

Focused Learning Lesson
Physical Science
Grades 9 – 12
PS-H-D5

Overview:

This lesson offers a simulation and practical applications on the balancing of simple equations.

Approximate Duration: 45 minutes

Benchmarks:

PS-H-D5 applying the law of conservation of matter to chemical reactions

PS-H-D3 writing balanced equations to represent a variety of chemical reactions (acid/base, oxidation/reduction, etc.)

PS GLE: 26. Illustrate the laws of conservation of matter and energy through balancing simple chemical reactions.

Benchmark:

SI-H-A4 formulating and revising scientific explanations and models using logic and evidence

SI GLE: 7. Choose appropriate models to explain scientific knowledge or experimental results.

Objectives:

1. Identify reactants and products in a chemical equation.
2. Apply the law of conservation of matter in balancing simple equations.

Teacher Preparation: See *Teacher Background* found in Attachment 1.

Materials:

- Attachment 4: Worksheet, Balancing Equations
- Attachment 5: Quiz, Balancing Equations

Lesson Procedures:

Set Induction: (10 minutes)

Simulate the concept of conservation of matter. For directions, see Attachment 2.

Body of the Lesson:

1. Review basic vocabulary and model or demonstrate the process used in balancing of a few simple equations on the chalkboard or on the overhead projector. For directions, see Attachment 3.
2. Give each student a copy of the worksheet, Balancing Equations, Attachment 4.
3. Provide assistance as needed to students as they balance the equations on this worksheet. Allow students to work with peers (peer tutoring) if you are certain that the peer understands the process.
4. Review answers to the equations on the handout.
5. Assess student understanding through administration of the Quiz, Balancing Equations, Attachment 5. Have students hand in their quiz upon completion.

Closure:

Have students demonstrate balancing the equations and provide answers to questions on the quiz, Attachment 5.

Attachments:

- Attachment 1: Teacher Background
- Attachment 2: Simulation of Conservation of Matter
- Attachment 3: Balancing Simple Equations
- Attachment 4: Balancing Simple Equations Worksheet
- Attachment 5: Balancing Simple Equations Worksheet Key
- Attachment 6: Balancing Simple Equations Quiz
- Attachment 6: Balancing Simple Equations Quiz Key

Assessment:

Teacher observation is used for formative assessment. The quiz, Balancing Equations, should be evaluated for completeness and to check for level of student understanding. A similar teacher-made quiz could be developed for summative assessment.

Reference Links:

Another hands-on method for balancing equations are online at
<http://www.iit.edu/~smile/ch8601.html>

Detailed notes on balancing equations are online at
<http://cator.hsc.edu/~mollusk/ChemArt/equations.html>

Attachment 1

Teacher Background

Concepts

Law of Conservation of Matter: Matter is neither created nor destroyed during chemical reactions.

Some students may point out that new substances are produced in chemical reactions; for example, magnesium reacts with oxygen to produce magnesium oxide. The concept to drive home to the students is that the **kinds** of atoms and the **number** of atoms on both sides of the yield sign must be the same to satisfy the law of conservation of matter.

Matter is neither created nor destroyed in chemical reactions; therefore, it must be accounted for so chemical equations must be balanced to show equal numbers of each different atom involved in both the reactants and the products of the reaction.

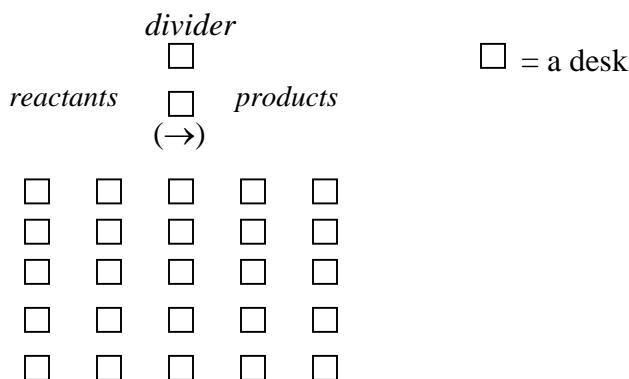
Attachment 2

Simulation of Conservation of Matter

Four students are needed for the simulation. For the purpose of explanation, an imaginary class of students having students with the following names will be used: Jake, Joe, Mandy, and Sam.

Create a “divider” at the front the classroom to separate the “reactants” from the “products.” A couple of desks could suffice to create the “divider.”

Front of the Classroom



The left side (*from the viewpoint of the students*) of the “divider” is where the “reactants” will be located. The right side (*from the viewpoint of the students*) of the “divider” is where “products” will be located. The “divider” is representative of the yield sign in a chemical equation.

Ask Jake and Joe to stand on the left side of the “yield sign” facing the class. They should not be touching each other. Say, “Jake and Joe represent two chemicals that will be mixed together to chemically react.” On the board, write: **Jake + Joe** \longrightarrow

Ask, “What is on the left side of the yield sign?” Students should respond, “*Jake and Joe.*” Ask, “How many Jakes?” Students should respond, “*One.*” Ask, “How many Joes?” Students should respond, “*One.*”

Tell Jake and Joe to continuously walk around each other as they move to the right side of the “yield sign” and to hold hands once they reach the right side of the “yield sign.” On the board, complete the following equation:



Ask, “What is on the right side of the yield sign?” Students should respond, “*Jakejoe.*” Ask, “How many Jakejoes are there?” Students should respond, “*One.*” Ask, “How many Jakes are there in one Jakejoe?” Students should respond, “*One.*” Ask, “How many Joes are there in one Jakejoe?” Students should respond, “*One.*”

Reinforce the concept by asking the following questions. How many Jakes did we start with? How many Jakes did we end up with? How many Joes did we start with? How many Joes did we end up with?

Say, “We will now take the new chemical, Jakejoe, and react it with another chemical.” Have Jakejoe (*still holding hands*) move to the left side of the “yield sign.” Ask Mandy to join Jakejoe on the left side of the yield sign. She should not touch Jakejoe. Say, “Jakejoe represents one chemical (*a compound*), and Mandy represents another chemical. They will be mixed together to chemically react.” On the board, write:



Ask, “What is on the left side of the yield sign?” Students should respond, “*Jakejoe and Mandy.*” Ask, “How many Jakejoes?” Students should respond, “*One.*” Ask, “What is the Jakejoe made of?” Students should respond, “*One Jake and one Joe.*” Ask, “How many Mandys?” Students should respond, “*One.*”

Tell Jakejoe and Mandy to continuously walk around each other as they move to the right side of the “yield sign.” Once they reach the right side of the “yield sign,” Jake should let go of Joe’s hand and hold hands with Mandy. Joe will not be holding anyone’s hand. On the board, complete the equation:



Ask, “What is on the right side of the yield sign?” Students should respond, “*Jakemandy and Joe.*” Ask, “How many Jakemandys are there?” Students should respond, “*One.*” Ask, “How many Jakes are there in one Jakemandy?” Students should respond, “*One.*” Ask, “How many Mandys are there in one Jakemandy?” Students should respond, “*One.*” Ask, “How many Joes are there?” Students should respond, “*One.*”

State the law of conservation of matter as, “**Matter can neither be created nor destroyed.**” In other words, what you start with is what you will end with. The atoms in chemicals can rearrange themselves, but the types of atoms and the number of atoms will remain the same. Relate this concept to the two previous simulations.

Say, “We will now repeat the last chemical reaction to emphasize a point.” Have Jakejoe move to the left side of the “yield sign.” Ask Mandy to join Jakejoe on the left side of the yield sign. She should not touch Jakejoe. Say, “Jakejoe represents one chemical (*a compound*), and Mandy represents another chemical. They will be mixed together to chemically react.” On the board, write:



Ask, “What is on the left side of the yield sign?” Students should respond, “*Jakejoe and Mandy.*” Ask, “How many Jakejoes?” Students should respond, “*One.*” Ask, “What is the Jakejoe made up of?” Students should respond, “*One Jake and one Joe.*” Ask, “How many Mandys?” Students should respond, “*One.*”

Tell Jakejoe and Mandy to continuously walk around each other as they move to the right side of the “yield sign.” Once they reach the right side of the “yield sign,” Jake should let go of Joe’s hand and hold hands with Mandy. Joe will not be holding anyone’s hand. Have Sam join the students on the right side of “yield sign” and hold Joe’s hand. On the board, complete the equation:



Ask, “What is wrong with this equation?” Students should respond, “*There is no Sam to begin with, so there cannot be a Sam to end with.*” or “*Sam is not one of the reactants, so he cannot be one of the products.*”

Attachment 3

Balancing Simple Equations

Chemical Symbols

A chemical symbol is represented as either a capital letter or a capital letter followed by a lower case letter; every capital letter in a chemical equation represents an element.

Examples: **S** = sulfur **I** = iodine **Si** = silicon **Ca** = calcium

Reactant: a beginning substance in a chemical reaction; those elements and compounds found to the left of the yield sign in a chemical equation.

Product: a substance formed by a chemical reaction; those elements and compounds found to the right of the yield sign in a chemical reaction.

Subscript: a number written as a subscript to a chemical symbol in a chemical formula. Subscripts are found to the lower right of a chemical symbol.

Examples:

O₂ In this formula, the number two is a subscript. It is part of the chemical formula. The number used indicates that there are two atoms of oxygen bonded together.

Al₂O₃ In this formula, the numbers two and three are subscripts. They are part of the chemical formula. The number two behind Al indicates that there are two atoms of aluminum and the number three behind O indicates that there are three atoms of oxygen. This formula uses subscripts tells us that two atoms of aluminum are bonded with three atoms of oxygen to form this compound.

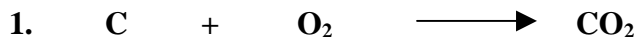
Coefficient: Once all formulas have been written correctly, coefficients are used to balance chemical equations. A coefficient is NOT part of a chemical formula; coefficients are written in front of chemical formulas to indicate the number of molecules or atoms reacting or being formed in a balanced chemical equation.

Examples:

2 O₂ The number two in front of the formula indicates that there are two oxygen molecules. The total number of oxygen atoms is four (2 x 2).

2 Al₂O₃ The number two in front of the formula indicates that there are two Al₂O₃ molecules. The total number of aluminum atoms in this molecule is four (2 x 2). The total number of oxygen atoms in this molecule is six (2 x 3).

Balancing Simple Equations



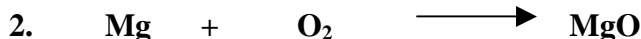
List the types of atoms found in the reactants. List the types of atoms found in the products.

<u>Reactants</u>	<u>Products</u>
C	C
O	O

Next, identify how many of each type of atom is present in the reactants and in the products.

<u>Reactants</u>	<u>Products</u>
C - 1	C - 1
O - 2	O - 2

Next, determine if the same number of each type of atom is present in the reactants and in the products. If so, the equation is already balanced. If not, then coefficients must be added to balance the equation. This equation is already balanced.



List the types of atoms found in the reactants and in the products.

<u>Reactants</u>	<u>Products</u>
Mg	Mg
O	O

Next, identify how many of each type of atom is present in the reactants and in the products.

<u>Reactants</u>	<u>Products</u>
Mg - 1	Mg - 1
O - 2	O - 1

Next, determine if the same number of each type of atom is present in the reactants and in the products. If so, the equation is already balanced. If not, then coefficients must be added to balance the equation. This equation is NOT balanced.

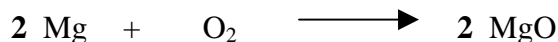
Only coefficients can be added to balance the equation.



There are two O's for the reactants and only one O for the product. Place a coefficient of two in front of the entire chemical formula, MgO. This will now indicate that there are two O's present in the product. Placing this two as a coefficient also indicates that there are two Mg's present in the product.

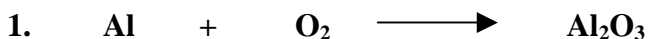


The equation is still not balanced. There is one Mg present as a reactant and two Mg's present as a product. Place a coefficient of two in front of the chemical formula, Mg. This will now indicate that there are two Mg's present as a reactant. This two does not transfer to the O₂ as there is a plus sign between the two chemical formulas.



The equation is now balanced.

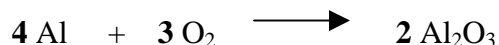
Additional Examples for Extension or Reteaching



Identify elements and count atoms in reactants and products.

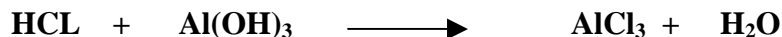
<u>Reactants</u>		<u>Products</u>
Al - 1		Al - 2
O - 2		O - 3

Insert coefficients to balance the equation and recount atoms in reactants and products. Allow students to use trial and error in repeated trials until they balance the equation.



<u>Reactants</u>		<u>Products</u>
Al - 4		Al - 4
O - 6		O - 6

2. This equation should be used for a class demonstration with interaction from students.

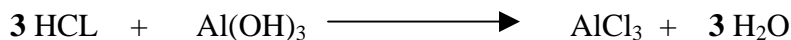


Explain that the subscript outside the parentheses in Al(OH)_3 applies only to the atoms inside the parentheses. The subscript of three multiplies the number of each atom in the parentheses by three in this case. In addition, explain that water is actually HOH or one hydrogen atom bonded to one hydroxide polyatomic ion (OH). Now, have students identify elements and count atoms in reactants and products. Allow selected students to provide the atom counts or have them record the data on the board or overhead transparency.

<u>Reactants</u>	<u>Products</u>
H - 4	H - 2
Cl - 1	Cl - 3
Al - 1	Al - 1
O - 3	O - 1

Next, determine if the same number of each type of atom is present in the reactants and in the products. If so, the equation is already balanced. If not, then coefficients must be added to balance the equation. Allow students to tell you that this equation is NOT balanced.

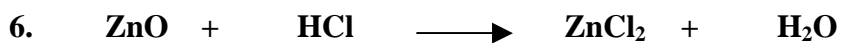
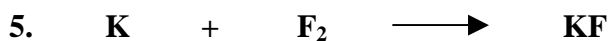
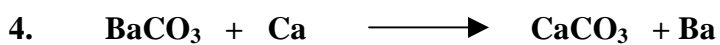
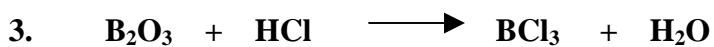
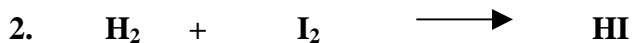
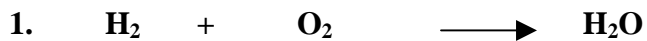
Ask students to suggest coefficients, add their suggested coefficients, and have them recount atoms. If their first try is not correct, repeat this process until they find the coefficients that balance the equation. The solution is shown below.



<u>Reactants</u>	<u>Products</u>
H - 6	H - 6
Cl - 3	Cl - 3
Al - 1	Al - 1
O - 3	O - 3

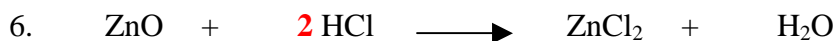
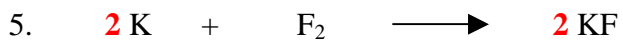
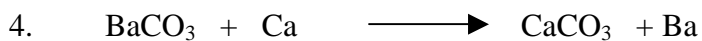
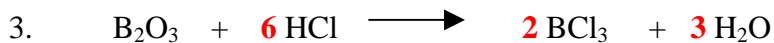
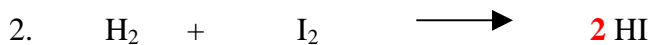
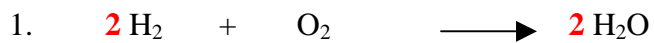
Attachment 4
Balancing Simple Equations Worksheet

Use coefficients to balance the following equations.



Attachment 5
Balancing Simple Equations Worksheet
Key

Use coefficients to balance the following equations.



Attachment 6 Balancing Simple Equations Quiz

Use coefficients to balance the following equations.



Answer the following questions.

3. How does a balanced equation support the Law of Conservation of Matter?
4. In an experiment wood is burned. The mass of the wood before burning is heavier than the mass of the wood after burning. Which of the following best explains this event?
- A. The wood wasn't measured properly.
 - B. The material in the wood became lighter when heated.
 - C. The Law of Conservation of Matter does not apply to burning items.
 - D. While burning, the wood produced gases that escaped and were not weighed.

Attachment 7
Balancing Simple Equations Quiz
Key

Use coefficients to balance the following equations.



Answer the following questions.

3. How does a balanced equation support the Law of Conservation of Matter?

A balanced equation shows that whatever atoms you start out with is the same as what you end up with – they are just rearranged. The Law of Conservation of Matter says that matter can neither be created nor destroyed. Atoms are neither created nor destroyed – they are just rearranged.

2. In an experiment wood is burned. The mass of the wood before burning is heavier than the mass of the wood after burning. Which of the following best explains this event?
- A. The wood wasn't measured properly.
 - B. The material in the wood became lighter when heated.
 - C. The Law of Conservation of Matter does not apply to burning items.
 - D. While burning, the wood produced gases which escaped and were not weighed.

D.