Part I: Conceptual Problems

1) Place a check next to the correct statement(s) about the chemical equation below:

\[ 2 \text{NO} + \text{O}_2 \rightarrow \text{N}_2\text{O}_4 \]

- ☑ There is the same amount of reactant atoms as product atoms.
- ☐ There is the same amount of reactant molecules as product molecules.
- ☑ There is the same amount of reactant moles as product moles.
- ☐ There is the same mass of reactants as mass of products.

2) \[ 2\text{W} + \text{X} \rightarrow 3\text{Y} + \text{Z} \]
   Two substances, represented by W and X, react according to the equation above. 15 grams of W and 10 grams of X react completely to form 17 grams of Z. How many grams of Y will be formed in this reaction?

   Reactant mass = product mass (Law of conservation of mass)

   \[ 15\text{g} + 10\text{g} = 25\text{g total} \]

   \[ 25\text{g} - 17\text{g} = 8\text{g} \text{Y} \]

3) A chemical reaction is represented by the picture above. Write the balanced equation for this reaction in the space below.

   \[ 2\text{HCl} + \text{Mg(NO}_3\text{)}_2 \rightarrow \text{MgCl}_2 + 2\text{HNO}_3 \]

4) \[ \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \]

<table>
<thead>
<tr>
<th>Trial #</th>
<th>Amount \text{N}_2 input</th>
<th>Amount \text{NH}_3 produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0 mole</td>
<td>1.0 mole</td>
</tr>
<tr>
<td>2</td>
<td>1.0 mole</td>
<td>1.8 moles</td>
</tr>
<tr>
<td>3</td>
<td>2.0 moles</td>
<td>2.5 moles</td>
</tr>
<tr>
<td>4</td>
<td>2.0 moles</td>
<td>3.0 moles</td>
</tr>
</tbody>
</table>

   The reaction between nitrogen and hydrogen to form ammonia was performed in a laboratory four times. The data above were taken for the four trials. Which trial showed the highest percent yield? Justify your answer.

   \[ \% \text{ yield} = \frac{\text{actual yield } \text{NH}_3}{\text{theoretical yield } \text{NH}_3} \]

   Trial 2 had the highest percent yield.
Unit 5 Review: Reactions and Stoichiometry

Part II: Computational Problems

Directions: Answer the questions below. Clearly show the method used and the steps involved at arriving at your answers. It is to your advantage to do this, since you may obtain partial credit if you do and you will receive little or no credit if you do not.

5) The equation below shows the combustion of butane (C₄H₁₀). How many moles of water can be produced by 12.5 moles of C₄H₁₀ with excess oxygen?

\[ 2 \text{C}_4\text{H}_10 + 13 \text{O}_2 \rightarrow 8 \text{CO}_2 + 10 \text{H}_2\text{O} \]

\[
12.5 \text{ mol C}_4\text{H}_10 \times \frac{10 \text{ mol H}_2\text{O}}{2 \text{ mol C}_4\text{H}_10} = 62.5 \text{ mol H}_2\text{O}
\]

6) If 2.0 moles of sodium reacts with oxygen to produce sodium oxide, what mass of oxygen is required to complete the reaction?

\[ 4 \text{Na} + \text{O}_2 \rightarrow 2 \text{Na}_2\text{O} \]

\[
2.0 \text{ mol Na} \times \frac{1 \text{ mol O}_2}{4 \text{ mol Na}} \times \frac{32.0 \text{ g O}_2}{1 \text{ mol O}_2} = 16 \text{ g O}_2
\]

7) What mass of potassium hydroxide is required to react completely with 2.70 g of magnesium nitrate?

\[ 2 \text{KOH} + \text{Mg(NO}_3\text{)}_2 \rightarrow 2 \text{KNO}_3 + \text{Mg(OH)}_2 \]

\[
2.70 \text{ g Mg(NO}_3\text{)}_2 \times \frac{1 \text{ mol Mg(NO}_3\text{)}_2}{146.32 \text{ g Mg(NO}_3\text{)}_2} \times \frac{2 \text{ mol KOH}}{1 \text{ mol Mg(NO}_3\text{)}_2} \times \frac{56.1 \text{ g KOH}}{1 \text{ mol KOH}} = 2.04 \text{ g KOH}
\]

8) If 20.0 grams of oxygen combines with nitrogen, and 20.0 grams of N₂O₅ are captured from the reaction, what is the percent yield of the reaction?

\[ 2 \text{N}_2 + 5 \text{O}_2 \rightarrow 2 \text{N}_2\text{O}_5 \]

\[
\% \text{ yield} = \frac{\text{actual yield} \ N_2\text{O}_5 \times 100}{\text{theoretical yield} \ N_2\text{O}_5} = \frac{20.0 \text{ g N}_2\text{O}_5}{27.0 \text{ g N}_2\text{O}_5} \times 100 = 74.1\%
\]

| Common polyatomic ions | nitrate | NO₃⁻¹ | sulfate | SO₄²⁻ | carbonate | CO₃⁻² | phosphate | PO₄³⁻ | hydroxide | OH⁻¹ | acetate | C₂H₃O₂⁻¹ | ammonium | NH₄⁺¹ |