Balancing Equations

Introduction to Measurement

Introduction

Use this creative visual model to demonstrate for your students the relationship between a balanced chemical equation and conservation of mass.

Concepts

- Chemical equations
- Balanced chemical equation
- Conservation of mass

Materials

Balance support (optional)
Lever clamps, with hangers, 5
Magnets, 2
Meter stick with brass ends, English/metric
Paper clips, 5
Tape, electrical
Washers, several
Weighted cards, labeled, 9*

**see tips*

Safety Precautions

Although this activity is considered nonhazardous, please observe all normal laboratory safety guidelines.

Procedure

1. Attach the center meter stick with brass ends to a classroom board or other surface so the meter stick is able to swing freely. Anchor one end of the meter stick to the classroom board using a magnet.
2. Using lever clamps with hangers, attach five opened paper clips to the meter stick, with one at the center of the meter stick, one to the immediate left of this paper clip, and three to the right of the center paper clip.
3. Present a chemical equation that must be balanced. Hang labeled and weighted cards from the paper clips for each component of the equation. The card labeled with the arrow should be hanging from the clamp at the center of the meter stick. *Example:* $Fe_2O_3(s) \rightarrow Fe(s) + O_2(g)$
4. Remove the magnet from the classroom board and let the meter stick hang freely. *(The meter stick will be off-balance, such that one end will fall, depending on what cards were used and how they were weighted.)*
5. As you go through the process of balancing the equation, hang new weighted cards on top of the original cards to represent the coefficients placed in front of each reaction component.
6. When the equation is balanced, the meter stick should be completely level.

Tips

- If desired, a demonstration balance support (AP4669) may be used to support the meter stick rather than hanging it from a classroom board. In this case, the center reaction arrow may be taped to the balance support rather than hanging it directly from the meter stick. Additionally, a stack of wooden blocks or books may be placed underneath both ends of the meter stick to keep it level for the beginning of the demonstration.
- Nine total cards should be prepared for this demonstration so that all stages of the equation-balancing process can be visually represented for the students. A card should be made for each of the following: Fe_2O_3, →, Fe, +, O_2, 2Fe, $3O_2$, $2Fe_2O_3$, and 4Fe.
- The cards may be weighted using washers, pennies, tape, or other readily available materials. Ideally, the placement of each new card should unbalance the equation in a new way, with the exception of the last card, which should allow

Publication No. 91530
061616

the meter stick to hang perfectly level. It may take a bit of practice and reworking to make sure each card is weighted just right.

- When presenting this demonstration, it may be helpful to first place each individual component of the reaction equation, including the arrow and the plus sign on the meter stick, and then proceed to balance the equation, first addressing the iron, then the oxygen, and finally the iron again.
- Any chemical equation may be used, provided it can be fairly easily balanced with few enough terms to fit easily on the meter stick. If using another reaction, be sure to make up enough cards so that you can demonstrate for your students each step of the balancing process!

Discussion

Iron oxide decomposes to form elemental iron and oxygen gas according to the following unbalanced chemical equation:

$$Fe_2O_3(s) \rightarrow Fe(s) + O_2(g) \qquad \textit{Equation 1}$$

Using the *law of conservation of mass*, which states that matter cannot be created nor destroyed, we know that all of the matter, or mass, present at the beginning of the reaction will be present at the end of the reaction. In the case of the reaction shown in Equation 1, all of the iron atoms present prior to the reaction will still be present following the reaction, and the same is true for the oxygen atoms. The chemical from of the atoms is different; however—the compound Fe_2O_3 is broken down to give its elements. The chemical equation must be balanced in order to conserve mass and number and types of atoms. Balancing yields the following chemical equation:

$$2Fe_2O_3(s) \rightarrow 4Fe(s) + 3O_2(g) \qquad \textit{Equation 2}$$

The stoichiometry of this equation indicates that for every two molecules of iron oxide that are used up, four molecules of elemental iron and three molecules of oxygen gas will be produced. We see that the law of conservation of mass is upheld and that all matter present at the start of the reaction is also present upon the completion of the reaction.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, chemical reactions, motions and forces

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Balancing Equations* activity, presented by Bob Becker, is available in *Introduction to Measurement*, part of Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Balancing Equations* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP5384	Meter Stick, Hardwood, English/Metric
AP4672	Clamp with Hanger, Lever
AP4669	Demonstration Balance Support (optional)
AP6011	Electrical Tape

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.