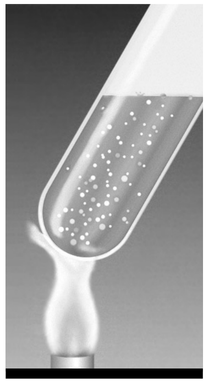
Name

Date Class



CHEMLAB AND MINILAB WORKSHEETS

CHEMLAB 4

The Formation and Decomposition of Zinc Iodide

Compounds are chemical combinations of elements. Many chemical reactions of elements to form compounds are spectacular but must be run under special laboratory conditions because they are dangerous. The reaction of sodium and chlorine to form sodium chloride pictured at the beginning of Chapter 4 is a good example. If elements react spontaneously to form compounds, that is a good indication that the compound state is more stable than the free element state. To break a stable compound down into its component elements, energy must be put into the compound. Electricity is often used as this energy source. The process of decomposing a compound into its component elements by electricity is called electrolysis.

PROBLEM

Can a compound be synthesized from its elements and then decomposed back into its original elements?

OBJECTIVES

- **Compare** a compound with its component elements.
- **Observe** and monitor a chemical reaction.
- **Observe** the decomposition of the compound back to its elements.

MATERIALS

10 × 150-mm test tube
test-tube rack
test-tube holder
100-mL beaker
spatula
plastic stirring rod
zinc
iodine crystals
distilled water
9-V battery with terminal clip and leads
two 20-cm insulated copper wires stripped at least 1 cm on each end

SAFETY PRECAUTIONS

Wear aprons and goggles.

CAUTION: *Iodine crystals are toxic and can stain the skin. Use care when using solid iodine. The reaction of zinc and iodine releases heat. Always use the test-tube holder to handle the reaction test tube.*

PROCEDURE

1. Obtain a test tube and a small beaker. Place the test tube upright in a test-tube rack.
2. Carefully add approximately 1 g of zinc dust and about 10 mL of distilled water to the test tube.
3. Carefully add about 1 g of iodine to the test tube. Record your observations in the data table.
4. Stir the contents of the test tube thoroughly with a plastic stirring rod until there is no more evidence of a reaction. Record any observations of physical or chemical changes.
5. Allow the reaction mixture to settle. Using a test-tube holder, carefully pick up the test tube and pour off the solution phase into the small beaker.
6. Add water to the beaker to bring the volume up to about 25 mL.

7. Obtain a 9-V battery with wire leads and two pieces of copper wire. Attach the copper wires to the wire leads from the battery. Make sure that the wires are not touching each other.
8. Dip the wires into the solution and observe what takes place. Record your observations.
9. After two minutes, remove the wires from the solution and examine the wires. Again, record your observations.

DATA AND OBSERVATIONS

Step	Observations
3. Addition of iodine to zinc	
4. Reaction of iodine and zinc	
8. Electrolysis of solution	
9. Examination of wires	

ANALYZE AND CONCLUDE

1. **Observing and Inferring** What evidence was there that a chemical reaction occurred?

2. **Comparing and Contrasting** How did you know the reaction was complete?

3. **Making Inferences** What term is used to describe a reaction in which heat is given off?

   How can you account for the heat given off in this reaction?

4. **Checking Your Hypothesis** What evidence do you have that the compound was decomposed by electrolysis?

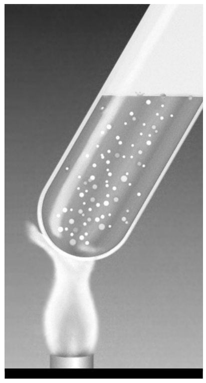
5. **Drawing Conclusions** Why do you think the reaction between zinc and iodine stopped?

APPLY AND ASSESS

1. What role did the water play in this reaction?

2. Do you think zinc iodide is an ionic or covalent compound? What evidence do you have to support your conclusion?

3. The formula of zinc iodide is ZnI_2. Use Lewis dot structures to show how it forms from its elements. Hint: Zinc atoms have two valence electrons.



CHEMLAB AND MINILAB WORKSHEETS

Name

Date Class

The Formation of Ionic Compounds

A sodium atom reacts by losing an electron to form a sodium 1+ ion. A chlorine atom gains one electron to form a chloride 1− ion. In this MiniLab, you will consider other combinations of atoms.

MINILAB 4.2

PROCEDURE

1. Cut three paper disks about 7 cm in diameter for each of the elements: Li, S, Mg, O, Ca, N, Al, and I. Use a different color of paper for each element. Write the symbol of each element on the appropriate disks.
2. Select atoms of lithium and sulfur, and lay the circles side-by-side on a piece of corrugated cardboard.
3. Using thumbtacks of one color for lithium and another color for sulfur, place one tack for each valence electron on the disks, spacing the tacks evenly around the perimeters.
4. Transfer tacks from the metallic atoms to the nonmetallic atoms so that both elements achieve noble gas electron arrangements. Add more atoms if needed.
5. Once you have created a stable compound, write the ion symbols and charges and the formula and name for the resulting compound on the cardboard.
6. Repeat steps 2 through 5 for the remaining combinations of atoms.

ANALYSIS

1. Why did you have to use more than one atom in some cases? Why couldn't you just take more electrons from one metal atom or add extra ones to a nonmetal atom?

2. Identify the noble gas elements that have the same electron structures as the ions produced.

2. Interpret your results from procedures 3 and 4 in this way. If chlorine is more reactive than bromine, it will replace the bromine in NaBr and produce an orange color due to bromine in the upper layer. If chlorine is more reactive than iodine, it will replace iodine in NaI and produce a violet color characteristic of iodine in the upper layer. The ease with which the replacement reactions occur is an indication of the reactivities of the two elements. Given this information, how do the reactivities of chlorine, bromine, and iodine compare? If this trend holds true for other groups, are the more reactive nonmetallic elements toward the top or the bottom of the periodic table?

Cl is more reactive than Br and much more reactive than I. The nonmetallic elements are more reactive toward the top of the periodic table.

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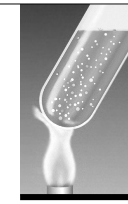

CHEMLAB AND MINILAB WORKSHEETS

CHEMLAB 4

The Formation and Decomposition of Zinc Iodide

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PROBLEM

Can a compound be synthesized from its elements and then decomposed back into its original elements?

OBJECTIVES

- **Compare** a compound with its component elements.
- **Observe** and monitor a chemical reaction.
- **Observe** the decomposition of the compound back to its elements.

MATERIALS

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test-tube holder
100-mL beaker
spatula
plastic stirring rod
zinc
iodine crystals
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9-V battery with terminal clip and leads
two 20-cm insulated copper wires stripped at least 1 cm on each end

SAFETY PRECAUTIONS

Wear aprons and goggles.

CAUTION: *Iodine crystals are toxic and can stain the skin. Use care when using solid iodine. The reaction of zinc and iodine releases heat. Always use the test-tube holder to handle the reaction test tube.*

PROCEDURE

1. Obtain a test tube and a small beaker. Place the test tube upright in a test-tube rack.
2. Carefully add approximately 1 g of zinc dust and about 10 mL of distilled water to the test tube.
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4. Stir the contents of the test tube thoroughly with a plastic stirring rod until there is no more evidence of a reaction. Record any observations of physical or chemical changes.
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8. Dip the wires into the solution and observe what takes place. Record your observations.
9. After two minutes, remove the wires from the solution and examine the wires. Again, record your observations.

DATA AND OBSERVATIONS

Step	Observations
3. Addition of iodine to zinc	**Iodine dissolves in water and turns dark brown.**
4. Reaction of iodine and zinc	**After about 30 seconds, the mixture gets warm. Brown color fades to clear to pale yellow. Solid Zn remains.**
8. Electrolysis of solution	**Brown substance diffuses from one electrode.**
9. Examination of wires	**Electrode from which brown liquid diffused is copper colored; other electrode is "silvery" zinc colored.**

ANALYZE AND CONCLUDE

1. **Observing and Inferring** What evidence was there that a chemical reaction occurred?
Heat was evolved. The iodine color disappeared or almost disappeared. Students may hear a sizzling sound and see white ZnI_2 crystals.

2. **Comparing and Contrasting** How did you know the reaction was complete?
The iodine appeared to be used up. The reaction also stopped generating heat and began to cool.

3. **Making Inferences** What term is used to describe a reaction in which heat is given off?
It is an exothermic reaction.
How can you account for the heat given off in this reaction?
Students may give a variety of reasons. When the products of a spontaneous reaction are at a more stable state than the reactants, energy is given off, usually in the form of heat.

4. **Checking Your Hypothesis** What evidence do you have that the compound was decomposed by electrolysis?
Brown I_2(aq) formed at one copper wire. Zn metal appeared on the other.

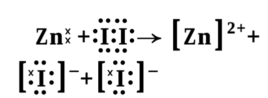
5. **Drawing Conclusions** Why do you think the reaction between zinc and iodine stopped?
The iodine was used up. Residue in test tube appeared to be unreacted zinc.

APPLY AND ASSESS

1. What role did the water play in this reaction?
Water acted as a reaction medium, one of the properties of water. By dissolving some iodine, water maximized the contact between Zn atoms and I_2 molecules.

2. Do you think zinc iodide is an ionic or covalent compound? What evidence do you have to support your conclusion?
Zinc iodide is an ionic compound. Zn is a metal; I_2 is a nonmetal. Metals and nonmetals usually react to form ionic compounds. The solution containing the reaction product conducts electricity.

3. The formula of zinc iodide is ZnI_2. Use Lewis dot structures to show how it forms from its elements. Hint: Zinc atoms have two valence electrons.



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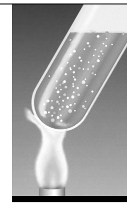

CHEMLAB AND MINILAB WORKSHEETS

MINILAB 4.1

Evidence of a Chemical Reaction: Iron Versus Rust

Here's a chemical reaction whose result everyone has seen—the rusting of iron. Iron metal combines with oxygen in the air to form rust, Fe_2O_3, iron(III) oxide. This reaction is an example of a familiar compound forming from its component elements. One property of iron that everyone is familiar with is that it is attracted to a magnet. Attraction to a magnet is a simple property to measure—all you need is a magnet.

PROCEDURE

1. Obtain a small wad of fresh steel wool in one small paper cup and another small wad of rusty steel wool in another small paper cup.
2. Obtain a 3″ × 5″ index card and a magnet wrapped in a plastic bag.
3. Test the fresh steel wool with the magnet. Record your observations.
4. Hold the rusty steel wool over the white card, and lightly rub the rusty steel wool between your thumb and forefinger. Some fine rust powder should fall onto the white card.
5. Next, hold the card up and slowly move the magnet under the card. Record your observations.

ANALYSIS

1. What effect did the magnet have on the fresh steel wool?

   The magnet attracted the fresh steel wool.

2. What did you observe when the magnet was moved under the card with the rust powder?

   Some of the material followed the magnet. Other particles did not move.

3. Was your pile of rust powder a pure substance? How does your experimental evidence support your answer?

   No, it is a mixture. There are at least two different substances present, each having different magnetic properties. Some of the material was attracted by the magnet and some was not.

4. What evidence do you have that the rust is a different substance from iron itself?

   Students may say that iron is silvery gray, rust is brown; iron is metallic and flexible whereas rust is flaky or powdery. The iron is attracted to the magnet, the brown rust is not. Other observations are possible.

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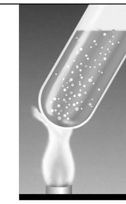

CHEMLAB AND MINILAB WORKSHEETS

MINILAB 4.2

The Formation of Ionic Compounds

A sodium atom reacts by losing an electron to form a sodium 1+ ion. A chlorine atom gains one electron to form a chloride 1− ion. In this MiniLab, you will consider other combinations of atoms.

PROCEDURE

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2. Select atoms of lithium and sulfur, and lay the circles side-by-side on a piece of corrugated cardboard.
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4. Transfer tacks from the metallic atoms to the nonmetallic atoms so that both elements achieve noble gas electron arrangements. Add more atoms if needed.
5. Once you have created a stable compound, write the ion symbols and charges and the formula and name for the resulting compound on the cardboard.
6. Repeat steps 2 through 5 for the remaining combinations of atoms.

ANALYSIS

1. Why did you have to use more than one atom in some cases? Why couldn't you just take more electrons from one metal atom or add extra ones to a nonmetal atom?

   Removing or adding extra electrons would not yield structures that have noble-gas configurations.

   Li^+: He; S^{2-}: Ar; Mg^{2+}: Ne; O^{2-}: Ne; Ca^{2+}: Ar; N^{3-}: Ne; Al^{3+}: Ne; I^-: Xe

2. Identify the noble gas elements that have the same electron structures as the ions produced.

   Li^+ is an exception to the octet rule because it becomes stable by attaining a helium configuration of two electrons.