Practice Packet Unit 6: Moles & Stoichiometry
LESSON 1: Moles and Molar Mass

Objective:
• *Calculate Molar Mass (gram formula mass)*

1. Put an "M" if the substance is molecular/covalent, an "I" if ionic under the formula listed. Then Fill in the remainder of the table

<table>
<thead>
<tr>
<th></th>
<th>Formula</th>
<th>Moles of each atom</th>
<th>Total moles of atoms</th>
<th>Formula</th>
<th>Moles of each atom</th>
<th>Total moles of atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>HClO₃</td>
<td>1 mol of H atoms</td>
<td>5 mol of Cl atoms</td>
<td>f. CaCl₂</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
<pre><code>   |         | 1 mol of Cl atoms | 3 mol of O atoms |         |                   |                      |
</code></pre>
<p>| b. | NH₄C₂H₃O₂ |                   | g. Mg₃(PO₄)₂ |                   |                      |
| c. | Mg(OH)₂ |                   | h. CH₃CH₂CH₃ |                   |                      |</p>

2. *Complete the table below. Use Table E!!*

<table>
<thead>
<tr>
<th></th>
<th>Ionic Compound</th>
<th>Cation (+ ion)</th>
<th>Anion (- ion)</th>
<th>Total moles of ions</th>
<th>Ionic Compound</th>
<th>Cation (+ ion)</th>
<th>Anion (- ion)</th>
<th>Total moles of ions</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>NH₄C₂H₃O₂</td>
<td>NH₄⁺</td>
<td>C₂H₅O₂⁻</td>
<td>2</td>
<td>e. CaF₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Ba(NO₃)₂</td>
<td>Ba²⁺</td>
<td>NO₃⁻</td>
<td></td>
<td>f. Al₂O₃</td>
<td></td>
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<tr>
<td>c.</td>
<td>Li₂CO₃</td>
<td>Li⁺</td>
<td>CO₃⁻</td>
<td></td>
<td>g. KMnO₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>NaHCO₃</td>
<td>Na⁺</td>
<td>HCO₃⁻</td>
<td></td>
<td>h. (NH₄)₃PO₄</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Calculate the gram formula mass (molar mass) and don’t forget the units!!!

1. CO₂
2. FeS
3. NaCl
4. Al₂(CO₃)₃
5. SiO₂
6. H₂SO₄
7. Al₂(SO₃)₃
8. C₁₂H₂₂O₄
9. Fe₂O₃
10. MgO
11. Ca(OH)₂
12. CH₄
13. NH₃
14. H₂O₂
15. NaHCO₃
16. C₆H₁₂O₆
# Lesson 2: Calculating Moles

**Objective:**
- Calculate the number of moles given the grams
- Calculate the number of grams given the moles

Solve for the mass given the moles. (Show your work)

1. 2.00 moles of C\textsubscript{6}H\textsubscript{12}O\textsubscript{6}  
2. 5.00 moles of SrSO\textsubscript{4}  
3. 0.250 moles of CH\textsubscript{4}  
4. 0.100 moles of NH\textsubscript{3}  
5. 12.0 moles of SiO\textsubscript{2}  
6. 0.330 moles of FeS  
7. 1.50 moles of MgO  
8. 0.500 moles of ZnCl\textsubscript{2}
Find the number of moles in the following measurements: (Show your work)

1. 900. grams C₆H₁₂O₆
5. 22 grams of CO₂

2. 24.5 grams H₂SO₄
6. 20. grams of Fe₂O₃

3. 192 grams SiO₂
7. 3.40 grams of H₂O₂

4. 450. grams of ZnCl₂
8. 840. grams of NaHCO₃

Regents Practice:

1. The molar mass of Ba(OH)₂ is
   A) 154.3 g  B) 155.3 g
   C) 171.3 g  D) 308.6 g

2. The gram formula mass of NH₄Cl is
   A) 22.4 g/mole  B) 28.0 g/mole
   C) 53.5 g/mole  D) 95.5 g/mole

3. The gram-formula mass of (NH₄)₂CO₃ is
   A) 46.0 g  B) 64.0 g  C) 78.0 g  D) 96.0 g

4. What is the total number of moles in 80.0 grams of C₂H₅Cl (gram-formula mass = 64.5 grams/mole)?
Lesson 3: Mole to Mole Ratios

**Objective:**
- Calculate mole ratios in a chemical formula

*Use the formula below to answer questions 1-7*

\[3\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu(NO}_3\text{)}_2 + 2\text{NO} + 4\text{H}_2\text{O}\]

1. If 1.00 mole of water is produced, how many moles of HNO\textsubscript{3} are used?

2. If 1.50 moles of copper are used, how many moles of NO are produced?

3. If 4.50 moles of HNO\textsubscript{3} are used, how many moles of copper (II) nitrate are produced?

4. If 0.200 moles of NO are produced, how many moles of copper (II) nitrate produced?

**Challenge Problems**

5. If 9.00 grams of water are produced, how many moles of copper were used?

6. If 3.00 moles of copper are mixed with 4 moles of HNO\textsubscript{3}, how many moles of NO can be formed?

7. If 16.0 moles of HNO\textsubscript{3} react with 4.00 moles of copper, how many moles of water are produced?
Use the formula below to answer questions 8-13

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

8. If 3.00 moles of Iron (III) oxide are used, how many moles of Iron are formed?

9. If 2.50 moles of CO are used, how many moles of carbon dioxide are formed?

10. If 8.56 moles of iron were produced, how many moles of the iron ore were used?

Challenge Problems:

11. If 25.68 grams of iron (III) oxide were used, how many grams of carbon dioxide are formed?

12. If 3.00 moles of iron (III) oxide react with 5.50 moles of CO, how many moles of \( \text{CO}_2 \) are formed?

13. If 1.00 moles of \( \text{Fe}_2\text{O}_3 \) react with 4.00 moles of CO how many moles of the excess reactant are left over?
14. Given the balanced equation:
\[ \text{CaCO}_3(s) + 2\text{HCl(aq)} \rightarrow \text{CaCl}_2(aq) + \text{H}_2\text{O(l)} + \text{CO}_2(g) \]
What is the total number of moles of \( \text{CO}_2 \) formed when 20. moles of \( \text{HCl} \) is completely consumed?
A) 5.0 mol  
B) 10. mol  
C) 20. mol  
D) 40. mol

15. Given the balanced equation representing a reaction:
\[ \text{F}_2(g) + \text{H}_2(g) \rightarrow 2\text{HF(g)} \]
What is the mole ratio of \( \text{H}_2(g) \) to \( \text{HF(g)} \) in this reaction?
A) 1:1  
B) 1:2  
C) 2:1  
D) 2:3

16. Given the balanced equation:
\[ 2\text{C} + 3\text{H}_2 \rightarrow \text{C}_2\text{H}_6 \]
What is the total number of moles of \( \text{C} \) that must completely react to produce 2.0 moles of \( \text{C}_2\text{H}_6 \)?
A) 1.0 mol  
B) 2.0 mol  
C) 3.0 mol  
D) 4.0 mol

17. Given the reaction:
\[ \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) \]
What is the mole-to-mole ratio between nitrogen gas and hydrogen gas?
A) 1:2  
B) 1.3  
C) 2:2  
D) 2:3

18. Given the reaction:
\[ \text{PbCl}_2(aq) + \text{Na}_2\text{CrO}_4(aq) \rightarrow \text{PbCrO}_4(s) + 2\text{NaCl}(aq) \]
What is the total number of moles of \( \text{NaCl} \) formed when 2 moles of \( \text{Na}_2\text{CrO}_4 \) react completely?
A) 1 mole  
B) 2 moles  
C) 3 moles  
D) 4 moles

19. Given the equation:
\[ 2\text{C}_2\text{H}_2(g) + 5\text{O}_2(g) \rightarrow 4\text{CO}_2(g) + 2\text{H}_2\text{O}(g) \]
How many moles of oxygen are required to react completely with 1.0 mole of \( \text{C}_2\text{H}_2 \)?
A) 2.5  
B) 2.0  
C) 5.0  
D) 10

20. Given the reaction:
\[ 6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2 \]
What is the total number of moles of water needed to make 2.5 moles of \( \text{C}_6\text{H}_12\text{O}_6 \)?
A) 2.5  
B) 6.0  
C) 12  
D) 15

21. Given the reaction:
\[ \text{C}_6\text{H}_12\text{O}_6(s) + 6\text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 6\text{H}_2\text{O}(l) \]
How many moles of \( \text{C}_6\text{H}_12\text{O}_6(s) \) are needed to produce 24 moles of carbon dioxide?
A) 1.0 moles  
B) 12 moles  
C) 24 moles  
D) 4.0 moles
Lesson 4: Balancing Reactions

Objective:
- Assess and Balance chemical reactions using coefficients

1. Which equation represents conservation of mass?
   (1) \( \text{H}_2 + \text{Cl}_2 \rightarrow \text{HCl} \)  
   (2) \( \text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl} \)  
   (3) \( \text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O} \)  
   (4) \( \text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \)

2. A 4.86-gram sample of calcium reacted completely with oxygen to form 6.80 grams of calcium oxide. This reaction is represented by the balanced equation below. Determine the total mass of Oxygen that reacted.
   \[ 2\text{Ca(s)} + \text{O}_2(\text{g}) \rightarrow 2\text{CaO(s)} \]

### Balance the Following Reactions

<table>
<thead>
<tr>
<th>Reaction (fill in the coefficients)</th>
<th>Sum of Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{C(s)} + \text{H}_2(\text{g}) \rightarrow \text{CH}_4 )</td>
<td></td>
</tr>
<tr>
<td>( \text{Fe (s)} + \text{O}_2(\text{g}) \rightarrow \text{Fe}_2\text{O}_3 )</td>
<td></td>
</tr>
<tr>
<td>( \text{Na} (\text{s}) \rightarrow \text{Na} (\text{s}) + \text{I}_2 (\text{s}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{C}_6\text{H}_12\text{O}_6 (\text{s}) \rightarrow \text{C} (\text{s}) + \text{H}_2\text{O} (\text{l}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{AgNO}_3 (\text{aq}) + \text{Cu} (\text{s}) \rightarrow \text{Ag} (\text{s}) + \text{Cu(NO}_3)_2 (\text{aq}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{Na}_2\text{CO}_3 (\text{aq}) + \text{HCl} (\text{aq}) \rightarrow \text{NaCl} (\text{aq}) + \text{H}_2\text{O} (\text{l}) + \text{CO}_2 (\text{g}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{H}_2 (\text{g}) + \text{Cl}_2 (\text{g}) \rightarrow \text{HCl} (\text{g}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{N}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightarrow \text{N}_2\text{O}_4 (\text{g}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{CH}_4 (\text{g}) + \text{O}_2 (\text{g}) \rightarrow \text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{g}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{N}_2 (\text{g}) + \text{H}_2 (\text{g}) \rightarrow \text{NH}_3 (\text{g}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{H}_2\text{O}_2 (\text{l}) \rightarrow \text{H}_2\text{O} (\text{l}) + \text{O}_2 (\text{g}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{Al}_2\text{O}_3 \rightarrow \text{Al} (\text{s}) + \text{O}_2 (\text{g}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{C} (\text{g}) + \text{O}_2 (\text{g}) \rightarrow \text{CO}_2 (\text{g}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{CuO} (\text{s}) + \text{C} (\text{s}) \rightarrow \text{Cu} (\text{s}) + \text{CO}_2 (\text{g}) )</td>
<td></td>
</tr>
<tr>
<td>( \text{Ca(OH)}_2 (\text{aq}) + \text{HCl} (\text{aq}) \rightarrow \text{CaCl}_2 (\text{aq}) + \text{H}_2\text{O} (\text{l}) )</td>
<td></td>
</tr>
</tbody>
</table>
Challenge:

\[ \text{_____Fe}_2\text{O}_3 + \text{_____CO} \rightarrow \text{_____Fe} + \text{_____CO}_2 \]

Regents Practice

7. Which equation shows a conservation of mass?
   A) \( \text{Na} + \text{Cl}_2 \rightarrow \text{NaCl} \)   B) \( \text{Al} + \text{Br}_2 \rightarrow \text{AlBr}_3 \)
   C) \( \text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}_2 \)   D) \( \text{PCl}_5 \rightarrow \text{PCl}_3 + \text{Cl}_2 \)

8. All chemical reactions have a conservation of
   A) mass, only
   B) mass and charge, only
   C) charge and energy, only
   D) mass, charge, and energy

9. Given the incomplete equation for the combustion of ethane:
   \[ 2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + \text{_____} \]
   What is the formula of the missing product?
   A) CH\text{3OH}   B) H\text{COOH}
   C) H\text{2O}   D) H\text{2O}_2

10. Which chemical equation is correctly balanced?
    A) \( \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g}) \)
    B) \( \text{N}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{NH}_3(\text{g}) \)
    C) \( 2\text{NaCl}(\text{s}) \rightarrow \text{Na}(\text{s}) + \text{Cl}_2(\text{g}) \)
    D) \( 2\text{KCl}(\text{s}) \rightarrow 2\text{K}(\text{s}) + \text{Cl}_2(\text{g}) \)

11. Given the unbalanced equation:
    \[ \text{_____Fe}_2\text{O}_3 + \text{_____CO} \rightarrow \text{_____Fe} + \text{_____CO}_2 \]
    When the equation is correctly balanced using the \textit{smallest} whole-number coefficients, what is the coefficient of CO?
    A) 1   B) 2   C) 3   D) 4
12. Given the unbalanced equation:

\[ \text{___ Al + ___ CuSO}_4 \rightarrow \text{___ Al}_2(\text{SO}_4)_3 + \text{___ Cu} \]

When the equation is balanced using the smallest whole-number coefficients, what is the coefficient of Al?

A) 1  B) 2  C) 3  D) 4

13. Given the unbalanced equation:

\[ \text{___ Mg(ClO}_3)_2(\text{s)} \rightarrow \text{___ MgCl}_2(\text{s}) + \text{___ O}_2(\text{g)} \]

What is the coefficient of O\(_2\) when the equation is balanced correctly using the smallest whole number coefficients?

A) 1  B) 2  C) 3  D) 4

Types of Reactions

<table>
<thead>
<tr>
<th>Equation</th>
<th>Reactant(s)</th>
<th>Product(s)</th>
<th>Type of Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [ \text{Cl}_2 + 2\text{NaI} \rightarrow 2\text{NaCl} + \text{I}_2 ]</td>
<td>Cl(_2) and NaI</td>
<td>NaCl and I(_2)</td>
<td>Single replacement</td>
</tr>
<tr>
<td>b. [ \text{HNO}_3 + \text{LiOH} \rightarrow \text{H}_2\text{O} + \text{LiNO}_3 ]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [ 2\text{NaN}_3 \rightarrow 2\text{Na} + 3\text{N}_2 ]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. [ \text{Ba(NO}_3)_2 + \text{K}_2\text{SO}_4 \rightarrow 2\text{KNO}_3 + \text{BaSO}_4 ]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. [ \text{BaO} + \text{SO}_3 \rightarrow \text{BaSO}_4 ]</td>
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<td></td>
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<tr>
<td>f. [ 2\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe} ]</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>g. [ \text{P}_4 + 6\text{Cl}_2 \rightarrow 4\text{PCl}_3 ]</td>
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</tbody>
</table>
Using TABLE J to predict a Single Replacement Reaction

The higher up on table J the more REACTIVE the metal.

- If the unbonded metal is higher than bonded metal it replaces it.
- If the unbonded metal is lower than the bonded metal no reaction occurs.

Example:

\[ \text{Fe}(s) + \text{CuSO}_4(aq) \rightarrow \text{Cu}(s) + \text{FeSO}_4(aq) \]

Fe (unbounded metal) is higher on table J (more reactive) so it replaces the bonded metal (Cu)

Example:

\[ \text{Cu}(s) + \text{ZnSO}_4(aq) \rightarrow \text{No Reaction} \]

(Copper cannot replace zinc because it is LOWER than ZINC on chart)
### Find the missing substance:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
a. $2 \text{Na} + \text{Br}_2 \rightarrow 2$   |
b. $3 \text{Zn} + 2 \text{Fe(NO}_3\text{)}_3 \rightarrow 3$   + $2\text{Fe}$   |
c. $2 \text{BaO} \rightarrow 2 \text{Ba} + $   |
d. $2 \text{Sc} + 3 \text{CuSO}_4 \rightarrow \text{Sc}_2(\text{SO}_4)_3 + 3$   |
e. $2 \text{NO}_2 \rightarrow $   + $2 \text{O}_2$   |
f. $2$   + $\text{S} \rightarrow \text{L}_2\text{S}$   |
g. $\text{Cu} + 2$   $\rightarrow \text{Cu(NO}_3\text{)}_2 + 2 \text{K}$   |
h. $\text{Mg} + $   $\rightarrow \text{MgCl}_2$   |
i. $2$   $\rightarrow 6 \text{Li} + \text{N}_2$   |
j. $2 \text{Na} + $   $\rightarrow \text{Na}_2\text{CO}_3 + \text{Ca}$   |

### Identify the type of reactions from above:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
a.   | f.   |
b.   | g.   |
c.   | h.   |
d.   | i.   |
e.   | j.   |
Lesson 5: Determining empirical and molecular formulas

**Objective:**
- **Determine the empirical formula from the molecular formula**
- **Determine the molecular formula from the empirical formula**

Below is a list of formulas. Write the empirical formula (if not already empirical) and identify the type of substance & type of bonds inside the substance.

<table>
<thead>
<tr>
<th></th>
<th>Formula</th>
<th>Empirical formula (simplest ratio)</th>
<th>Type of Substance (ionic or covalent)</th>
<th>Type of Bonds (ionic and/or covalent)</th>
<th>Electrons are… (shared and/or transferred)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>C₄H₁₀</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>b.</td>
<td>C₃H₆</td>
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<td></td>
<td></td>
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<tr>
<td>c.</td>
<td>N₂O₄</td>
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<tr>
<td>d.</td>
<td>Na₂SO₄</td>
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<td></td>
<td></td>
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<tr>
<td>e.</td>
<td>C₆H₁₀</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>Al₂O₃</td>
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<tr>
<td>g.</td>
<td>NH₄NO₃</td>
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<tr>
<td>h.</td>
<td>C₁₁H₂₂O₁₁</td>
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<tr>
<td>i.</td>
<td>K₂S₂O₃</td>
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<tr>
<td>j.</td>
<td>S₂O₄</td>
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<td></td>
<td></td>
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<tr>
<td>k.</td>
<td>CH₄</td>
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<tr>
<td>l.</td>
<td>C₆H₁₂Cl₂O₂</td>
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</tbody>
</table>

**Calculate the molecular formula from the empirical**

1. What is the molecular formula of a compound that has a mass of 276 and an empirical formula of NO₂?

2. What is the molecular formula of a compound that has a mass of 56g and an empirical formula of CH₂?
3. What is the molecular formula of a compound that has a mass of 51g and an empirical formula of HO?

4. What is the molecular formula of a compound that has a mass of 289g and an empirical formula of NH$_3$?

5. What is the molecular formula of a compound with a mass of 760g and an empirical formula of Cr$_2$O$_3$?

6. What is the molecular formula of a compound that has a mass of 126g and an empirical formula of SO$_2$?

7. What is the molecular formula of a compound that has a mass of 248g and an empirical formula of NO$_3$?
22. Which pair consists of a molecular formula and its corresponding empirical formula?
   A) C₂H₂ and CH₃
   B) C₆H₆ and C₂H₂
   C) P₄O₁₀ and P₂O₅
   D) SO₂ and SO₃

23. Given the structural formula:
    H₂ H₂ H₂
    H – C – C – C – OH
    H₂ H₂ H₂

   What is the empirical formula of this compound?
   A) CH₃O  B) C₂H₅O
   C) C₆H₁₀O₂  D) C₆H₁₂O₄

24. The molecular formula of glucose is C₆H₁₂O₆. What is the empirical formula of glucose?
   A) CHO  B) CH₂O
   C) C₆H₁₂O₂  D) C₆H₁₂O₁₂

25. Which pair of compounds has the same empirical formula?
   A) C₂H₂ and C₆H₆
   B) C₆H₆ and C₃H₆
   C) CH₃OH and C₂H₅OH
   D) CH₃CHO and CH₃COOH

26. Which pair of formulas correctly represents a molecular formula and its corresponding empirical formula?
   A) C₂H₂ and CH
   B) C₄H₆ and CH₂
   C) C₄H₆ and CH
   D) C₅H₈ and C₂H₂

27. What is the empirical formula of a compound with the molecular formula N₂O₄?
   A) NO  B) NO₂  C) N₂O  D) N₂O₂

28. Which is an empirical formula?
   A) P₂O₅  B) P₄O₆  C) C₂H₄  D) C₂H₆

29. Which formula is an empirical formula?
   A) C₂H₆  B) C₄H₁₀  C) H₂O  D) H₂O₂

30. What is the molecular formula of a compound that has a molecular mass of 54 and the empirical formula C₂H₃?
   A) C₂H₃  B) C₄H₆  C) C₆H₉  D) C₈H₁₂

31. A compound has the empirical formula CH₂O and a gram-formula mass of 60 grams per mole. What is the molecular formula of this compound?
   A) CH₂O  B) C₃H₄O₂  C) C₃H₅O  D) C₄H₆O₄

32. A compound whose empirical formula is NO₃ could have a molecular mass of
   A) 23  B) 39  C) 92  D) 120

33. A compound has a molecular mass of 54 and an empirical formula of C₂H₅. What is the molecular formula of the compound?
   A) C₂H₅  B) C₄H₆  C) C₅H₈  D) C₆H₁₀

34. Which chemical formula is both an empirical formula and a molecular formula?
   A) CH₄  B) C₃H₆
   C) CH₃COOH  D) CH₃(CH₂)COOCH₃

35. The empirical formula of a compound is CH₂. The molecular formula of this compound could be
   A) CH₄  B) C₂H₂  C) C₂H₄  D) C₃H₃

36. A compound contains nitrogen and oxygen in the mole ratio of 1:1. The molecular mass of this compound could be
   A) 14  B) 16  C) 30  D) 40

37. Which list includes three types of chemical reactions?
   A) condensation, double replacement, and sublimation
   B) condensation, solidification, and synthesis
   C) decomposition, double replacement, and synthesis
   D) decomposition, solidification, and sublimation

38. Given the balanced equation:
   2KClO₃ → 2KCl + 3O₂

   What type of reaction is represented by this equation?
   A) synthesis  B) decomposition
   C) single replacement  D) double replacement

39. Given the balanced equation:
   AgNO₃(aq) + NaCl(aq) → NaNO₃(aq) + AgCl(s)

   This reaction is classified as
   A) synthesis  B) decomposition
   C) single replacement  D) double replacement
Lesson 6: Percent Composition

**Objective:**
- Calculate Percent Composition
- Calculate Percent composition of a hydrate

Determine the % composition of all elements in these compounds. Show all work!

1) ammonium sulfite

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<thead>
<tr>
<th>Element</th>
<th>Mass (g)</th>
<th>% Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>_______</td>
<td>%N</td>
</tr>
<tr>
<td>H</td>
<td>_______</td>
<td>%H</td>
</tr>
<tr>
<td>S</td>
<td>_______</td>
<td>%S</td>
</tr>
<tr>
<td>O</td>
<td>_______</td>
<td>%O</td>
</tr>
</tbody>
</table>

2) aluminum acetate

<table>
<thead>
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<th>% Mass</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
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<tr>
<td>H</td>
<td>_______</td>
<td>%H</td>
</tr>
<tr>
<td>O</td>
<td>_______</td>
<td>%O</td>
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</table>

3) sodium bromide

<table>
<thead>
<tr>
<th>Element</th>
<th>Mass (g)</th>
<th>% Mass</th>
</tr>
</thead>
<tbody>
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<td>%Na</td>
</tr>
<tr>
<td>Br</td>
<td>_______</td>
<td>%Br</td>
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</table>

4) copper (II) hydroxide

<table>
<thead>
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<th>% Mass</th>
</tr>
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<tbody>
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<td>%Cu</td>
</tr>
<tr>
<td>O</td>
<td>_______</td>
<td>%O</td>
</tr>
<tr>
<td>H</td>
<td>_______</td>
<td>%H</td>
</tr>
</tbody>
</table>
5) magnesium carbonate

- Formula _______ 
  - Mass of Mg _______ 
  - %Mg _______

- Molar mass _______ 
  - Mass of C _______ 
  - %C _______

  - Mass of O _______ 
  - %O _______

Percent Composition of a Hydrate

1. Determine the percent by mass of water in the following hydrates.
   a. \( \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} \) (GFM = 286 g)
   b. \( \text{MgSO}_4 \cdot 7\text{H}_2\text{O} \) (GFM = 246 g)
   c. \( \text{MgSO}_4 \cdot 7\text{H}_2\text{O} \) (GFM = 246 g)

   b. Initial mass of hydrate: 9.5 g 
      Final mass of anhydrous salt: 3.77 g
   d. Initial mass of hydrate: 5.3 g 
      Final mass of anhydrous salt: 4.1 g

2. If 125 grams of \( \text{BaCl}_2 \cdot 2\text{H}_2\text{O} \) is completely dehydrated, how many grams of anhydrous Barium Chloride will remain?

3. What is the percent composition of water in \( \text{FeCl}_3 \cdot 6\text{H}_2\text{O} \)?
UNIT 6 MOLES REVIEW

MOLES and MOLAR MASS

1. The mole represents $6.02 \times 10^{23}$ particles such as atoms and molecules of any substance. The Molar Mass (aka gram formula mass or molecular mass) is the mass of one mole of a substance. Element’s molar masses are reported on the periodic table. Using formulas on the last page of your reference tables as well as you periodic table you should be able to calculate the mass or moles of any substance.

   a. Calculate the molar mass of the following:

      | Zn  | Li  | Ne |
      |-----|-----|-----|
      | NaCl| KNO₃| Al₂(SO₃)₃ |

   b. Calculate the moles of the following:

      | 23.0 grams Zn | 100.59 grams of Li |
      | 56.8 grams KNO₃ | 250.0 grams of Al₂(SO₃)₃ |

   c. Calculate the mass of the following:

      | 2.00 moles of Zn | 0.025 moles of Ne |
      | 3.50 moles of NaCl | 2.50 \times 10^{-4} moles of KNO₃ |
REATIONS

2. Reactants refer to the substances you start with in a reaction (before the arrow). Products refer to the substances you create in a reaction after the arrow). Coefficients are how many moles of the substance are needed in a reaction. To relate moles of one substance to another, simply create a proportion.

   a. Identify the reactants and products in the reaction below:

      \[ 3\text{CuSO}_4 + 2\text{Fe} \rightarrow 2\text{Fe}_2(\text{SO}_4)_3 + 3\text{Cu} \]

   b. If 3.0 moles of Fe react with excess copper (II) sulfate, how many moles of copper are formed?

   c. If 2.50 moles of Fe\(_2(\text{SO}_4)_3\) are formed, how many moles of copper (II) sulfate are used?

BALANCING and TYPES OF REACTIONS

3. In a reaction, atoms and molecules cannot appear or disappear. Mass must stay constant from the beginning to the end of the reaction. This is known as conservation of mass. In addition, charge and energy must also be conserved. Balance the following:

   a. \[ ___\text{C}_2\text{H}_8 + ___\text{CO}_2 \rightarrow ___\text{H}_2\text{O} + ___\text{CO}_2 \]

   b. \[ ___\text{Li} + ___\text{Ca(NO}_3)_2 \rightarrow ___\text{Li NO}_3 + ___\text{Ca} \]

   c. \[ ___\text{Ca(OH}_2 + ___\text{KCl} \rightarrow ___\text{KOH} + ___\text{CaCl}_2 \]

   d. \[ ___\text{N}_2 + ___\text{H}_2 \rightarrow ___\text{NH}_3 \]

   e. \[ ___\text{H}_2\text{O} \rightarrow ___\text{H}_2 + ___\text{O}_2 \]

4. Types of Reactions include:

   - Synthesis: \[ \text{A} + 2\text{B} \rightarrow \text{AB}_2 \]
   - Decomposition: \[ \text{AB}_2 \rightarrow \text{A} + 2\text{B} \]
   - Combustion: \[ \text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]
   - Single Replacement: \[ \text{AB} + \text{C} \rightarrow \text{CB} + \text{A} \]
   - Double Replacement: \[ \text{AB} + \text{CD} \rightarrow \text{AD} + \text{CB} \]

Identify the types of reactions in question 3.
FORMULAS

5. Empirical formula refers to any molecular formula in its reduced form. Molecular Formulas are some multiple of the empirical formula. To find molecular formulas: Find the mass of the empirical formula. Divide the mass given by the empirical mass. Distribute your answer through the empirical formula.

a. Find the empirical formula of the following:

\[
\text{N}_2\text{H}_4 \hspace{2cm} \text{N}_3\text{O}_9 \hspace{2cm} \text{C}_4\text{H}_8 \hspace{2cm} \text{P}_2\text{O}_5
\]

b. Find the molecular formula of a substance with a mass of 26.0 grams and an empirical formula of CH.

PERCENT COMPOSITION

6. Percent composition formula is on the last page of the reference tables.

a. Find the percent of C in the following:

\[
\text{C}_4\text{H}_8 \hspace{2cm} \text{CO}_2
\]

b. Find the percent composition of water in CuNO\textsubscript{3} \cdot 5\text{H}_2\text{O}

c. A 5.43 gram sample of hydrated crystal is heated to a constant mass of 3.41 grams. This means all of the water has been evaporated (lost) by the heat. Calculate the percent composition of water in the hydrate.