

## Introduction to Stoichiometry

Read from **Lesson 1: A Framework for Thinking Stoichiometrically** in the **Chemistry Tutorial Section, Chapter 9 of The Physics Classroom:**

Part a: [Recipes, Ratios, and Relationships](#)

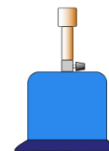
Part b: [The Law of Conservation of Mass](#)

Part c: [Conversions and Connections](#)

The combustion reaction of butane and oxygen produces carbon dioxide and water:



The reaction can be read as *2 molecules of butane gas reacts with 13 molecules of oxygen gas to produce 8 molecules of carbon dioxide gas and 10 molecules of water.* The 2, 13, 8, and 10 are the coefficients and indicate the ratios at which the reactants and products are involved in the reaction.



The  $\text{C}_4\text{H}_{10}$  -  $\text{O}_2$  particle ratio is 2: 13. The  $\text{C}_4\text{H}_{10}$  -  $\text{CO}_2$  particle ratio is 2:8 (or 1:4). The  $\text{C}_4\text{H}_{10}$  -  $\text{H}_2\text{O}$  particle ratio is 2:10. (or 1:5), etc.

The  $\text{C}_4\text{H}_{10}$  -  $\text{O}_2$  mole ratio is 2: 13. The  $\text{C}_4\text{H}_{10}$  -  $\text{CO}_2$  mole ratio is 2:8 (or 1:4). The  $\text{C}_4\text{H}_{10}$  -  $\text{H}_2\text{O}$  mole ratio is 2:10. (or 1:5), etc.

These ratios will be used to make calculations to determine the relative mass of reactants and products involved in a reaction.

Use the combustion reaction of butane and oxygen from above to answer the following questions.

1. What are the number of atoms of the elements C, O, and H on both sides of the equation?

	Reactant Side	Product Side
Number of C atoms		
Number of O atoms		
Number of H atoms		

What law indicates the number of atoms on each side of the arrow (equation) should be equal?

2. What is the total mass (in grams) of the elements C, O, and H on both sides of the equation?

	Reactant Side	Product Side
Mass of C		
Mass of O		
Mass of H		

What law indicates the mass on each side of the arrow (equation) should be equal?

3. Use the coefficients of the equation and molar mass values to determine the missing cells of the table.

	$2 \text{C}_4\text{H}_{10} (\text{g})$	+	$13 \text{O}_2 (\text{g})$	$\rightarrow$	$8 \text{CO}_2 (\text{g})$	+	$10 \text{H}_2\text{O} (\text{g})$
a.	2 mol		13 mol		8 mol		10 mol
	116 g		512 g		352 g		180 g
b.	3.5 mol		_____ mol		_____ mol		_____ mol
	203 g		_____ g		_____ g		_____ g
c.	_____ mol		_____ mol		_____ mol		_____ mol
	_____ g		_____ g		_____ g		360 g
d.	_____ particles		$7.28 \times 10^{24}$ particles		_____ particles		_____ particles
	_____ g		_____ g		_____ g		_____ g

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4. NASA uses lithium hydroxide to remove carbon dioxide in spacecraft. Solid lithium hydroxide reacts with carbon dioxide gas to produce solid lithium carbonate and water. Write the balanced equation with the correct formulae and then use the coefficients of the equation and molar mass values to determine the missing cells of the table.



	(s)	+	(g)	→	(s)	+	H <sub>2</sub> O (l)
a.	4 mol		_____ mol		_____ mol		_____ mol
b.	_____ g		_____ g		_____ g		360 g
c.	_____ particles		1.81 x 10 <sup>24</sup> particles		_____ particles		_____ particles

5. When a collision triggers the rapid inflation of an airbag, sodium azide NaN<sub>3</sub> quickly decomposes into sodium metal and nitrogen gas. Write the balanced decomposition equation with the correct formulae and then use the coefficients of the equation and molar mass values to determine the missing cells of the table.

	NaN <sub>3</sub> (s)	→	(s)	+	(g)
a.	6 mol		_____ mol		_____ mol
b.	_____ g		_____ g		112 g
c.	_____ particles		3.61 x 10 <sup>24</sup> particles		_____ particles

6. Calcium phosphate is used in toothpastes to strengthen tooth enamel. It is produced from the double replacement reaction in a solution of phosphoric acid and calcium hydroxide. Write the balanced decomposition equation with the correct formulae and then use the coefficients of the equation and molar mass values to determine the missing cells of the table.



	(phosphoric acid)		(calcium hydroxide)		(calcium phosphate)		(water)
	(aq)	+	(aq)	→	(s)	+	(l)
a.	_____ mol		_____ mol		_____ mol		12 mol
b.	_____ g		_____ g		620 g		_____ g
c.	6.022 x 10 <sup>24</sup> particles		_____ particles		_____ particles		_____ particles