al limits} \end{array}$$

$$\text{mol Al} = 37.5\text{g} \left(\frac{1\text{mol Al}}{26.98\text{g}} \right) = 1.39\text{mol}$$

$$1.39\text{mol Al} \left(\frac{2\text{mol Fe}}{2\text{mol Al}} \right) \left(\frac{55.85\text{g Fe}}{1\text{mol}} \right) = \boxed{77.6\text{g Fe}}$$

18. If 1.00g of magnesium hydroxide reacts with 0.605g of sulfuric acid according to the following equation, what is the mass of magnesium sulfate produced?

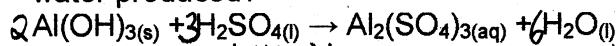


$$1.00\text{g Mg}(\text{OH})_2 \left(\frac{1\text{mol Mg}(\text{OH})_2}{58.326\text{g}} \right) = 0.0171\text{mol Mg}(\text{OH})_2$$

$$0.605\text{g H}_2\text{SO}_4 \left(\frac{1\text{mol H}_2\text{SO}_4}{98.086\text{g}} \right) = 0.00617\text{mol H}_2\text{SO}_4$$

$$0.00617\text{mol H}_2\text{SO}_4 \left(\frac{1\text{mol MgSO}_4}{1\text{mol H}_2\text{SO}_4} \right) = 0.00617\text{mol MgSO}_4 \left(\frac{120.38\text{g}}{1\text{mol MgSO}_4} \right) = \boxed{0.743\text{g MgSO}_4}$$

19. If 1.00g of aluminum hydroxide reacts with 3.00g of sulfuric acid according to the following equation, what is the mass of water produced?



$$1.00\text{g Al}(\text{OH})_3 \left(\frac{1\text{mol Al}(\text{OH})_3}{78.004\text{g}} \right) = 0.0128\text{mol Al}(\text{OH})_3$$

$$3.00\text{g H}_2\text{SO}_4 \left(\frac{1\text{mol H}_2\text{SO}_4}{98.086\text{g}} \right) = 0.0306\text{mol H}_2\text{SO}_4$$

Since $\text{Al}(\text{OH})_3$ & H_2SO_4 combine in a 2:3 ratio $\text{Al}(\text{OH})_3$ limits

$$0.0128\text{mol Al}(\text{OH})_3 \left(\frac{6\text{mol H}_2\text{O}}{2\text{mol Al}(\text{OH})_3} \right) \left(\frac{18.016\text{g H}_2\text{O}}{1\text{mol H}_2\text{O}} \right) = 0.69288\text{g}$$

Percent Yield

$$= \boxed{0.693\text{g H}_2\text{O}}$$

20. A chemistry student prepares acetone by decomposing 31.6g of calcium acetate. If the student collected 10.4g of acetone and the theoretical yield is 11.6g, what is the percent yield?

$$\% \text{ yield} = \left(\frac{10.4\text{g}}{11.6\text{g}} \right) 100\%$$

$$= \boxed{89.7\%}$$

21. A 1.50g sample of sodium nitrate is decomposed by heating. If the resulting sodium nitrite has a mass of 1.29g and the calculated yield is 1.29g, what is the percent yield?

$$\% \text{ yield} = \left(\frac{1.22\text{g}}{1.29\text{g}} \right) \times 100\%$$

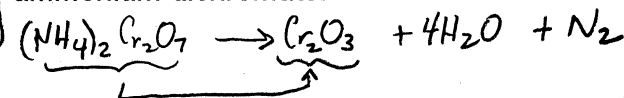
$$= \boxed{94.6\%}$$

General Exercises

22. What units are associated with molar mass?

grams per mole (g/mol)

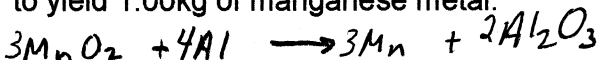
23. The "volcano reaction" produces chromium(III)oxide, water, and nitrogen gas from the decomposition of ammonium dichromate. Calculate the mass of green chromium(III)oxide produced by the decomposition of 1.54g of orange ammonium dichromate.



$$1.54\text{g } (\text{NH}_4)_2\text{Cr}_2\text{O}_7 \left(\frac{1\text{mol}}{252.084\text{g}} \right) = 0.006109\text{mol}$$

$$0.006109\text{mol} \left(\frac{1\text{mol Cr}_2\text{O}_3}{1\text{mol } (\text{NH}_4)_2\text{Cr}_2\text{O}_7} \right) \left(\frac{152.09\text{g}}{\text{mol}} \right) = \boxed{0.929\text{g Cr}_2\text{O}_3}$$

24. Manganese metal and aluminum oxide are produced by the reaction of manganese(IV)oxide and aluminum metal. Calculate the mass of aluminum necessary to yield 1.00kg of manganese metal.



$$1.00 \times 10^3\text{g Mn} \left(\frac{1\text{mol Mn}}{54.94\text{g}} \right) \left(\frac{4\text{mol Al}}{3\text{mol Mn}} \right) \left(\frac{26.98\text{g Al}}{1\text{mol Al}} \right)$$

$$= 654.77 = \boxed{655\text{g Al}}$$

25. A chemical reaction stops when one of the reactants is consumed. For example, the combustion reaction in an automobile stops when the gasoline "runs out." In this case, what is the limiting reactant? What is the excess reactant?

The gasoline is the limiting reactant.
Oxygen is the excess reactant.