Lesson 13: Ionic Equations & Intro to the Mole with Conversions

Box 1:

Balance:
1. $2\text{Mg} + 1\text{O}_2 \rightarrow 2\text{MgO}$
2. $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$
3. $2\text{C}_2\text{H}_6 + 5\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$

Write and balance the equation that represents the chemical reaction:
4. Aluminum sulfate, an ingredient used in water treatment, is made by the reaction of solid aluminum oxide with aqueous sulfuric acid ($\text{H}_2\text{SO}_4$). In addition to aqueous aluminum sulfate, water is also produced.

$$\text{A}_2\text{O}_3(\text{s}) + 3\text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{A}_2(\text{SO}_4)_3(\text{aq}) + 3\text{H}_2\text{O}(\text{l})$$

Complete Ionic equations

About 71 percent of the Earth's surface is water-covered, so it makes sense that many chemical reactions occur in water.

When ions are involved in these reactions, the chemical reactions equations may be written with different levels of detail.

Think about a reaction between ionic compounds taking place in an aqueous solution. When aqueous solutions of calcium chloride and silver nitrate are mixed, a reaction takes place producing aqueous calcium nitrate and solid silver chloride.

$$\text{CaCl}_2(\text{aq}) + 2\text{AgNO}_3(\text{aq}) \rightarrow \text{Ca(NO}_3)_2(\text{aq}) + 2\text{AgCl}(\text{s})$$

Molecular equation: Doesn't explicitly describe the ions in solution

When ionic compounds dissolve in water, they dissociate into ions. The ions are dispersed homogenously throughout the resulting solution.

Explicitly representing all dissolved ions results in a complete ionic equation.

$$\text{CaCl}_2(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq})$$
$$2\text{AgNO}_3(\text{aq}) \rightarrow 2\text{Ag}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq})$$
In the total ionic equations, all dissolved salts (in aqueous phase) are written as ions.

Write the following molecular equations as total ionic equations:

\[ 2 \text{Na}_3\text{PO}_4 \text{(aq)} + 3 \text{CaCl}_2 \text{(aq)} \rightarrow 6 \text{NaCl} \text{(aq)} + \text{Ca}_3(\text{PO}_4)_2 \text{(s)} \]

\[ 6 \text{Na}^+ \text{(aq)} + 2 \text{PO}_4^{3-} \text{(aq)} + 3 \text{Ca}^{2+} \text{(aq)} + 6 \text{Cl}^- \text{(aq)} \rightarrow 6 \text{Na}^+ \text{(aq)} + 6 \text{Cl}^- \text{(aq)} + \text{Ca}_3(\text{PO}_4)_2 \text{(s)} \]

\[ \text{NaCl} \text{(aq)} + \text{AgNO}_3 \text{(aq)} \rightarrow \text{NaNO}_3 \text{(aq)} + \text{AgCl} \text{(s)} \]

\[ \text{Na}^+ \text{(aq)} + \text{Cl}^- \text{(aq)} + \text{Ag}^{+} \text{(aq)} + \text{NO}_3^- \text{(aq)} \rightarrow \text{Na}^+ \text{(aq)} + \text{NO}_3^- \text{(aq)} + \text{AgCl} \text{(s)} \]

BTW: Not all ionic compounds dissolve in water (a later lesson).

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**Formula and Molecular Masses:**

= sum the *average atomic masses* of all the atoms in the compound’s formula (in amu)

!!! VOCABULARY ALERT!!! “molecular mass” is used for molecules (covalent bonds) while “formula mass” is used for ionic compounds, since the ionic empirical formula does not accurately represent the number of atoms in the compound.

Calculate the molecular or formula mass of each (in amu):

1. \( \text{P}_4 \)

\[ 30.97 \text{amu} \times 4 = 123.88 \text{amu} \]

2. \( \text{H}_2\text{O} \)

\[ (1.008 \text{amu} \times 2) + 16.00 \text{amu} = 18.016 \text{amu} \]

3. \( \text{Ca(NO}_3)_2 \)

\[ 40.08 \text{amu} + (14.01 \text{amu} \times 2) + (16.00 \text{amu} \times 6) = 164.1 \text{amu} \]
4. \[\text{H}-\text{C}≡\text{C}-\text{H}\]

\[(12.01 \text{ amu} \times 2) + (1.008 \text{ amu} \times 2) = 26.036 \text{ amu}\]

5. \[
\begin{array}{c}
\text{Cl} \\
\text{C}≡\text{O} \\
\text{Cl}
\end{array}
\]

\[12.01 \text{ amu} + 16.00 \text{ amu} + (35.45 \text{ amu} \times 2) = 98.91 \text{ amu}\]

**Box 2: Write and balance the equation that represents the chemical reaction:**

The white paste that some lifeguards run on their noses to prevent sunburn contains the active ingredient zinc oxide. Zinc oxide is made by reacting solid zinc sulfide with oxygen gas. Sulfur dioxide gas is also produced.

Nitrogen dioxide gas reacts with liquid water to form aqueous nitric acid (HNO₃) and nitrogen monoxide gas. When aqueous solutions of sulfuric acid and barium chloride are mixed, barium sulfate precipitates from an aqueous solution of hydrochloric acid.

**Box 3: Calculate the formula or molecular mass of each compound.**

Ibuprofen, C₁₃H₁₈O₂, is a covalent compound and the active ingredient in several popular nonprescription pain medications, such as Advil and Motrin. What is the molecular mass (amu) for this compound?

Acetaminophen, C₇H₁₀N₉O₂, is a covalent compound and the active ingredient in several popular nonprescription pain medications, such as Tylenol. What is the molecular mass (amu) for this compound?
The Mole

- The Mole
  a. Is the SI unit for amount of substance
  b. Is a counting unit

c. The Mole is defined as the amount of substance that contains as many particles as there are atoms in exactly 12 g of carbon-12.
d. 1 mole of any element contains the same number of atoms as 1 mole of any other element

- Avogadro’s Number = number of entities (things) in a mole

1 mole = $6.022 \times 10^{23}$

Practice Avogadro’s number:

1 mole of gumballs = $\frac{6.022 \times 10^{23}}{}$ gumballs

1 mole of Na+ ions = $\frac{6.022 \times 10^{23}}{}$ ions

1 mole of N$_2$ = $\frac{2 \times (6.022 \times 10^{23})}{1.2044 \times 10^{24}}$ atoms of N

* because 1 molecule of N$_2$ = 2 atoms.
- Molar Mass

- Molar mass of an element (or compound) is the mass in grams of 1 mol of a substance.
- Expressed in units of grams/mole or g/mol.
- Numerically equivalent to the average atomic mass of elements.
- Molecular/formula mass of molecules/salts.

<table>
<thead>
<tr>
<th></th>
<th>H</th>
<th>Be</th>
<th>F</th>
<th>Cd</th>
<th>Pb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.008</td>
<td>9.012</td>
<td>19.00</td>
<td>112.4</td>
<td>207.2</td>
</tr>
</tbody>
</table>

Practice: Don’t forget units!

1. What is the molar mass?
   - Be \(9.012 \text{ g/mol}\)
   - F \(19.00 \text{ g/mol}\)
   - Cd \(112.4 \text{ g/mol}\)
   - Pb \(207.2 \text{ g/mol}\)

2. If I have one mole of Be atoms, I have \(6.022 \times 10^{23}\) atoms.

3. What is the mass of \(6.022 \times 10^{23}\) Be atoms? \(9.012 \text{ g}\)

4. What is the mass of one mole of Pb atoms? \(207.2 \text{ g}\)

5. How many moles are in exactly 56.2 g of Cadmium? \(0.5 \text{ mol}\)

6. What is the molar mass of hydrogen fluoride, HF? \(20.018 \text{ g/mol}\)

   \[
   \frac{1.008 \text{ g/mol} + 19.00 \text{ g/mol}}{4 + 1} = 20.018 \text{ g/mol}
   \]

Relating Mass to the Number of Atoms:

<table>
<thead>
<tr>
<th>Mass of element in grams</th>
<th>convert</th>
<th>Amount of element in moles</th>
<th>convert</th>
<th>Number of atoms of element</th>
</tr>
</thead>
<tbody>
<tr>
<td>convert Molar Mass grams/mole</td>
<td>Avo's # particles/mole</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Practice: Calculate Molar Mass

1. Calculate the molar mass of $\text{S}_8$.
   \[ 32.06 \text{ g/mol} \times 8 = 256.48 \text{ g/mol} \]

2. Calculate the molar mass of $\text{C}_6\text{H}_{12}$.
   \[ (12.01 \text{ g/mol} \times 5) + (1.008 \text{ g/mol} \times 12) = 72.146 \text{ g/mol} \]

3. Calculate the molar mass of silver sulfate.
   \[ \text{Ag}_2\text{SO}_4 \]
   \[ (107.87 \text{ g/mol} \times 2) + 32.06 \text{ g/mol} + (16.00 \text{ g/mol} \times 4) = 311.8 \text{ g/mol} \]

PRACTICE MOLE CONVERSIONS:

Molar mass can be used as a conversion factor to convert between _______ grams and _______ moles.

Avogadro’s number can be used as a conversion factor to convert between _______ moles and _______ number of particles.

CONVERT MOLES → GRAMS (1 step)

Use molar mass as the conversion factor.

1. What is the mass in grams of 2.25 mol of the element iron, Fe?
   \[
   \frac{2.25 \text{ mol Fe}}{1} \times \frac{55.85 \text{ g Fe}}{1 \text{ mol Fe}} = 125.6625 = 12.6 \text{ g Fe}
   \]

2. What is the mass in grams of 0.0135 mol of the element sodium, Na?
   \[
   \frac{0.0135 \text{ mol Na}}{1} \times \frac{22.99 \text{ g Na}}{1 \text{ mol Na}} = 0.310365 = 0.310 \text{ g Na}
   \]

3. A liter of air contains $9.2 \times 10^{-4}$ mol argon. What is the mass of Ar in a liter of air?
   \[
   \frac{9.2 \times 10^{-4} \text{ mol Ar}}{1} \times \frac{39.95 \text{ g Ar}}{1 \text{ mol Ar}} = 0.036754 = 0.037 \text{ g Ar}
   \]
Box 4:

1. What is the mass of 0.0146 mol KOH?

2. What is the mass of 10.2 mol ethane, C₂H₆?

3. Vitamin C is a covalent compound with the molecular formula C₆H₈O₆. The recommended daily dietary allowance of vitamin C for children aged 4–8 years is 1.42 x 10⁻⁴ mol. What is the mass of this allowance in grams?

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CONVERT GRAMS → MOLES (1 step)

Use \( \text{molar mass} \) as the conversion factor.

1. How many moles of Calcium, Ca, are in 5.00 grams of calcium?

\[
\frac{5.00 \text{ g Ca}}{1} \times \frac{1 \text{ mol Ca}}{40.08 \text{ g Ca}} = 0.124750 = 0.125 \text{ mol Ca}
\]

2. How many moles of molecules are in 25.0 g of propylene, C₃H₆?

\[
\frac{25.0 \text{ g C}_2\text{H}_6}{1} \times \frac{1 \text{ mol C}_2\text{H}_6}{42.078 \text{ g C}_2\text{H}_6} = 0.594135 = 0.594 \text{ mol C}_2\text{H}_6
\]

3. How many moles of molecules are in 25 lb of the herbicide Treflan, C₁₃H₁₈N₂O₄F? (1 lb = 454 g)

\[
\frac{25 \text{ lb}}{1} \times \frac{454 \text{ g}}{11b} \times \frac{1 \text{ mol}}{283.278 \text{ g mol}} = 40.0666 \text{ mol Treflan}
\]
4. How many moles of atoms are in 50.2 grams of oxygen gas?

\[
\frac{50.2 \text{ g} \text{ O}_2}{1} \times \frac{1 \text{ mol} \text{ O}_2}{32.00 \text{ g} \text{ O}_2} = 1.56875 = 1.57 \text{ mol } \text{O}_2
\]

5. Our bodies synthesize protein from amino acids. One of these amino acids is glycine, which has the molecular formula C₂H₅O₂N. How many moles of glycine molecules are contained in 28.35 g of glycine?

\[
(12.01 \text{ g/mol} \times 2) + (1.008 \text{ g/mol} \times 5) + (16.00 \text{ g/mol} \times 2) + 14.01 \text{ amu} = 75.07 \text{ g/mol}
\]

\[
\frac{28.35 \text{ g glycine}}{1} \times \frac{1 \text{ mol glycine}}{75.07 \text{ g glycine}} = 0.3776 \text{ mol glycine}
\]

**CONVERT PARTICLES (ATOMS OR MOLECULES) \rightarrow MOLES (1 step)**

Use Avogadros number as the conversion factor.

1. How many moles are of lead, Pb, are in \(1.50 \times 10^{12}\) atoms of lead?

\[
\frac{1.50 \times 10^{12} \text{ atoms Pb}}{1} \times \frac{1 \text{ mol Pb}}{6.022 \times 10^{23} \text{ atoms Pb}} = 2.49 \times 10^{-12} \text{ mol Pb}
\]

2. How many moles of water molecules are in \(2.01 \times 10^{25}\) molecules of water?

\[
\frac{2.01 \times 10^{25} \text{ molec H}_2\text{O}}{1} \times \frac{1 \text{ mol H}_2\text{O}}{6.022 \times 10^{23} \text{ molec H}_2\text{O}} = 33.4 \text{ mol H}_2\text{O}
\]

3. How many moles of oxygen atoms are in \(2.01 \times 10^{25}\) molecules of water?

\[
\frac{2.01 \times 10^{25} \text{ molec H}_2\text{O}}{1} \times \frac{1 \text{ mol H}_2\text{O}}{6.022 \times 10^{23} \text{ molec H}_2\text{O}} \times \frac{1 \text{ mol O atoms}}{1 \text{ mol H}_2\text{O molec}} = 33.4 \text{ mol O atoms}
\]

4. How many moles of tin, Sn, are in 2500 atoms of tin?

\[
\frac{2500 \text{ atoms Sn}}{1} \times \frac{1 \text{ mol Sn}}{6.022 \times 10^{23} \text{ atoms Sn}} = 4.2 \times 10^{21} \text{ mol Sn}
\]
CONVERT MOLES → PARTICLES (ATOMS OR MOLECULES) (1 step)

Use _Avogadro's number_ as the conversion factor.

1. How many atoms of aluminum, Al, are in 2.75 mol of aluminum?
\[
\frac{2.75 \text{ mol Al}}{1} \times \frac{6.022 \times 10^{23} \text{ atoms Al}}{1 \text{ mol Al}} = 1.66 \times 10^{24} \text{ atoms Al}
\]

2. How many atoms of carbon are in 0.128 mol of carbon?
\[
\frac{0.128 \text{ mol C}}{1} \times \frac{6.022 \times 10^{23} \text{ atoms C}}{1 \text{ mol C}} = 7.71 \times 10^{22} \text{ atoms C}
\]

3. How many atoms of hydrogen are in 1.99 mol of methane (CH₄)?
\[
\frac{1.99 \text{ mol CH₄}}{1} \times \frac{6.022 \times 10^{23} \text{ molec CH₄}}{1 \text{ mol CH₄}} \times \frac{4 \text{ atoms H}}{1 \text{ molec CH₄}} = 4.79 \times 10^{24} \text{ atoms H}
\]

Mass – Mole – Particle Conversions

Conversion factors can be used in sequence to directly convert between masses and the number of particles.

**EXAMPLE:**

\[
\frac{615.58 \text{ g Na}_2\text{CO}_3}{1} \times \frac{1 \text{ mole Na}_2\text{CO}_3}{105.99 \text{ g Na}_2\text{CO}_3} \times \frac{6.022 \times 10^{23} \text{ compounds Na}_2\text{CO}_3}{1 \text{ mole Na}_2\text{CO}_3} =
\]

- Molar mass (Periodic table)
- Definition of a mole
CONVERT GRAMS → PARTICLES (ATOMS OR MOLECULES) (2-steps)

Use \textbf{molecular mass}, then \textbf{Avogadro's #} as the conversion factors.

1. Copper is commonly used to fabricate electrical wire. How many copper atoms are in 5.00 g of copper wire?
   \[ \frac{5.00 \text{ g Cu}}{1 \text{ mol Cu}} \times \frac{1 \text{ mol Cu}}{63.55 \text{ g Cu}} \times \frac{6.022 \times 10^{23} \text{ atoms Cu}}{1 \text{ mol Cu}} = \frac{4.74 \times 10^{22} \text{ atoms Cu}}{} \]

2. A packet of an artificial sweetener contains 40.0 mg of saccharin (C7H5NO3S), which has the structural formula:

   Given that saccharin has a molar mass of 183.18 g/mol, how many saccharin molecules are in a 40.0-mg (0.0400-g) sample of saccharin? How many carbon atoms are in the same sample?
   \[ \frac{0.0400 \text{ g sac}}{1 \text{ mol sac}} \times \frac{1 \text{ mol sac}}{183.18 \text{ g sac}} \times \frac{6.022 \times 10^{23} \text{ molec. sac}}{1 \text{ mol sac}} = \frac{1.31 \times 10^{20} \text{ molec. saccharin}}{} \]
   \[ \frac{1.3149 \times 10^{-2} \text{ molec. sac}}{1 \text{ molec. sac}} \times \frac{7 \text{ atoms C}}{1 \text{ molec. sac}} = \frac{9.20 \times 10^{20} \text{ atoms carbon}}{} \]

3. How many atoms of Cl are there in 4.56 g ClO3?
   \[ \frac{4.56 \text{ g ClO}_3}{1 \text{ mol ClO}_3} \times \frac{1 \text{ mol ClO}_3}{159.8 \text{ g ClO}_3} \times \frac{2 \text{ atoms O}}{1 \text{ mol ClO}_3} = \frac{3.44 \times 10^{22} \text{ atoms Cl}}{} \]

CONVERT PARTICLES → GRAMS (2-steps)

Use \textbf{Avogadro's #}, then \textbf{molar mass} as the conversion factors.

1. What is the mass in grams of \(3.22 \times 10^{33}\) molecules of \(\text{H}_2\text{O}\)?
   \[ \frac{3.22 \times 10^{33} \text{ molec H}_2\text{O}}{1} \times \frac{1 \text{ mol H}_2\text{O}}{6.022 \times 10^{23} \text{ molec H}_2\text{O}} \times \frac{18.016 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \frac{9.63 \times 10^{10} \text{ g H}_2\text{O}}{} \]
2. What is the mass in grams of $4.9 \times 10^{45}$ atoms of S?

\[
\frac{4.9 \times 10^{45}}{\text{atoms S}} \times \frac{1}{6.022 \times 10^{23}} \frac{\text{mol S}}{\text{atoms S}} \times \frac{32.06}{1 \text{ mol S}} = 2.6 \times 10^{23} \text{ g S}
\]

3. How many grams of CaCO$_3$ are there if you have $1.00 \times 10^{43}$ molecules of CaCO$_3$?

\[
\frac{1.00 \times 10^{43}}{\text{f.u. CaCO}_3} \times \frac{1}{6.022 \times 10^{23}} \frac{\text{mol CaCO}_3}{\text{f.u. CaCO}_3} \times \frac{100.09}{1 \text{ mol CaCO}_3} = 1.66 \times 10^{24} \text{ g CaCO}_3
\]
Reading Formula Equations by Formula Units, Mole Quantities, and Mass

Introduction:
Chemical equations show relative amounts, masses, and progression of chemical reactions. The relative masses of the reactants and products of a chemical reaction can be determined from the reaction's coefficients. Coefficients represent the smallest possible relative amounts of the reactants and products.

\[ \text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr} \]

*One molecule of hydrogen and one molecule of bromine react to form 2 molecules of HBr.*

**Ratio:** 1 molecule of H₂ : 1 molecule of Br₂ : 2 molecules of HBr

To obtain larger relative amounts, multiply each coefficient by the same number. So, 30 molecules of hydrogen and 30 molecules of bromine react to form 60 molecules of hydrogen bromide. The reaction can also be considered in terms of moles.

*One mole of hydrogen and one mole of bromine react to form 2 moles of HBr.*

**Ratio:** 1 mole of H₂ : 1 mole of Br₂ : 2 moles of HBr

Remember, the amount of an element or compound in moles can be converted to a mass in grams by multiplying by the appropriate molar mass.

\[
\begin{align*}
H &= 1.008 \text{ g/mol}, \text{ so } H_2 = 2 \text{ g/mol} \\
Br &= 79.90 \text{ g/mol}, \text{ so } Br_2 = 160 \text{ g/mol} \\
HBr &= 2 \text{ g/mol} + 160 \text{ g/mol} = 162 \text{ g/mol}
\end{align*}
\]

**Ratio:** 2 grams of H₂ : 160 grams of Br₂ : 162 grams of HBr

**Example #1**

Formula equation: \(2 \text{NaBr} + \text{Cl}_2 \rightarrow 2 \text{NaCl} + \text{Br}_2\)

**How to read this equation by formula units:** "2 formula units of sodium bromide react with 1 molecule of chlorine to form 2 formula units of sodium chloride and 1 molecule of bromine."

**How to read this equation by mole quantities:** "2 moles of sodium bromide react with 1 mole of chlorine to form 2 moles of sodium chloride and 1 mole of bromine."

**How to read this equation by mass:** "206 g of sodium bromide react with 71 g of chlorine to form 117 g of sodium chloride and 160 g bromine."

\[
\begin{align*}
\frac{2 \text{ moles NaBr}}{1} \times \frac{102.89 \text{ g NaBr}}{1 \text{ mole NaBr}} &= \approx 206 \text{ g NaBr} \\
\frac{1 \text{ mole } \text{Cl}_2}{1} \times \frac{70.9 \text{ g } \text{Cl}_2}{1 \text{ mole } \text{Cl}_2} &= \approx 71 \text{ g Cl}_2 \\
\frac{1 \text{ mole Br}_2}{1} \times \frac{159.8 \text{ g Br}_2}{1 \text{ mole Br}_2} &= \approx 160 \text{ g Br}_2 \\
\frac{2 \text{ moles NaCl}}{1} \times \frac{58.44 \text{ g NaCl}}{1 \text{ mole NaCl}} &= \approx 117 \text{ g Br}_2
\end{align*}
\]

Molar masses (rounded):

\[
\begin{align*}
\text{Na} &= 22.99 \text{ g/mol} \\
\text{Br} &= 79.90 \text{ g/mol} \\
\text{Cl} &= 35.45 \text{ g/mol}
\end{align*}
\]
Example #2

Formula equation: \( 2 \text{Na} + 2 \text{H}_2\text{O} \rightarrow 2 \text{NaOH} + \text{H}_2 \)

How to read this equation by formula units: "2 atoms of sodium react with 2 molecules of water to form 2 formula units of sodium hydroxide and 1 molecule of hydrogen."

How to read this equation by mole quantities: "2 moles of sodium react with 2 moles of water to form 2 moles of sodium hydroxide and 1 mole of hydrogen."

How to read this equation by mass: "46 grams of sodium react with 36 grams of water to form 80 grams of sodium hydroxide and 2 grams of hydrogen."

**REMEMBER: "formula units" for ionic compounds and "molecules" for covalent compounds.**

**DIRECTIONS:** First, balance the formula equations given below. Then, write captions for the reactions, considering formula units, molar quantities, and mass.

1. \( 2 \text{AgNO}_3 + 2 \text{CaBr}_2 \rightarrow 2 \text{AgBr} + 2 \text{Ca(NO)}_3 \text{2} \)

   - Reading by formula units:

   
   
   

   - Reading by mole quantities:

   
   
   

   - Reading by mass:

   
   
   

2. \( 2 \text{Ca} + 2 \text{H}_2\text{O} \rightarrow 2 \text{Ca(OH)}_2 + \text{H}_2 \)

   - Reading by formula units:

   
   
   

   - Reading by mole quantities:

   
   
   

   - Reading by mass:

   
   
   

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Box 7:

First, balance the formula equations given below. Then, write captions for the reactions, considering formula units, molar quantities, and mass.

$$\Box C_4H_{10} + \Box O_2 \rightarrow \Box CO_2 + \Box H_2O$$

**Balancing Order:** First C, then H, then O. Use a fractional coefficient to balance O_2. Then multiply all coefficients by the denominator so all coefficients are the smallest-ratio whole number.

Reading by **formula units:**

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Reading by **moles:**

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

How many grams are there in 2 moles of NaCl?

Box 8