Elements of Science — Tips and Corrections

1. Alternatives to Experiments with Phenolphthalein Solution

Phenolphthalein solution is no longer allowed in chemistry sets in Europe, so we removed it from our chemistry sets. Experiments 95 and 98 call for phenolphthalein solution, but you can follow these alternative instructions using a safe, natural indicator: cabbage juice.

95 Acids and Their Enemies

In Experiment 91, you saw how citric acid was somehow tamed and robbed of its acidic power by sodium bicarbonate powder. We will now use a few experiments to investigate this strange contest between **acids** and their opponents, **bases**. To have an indicator, you will first create a substance that will reveal the chemical process by its color: red cabbage juice.

You will need: safety glasses, 2 large and 3 small measuring cups, pipette, measuring spoon, citric acid, sodium carbonate (soda), sodium bicarbonate (baking soda), *red cabbage (juice), 1 cooking pot, water, stove, vinegar, 1 piece of soap, 1 tablespoon*

Here's how: The first thing to do is to make the red cabbage juice. In the pot, pour some hot water over finely chopped red cabbage and let stand an hour while stirring. Carefully pour off the juice. For the duration of the experiment, you can keep the supply of juice in an old jelly jar. Label the container with contents and date. Careful, the juice produces stubborn stains!

Red cabbage juice in water, vinegar, and soap solution

1. Drip some cabbage juice into pure water in a small measuring cup. The water hardly changes: It is not an acid.
2. Drip some cabbage juice into some vinegar. The red coloring shows what you already know from the taste: Vinegar contains **acid**. Try it with lemon juice and other sour-tasting liquids.
3. Prepare some soap solution with warm water, and drip some cabbage juice into it. The green coloring shows that soap contains a **base**.
4. Now dissolve a small measuring spoon of citric acid in 10 ml water in the large measuring cup. With the pipette, add 10 drops of cabbage juice. The red coloring indicates an acid.
5. In the other large measuring cup, dissolve three large measuring spoons of sodium carbonate (soda) in a tablespoon of water. Add 10 drops of juice. The solution will turn a bluish-green color. Rinse the pipette well with water and slowly add soda solution to the cup with citric acid. The solution will foam up some, and the color will change from red to blue to bluish-green. Stir well each time you add some soda solution!
6. Make some more citric acid solution with cabbage juice, as in step 4. In the small measuring cup, dissolve a large measuring spoon of sodium bicarbonate in a tablespoon of water, and add this solution drop by drop to the citric acid solution. As it foams, the color will change from red to blue.
7. Repeat the experiment a little differently, by first making a citric acid solution and adding, drop by drop, a sodium carbonate solution mixed with a little cabbage juice. Now the color change happens in reverse, from bluish-green to bluish-purple to red.

What's going on? The juice is an **indicator** (literally, something that indicates or "shows") for acids and their counterparts. In the kitchen, sweet is the opposite of sour. In chemistry, it is different. Here, the opposite to sour or acidic is called **alkaline** or **basic**. Your juice indicates whether a solution in water is acidic or alkaline. Sometimes, neither category applies, as is the case with pure water, which is called **neutral**.

There are many other substances that are acids in addition to citric acid and vinegar. Among the substances (called **bases**) that turn water alkaline are sodium bicarbonate, sodium carbonate, and soap. If you gradually add some alkaline solution to an acidic solution, it will become less and less acidic until it reacts neutrally, and then it will gradually turn more and more alkaline. Solutions like these are measured by their pH value. Acidic solutions have pH values of 6 and lower. The neutral point lies at pH 7 (pure water, for example), and the alkaline range goes from pH 8 up.

Supplemental Experiment

Your science teacher may have access to **phenolphthalein**, allowing you to do the Supplemental Experiment in the manual.

98 Chemical "Magic"

Chemical reactions often seem like magic. In fact, carnival performers used to use chemistry to perform some of their magical tricks. The trick here is simple but amazing.

You will need: safety glasses, sodium carbonate, citric acid, balloon, measuring spoon, 3 small measuring cups, red cabbage juice from Experiment 95, *some light-colored honey, 1 tablespoon, water*

Here's how: First, the preparation: Fill the first cup (Cup One) with water and add two drops of red cabbage juice. The water will remain fairly clear. In Cup Two, use a little honey to glue a granule of citric acid to the inside of the cup, which will appear empty. In Cup Three, dissolve a large measuring spoon of sodium carbonate in two tablespoons of water. Then pour this mixture down the drain, but leave a few drops of it coating the cup. It will look empty.

Now it's time to invite the audience into the room. Explain that you want to perform a "miracle" by turning water into juice. Present the first, seemingly empty cup (Cup Two). Pour your clear "water" from Cup One into Cup Two. It will immediately turn red, like juice. Of course, as you will explain, you are not supposed to drink this juice. Then pour the red liquid into the apparently empty Cup Three, muttering magical spells while stirring. In seconds, the "juice" will turn back to clear or just slightly blue. If it does not work right the first time, try adjusting the amounts of chemicals in each cup.

What's going on? As you saw in Experiment 95, red cabbage juice is an indicator, which is a substance that reacts to the degree of acidity of a liquid by turning color. In an acidic solution (with citric acid), it turns red, while in an alkaline solution (with sodium carbonate) it turns bluish. Of course, you have not actually made juice in this experiment. Do not drink the solution, and do not let your audience drink it!

Warning

Citric acid, Xi. — R 36/38: Irritates skin and eyes. — S 24/25: Avoid contact with eyes and skin.
Sodium carbonate, Xi. — R 36: Irritates eyes. — S 22: Do not inhale dust. — S 26: In case of contact with eyes rinse thoroughly with water and consult a doctor.
Phenolphthalein solution (contains ethyl alcohol), F. — R 11: Flammable.
S 7: Keep container tightly closed. — S 16: Keep away from flame. — No smoking.

2. Alternative to the 4.5-Volt Batteries

The 4.5-volt batteries required by a number of the experiments with electricity and light can be hard to find. As an alternative, you can use *two 1.5-volt C batteries (also known as Type 14A or LR14)* for these experiments.

For most of the experiments that use the batteries, a special assembly must be used: with a rubber band wrapped around the battery as shown, a paper clip can be held in place at both ends of the battery. Wires can be easily connected to these paper clips.

This applies to Experiments 49-52, 54-65, 85, 87, and 90.