Stoichiometric Conversions Worksheet

Use this worksheet for:

Convert

<table>
<thead>
<tr>
<th>Substance A</th>
<th>Substance B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moles, mass, volume, or number of particles</td>
<td>Moles, mass, volume, or number of particles</td>
</tr>
</tbody>
</table>

Procedure:

First identify the given quantity. This will be a given amount of moles, grams, liters, or particles.

1. **Convert to moles.** If the given quantity is in grams, liters or particles, convert to moles.

2. **Use the mole ratio from the coefficients in the balanced chemical equation to convert from moles of the given substance to moles of the substance you need.**

3. Convert moles of the substance you need to grams, liters or particles, depending on what the question asks for.

### Converting between to moles from moles

<table>
<thead>
<tr>
<th></th>
<th>to moles</th>
<th>from moles</th>
</tr>
</thead>
<tbody>
<tr>
<td>grams and moles: use molar mass (add up masses from periodic table)</td>
<td>$\frac{1 \text{ mol}}{\text{XX} \cdot \text{X g}}$</td>
<td>$\frac{\text{XX} \cdot \text{X g}}{\text{mol}}$</td>
</tr>
<tr>
<td>liters and moles of a gas at STP</td>
<td>$\frac{1 \text{ mol}}{22.4 \text{ L}}$</td>
<td>$\frac{22.4 \text{ L}}{\text{mol}}$</td>
</tr>
<tr>
<td>particles and moles (particles are atoms, molecules or formula units)</td>
<td>$\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ particles}}$</td>
<td>$\frac{6.02 \times 10^{23} \text{ particles}}{\text{mol}}$</td>
</tr>
</tbody>
</table>

**Example:**

$$2\text{C(s) + O}_2\text{(g) → 2CO}_2\text{(g)}$$

How many grams of oxygen gas are required to react completely with 48 g of carbon?

**Step 1:** How many moles is 48 grams of carbon? (convert 48 grams of carbon to moles of carbon).

$$48 \text{ g C} \times \frac{1 \text{ mol C}}{12 \text{ g C}} = 4.0 \text{ mol C}$$

**Step 2:** Convert moles carbon to moles oxygen gas. Use coefficients from balanced equation.

$$4.0 \text{ mol C} \times \frac{1 \text{ mol O}_2}{2 \text{ mol C}} = 2.0 \text{ mol O}_2$$

**Step 3:** What is the mass of 2.0 moles of oxygen gas at STP? (convert moles oxygen gas to grams oxygen gas).

$$2.0 \text{ mol O}_2 \times \frac{32 \text{ g O}_2}{\text{mol O}_2} = 64 \text{ g O}_2$$

You can also perform the entire calculation in one setup.

$$48 \text{ g C} \times \frac{1 \text{ mol C}}{12.0 \text{ g C}} \times \frac{1 \text{ mol O}_2}{2 \text{ mol C}} \times \frac{32 \text{ g O}_2}{\text{mol O}_2} = 64 \text{ g O}_2$$

**Problems:**
Set up all problems neatly and show which units cancel!

1. For the reaction \[ 2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 \], what is the volume at STP of hydrogen gas produced when 69 grams of sodium react with water?

   a. Step 1: How many moles is 69 g Na?

   \[
   69 \text{ g Na} \times \frac{1 \text{ mol Na}}{23.0 \text{ g Na}} = 3.0 \text{ mol Na}
   \]

   b. Step 2: How many moles of hydrogen gas are produced from the number of moles of sodium calculated above?

   \[
   3.0 \text{ mol Na} \times \frac{1 \text{ mol H}_2}{2 \text{ mol Na}} = 1.5 \text{ mol H}_2
   \]

   c. Step 3: What is the volume at STP of hydrogen gas produced?

   \[
   1.5 \text{ mol H}_2 \times \frac{22.4 \text{ L H}_2}{\text{mol H}_2} = 34 \text{ L H}_2
   \]

   d. Show this calculation in one setup.

   \[
   69 \text{ g Na} \times \frac{1 \text{ mol Na}}{23.0 \text{ g Na}} \times \frac{1 \text{ mol H}_2}{2 \text{ mol Na}} \times \frac{22.4 \text{ L H}_2}{\text{mol H}_2} = 34 \text{ L H}_2
   \]

2. In the reaction \[ 3\text{CuSO}_4 + 2\text{Al} \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{Cu} \], how many moles of copper will be produced from 2 moles of aluminum?

   \[
   2 \text{ mol Al} \times \frac{3 \text{ mol Cu}}{2 \text{ mol Al}} = 3 \text{ mol Cu}
   \]

3. In the reaction \[ 2\text{FeBr}_3 + 3\text{Cl}_2 \rightarrow 2\text{FeCl}_3 + 3\text{Br}_2 \], how many moles of FeCl_3 will be produced from 6 moles of Cl_2?

   \[
   6 \text{ mol Cl}_2 \times \frac{2 \text{ mol FeCl}_3}{3 \text{ mol Cl}_2} = 4 \text{ mol FeCl}_3
   \]

4. For the reaction of problem 3, how many grams of bromine are produced from each mole of FeBr3?

   \[
   1 \text{ mol FeBr}_3 \times \frac{3 \text{ mol Br}_2}{2 \text{ mol FeBr}_3} \times \frac{159.8 \text{ g Br}_2}{\text{mol Br}_2} = 239.7 \text{ g Br}_2
   \]

5. For the reaction of problem 3, how many moles of chlorine gas are required to produce 145 g of FeCl_3?

   \[
   145 \text{ g FeCl}_3 \times \frac{\text{mol FeCl}_3}{162.2 \text{ g FeCl}_3} \times \frac{3 \text{ mol Cl}_2}{2 \text{ mol FeCl}_3} = 1.34 \text{ mol Cl}_2
   \]
6. From the reaction $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$, how many grams of iron oxide ($\text{Fe}_2\text{O}_3$) are produced when 111 grams of iron ($\text{Fe}$) rusts?

$$111 \text{ g Fe} \times \frac{1 \text{ mol Fe}}{55.85 \text{ g Fe}} \times \frac{2 \text{ mol Fe}_2\text{O}_3}{4 \text{ mol Fe}} \times \frac{159.7 \text{ g Fe}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3} = 159 \text{ g Fe}_2\text{O}_3$$

7. For the reaction $3\text{BaCl}_2 + 2\text{Na}_3\text{PO}_4 \rightarrow \text{Ba}_3(\text{PO}_4)_2 + 6\text{NaCl}$, what mass of barium chloride is needed to react completely with 46.8 g of sodium phosphate?

$$46.8 \text{ g Na}_3\text{PO}_4 \times \frac{1 \text{ mol Na}_3\text{PO}_4}{163.9 \text{ g Na}_3\text{PO}_4} \times \frac{3 \text{ mol BaCl}_2}{2 \text{ mol Na}_3\text{PO}_4} \times \frac{208.2 \text{ g BaCl}_2}{1 \text{ mol BaCl}_2} = 89.2 \text{ g BaCl}_2$$

8. Hydrogen gas reacts with oxygen gas to form water. At STP, how many liters of hydrogen gas react with 32.45 liter of oxygen gas?

$$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \quad 32.45 \text{ L O}_2 \times \frac{2 \text{ L H}_2}{1 \text{ L O}_2} = 64.90 \text{ L H}_2$$

9. Lithium hydroxide (LiOH) is used in spacecraft to remove exhaled carbon dioxide from the air. The lithium hydroxide reacts with carbon dioxide to produce lithium carbonate ($\text{Li}_2\text{CO}_3$) and water. How many grams of carbon dioxide can be absorbed from each gram of lithium hydroxide?

$$2\text{LiOH} + \text{CO}_2 \rightarrow \text{Li}_2\text{CO}_3 + \text{H}_2\text{O} \quad 1 \text{ g LiOH} \times \frac{1 \text{ mol LiOH}}{23.9 \text{ g LiOH}} \times \frac{1 \text{ mol CO}_2}{2 \text{ mol LiOH}} \times \frac{44.01 \text{ g CO}_2}{1 \text{ mol CO}_2} = 0.921 \text{ g CO}_2$$

10. If 3.0 L of methane gas ($\text{CH}_4$) are burned, what volume of carbon dioxide at STP will be produced?

$$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \quad 3.0 \text{ L CH}_4 \times \frac{1 \text{ L CO}_2}{1 \text{ L CH}_4} = 3.0 \text{ L CO}_2$$

11. Given the reaction $3\text{NO}_2(\text{g}) + \text{H}_2\text{O}(\ell) \rightarrow 2\text{HNO}_3(\text{aq}) + \text{NO}(\text{g})$, how many grams of nitric acid ($\text{HNO}_3$) are produced from 10.0 L of NO$_2$?

$$10.0 \text{ L NO}_2 \times \frac{1 \text{ mol NO}_2}{22.4 \text{ L NO}_2} \times \frac{2 \text{ mol HNO}_3}{3 \text{ mol NO}_2} \times \frac{63.0 \text{ g HNO}_3}{1 \text{ mol HNO}_3} = 18.8 \text{ g HNO}_3$$

12. From the reaction $\text{NH}_3 + 2\text{O}_2 \rightarrow \text{HNO}_3 + \text{H}_2\text{O}$, how many moles, grams, liters at STP, and molecules of oxygen gas are required to react completely with 68.0 grams of ammonia ($\text{NH}_3$)?

$$68.0 \text{ g NH}_3 \times \frac{1 \text{ mol NH}_3}{17.0 \text{ g NH}_3} = 4.00 \text{ mol NH}_3 \quad 4.00 \text{ mol NH}_3 \times \frac{2 \text{ mol O}_2}{1 \text{ mol NH}_3} = 8.00 \text{ mol O}_2$$

$$8.00 \text{ mol O}_2 \times \frac{32.0 \text{ g O}_2}{1 \text{ mol O}_2} = 256 \text{ g O}_2 \quad 8.00 \text{ mol O}_2 \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2} = 179. \text{ L O}_2$$

$$8.00 \text{ mol O}_2 \times \frac{6.02 \times 10^{23} \text{ molecules O}_2}{1 \text{ mol O}_2} = 4.82 \times 10^{24} \text{ molecules O}_2$$