### Chapter 3: Quick Activities

# Elements of Chemistry

## The Fire-Extinguishing Gas

You likely know that baking soda and vinegar combine to form a froth of bubbles. But what is the nature of the gas within these bubbles?

### PROCEDURE

1. Wearing your safety goggles, add about a teaspoon of baking soda to a tall glass.

2. Place tape on the outside of the glass one-third of the way up from the bottom of the glass.

3. Slowly add about a tablespoon of white distilled vinegar to the baking soda. Allow the bubbles to subside before adding additional tablespoons of the vinegar. Do not fill the glass with vinegar beyond the taped mark.


4. Remove all flammable materials from around the glass, especially paper towels.

5. Light a wooden match and dip the flame into the mouth of the glass. At some point the flame should be extinguished. Drop the match into the glass if it does not go out.

### ANALYZE AND CONCLUDE

1. At what level inside the glass is the flame extinguished? If others are doing this with you, do their matches go out at the same level? Are you able to raise and lower the flame right at the point where the flame is about to be extinguished? Your glass is not sealed on top, so why doesn't the invisible gas it contains escape?

2. Is there a limit to the number of times a flame can be extinguished by this gas? If you were to tilt the glass part way so that no liquid poured out, would anything else pour out? How might you tell?

3. Did the gas in the glass exist before you added the vinegar to the baking soda? Is this gas heavier or lighter than air? How else is this gas different from the air we breathe? Why might a spider not want to lower itself into this gas?

## Humid Flames

Place a large pot of cool water on top of a gas stove and set the burner on high. What product from the combustion of the natural gas do you see condensing on the outside of the pot? Where did it come from? Would more or less of this product form if the pot contained ice water? Where does this product go as the pot gets warmer? What physical and chemical changes can you identify?

## Burning Bubbles

When you pour a solution of hydrogen peroxide, $H_2O_2$, over a cut, an enzyme in your blood decomposes it to produce oxygen gas, $O_2$, as evidenced by the bubbling that takes place. It is this oxygen at high concentrations at the site of injury that kills off microorganisms. A similar enzyme is found in baker's yeast.

Wear safety glasses and remove all combustibles, such as paper towels, from a clear countertop area. Pour a small packet of baker's yeast into a tall glass. Add a couple capfuls of 3 percent hydrogen peroxide and watch oxygen bubbles form. Test for the presence of oxygen by holding a lighted match with tweezers and putting the flame near the bubbles. Look for the flame to glow more brightly as the escaping oxygen passes over it. Describe oxygen's physical and chemical properties.

## Cold Bubbles

To see the gases dissolved in your water, fill a clean cooking pot with water and let it stand at room temperature overnight. Note the tiny bubbles that adhere to the inner sides of the pot. Where did these tiny bubbles come from? What do you suppose they contain? For further experimentation, repeat this activity in two pots side by side. In one pot, use cool water from the kitchen faucet. In the second pot, use boiled water that has cooled down to about the same temperature. Why might a goldfish not be so comfortable within cool water that was just previously brought to a boil?

## Solids in Water

Put on your safety glasses and add several cups of tap water to a cooking pot. Boil the water to dryness. (Turn off the burner before the water is all gone. The heat from the pot will finish the evaporation. Watch out for splattering!) Examine the resulting residue by scraping it with the knife. These are the solids you ingest with every glass of water you drink.

## Author Responses to Quick Activities

### The Fire-Extinguishing Gas

*1. The flame should extinguish at a reproducible height within the glass. The gas stays in the glass because the gas is denser than air.*

*2. Currents of air will eventually allow oxygen into the container, but the extinguishing capabilities of the newly created gas, which is carbon dioxide, should persist. By tilting the glass part way, some of the carbon dioxide gas will "spill" out of the glass. This can be detected by "pouring" this gas onto a burning candle and watch the flame go out.*

*3. The gas was not there (did not exist) beforehand. It was created by the reaction of vinegar and baking soda. The gas stays in the glass, which suggests it is heavier than air. Furthermore, the gas is different from air in that it does not support the burning of a flame.*

### Humid Flames

*Water vapor condenses into water droplets on the outside of the pot. This water vapor is a product of the reaction of the natural gas with oxygen. Ice water in the pot will favor the condensation of more liquid water from the water vapor. As the pot gets warmer the condensed water evaporates. Physical changes include the condensation and evaporation of water. Note that the water vapor from the flame results from chemical changes occurring within the flame.*

### Burning Bubbles

*Hydrogen peroxide, $H_2O_2$, is a relatively unstable compound. In solution with water, it slowly decomposes, producing oxygen gas. In describing oxygen's physical properties, you should have noted that it is an invisible gas having no odor detectable over that of the yeast. Oxygen is light enough to rise out of the glass once it is released from the bubbles. A chemical property of oxygen is that it intensifies burning.*

### Cold Bubbles

*The tiny bubbles that form in this activity are from the air that was dissolved in the water. These bubbles contain mostly air, along with some residual water vapor. As we explore in Chapter 7, gases do not dissolve well in hot liquids. Air that is dissolved in room-temperature water, for example, will quickly bubble out when the water is heated. Thus, you can speed up the formation of air bubbles by using warm water. You'll find that boiling deaerates the water, that is, removes the atmospheric gases. Chemists sometimes need to use deaerated water, which is made by allowing boiled water to cool in a sealed container. Why don't fish live very long in deaerated water? Answer: They rely on the dissolved oxygen to "breathe".*

### Solids in Water

*It would be humorous to scrape the residue from your boiled-down drinking water into sealable containers labeled as drinking water from your particular region, such as "Rocky Mountain Drinking Water." Think of the potential market. You could ship these containers to customers around the world, and because the containers are not weighted down with water, shipping costs would be low. Of course, each bottle would have to come with the instruction "Just add distilled water." Would you or would you not want to push it by adding the word Pure to your label? With your classmates, discuss the science and ethics of such a venture.*