

# A Potpourri of Chemical Demonstrations and "How-To" Guide

## A. Safety

- If it is appropriate for your school or presentation, call the fire department to let them know when you will be doing demonstrations which could potentially set off smoke or heat alarms!
- Make sure you have enough goggles for all who are helping with the show as well as possible audience participants
- It is a good idea to have a flashlight or two handy, especially during some of the demos where you may want to turn out the lights for enhanced effect.
- Make sure you have a fire extinguisher, safety shield, and sand bucket present!
- **ALWAYS USE AND DEMONSTRATE PROPER SAFETY PROCEDURES!**
- Wear goggles and gloves as needed/appropriate.

## B. The Demos

These are some of the demonstrations I have been doing over the past few years. I have tried to include not only how to do them, but also the materials you will need (a check list is included as a separate item).

Some key points to putting on a successful demo show are: 1) Know what you are doing and be able to explain it to the audience, 2) Enjoy what you are doing and let your enthusiasm show, and 3) Don't be afraid of the audience! Have fun with them, whether you are performing for 3.0 or 300.

### 1. Rainbow Tube

**Preparation:** This demo requires a 2 to 6 ft. long clear plastic pipe (depending on whether you want a wand or a staff effect. Once you have the tube, place stoppers at each end and fill it 2/3 full with distilled water. Add a couple of drops of universal indicator until the tube has a medium green color.

**During the Show:** Take one stopper off and add 5-10 drops of 0.1M HCl. Put the stopper back on and invert the tube. The side with the HCl will turn pink and yellow the

farther into the tube you go. Now take off the stopper from the other side and add 5-10 drop of 0.1M NaOH. Put the stopper back on and invert the tube. This side will be purple and slowly progress through blue to green. The result is a rainbow of colors when the tube is held parallel to the floor. This works best against a white background (a sheet or a projector screen).

**Cleanup:** Reset the pH of the tube to 7.0 using the acid and base. Leave the solution in the tube for future use.

## 2. Boiling Color Tube

**Preparation:** This demo requires a large, graduated cylinder or glass/plastic cylinder with a stand. Fill the cylinder 2/3 full of distilled water and add enough universal indicator for the solution to be medium green. Then add enough 1M NaOH so that the solution is purple (~10-20 ml). You will also need approximately 1/2 lb. of dry ice.

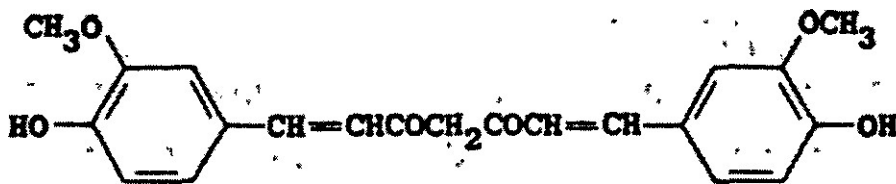
**During the Show:** Place the tube or cylinder onto a table. Add a few chunks of dry ice. As carbonic acid is formed and neutralizes the base the color will change from purple to green to yellow to pink. The frothing from the dry ice is an added bonus. NOTE: Do not overfill the glass cylinder, otherwise solution will spill over the sides once the dry ice is added. If you want to be extra cautious, place a collecting tray under the cylinder.

**Cleanup:** Pour the solution back into a storage jar and reset the pH to basic.

## 3. Goldenrod Paper

**Preparation:** Buy some goldenrod paper from a bookstore. The paper must have been made golden by the application of tumeric (i.e., turmeric yellow).

**During the show:** Spray the goldenrod paper with ammonia water. The paper will turn blood red. As the ammonia water evaporates the paper will return to its yellow color. This can be hastened by spraying the paper with a second bottle containing vinegar. It works because turmeric, which is a spice, contains turmeric yellow ( a.k.a., curcumin, or 1,7-bis(4-hydroxy-3methoxyphenyl)-1,6-heptadiene-3,5-dione, an orange-yellow crystalline powder with a m.p. Of 183 °c) which is an indicator.



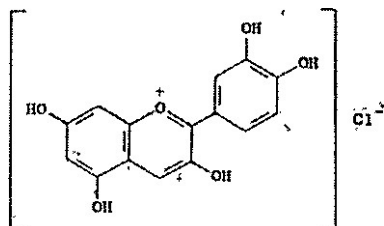
It turns red above pH 8.0.

**Cleanup:** Place the goldenrod paper, when dry, and the ammonia/vinegar spritz bottle back into an appropriate storage space for later use.

#### 4. Red Cabbage Indicator

**Preparation:** Place about 5-8 strips of red cabbage in a 1000 ml beaker containing approximately 500 ml of boiling water. Boil until the cabbage leaves are grey in color and the solution is deep purple. Save the solution for use in the demo.

**During the Show:** Place a ten-well tray on top of an overhead projector. Put approximately 10 drops of the indicator in each of 6 wells. Alternatively, place approximately 10 drops of the indicator on six watch glasses and place these on the projector. Put one squirt of each of the following household chemicals into each of the holders containing indicator: lemon juice, vinegar, boric acid, de-ionized water, baking soda, and Drano. Note the color changes, from red (acid) to blue (base). The active indicator in red cabbage is cyanidin (2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-1-benzopyrylium) chloride, shown below. It belongs to a class of compounds called anthocyanins (also, flavonoids), which are responsible for the color in cranberries, gooseberries, figs, and blackberries, and is a component of color in apples, blueberries, cherries, cranberry, elderberries, grapes, mulberries, red onions, and raspberries, among others.



**Cleanup:** Carefully pour the solutions down the drain.

#### 5. Luminol

**Preparation:** You will need two 400 ml beakers, potassium ferricyanide, luminol (5-amino-2,3-dihydro-1,4-phthalazinedione, or o-aminophthalylhydrazine), 2M KOH (1M NaOH can also be used) solution, 6%-30% hydrogen peroxide solution, water, glass stirring rod. Add 15 ml of 2M KOH to 0.05 g of luminol (it is not necessary that this be measured out precisely) in beaker 1. Now add 100 ml of water and 1 ml of the peroxide solution to this same beaker. In a second beaker, add 100 ml of water and 0.1 g of the potassium ferricyanide (again, this does not have to be quantitative).

**During the Demo:** You can discuss chemiluminescence if you so desire (see Shakashiri, Volume I if need be). When you want to do the demo, simply pour the contents of beaker 2 into beaker 1 with the lights off. A light blue glow will occur and persist for approximately 10-15 seconds. Additional stirring may promote more light.

**Cleanup:** Pour the solution into an organic waste container and clean out beakers.

## **6. Fun With Liquid Nitrogen**

**Preparation:** Obtain a good Dewar Bottle (purchased in advance from Union Carbide or other supply houses), as well as a bottle with attached nozzle or hose, an Erlenmeyer flask, a balloon, perhaps a brass ring with a brass ball that fits through it, a board, and some nails. You will also need to purchase some flowers, two bananas, and a racquetball.

**Safety:** A good pair of insulating gloves and goggles are essential.

**During the Show:** Place some of the liquid nitrogen into the Dewar flask located in the crate. There are a variety of things one can do with liquid nitrogen. Some of them are listed below:

1. Pour some onto the floor. The smoke and N<sub>2</sub> bubbles are usually impressive.
2. Put some in the bottle with the hose attached. The pressure buildup will force some of the LiN<sub>2</sub> out of the nozzle, making a LiN<sub>2</sub> cannon. You can do the same by immersing part of a rubber hose directly into the dewar. **Make sure that you do not point the cannon at anyone!!!**
3. Use the brass ball and ring and the bell to indicate that metals contract when frozen.
4. Place some LiN<sub>2</sub> into a side-arm flask which has a balloon on the side arm which is tied down with string. Put a stopper on the flask and watch the balloon inflate (shows that LiN<sub>2</sub> really is a gas). Pop the balloon if you desire (**Be careful!** Wear goggles and earplugs if you have them).
5. Put some soft flowers into LiN<sub>2</sub> and then crumble them when you take them out.
6. Put a racquetball into the LiN<sub>2</sub>, after first bouncing it to show its flexibility. It takes about five minutes for the ball to stiffen enough, so have other things to do

in the meantime. After about five minutes, take the ball out with tongs or wearing insulated gloves, and bounce the ball against a hard surface. It will shatter (be careful not to do this around people, as the shards can be dangerous).

7. Place a banana in the LiN<sub>2</sub>. After about five minutes, take it out using gloves and use it to hammer nails into a board. For added effect, first try to do it with an unfrozen banana.

**Cleanup:** Place the items in an appropriate storage container. Allow the LiN to bubble off.

## **7. Supersorb (Sodium Polyacrylate)**

**Preparation:** Place approximately 2.0 g of sodium polyacrylate into a 400 ml beaker. Have available 100 ml of distilled water in a separate beaker and a piece of cardboard that will cover the top of the 400 ml beaker.

**During the Show:** Ask for a volunteer, one that won't mind getting their hair wet. You can talk about sodium polyacrylate and its commercial uses while you are pouring the 100 ml of water into the 400 ml beaker containing the sodium polyacrylate. Now place the cardboard on top of the beaker and place it upside down on the head of the volunteer. Very carefully remove the cardboard. The water in the beaker should have reacted with the sodium polyacrylate to form a viscous gel that will not spill out of the beaker, so the volunteer should remain dry.

**Cleanup:** Place the gel in a solid waste disposal jar.

## **8. Polystyrene/Acetone**

**Preparation:** Place approximately 200 ml of acetone into a 1000 ml beaker. Have available a few hundred packing peanuts.

**During the Show:** Have volunteers come up and fill the beaker with the peanuts. As the acetone dissolves the polystyrene, you can point out that the beaker is really not filled. Have other volunteers come up and continue to fill the beaker for a while.

**Cleanup:** Let the acetone evaporate and remove the polystyrene plug and discard.

## **9. Elephant Toothpaste**

**Preparation:** You will need a large graduated cylinder, a catch tray underneath it, some bubble bath, some KI, and 30% hydrogen peroxide solution.

**During the Show:** Place a capful (or a little more) of bubble bath in the graduated cylinder. Then place a few crystals of KI in the bottom of the cylinder. When you are ready for the effect, add approximately 10 ml of the peroxide solution. The foam will rise up the cylinder (the "toothpaste" effect). Depending upon the amount of KI and peroxide added, the foam will spill out of the top of the cylinder. Food coloring may be added to the sides of the cylinder to give "peppermint" etc. toothpaste. I also use this as a "--- o-meter" (depending on the audience). The spilling indicates an over the top response.

**Cleanup:** Dilute with water and place the solution in an inorganic waste jar.

## **10. Gak (Gluep)**

**Preparation:** Prepare the glue solution (50/50 v/v water and Elmer's Glue) and borax solution (4% by weight) in advance. You also need 2 plastic medicine cups and 1 baggie per volunteer.

**During the Show:** Select as many volunteers as you have supplies for. Have them add the glue solution to the baggie. Then (you can do this as a race if you wish) have them add the borax solution (ratio of glue to borax 3: 1), seal the baggie, and kneed the solution. After it becomes viscous, the volunteers can remove the Gak (we need to call it Gluep, because Gak is a trademarked name) and play with it. The volunteers can keep the baggie and Gluep, with all the caveats about not eating it, etc.

**Cleanup:** Rinse out the cups with water before the glue has a chance to set.

## **11. Slime**

**Preparation and Demo:** You will need a polyvinyl alcohol solution for this. The demo is similar to the one above for Gluep, except that the solution is clear or "slimy" looking. You can dye the PVA with food coloring if different colors are desired. Be careful, as the food coloring will dye your hands if not mixed well! Do not overuse food coloring. One or two drops should be sufficient.

**Cleanup:** Same as for Gluep

**For any demos past this point you must have a fire extinguisher and sand bucket handy!!! Before doing the remaining demos, have a trained safety officer check your set up. Check for the possibility of smoke alarms and other devices that might be set off.**

## **12. Woosh Tube**

**Preparation:** You will need either a very large bottle or a cylinder with a stopcock on the end clamped to a ring stand. You will also need some 50-100% ethanol or isopropanol and matches or a charcoal lighter.

**During the demo:** If using the cylinder, set it on a ring stand using a finger clamp. When the time comes, place about 20 ml of alcohol in the container, making sure that the top is coated. Then light the top. It should make a loud "woosh" noise as the hot gases escape from the narrow opening. You can add wheels to the base of a large, light (5 gallon) container. The exhaust when the alcohol is lighted (make sure to pour out excess alcohol before lighting!) will send the container about 25 feet.

**Cleanup:** Place all materials in appropriate storage places.

## **13. Burning Money**

**Preparation:** Put some commercial isopropanol in a glass plate. Also have handy some tongs and a charcoal lighter.

**During the Show:** Ask a volunteer for a dollar bill. Then place the bill in the alcohol solution, remove it and, while still wet, light it. Once the flame starts going, blow it out or place in water immediately. The dollar bill will be moist from the water in the isopropanol but unburned.

**Cleanup:** Pour the isopropanol down the sink and replace plate, tongs, and lighter into their appropriate locations.

## **14. Burning Ice**

**Preparation:** For this demo you will need some finely cut up newspaper, about a handful, and a ceramic plate. You will also need some sodium peroxide and a cup of ice.

**During the Demo:** Place the newspaper on the ceramic plate, and announce that you can start a fire using ice. Put a teaspoon of sodium peroxide on the newsprint and then an ice cube or small shards of ice. As the ice melts, the heat generated will ignite the

paper, leaving a charred residue behind.

**Cleanup:** Scrape off the ash into a metal wastebasket, and then rinse down and dry the ceramic plate.

### **15. Nitrogen Triiodide**

**Preparation and Demo:** See Shakashiri, Volume I. **Make sure you have a blast shield in front of the audience and yourself (i.e., in front of the ring stand) for safety purposes!** I will often use a leftover flower from the LiN<sub>2</sub> demo to detonate the N<sub>2</sub>I<sub>3</sub>. Note that triiodide will splatter after the explosion, so **do not** let people walk in that area until after you have had a chance to clean it up. Also, this should be done in a well-ventilated room, as iodine vapors are released as well.

**Cleanup:** Replace the ammonia and iodine to their appropriate storage places. To kill off any un-reacted NI<sub>3</sub>, rinse containers and wipe off the bench top and floor with ethanol. Let the containers sit for a few minutes before disposing the contents in an inorganic waste container.

### **16. Collapsing Can**

**Preparation:** Buy a paint thinner can from Sears or any other hardware store and empty the contents completely into another container for use or disposal. Rinse several times with water so that no paint thinner remains. Then fill the can with approximately an inch of water. You will also need insulated gloves.

**During the Demo:** With the cap OFF, heat the can on a stirrer hotplate until steam is seen to come out of the top of the can. Then, using tongs and insulated gloves remove the can from the heat and seal it with the cap. As the can cools it will slowly crush.

**Cleanup:** Take the can to a dumpster or place in trash.

### **17. Natural Gas Explosion**

**Preparation:** Use a small paint can that is empty and clean. Place a small (pipette diameter) hole in the top.



**During the Demo:** Fill the can that has the top on it, relatively well sealed, with methane from a gas jet for about 20-30 seconds. Light the top. The hole in the can should display a flame. As the methane/oxygen ratio reaches the combustible proportion, the top of the can will shoot into the air about 20 feet.

**Cleanup:** Replace the supplies to their appropriate places.

### **18. Dust Explosion (Can or Pumpkin)**

**Preparation:** Carve a Jack-O-Lantern. Place a candle in the bottom of the pumpkin. Using lycopodium, sawdust, or flour, sprinkle the dust over the over the candle with a spoon (or blow dust into the pumpkin if you have a tubing/shelf arrangement for the inside of the pumpkin with the top of the pumpkin on). Flame will shoot out of the Jack-O-Lantern's eyes and mouth. You can do the same thing with a large-diameter piece of plexiglass tubing. Put the lighted candle on the floor and the tube over the candles sprinkle with a spoon a little bit of powder over the flame. Stand back! When the powder reaches the candle, a large flame will shoot out of the tube.

**Cleanup:** Replace the supplies to their appropriate places. Throw the pumpkin in the trash.

### **19. Methane Mamba**

**Preparation:** For this one you will need a large, fritted funnel with a tube attached to the end which has a pinch clamp on it, a ring stand with a holder for the funnel, a soap solution, a source of gas, and a charcoal lighter.

**During the demo:** This one requires a co-worker. Attach the tubing to the gas jet. Pour a little of the soap solution into the funnel, which is held by a ring on the ring stand. Quickly open the pinch clamp and turn on the gas. A column of bubble should rise from the funnel. These bubbles are filled with methane and are highly flammable. Have the coworker scoop some of the bubbles off the funnel and send them into the air. Before they get out of reach, light them - CAREFULLY! A plume of flame a couple of feet high will result (depending on how many bubbles you light). Do not light bubbles that are on your coworkers hands!! This demo is spectacular under low light conditions.

**Cleanup:** Replace the supplies to their appropriate places.

## **20. An Exothermic Reaction**

**Preparation and Demo:** I often use a gummy bear and set up a "great gummy bear trial", involving the audience as jury. Place about 5g of  $\text{KClO}_3$  in a large test tube that is clamped to a heavy duty ring stand. Using an Bunsen burner, melt the  $\text{KClO}_3$ . Once the  $\text{KClO}_3$  is melted, drop in the gummy bear or other carbon source (e.g., wood splint). The carbon source will burn and produce significant amounts of smoke. Make sure you have a blast shield in front of the audience for safety.

**Cleanup:** Place the plug of remaining solid in a solid waste disposal jar and wash out, using a test tube brush, the test tube. Replace the supplies to their appropriate places.

## **21. Thermite**

**Preparation and Demo: Make sure you have on goggles and have a fire extinguisher handy! Make sure you have a blast shield in front of the audience for safety purposes.** NOTE: Thermite (60 g  $\text{Fe}_2\text{O}_3$  and 30 g Al mixed together (You actually only need 20.27 g Al stoichiometrically; this gives some excess) can be prepared in advance and stored. Place the thermite in a flower pot in a flower pot (double flower potted). The upper flower pot should have a piece of filter paper on the bottom to prevent thermite from leaking out. Put a small depression in the thermite. When you want to ignite the thermite, add a small amount of ground potassium permanganate into the depression and an eyedropper full of glycerin over that. Stand back!

**Cleanup:** Once the flowerpots have cooled, place them in the trash. Place the sand bucket, blast shield, and ring stand in their appropriate locations. Replace the flowerpots. Replace all other supplies to their appropriate places.

## **22. Liquid Nitrogen Ice Cream**

**Preparation:** You will need a large bowl (I prefer metal, but ceramic is fine), a spoon, and ingredient. There are a variety of recipes for ice cream. The eggs in the recipe below are optional. **If you are in a school with certified food handlers, you should check with them before doing this demo so that they can supervise to prevent the possibility of food borne illnesses.**

**During the demo:** Recipe: 1 qt. half-n-half, 1qt. whipping cream, 1 cup sugar, 3-5 tsp vanilla, 2 eggs, fruit or preserves (if desired). Pour all of the ingredients into a bowl, add liquid nitrogen in —50 mil aliquots and stir, keeping the ice cream away from the

sides of the bowl. Makes about 25 dixie-cup size servings (you will need small cups and spoons to serve).



**8. Polystyrene/Acetone**

\_\_\_ 1000 ml Beaker      \_\_\_ 200 ml Acetone      \_\_\_ Packing Peanuts

**9. Elephant Toothpaste**

\_\_\_ Large Graduated Cylinder      \_\_\_ Potassium Iodide  
\_\_\_ 30% Hydrogen Peroxide      \_\_\_ Bubble Bath

**10. Gak(Gluep)**

\_\_\_ Glue/H<sub>2</sub>O      \_\_\_ 4% Borax  
\_\_\_ 2 Plastic Cups per volunteer      \_\_\_ Food Coloring  
\_\_\_ Baggies      \_\_\_ Gloves  
\_\_\_ Goggles

**11. Slime**

\_\_\_ Polyvinyl Alcohol Solution      \_\_\_ 4% Borax Solution  
\_\_\_ Food Coloring      \_\_\_ Baggies  
\_\_\_ Gloves      \_\_\_ Goggles

**12. Woosh Tube**

\_\_\_ Tube or bottle      \_\_\_ 90% isopropanol or pure ethanol  
\_\_\_ Charcoal lighter or matches

**13. Burning Money**

\_\_\_ Alcohol Mixture      \_\_\_ Glass Bowl  
\_\_\_ Matches or Charcoal Lighter      \_\_\_ Tongs

**14. Burning Ice**

\_\_\_ Ceramic Plate      \_\_\_ Shredded Newspaper  
\_\_\_ Sodium Peroxide      \_\_\_ Spatula      \_\_\_ Cup of Ice

**15. Nitrogen Triiodide**

\_\_\_ Concentrated Ammonia (15 ml)      \_\_\_ 2-3 g of iodine      \_\_\_  
Tape  
\_\_\_ Small graduated cylinder      \_\_\_ 100 ml Beaker      \_\_\_ Blast  
Shield  
\_\_\_ Ring Stand with Three Rings      \_\_\_ Filter Paper (Nine Sheets)

**16. Collapsing Can**

\_\_\_ Paint Thinner Can      \_\_\_ 50 ml H<sub>2</sub>O      \_\_\_ Stirrer Hotplate

**17. Natural Gas Explosion**

\_\_\_ Paint Can with Hole in the Top      \_\_\_ Tripod Holder      \_\_\_ Gas Source  
\_\_\_ Tubing      \_\_\_ Matches or Charcoal Lighter

**18. Dust Explosion**

\_\_\_ Pumpkin or Can or Clear Tube      \_\_\_ Spatula      \_\_\_ Mold      Dust  
(Lycopodium)  
\_\_\_ Matches or Charcoal Lighter      \_\_\_ Ledge/Tubing or Glass Funnel/Tubing

**19. Methane Mamba**

\_\_\_ Funnel/Tubing      \_\_\_ Ring Stand with Ring for Funnel  
\_\_\_ Soap Solution      \_\_\_ Matches or Charcoal Lighter      \_\_\_ Pinch  
Clamp

**20. An Exothermic Reaction**

\_\_\_ Carbon Source (Gummy Bear, for example)      \_\_\_ Ring stand  
\_\_\_ Utility Clamp      \_\_\_ Fire Extinguisher  
\_\_\_ Blast Shield      \_\_\_ Safety Goggles  
\_\_\_ KClO<sub>3</sub>      \_\_\_ Spatula  
\_\_\_ Large Test Tube      \_\_\_ Fisher Burner  
\_\_\_ Gas Source

**21. Thermite Reaction**

\_\_\_ 2 Flower Pots      \_\_\_ Glycerin      \_\_\_ Sand Bucket      \_\_\_ Safety Shield  
\_\_\_ Fire Extinguisher      \_\_\_ Potassium Permanganate  
\_\_\_ Thermite (60 g Fe<sub>2</sub>O<sub>3</sub> and 30 g Al mixed together (You actually only need 20.27 g Al  
stoichiometrically; this gives some excess)