8A

Investigation

Separating the Elements from a Compound

There is a great deal of talk about using hydrogen as a fuel when we run out of fossil fuels. It is a proven source of fuel for the space shuttle, where it powers the shuttle's three main rocket engines (Figure 1).

Hydrogen is the most abundant element on Earth and in the universe, making up almost 93 % of all matter. Hydrogen is one of the elements in the compound water; the other is oxygen. Water is abundant on Earth and could be an invaluable source of hydrogen.

In this Investigation, you will separate the elements that form water and verify their proportions in the compound.

Figure 1 The main engines of the space shuttle react liquid hydrogen with liquid oxygen to provide thrust. Notice the blue flames on the right—this is hydrogen fuel being burned.

INQUIRY SKILLS

○ Questioning	● Conducting	● Evaluating
○ Hypothesizing	● Recording	● Synthesizing
● Predicting	● Analyzing	● Communicating
○ Planning		

Question

What are the proportions of the elements hydrogen and oxygen in the compound water?

Prediction

Make a prediction about the proportions of hydrogen and oxygen in water.

Experimental Design

In this Investigation, you will use electrolysis to separate water into its two elements and verify their proportions.

Materials

- safety goggles
- apron
- electrolysis apparatus
- water
- 2 g of sodium sulfate (Na_2SO_4)
- 6 V power supply
- electrical leads
- wood splints
- Bunsen burner and flint

Procedure

1. Work with a partner. Put on your safety goggles and apron.
2. Read through the Procedure and make a table to record your observations.

3. Assemble the electrolysis apparatus as shown in Figure 2. Mark the test tubes A and B. Place test tube A over the positive terminal and test tube B over the negative terminal.

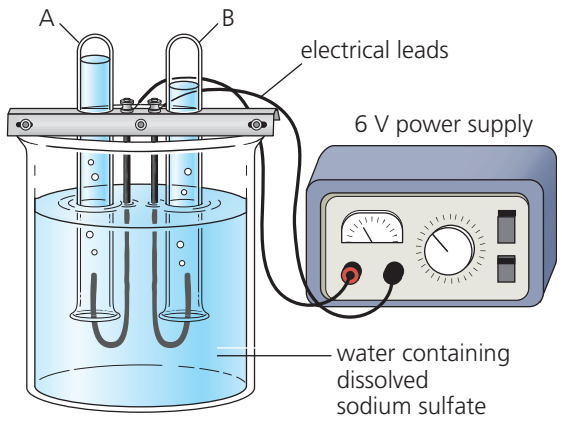

Figure 2 Step 3

4. Add the sodium sulfate (Na_2SO_4) to the water. The purpose of the sodium sulfate is to provide ions so the electric current will flow through the water. Pure water contains too few ions for an effective current to form.
5. Turn on the power. Observe what happens as soon as the power is turned on. Record your observations.
6. Turn off the power as soon as one of the test tubes fills with gas. Observe what happens when the power is turned off. Compare and record the relative amounts of gas in the tubes.
7. With a partner, prepare to check the nature of the gas in each test tube. **Start with test tube A (which was over the positive terminal).** Hold a thumb or finger over the mouth of the test tube. Remove the test tube from the water, keeping it covered and upside down.
8. Light the splint, and then blow out the flame so the splint is glowing. Next, with test tube A still upside down, remove your thumb and immediately place the glowing splint just inside the mouth of the test tube. Record your observations.
9. Repeat the process for test tube B, but **use a burning splint this time**. Record your observations.
10. Dispose of the solution and put the materials away as directed by your teacher. Clean your work area and wash your hands.

Analysis

(a) What was the identity of the gas in test tube B? Provide two pieces of evidence to support your answer.

(b) What was the identity of the gas in test tube A? Provide two pieces of evidence to support your answer.

(c) Write a simple word equation with an arrow connecting the substance you started with and the substances you ended up with.

(d) Write a simple word equation to describe what you think happened at the mouth of test tube B with the lit splint.

(e) What were the relative volumes of the hydrogen and oxygen gases produced? Do these proportions support your prediction?

(f) What do you know about the chemical formula of water that supports your results?

Evaluation

(g) What safety precautions did you take during this Investigation? Why were these precautions necessary?

Synthesis

(h) During the 1800s, electrolysis was a technique used by many chemists all over the world. Why do you think it was so popular at that time?

(i) Do you think hydrogen has the energy needed to replace fossil fuels? Why or why not?

(j) Suggest possible problems or concerns that might arise when switching from gasoline to hydrogen fuel for cars.