LEGO Stoichiometry (TEACHER)

Are there enough reactants to make the desired product?

Why?

If a sandwich chain restaurant runs out of bread slices while assembling sandwiches, sandwich production halts. No more sandwiches can be fully made without acquiring more bread slices. Making a sandwich involves specific quantities of ingredients. For instance, if you have two slices of bread, one piece of turkey, and one piece of cheese, one of these ingredients may be depleted first, ceasing the production of additional sandwiches. In this exercise, you will explore various scenarios where a similar process using LEGOs is interrupted due to the exhaustion of one or more of the essential components.

Model 1 - Assembling your products

Use your Product Lego Bag to create an object using all of your pieces.
Draw a sketch of your product in the space provided. Give your product a name:

Give your product a name: _____

Symbol	Blue = Bl	Yellow = Y	Green = Gr	Red = R

1. Use the symbols from model 1 to create the formula for your product (example: the formula for water is H_2O because a water molecule has two hydrogen atoms and one oxygen atom).

Bl_2Y_4GrR

2. Use the symbols from model 1 to write the equation to create your product. (Use coefficients to indicate the amount of each reactant and product).

$$2Bl + 4Y + G + R \rightarrow Bl_2Y_4GrR$$

3. Your instructor will present you with different samples of lego reactants. Discuss each sample with your group and complete the table.

	Bl	Y	Gr	R		Products	Extra Bl	Extra Y	Extra Gr	Extra R	Limiting Piece(s)
Amount	2	12	1	1	→	1	0	8	0	0	Bl, G, R
	8	16	4	4		4	0	0	0	0	NONE
	3	8	2	6		1	1	4	1	5	Bl
	4	8	3	2		2	0	0	1	0	Bl, R, Y
	1	4	1	1		0	1	4	1	1	Bl

4. The law of conservation of matter states that matter can be neither created nor destroyed. Explain how building your product demonstrates this law.

Each sample has a limited number of LEGO pieces and you can't add more or subtract pieces from the sample. You also can't break the pieces in half as they must be kept whole.

Model 2 - Using mass in stoichiometry calculations

	Bl	Y	Gr	R
mass	1.85 g	0.44 g	2.42	2.32 g

5. Complete the table below based on the total amount of each component required to make your product.

Component symbol	Description	Mass (g)	Number required	Total mass (g)
Bl	**3 x 2**	**1.85 g**	**2**	**3.70 g**
Y	**1 x 1**	**0.44 g**	**4**	**1.76 g**
Gr	**4 x 2**	**2.42 g**	**1**	**2.42 g**
R	**6 x 1**	**2.32 g**	**1**	**2.32 g**

6. Calculate the total mass of your product.

3.70 g + 1.76 g + 2.42 g + 2.32 g = 10.20 g

7. Calculate the total mass of products if you had enough supplies to build 9 complete products.

10.20 g x 9 = 91.80 g

8. Calculate the number of red pieces if you had 32.48 g of red pieces.

$$\textbf{32.48 g of R} \times \frac{\textbf{1 piece}}{\textbf{0.44g}} = \textbf{14 R pieces}$$

9. Calculate the number of products that could be produced from 7.04 g of yellow pieces (assume you have plenty of the other pieces).

7.04 g Y x $\frac{\text{1 piece}}{\text{0.44g}}$ x $\frac{\text{1 product}}{\text{4 Y pieces}}$ = 4 products

10. Calculate the total mass of products that could be produced if you had 11.10 g of Bl (assume you have plenty of other pieces).

11.10 g Bl x $\frac{\text{1 piece}}{\text{1.85g}}$ x $\frac{\text{1 product}}{\text{2 Bl pieces}}$ x $\frac{\text{10.20 g}}{\text{1 product}}$ = 30.60 g

Read this

Similar to lego pieces, atoms and molecules react in whole number ratios according to balanced chemical equations. The coefficients used in balanced chemical equations are in units of moles, so chemists often use the molar mass of a chemical convert between grams and moles and predict amounts of products and reactants.

Model 3 - Stoichiometry with Chemical Equations

Reaction A: $2H_2O \rightarrow 2H_2 + O_2$

Reaction B: $2Li + 2H_2O \rightarrow 2LiOH + H_2$

Reaction C: $CH_4 + H_2O \rightarrow C + 2H_2$

Chemical Formula	Molar Mass (g/mol)	Chemical Formula	Molar Mass (g/mol)
H_2O	18.0 g/mol	LiOH	23.9 g/mol
H_2	2.0 g/mol	CH_4	16.0 g/mol
O_2	16.0 g/mol	C	12.0 g/mol
Li	6.9 g/mol		

11. Consider each of the balanced chemical equations in model 3 and complete the table.

Reaction	Moles of H_2 produced?	Moles of H_2O required?
A	2	2
B	1	2
C	2	1

a. How many moles of water are required to produce 10 moles of H_2?

REACTION A	REACTION B	REACTION C
$10\ mol\ H_2 \times \frac{2\ H_2O}{2\ H_2} = 10\ mol\ H_2O$	$10\ mol\ H_2 \times \frac{2\ H_2O}{1\ H_2} = 20\ mol\ H_2O$	$10\ mol\ H_2 \times \frac{1\ H_2O}{2\ H_2} = 5\ mol\ H_2O$

12. Consider reaction C in model 3. How many grams of CH_4 are required to produce 17.0 moles of H_2?

17.0 mol H_2 x $\frac{1\ CH_4}{2\ H_2}$ x $\frac{16.0\ g}{1\ mol}$ = 136 g CH_4

13. Consider reaction B in model 3. How many grams of lithium hydroxide (LiOH) are produced when 78.1 g of water (H_2O) reacts?

78.1 g H_2O x $\frac{1\ mol}{180\ g}$ x $\frac{2\ LiOH}{2\ H_2O}$ x $\frac{23.9\ g}{1\ mol}$ = 104 g LiOH

14. Consider reaction B in model 3. How many grams of lithium are required to produce 189.23 g of H_2?

189.23 g H_2 x $\frac{1\ mol}{2.0\ g}$ x $\frac{2\ Li}{1\ H_2}$ x $\frac{6.9\ g}{1\ mol}$ = 1305.7 g Li