Classifying Chemical Reactions—Synthesis

Synthesis Reactions

Introduction

The rusting of iron is the most well known example of an oxidation–reduction reaction that is also a synthesis reaction. While not as well known, the synthesis of zinc sulfide from elemental zinc and sulfur will be one of the most memorable redox reactions your students will ever witness!

Concepts

- Oxidation—reduction
- Synthesis

Materials

Magnesium ribbon, Mg, 8 cm
Sulfur, S, powder, 1g
Zinc, Zn, powder, 6g
Balance, 0.1-g precision
Butane safety lighter
Ceramic pad
Crucible, porcelain, wide form, 50-mL
Safety shield
Spatula
Weighing dish

Safety Precautions

Zinc powder can be a fire risk. Keep this product dry. Sulfur powder can be a moderate fire risk. The reaction produces thick smoke along with the poisonous gas sulfur dioxide. Perform this demonstration only in an operating fume hood! Place a safety shield between the demonstration and you and the students. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please consult current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Weigh out six grams of zinc powder and transfer the zinc to the crucible.
2. Weigh out one gram of sulfur powder and transfer the sulfur to the crucible. Using the spatula, thoroughly mix the sulfur and zinc powders in the crucible.
3. After mixing, place the magnesium ribbon in the zinc/sulfur mixture, leaving about half the ribbon extending above the mixture surface.
4. Place the crucible on a ceramic pad in the fume hood. Place the safety shield in front of the crucible.
5. Turn on the fume hood, then reach around the safety shield and light the exposed magnesium ribbon.
6. Observe as the mixture ignites, producing a bright flash of light, sparks and a dark cloud of smoke!

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. After the reaction, the residue may be wiped up and disposed of according to Flinn Suggested Disposal Method #26a.

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Tip

Do not try to upscale the experiment.

Discussion

In this ratio, all the zinc will be consumed. This combination of elements results in three distinct reactions. The first is the redox/synthesis reaction of elemental zinc and sulfur;

$$Zn(s) + S(s) \rightarrow ZnS(s) \qquad \Delta H_f = -206.0 \text{ kJ/mole} \qquad \textit{Equation 1}$$

The second redox/synthesis reaction is zinc with oxygen;

$$Zn(s) + \tfrac{1}{2}O_2(s) \rightarrow ZnO(s) \qquad \Delta H_f = -348.3 \text{ kJ/mole} \qquad \textit{Equation 2}$$

The third redox/synthesis reaction is sulfur with oxygen;

$$S(s) + O_2(s) \rightarrow SO_2(g) \qquad \Delta H_f = -348.3 \text{ kJ/mole} \qquad \textit{Equation 3}$$

All these reactions are exothermic. The reaction must be initiated by heat, but once started, the reaction sustains itself.

Connecting to the National Standards

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

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

References

Shakhashiri, B.Z. *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; University of Wisconsin Press: Madison; 1985, Vol. 1, pp. 53–54.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Classifying Chemical Reactions—Synthesis* activity, presented by Lee Marek, is available in *Synthesis Reactions*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Classifying Chemical Reactions—Synthesis* are available from Flinn Scientific, Inc.

Catalog No.	Description
M0139	Magnesium Ribbon
S0138	Sulfur, Flowers
Z0005	Zinc, Dust
AP1255	Crucible, Porcelain, Wide Form, 50-mL
SE261	Safety Shield

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