Mind Your Matter—Science Processes and KMT

1. The cylinder to the left contains water. An object with a mass of 21 g and a volume of 15 cm³ is lowered into the water. Sketch the object and the new water level in the cylinder on the right.

\[ V = \frac{\text{mass}}{\text{density}} = \frac{21 \text{ g}}{1.49 \text{ g/cm}^3} = 14.0 \text{ cm}^3 \]

2. Calculate the density of the object from question 1.

3. What property does the unit cubic centimeters describe?

4. Study the matter shown below: Each dot represents a particle of matter. [Assume the particles are uniformly distributed throughout each object, and particles of the same size have the same mass.]

In the table below, show how the masses, volumes, and densities of A and B and C compare by adding the symbol <, >, or = to the statement in the second column. Explain your reasoning for each answer in the last column.

<table>
<thead>
<tr>
<th>Property</th>
<th>Relationship</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>A &lt; B</td>
<td>the # of same # of particles</td>
</tr>
<tr>
<td></td>
<td>A ( \leq ) C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B ( \geq ) C</td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td>A = B</td>
<td>1 x w x h</td>
</tr>
<tr>
<td></td>
<td>A ( \geq ) C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B ( \geq ) C</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>A ( \leq ) B</td>
<td>[ \frac{m}{V} ]</td>
</tr>
<tr>
<td></td>
<td>A ( \leq ) C</td>
<td>[ \frac{m}{V} ]</td>
</tr>
<tr>
<td></td>
<td>B = C</td>
<td>[ \frac{m}{V} ]</td>
</tr>
</tbody>
</table>

1

\[ B = \frac{C}{sm} \]
5. Read the following graduated cylinder to the correct number of significant figures.

- 176
- 38.5 ml
- 2.35 ml

- 5.5
- 70.0
- 27.0
6. Calculate the slope (which is the density) of Unknown A and Unknown B.

**Unknown A**
\[
\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{Y_2 - Y_1}{X_2 - X_1} = \frac{14 g}{10 mL} = 1.4 g/mL
\]

**Unknown B**
\[
\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{18 g - 10 g}{22 mL - 12 mL} = \frac{8 g}{10 mL} = 0.8 g/mL
\]

7. Calculate the density of a substance that occupies a volume of 57.5 cm³ and has a mass of 86.20 grams. Could this substance be Unknown A or B or neither?

\[
D = \frac{\text{mass}}{\text{volume}} = \frac{86.20 g}{57.5 mL} = 1.49 g/mL
\]

Could be Substance A

8. Would Unknown A from the graph float or sink in water?

Density water = 1.0 g/mL

Sink
Energy and Matter—it's a Gas

1. Kinetic Molecular Theory describes all matter as being composed of tiny particles in endless random motion. In a solid, the particles vibrate, but are locked into an orderly array. In a liquid, the particles are still touching but are free to move around past one another. In a gas, the particles are moving very rapidly and are widely separated.

Draw particle diagrams below to represent samples of a:
1. solid phase below its melting point
2. a liquid only as it is warming
3. the boiling process
4. the melting process
5. gas only phase

a. Of the above pictures, which is the most dense?
   
   1. solid below melting point

b. How would you describe the attraction between the liquid particles? The gas particles?
   - Slide between each other; semi-attracted
   - Far apart; not "well" attracted

c. How does the motion of the liquid particles compare to the motion of the gas particles?
   - Move slower than gas particles
   - Move quicker (faster)
GENERAL CHEMISTRY FINAL REVIEW

2. State the PVTn relationships described by each of the following graphs.

3. Use KMT to describe why the liquid in a thermometer rises when the thermometer is placed in warm water.

4. A 350 mL sample of gas has a temperature of 30 °C and a pressure of 1.20 atm. What temperature would be needed for the same amount of gas to fit into a 250 mL flask at standard pressure?

5. A giant helium balloon contains 1.83 moles of He. The balloon has a volume of 50 L at a pressure of 763 mm Hg and a temperature of 35 °C. After a period of time, the balloon loses 0.5 moles of He. The balloon is then taken to a hyperbaric chamber where the pressure is 1025 mm Hg and a comfortable 23.4 °C. What is the new volume of the balloon?

6. A sample of gas occupies 806 mL at 26°C and 998 mmHg. Find the volume of the gas at STP.
Energy and States of Matter

1. Describe the change in state that occurs (from ____ to ____ ) for each of the following processes
   a. Boiling
      from liquid to gas
   b. Melting
      from solid to liquid
   c. Evaporation
      from liquid to gas
   d. Freezing
      from liquid to solid
   e. Condensation
      from gas to liquid

2. On the heating curve below, label which phases are present in each portion. Then label each region with either $E_{th}$ or $E_{ph}$ to describe whether the thermal energy or phase energy is changing.

3. What happened to the energy that was released in the previous question? Where does the energy that is being absorbed go?

4. What type of process is this (endothermic or exothermic)? Endothermic

5. Create a cooling curve below.
6. Label which phases are present in each portion.
7. Then label each region with either $E_{th}$ or $E_{ph}$ to describe whether the thermal energy or phase energy is changing.

8. What is in the bubbles of boiling water? Water vapor ($H_2O$)

9. Draw a particle diagram of a magnified view of a very small portion of liquid water in a closed container. Draw a particle diagram that shows the same container after the water evaporates inside the closed container.
Describing substances

For questions 10 – 13 below:
use the letters above or choose E if the answer is None of the above choices.

Note: The choices A, B, C, D and E may be used more than once or not at all.

Note: A model for water, H\textsubscript{2}O, could be the following: 

**B** 10. Which of the above contains a model that could represent N\textsubscript{2}?

**A** 11. Which of the above contains a model that could represent CO\textsubscript{2}?

**B** 12. Which one of the above contains a model that could represent only elements? diatomic

**C** 13. Which of the above is a mixture of compounds?

Match each diagram with its correct description. Diagrams will be used once.

14. **C** Pure Element – only one type of atom present.

15. **E** Mixture of two elements – two types of uncombined atoms present.

16. **B** Pure compound – only one type of compound present.

17. **A** Mixture of two compounds – two types of compounds present.

18. **D** Mixture of a compound and an element.
Molar Mass

1. What is the weight of 0.30 mole of sulfur?

\[ 0.3 \text{ mol} \left( \frac{32.07 \text{ g}}{1 \text{ mol}} \right) = 9.62 \text{ g S} \]

2. What is the weight of 5.5 mole of silicon?

\[ 5.5 \text{ mol Si} \left( \frac{28.09 \text{ g}}{1 \text{ mol}} \right) = 154.50 \text{ g Si} \]

3. How many moles are there in 45 g of Cl?

\[ 45 \text{ g Cl} \left( \frac{1 \text{ mol}}{35.45 \text{ g}} \right) = 1.27 \text{ mol Cl} \]

4. If you have 4.15 moles of barium hydroxide, how many grams of barium hydroxide do you have?

\[ 4.15 \text{ mol Ba(OH)}_2 \left( \frac{171.35 \text{ g}}{1 \text{ mol}} \right) = 711.35 \text{ g Ba(OH)}_2 \]

\[ 137.33 + 2(16) + 2(1.01) = 171.35 \text{ g/mol} \]

5. What is the correct molar mass for H₂O?

\[ 2(1.01) + 16 = 18.02 \text{ g/mol} \]

6. Draw a particle diagram below of a mixture of pure atoms: 9 Nickle (II) and 9 selenium.

![Particle Diagram 1]

\[ \text{O} = \text{Ni}^{2+} \]
\[ \text{O} = \text{Se} \]

Draw a particle diagram below of the same atoms of Nickel (II) and selenium once nickel and selenium are chemically bound in a solid compound.

![Particle Diagram 2]
Periodic Table and Bonding

1. Know the names of the groups/families on the Periodic table. Place these names on the Periodic Table below (make sure to include main group elements and transition elements)

   - main group elements
   - transition metals
   - alkali metals
   - alkaline earth metals
   - halogens
   - noble gases
   - lanthanides
   - actinides
   - rare earth elements

3. How are elements in a group alike and how are they different?
   - have similar properties and same charges as ions
   - different sizes (they get bigger as you go down the group)

4. Which of the following has the most in common with neon?
   a. Cl  b. Mg  c. Ar  d. N  e. Ga

   Use the diagram below to answer question 5

   - a
   - b
   - c
   - d

5. Identify the charge of the ion formed by each element labeled in the above periodic table
   a. \(2^-\)  b. \(2^+\)  c. \(1^+\)  d. \(1^-\)
Naming and Forming

WORK THROUGH THIS EXCELLENT NAMING TUTORIAL PACKET—

Naming Compounds Tutorial and Worksheet
(http://saddleback.edu/faculty/jzova/worksheets_tutorials/ch3worksheets/compound_names_and_formulas_tutorial_and_worksheet.pdf)

WRITING IONIC COMPOUNDS

Ionic compounds are formed from a positive ion (cation) and a negative ion (anion).
The positive ion is always written first.
The resulting compound must be electrically neutral.
Use parentheses when you need two or more polyatomic ions in a formula.

<table>
<thead>
<tr>
<th></th>
<th>Cl⁻</th>
<th>OH⁻</th>
<th>S²⁻</th>
<th>CO₃²⁻</th>
<th>PO₄³⁻</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>NaCl</td>
<td>NaOH</td>
<td>Na₂S</td>
<td>Na₂CO₃</td>
<td>Na₃PO₄</td>
</tr>
<tr>
<td>NH₄⁺</td>
<td>NH₄Cl</td>
<td>NH₄OH</td>
<td>(NH₄)₂S</td>
<td>(NH₄)₂CO₃</td>
<td>(NH₄)₃PO₄</td>
</tr>
<tr>
<td>Ca²⁺</td>
<td>CaCl₂</td>
<td>Ca(OH)₂</td>
<td>CaS</td>
<td>CaCO₃</td>
<td>Ca₃(PO₄)₂</td>
</tr>
<tr>
<td>Al³⁺</td>
<td>AlCl₃</td>
<td>Al(OH)₃</td>
<td>Al₂S₃</td>
<td>Al₂(CO₃)₃</td>
<td>AlPO₄</td>
</tr>
<tr>
<td>Sn⁴⁺</td>
<td>SnCl₄</td>
<td>Sn(OH)₄</td>
<td>SnS₂</td>
<td>Sn(CO₃)₂</td>
<td>Sn₄(PO₄)₄</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Cation</th>
<th>Anion</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonium phosphate</td>
<td>NH₄⁺</td>
<td>PO₄³⁻</td>
<td>(NH₄)₃PO₄</td>
</tr>
<tr>
<td>barium nitrate</td>
<td>Ba²⁺</td>
<td>NO₃⁻</td>
<td>Ba(NO₃)₂</td>
</tr>
<tr>
<td>copper (I) sulfide</td>
<td>Cu⁺</td>
<td>S²⁻</td>
<td>Cu₂S</td>
</tr>
<tr>
<td>aluminum carbonate</td>
<td>Al³⁺</td>
<td>CO₃²⁻</td>
<td>Al₂(CO₃)₃</td>
</tr>
<tr>
<td>strontium hydroxide</td>
<td>Sr²⁺</td>
<td>OH⁻</td>
<td>Sr(OH)₂</td>
</tr>
</tbody>
</table>
Naming and forming

Write the names of the following compounds.

1. BaCl₂  barium chloride
2. MgO  magnesium oxide
3. Ni(OH)₂  nickel (II) hydroxide
4. Na₃PO₄  sodium phosphate
5. SnBr₄  tin (IV) bromide
6. (NH₄)₂CrO₄  ammonium chromate

Write the formulas for the following compounds.

1. copper (II) sulfate  CuSO₄
2. iron (III) chloride  FeCl₃
3. aluminum oxide  Al₂O₃
4. potassium phosphate  K₃PO₄
5. ammonium carbonate  (NH₄)₂CO₃
6. chromium (III) oxide  Cr₂O₃
7. silver sulfide  Ag₂S
8. zinc nitrate  Zn(NO₃)₂
9. strontium fluoride  SrF₂
10. magnesium hydroxide  Mg(OH)₂
Equations and reaction Types

1. New substances formed in a chemical reaction are called
   a. coefficients
   b. subscripts
   c. products
   d. reactants

2. Numbers placed in front of formulas in an equation are called
   a. coefficients
   b. subscripts
   c. products
   d. reactants

3. The symbol that indicates a substance dissolved in water is
   a. (H₂O)
   b. (l)
   c. (aq)
   d. (w)

4. The total number of atoms represented by the formula Fe₇(SO₄)₃ is
   a. 12
   b. 14
   c. 15
   d. 17

5. Which of the following is always equal on each side of the arrow in a balanced chemical reaction?
   a. total number of atoms
   b. total number of molecules
   c. sum of the coefficients
   d. sum of the subscripts

6. The charge on tin in Sn(SO₄)₂ is
   a. 2−
   b. 2+
   c. 4+
   d. 16+

7. Which of the following is not conserved in a chemical reaction?
   a. number of atoms
   b. number of molecules
   c. number of grams
   d. actually, all three of these are conserved

8. The calculated amount of product that should ideally be produced in a chemical reaction is called the
   a. true yield
   b. actual yield
   c. theoretical yield
   d. percent yield

9. Nitrogen gas and hydrogen gas react to form ammonia (NH₃) gas. The box shows a mixture of nitrogen and hydrogen molecules before the reaction begins.

   Draw a diagram that shows the results after the mixture reacts completely according to the equation.

   \[ \text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3 \]
Short Answer:

10. What should be the total number of C atoms on the right side of the equation?

11. What is the formula of the missing product molecule? (you may draw a picture)

12. What are particles on the left side of the arrow called?

13. Write the completed chemical equation for the reaction pictured.

\[ \text{AB}_2 + 2 \text{CD} \rightarrow \text{ABCD} + \text{BCD} \]

Balance the following reactions.

14. \[ _{\text{l}} \text{C}_3\text{H}_8 + _{\text{5}} \text{O}_2 \rightarrow _{\text{3}} \text{CO}_2 + _{\text{4}} \text{H}_2\text{O} \]

15. \[ _{\text{3}} \text{Sr(OH)}_2 + _{\text{2}} \text{FeCl}_3 \rightarrow _{\text{3}} \text{SrCl}_2 + _{\text{2}} \text{Fe(OH)}_3 \]

16. \[ _{\text{2}} \text{C}_6\text{H}_6 + _{\text{15}} \text{O}_2 \rightarrow _{\text{12}} \text{CO}_2 + _{\text{6}} \text{H}_2\text{O} \]

17. \[ _{\text{l}} \text{H}_2\text{SO}_4 + _{\text{1}} \text{Ba(OH)}_2 \rightarrow _{\text{2}} \text{H}_2\text{O} + _{\text{1}} \text{BaSO}_4 \]

18. \[ _{\text{2}} \text{C}_2\text{H}_2 + _{\text{5}} \text{O}_2 \rightarrow _{\text{4}} \text{CO}_2 + _{\text{2}} \text{H}_2\text{O} \]
Write balanced equations for each of the following chemical reactions. # 19-#22

19. Iron burns in air to form a black solid, iron (III) oxide.

$$4 \text{Fe} + 3 \text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$$

20. Magnesium hydroxide reacts with nitric acid (HNO₃) to form water and magnesium nitrate.

$$\text{Mg} (\text{OH})_2 + 2\text{HNO}_3 \rightarrow 2\text{H}_2\text{O} + \text{Mg(NO}_3)_2$$


$$\text{Fe} + \text{H}_2\text{SO}_4 \rightarrow \text{FeSO}_4 + \text{H}_2$$

22. The combustion of ethane gas, C₂H₆, produces carbon dioxide gas and water vapor.

$$2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$$

23. Describe the following reactions as synthesis, decomposition, single replacement, double replacement or combustion.

   a. C₂H₄ + 3 O₂ → 2 CO₂ + 2 H₂O  combustion

   b. N₂ + 3 Cl₂ → 2 NCl₃  synthesis

   c. 2 Mg + CO₂ → C + 2 MgO  single replacement

   d. 2 Al₂O₃ → 4 Al + 3 O₂  decomposition

24. Label the following as an exothermic or endothermic reaction?

   **endothermic**  energy + PO₃ → P₂ + O₂
   **exothermic**  SeO₂ + O₂ → SeO₃ + energy
   **exothermic**  2 Mg + CO₂ → C + 2 MgO + energy
   **endothermic**  energy + CO₂ → O₂ + CO
   **exothermic**  A + B → AB + energy
   **endothermic**  energy + A + B → AB
**Stoichiometry**

1. When potassium carbonate reacts with hydrogen chloride, the products are potassium chloride, carbon dioxide and water. What mass of hydrogen chloride is needed to completely react with 14.8 g of potassium carbonate?

   \[ \text{K}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{KCl} + \text{CO}_2 + \text{H}_2\text{O} \]

   \[
   \begin{align*}
   14.8\text{g}\text{K}_2\text{CO}_3 &\times \frac{1\text{mol}\text{K}_2\text{CO}_3}{138\text{g}\text{K}_2\text{CO}_3} &\times \frac{2\text{mol}\text{HCl}}{1\text{mol}\text{K}_2\text{CO}_3} &\times \frac{36.45\text{g}\text{HCl}}{1\text{mol}\text{HCl}} = 7.8\text{g}\text{HCl}
   \end{align*}
   \]

2. Nitric oxide (NO) reacts with oxygen gas to produce nitrogen dioxide. In the box at left represent a mixture containing 8 molecules of NO and 6 molecules of O\(_2\). In the box at right represent the system after the reaction had gone to completion. Be sure to provide a key.

   ![Diagram of reaction]

   a. Write the balanced equation for the reaction.

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

   b. Which is the limiting reactant? \text{NO}

   * If more NO was added I could increase amount of NO\(_2\) produced
   * If more O\(_2\) was adding the product would stay the same because O\(_2\) is excess reactant.

3. Lead (II) sulfide, reacts with oxygen gas to produce lead (II) oxide and sulfur dioxide. If 0.500 moles of O\(_2\) were consumed using this chemical reaction, how many grams of lead (II) oxide would be produced?

   \[ 2\text{PbS} + 3\text{O}_2 \rightarrow 2\text{PbO} + 2\text{SO}_2 \]

   \[
   0.500\text{moles O}_2 \times \frac{2\text{mol PbO}}{3\text{mol O}_2} \times \frac{122.4\text{g PbO}}{1\text{mol PbO}} = 44.0\text{g PbO}
   \]
4. Potassium chlorate, decomposes when heated to produce potassium chloride and oxygen gas.

\[ 2 \text{KClO}_3 \rightarrow 2 \text{KCl} + 3 \text{O}_2 \]

If 2.50 grams of potassium chlorate were heated in a test tube, how many grams of oxygen gas should be given off?

\[ 2.5 \text{g KClO}_3 \times \frac{1 \text{mol KClO}_3}{122 \text{g KClO}_3} \times \frac{3 \text{mol O}_2}{2 \text{mol KClO}_3} \times \frac{82 g \text{O}_2}{1 \text{mol O}_2} = 0.977 g \text{O}_2 \]

5. What mass of SO\(_2\) was used up in the reaction with an excess of oxygen gas if 12.4 g of sulfur trioxide is formed?

\[ 2 \text{SO}_2 + \text{O}_2 \rightarrow 2 \text{SO}_3 \]

\[ 12.4 g \text{SO}_3 \times \frac{1 \text{mol SO}_3}{80 g \text{SO}_3} \times \frac{2 \text{mol SO}_2}{2 \text{mol SO}_3} \times \frac{62 g \text{SO}_2}{1 \text{mol SO}_2} = 9.61 g \text{SO}_2 \]

6. The reaction between 15.8 g of NH\(_3\) and excess oxygen gas produces 21.8 g of NO\(_x\) gas and some water. Determine the percent yield.

\[ 4 \text{NH}_3 + \text{SO}_2 \rightarrow 4 \text{NO} + 6 \text{H}_2\text{O} \]

\[ 15.8 g \text{NH}_3 \times \frac{1 \text{mol NH}_3}{17 g \text{NH}_3} \times \frac{4 \text{mol NO}}{4 \text{mol NH}_3} \times \frac{30 g \text{NO}}{1 \text{mol NO}} = 27.9 g \text{NO} \quad \text{(Theoretical)} \]

\[ \frac{21.8 g \text{NO}}{27.9 g \text{NO}} \times 100 = 78\% \]

7. If 21.4 g of aluminum is reacted with 91.3 g of iron (III) oxide, the products will be aluminum oxide and iron metal. What mass of iron will be produced?

\[ 2 \text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + 2 \text{Fe} \]

\[ 21.4 g \text{Al} \times \frac{1 \text{mol Al}}{26.9 g \text{Al}} \times \frac{2 \text{mol Fe}}{2 \text{mol Al}} \times \frac{55.8 g \text{Fe}}{1 \text{mol Fe}} = 44.38 g \text{Fe} \]

\[ 91.3 g \text{Fe}_2\text{O}_3 \times \frac{1 \text{mol Fe}_2\text{O}_3}{159.69 g \text{Fe}_2\text{O}_3} \times \frac{2 \text{mol Fe}}{2 \text{mol Fe}_2\text{O}_3} \times \frac{55.8 g \text{Fe}}{1 \text{mol Fe}} = 63.84 g \text{Fe} \]
A student placed a piece of nickel in silver nitrate solution. Silver metal precipitated and aqueous nickel (II) nitrate was produced. The student collected the following data:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of beaker</td>
<td>106.28 g</td>
</tr>
<tr>
<td>Mass of beaker with silver</td>
<td>107.46 g</td>
</tr>
<tr>
<td>Mass of nickel before</td>
<td>5.00 g</td>
</tr>
<tr>
<td>Mass of nickel after</td>
<td>4.65 g</td>
</tr>
</tbody>
</table>

\[ \text{Mass of nickel after} - \text{Mass of nickel before} = 0.35 \text{ g} \]

a. Write a balanced equation for the reaction.

\[ 2 \text{AgNO}_3 + \text{Ni} \rightarrow 2 \text{Ag} + \text{Ni(NO}_3\text{)}_2 \]

b. From the mass of Ni reacted, determine the theoretical yield of silver

\[ \frac{0.35 \text{ g Ni}}{58.69 \text{ g Ni}} \times \frac{2 \text{ mol Ag}}{1 \text{ mol Ni}} \times \frac{107.87 \text{ g Ag}}{2 \text{ mol Ag}} = 1.28 \text{ g Ag} \]

c. Determine the actual yield of silver

\[
\text{mass of beaker with silver} - \text{mass of beaker} = \frac{1.18 \text{ g Ag}}{1.28 \text{ g Ag}} \times 100 = 92.5\%\]

d. Determine the percent yield of silver.
9. If 6 mol CO and 6 mol Fe₂O₃ are allowed to react:

\[ 3\text{CO} + \text{Fe}_2\text{O}_3 \rightarrow 2\text{Fe} + 3\text{CO}_2 \]

What is the limiting reactant and how much of each product will be formed.

\[
6 \text{ mol CO} \times \frac{2 \text{ mol Fe}}{3 \text{ mol CO}} = 4 \text{ mol Fe} \quad \text{Limiting Reactant CO}
\]

\[
6 \text{ mol Fe}_2\text{O}_3 \times \frac{2 \text{ mol Fe}}{1 \text{ mol Fe}_2\text{O}_3} = 12 \text{ mol Fe}
\]

\[
6 \text{ mol CO} \times \frac{3 \text{ mol CO}_2}{3 \text{ mol CO}} = 6 \text{ mol CO}_2
\]

10. Consider the following combustion reaction: \(2 \text{C}_4\text{H}_{10} + 13 \text{ O}_2 \rightarrow 8 \text{ CO}_2 + 10 \text{ H}_2\text{O}\). If 125 g of \(\text{C}_4\text{H}_{10}\) react with 415 g of \(\text{O}_2\). What is the limiting reactant and how much of each product is produced.

The limiting reactant is the one that produces the least amount.

\[125 \text{ g C}_4\text{H}_{10} \times \frac{1 \text{ mol C}_4\text{H}_{10}}{34.1 \text{ g C}_4\text{H}_{10}} \times \frac{8 \text{ mol CO}_2}{2 \text{ mol}} = 14.66 \text{ mol CO}_2\]

\[415 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32 \text{ g O}_2} \times \frac{8 \text{ mol CO}_2}{13 \text{ mol O}_2} = 7.98 \text{ mol CO}_2\]

\[415 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32 \text{ g O}_2} \times \frac{10 \text{ mol H}_2\text{O}}{13 \text{ mol O}_2} = 9.97 \text{ mol H}_2\text{O}\]
Conservation of Mass

1. A student mixed 125 grams of sugar, 250 grams of water and 5 grams of flavoring. What does the final solution weigh? 380 g

2. 5 grams of salt is dissolved in 100 mL of water to form a salt solution. The solution is heated and the water boiled away. How much salt would you expect to have left in the final container? 5 grams

3. Circle the items below that are always conserved in any chemical reaction:
   - Atoms
   - Combustion reaction
   - Compounds
   - Density
   - Endothermic reactions
   - Mass
   - Only anions
   - Only cations
   - Volume
   - Moles

4. If two substances are completely mixed into a solution, which of the following statements accurately describes the relationship between the initial substances and the final mixture?
   A. The final solution must have a different physical state than the initial substances.
   B. The total mass of the substances going in must equal the total mass of the final mixture.
   C. The initial substances must contain more complex molecules than the final solution does.
   D. The density of the substances must equal the density of the final mixture.

5. When Chemical equations are balanced, what science law is being satisfied?

6. According to the law of conservation of mass, how much zinc was present in the zinc carbonate pictured above?
   A. 40 g
   B. 88 g
   C. 104 g
   D. 256 g
7. The chemical equation shows CaCO₃ being heated. Which of these statements best describes the mass of the products if 100 g of CaCO₃ is heated?

\[
\text{CaCO}_3 \xrightarrow{\text{heat}} \text{CaO} + \text{CO}_2
\]

A. The difference in the products’ masses is equal to the mass of the CaCO₃.
B. The sum of the products’ masses is less than the mass of the CaCO₃.
C. The mass of each product is equal to the mass of the CaCO₃.
D. The sum of the products’ masses equals the mass of the CaCO₃.

8. The mass of a rusty bicycle is found to be slightly greater than the mass of the same bicycle before it rusted. The change in mass indicates that the rusting process —

A. is a physical change
B. involves an energy-to-matter conversion
C. decreases the density of the metal
D. involves metal bonding with other atoms

\[\text{Fe} + \text{O}_2 \rightarrow \text{FeO}\]

Iron oxide = Rust

9. In the procedure shown above, a calcium chloride solution is mixed with a sodium sulfate solution to create the products shown. Why does this illustrate the law of conservation of mass?

The mass of reactants = mass of products
\[300.23 \text{ g} = 300.23 \text{ g}\]

10. When 127 g of copper reacts with 32 g of oxygen gas in a closed container to form copper (II) oxide, no copper or oxygen is left over. How much copper (II) oxide is produced?

\[2\text{Cu} + \text{O}_2 \rightarrow 2\text{CuO}\]

\[127 \text{ g Cu} + 32 \text{ g O}_2 = 159 \text{ g CuO}\]