



Experiments with Lemons

Invisible Ink

Add about 1 tablespoon (15 ml) of lemon juice to the cup. Fresh squeezed or bottled juice will work just fine. Soak an end of the cotton swab or put the paint brush into the lemon juice. You'll use this to write your message. Write your message on the plain paper. You'll be able to see it as long as the paper is wet so let the lemon-juice message dry completely. **Now with an adult's help**, use heat to reveal the message. You can hold it near an incandescent light bulb or heat lamp. You can also use an iron. Put a rag between the paper and the iron but make sure the steam setting is off. Which way worked better? Can you think of another heat source that might work?

Most invisible ink messages can be revealed by heating either side of the paper on which they're written. The message discolors before the rest of the paper gets hot enough to do so. When you wrote your message using the lemon juice, carbon-based compounds in the juice were absorbed into the paper's fibers. At room temperature, these compounds are pretty much colorless. Also, since lemon juice ink is a weak acid, it softened the fibers in the paper. The added heat caused some of the chemical bonds to break down in the dried juice and some carbon was cut loose. When the carbon came into contact with air (specifically oxygen), it burned or oxidized. One effect of oxidation is things turn a darker color. (Some oxidation doesn't need heat to occur; it just needs a little air. Think of a piece of apple, banana, or pear left out on a plate for a while.) If it oxidizes long enough, it can go all the way to black.

Fizzy Lemon Suds

Use lemon juice to create a bubbly mixture that displays the concept of two compounds reacting. Mix 1 tablespoon baking soda and 1 teaspoon dish soap in a drinking glass. Add a mixture of 1 tablespoon lemon juice and 2 tablespoons water. Stir and stand back. When the acidic lemon juice and basic baking soda mix, they give off carbon dioxide gas bubbles that create a lovely frothy mess. Add fruit or vegetable juices such as blueberry, cherry, carrot or beet for a colorful experience.

Cleaning or Aging Pennies

Start by adding a quarter cup of lemon juice, into a cup. Mix in a teaspoon of salt and stir until it is dissolved. Place your pennies in the bottom of the cup or glass so that they are not stacked on top of each other. Wait 5 minutes. Put some of them directly on a paper towel to dry, and rinse the others well in water first. The rinsed ones will now be clean and shiny, while the pennies you didn't rinse will turn blue-green.

This simple experiment is an easy way to demonstrate some basic scientific principles about oxidation and chemical reactions to children. Pennies minted between 1962 and 1982 work well for this experiment, as they contain 95 percent copper and have been in circulation long enough to build up a coating of copper oxide. Adding table salt, or sodium chloride, to the lemon juice creates a chemical reaction that increases the number of free hydrogen ions in the solution. This increased ionization increases the strength of the acid, allowing it to remove the copper oxide faster and more completely than can be done by the lemon juice alone.