

GREEN CHEMISTRY INTERACTIVE DISPLAYS

Examples and Experiments for the Educational Expo

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Within the past few years outstanding green chemistry experiments for elementary and high school level students have been developed, mostly due to greater availability of green products and processes in the market place. Most of these experiments cannot be transferred to a table-top or booth environment for interactive display due to the testing equipment needed, or the multi-step complexity of the experiment. Educational science expos often use table-top interactive displays, which allow children to go from booth to booth to learn about the different sciences and come into contact with different experiments. This document outlines four simple examples and experiments of green chemistry for a table-top/booth targeting elementary and high school students. These examples and experiments are also effective educational tools for the general public.

1.) Chlorinated versus Non-Chlorinated Cleaning Products: Chlorinated cleaning products are effective in killing surface bacteria and viruses. Chlorine is added to our drinking water to kill germs. Chlorine is also used to treat our paper products: paper towels, toilet paper, and tissues. In high concentrations chlorine is a hazardous material, and it can generate byproducts such as hydrochloric acid and chloroform. Recent studies show chlorine on our skin and in our drinking water can have adverse health consequence such as cancer, neurological disorders, and kidney damage. For these, and many more, reasons chlorinated products are discouraged for common uses.

A.) Create a handout on why chlorinated compounds are considered hazardous. Design this handout to be age appropriate.

B.) Compare a chlorinated cleaning product to a similar “green” product which uses no chlorine. There are quite a few examples on the market: paper products, abrasive scrubs, disinfectants, etc. Obtain an abrasive scrub with bleach and one “green” scrub without bleach. Take approximately 1 mg from each product and dilute in 100 ml of water, then transfer to a labeled plastic container. Do not allow the children to open or handle the product containers themselves, but rather just the diluted products in the labeled plastic containers. Purchase a chlorine test kit from a pool supply company. There are usually two cylinders in the test kit. Fill one cylinder with the chlorinated water and the other with the non-chlorinated water. Have the children add the reagent drops and watch the color change for the chlorinated product. Explain the color changes. Usually five drops of reagent are required for the color change, but you can concentrate the amount of chlorinated product water so just one drop of reagent will give a color change.



Abrasive Scrub with Bleach



“Green” Abrasive Scrub without Bleach



Chlorine Test Kit for Pools

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2.) Phosphates versus Non-Phosphate Cleaning Products: Phosphates are a limited nutrient for most plants and algae. When phosphates become abundant in the environment plant life may grow rapidly, and depending on the environment unwanted species can quickly become a nuisance. When phosphates enter waterways algae blooms can occur sucking oxygen out of the water, which in turn kills fish and wildlife. Phosphates in themselves are not a toxin, but when the ratio is thrown off within an ecosystem they become a hazard. The Environmental Protection Agency recognized early the problem of phosphorus pollution and has proactively addressed phosphate contamination. Up until ten years ago phosphates were a common additive in dish soaps, detergents, and cleaning products, but by the 1990s enough states and localities had limited or restricted laundry-detergent phosphates that detergent companies responded and phased the chemical out in most commonly used products.

A.) Incorporate visual examples (poster or handouts) of why phosphates can be a hazard. Explain why overgrowth of algae can reduce oxygen in lakes and streams, thus killing fish and wildlife higher up on the food chain.



Algae Blooms in Florida



Wildlife Threatened



Fish Kills from Algae Blooms

B.) Obtain a container of dish detergent with phosphate and one “green” dish detergent without phosphates. *Note: It is becoming more difficult to find dish detergents with phosphates in the United States.* I recommend having both original bottles of detergents on the table so students can physically examine the packaging differences. Purchase a phosphate test kit from an aquarium specialty store. There are quite a few varieties on the market, and some use proprietary reagent “indicator”, though most test for inorganic phosphate with a color change when the reagent is added. Depending on the amount of phosphate found in the detergent, dilute to an amount the test kit will give a positively color change (for instance, many detergents contain about 5% phosphorus as phosphates, which is equivalent to 5 grams/0.24 liters. Most test kits indicate up to 1 mg/liter. Dilute to this concentration). If the color change does not happen, or a different color occurs, it is most likely due to additive in the detergents such as colorants, sulfates, and silicates. This is why it is critical to spend time pretesting to find the right type of detergent and/or test kit to give a positive response. Educators can also dilute 1 mg/L of sodium phosphate (most detergents use *tripolyentasodium phosphate*) in water, and explain to children the test water is equivalent to the phosphate found in the detergent.

Let the children pour a small amount of the phosphate-containing water in the test kit cylinder and add reagent drops. Let them pour a small amount of the “green” non-phosphate containing water in the test kit cylinder and add reagent drops. Explain the color changes and differences.



Dish Detergent with Phosphate “Green” Dish Detergent without Phosphates Aquarium Phosphate Kit

3.) Biodegradable Packing Peanuts versus Petroleum Packing Peanuts: This classic example of cellulose-made packing peanuts versus regular petroleum-made packing peanuts is almost a decade old, yet continues to be an exciting example of green chemistry, especially for children. Obtain samples of packing peanuts made with both petroleum products and cellulose. Have children put both peanuts in a beaker filled with water. Take the time to explain why the cellulose material dissolves, making it biodegradable in nature, and often a better choice for consumers. A life cycle process poster can be created to accompany the example.



Styrofoam Peanuts



Cellulose Peanuts



Beaker with Water

4.) Plastic Recycling: Life cycle assessments and closed loop processes are an inextricable part of the green chemistry definition and approach. Take a variety of plastic bottles with different recycling codes clearly visible on the bottom. Put up a code poster, and have children find which code is affiliated with each plastic. Take the time to explain the types of plastics by feel and thickness. Further, take the time to explain what plastics can easily be recycled and, if possible, have an example of a recycled plastic product. Create a small poster explaining the life cycle process.

 PETE Polyethylene Terephthalate Ethylene PETE goes into soft drink, juice, water, detergent, and cleaner bottles. Also used for cooking and peanut butter jars.	 PP Polypropylene PP goes into caps, disks, syrup bottles, yogurt tubs, straws, and film packaging.
 HDPE High Density Polyethylene High Density Polyethylene HDPE goes into milk and water jugs, bleach bottles, detergent bottles, shampoo bottles, plastic bags and grocery sacks, motor oil bottles, household cleaners, and butter tubs.	 PS Polystyrene PS goes into meat trays, egg cartons, plates, cutlery, carry-out containers, and clear trays.
 PVC Polyvinyl Chloride PVC goes into window cleaner, cooking oils, and detergent bottles. Also used for peanut butter jars and water jugs.	 OTHER Other Includes resins not mentioned above or combinations of plastics.
 LDPE Low Density Polyethylene LDPE goes into plastic bags and grocery sacks, dry cleaning bags, flexible film packaging, and some bottles.	

Plastic Recycling Chart



Examples of Recyclable Plastics



Examples of Recycled Plastics