Program Outline

A lot of the demos that I do and have trained students to do at APSU revolve around 4 areas: (1) energy changes in matter, (2) new materials and polymers, (3) kinetics, (4) and the properties of "cool" things like dry ice and liquid nitrogen. I like to do demos for class size audiences that are easy to prepare, always work, and make loud noises or have good visual effect. Admittedly there are an awesome number of great demos that I would like to do but many take a good bit of prep time which I usually don't have. I share with you today a sampling of some activities that you have probably seen before, but they may be done with a slightly different flair and presentation. I also warn you that I love to sing corny science songs so sit back and enjoy the show! LABMAN

1. **Aladdin's Lamp**
   This demo has been my favorite for several years. It is the decomposition of hydrogen peroxide to oxygen gas and water and **heat**. 50 ml of 30% hydrogen peroxide is placed in a Florence flask and a few crystals of KI are added. This catalyzes the decomposition, releasing enough heat that in about 30 seconds to 1 minute steam is released from the boiling water in the flask. If you add too much KI, the reaction will be so violent that boiling water will overflow the flask! **Caution**: 30% H_2O_2 is a very reactive and dangerous reducing agent (the oxygen in it loves to get oxidized and reduced from the -1 state!). Do not let it come in contact with skin or clothing. Wear gloves.

2. **Dry ice and carbon dioxide**
   I love to "play" with dry ice. I could probably talk for an hour just about carbon dioxide and its use and environmental effects. For the classic demo use a long graduated cylinder and fill 2/3 with water. Add 80 drops of universal indicator or until the water is a fairly dark green (pH 7).. Add drops of 6M NaOH until dark blue/purple (very basic). Add dry ice and watch bubbling. Things I talk about:

- Temp of dry ice (-109 °F). You can "burn" skin due to freezing of water in cells so **be careful in handling**. **Always use gloves**. Uses are to ship meat, ice cream other cold things when refrigeration is not available. Dry ice is made by reducing temp and putting pressure on the molecules. This enables weak forces to stick molecules into the solid phase.

- Sublimation. I try to emphasize that solid CO_2 can actually melt into liquid but not at our normal atmospheric pressure. I use this to try to put in their mind that MP and other phase transitions are a function of outside pressure.

- Color changes in the cylinder as carbonic acid formed from CO_2 + water changes pH. Since carbonic acid is weak acid, at the end of bubbling add some drops of conc. HCl or your favorite strong acid to get the red color for the really acidic solutions.

- CO_2 cloud goes over the top and falls. This is a good illustration that CO_2 is more dense than air. You can talk about old movies and graveyard scenes with "fog" at the feet of people walking through the graveyard. Many of these were done with dry ice.

- I also talk about carbonated beverages and usually open one during the demo. I work some type of explanation of Henry's Law with the equilibria of carbonic acid, water and CO_2 into my talk. I emphasize with a balloon that bubbles have a hard time forming and need help. Thus nucleation sites on ice and the tongue help bubbles to form. Shaking also allows small bubbles to form larger bubbles and get "over the hump".

- Root beer - A great demo of Henry's Law or just good chemistry fun!
  My recipe for root beer is:

  1 gallon water
  1 lb sugar (or sweeten to taste)
  1 oz root beer extract
  1 lb dry ice

  Mix ingredients and put dry ice into mix. Cover mixture. It takes about 45 minutes to work. Ratio this up as you need.

  Comments: I use a container that is translucent so that you can see the dry ice sublimating. Tall, round, cylinder water coolers work very easily though. You can screw the lid on tight enough to allow for some pressure release, but still carbonate the drink. I used to get the extract at Food Lion, but lately I have had to order from places like Zatarain.

  Chemistry: Henry's law says that the greater the pressure of the gas above a liquid the more gas will dissolve in the liquid. Soda is carbonated by dissolving carbon dioxide at high pressures into the soda mix. In this demo you use the sublimation of dry ice (-109°F) to obtain the carbon dioxide gas. You need to partially (but to be safe not totally) contain the gas to build up the gas pressure and force more CO_2 into the root beer mix.

3. **Guncotton**
   Cotton that is soaked in concentrated sulfuric and nitric acid (70 ml sulfuric and 30 ml nitric for 24 hours and then dried) burns very differently than regular cotton! The -OH groups on the cellulose have been replaced by $-NO_2$ groups (nitro groups). The effect is dramatic. Show regular cotton and guncotton to the students. They both appear and feel the same - that is they seem to have the same physical properties. But when you ignite the guncotton be prepared for a brilliant flash of fire. This is another exothermic chemical change. It really emphasizes that even though they may look alike, something is different *inside* the guncotton -- maybe *bonds* between atoms? Most students have heard of *nitroglycerin*, guncotton is *nitrocellulose*. TNT (*trinitrotoluene*) is another explosive nitro compound. **Caution**: Carefully mix the sulfuric and nitric acid under a hood and in an ice bath since a good deal of heat is generated on mixing. Take small pieces of cotton and immerse in the acid solution. After letting set for 24 hours, take the cotton pieces out and rinse several times. Let dry for 12 hours and store in a glass container for maximum storage time. You will need to neutralize the acid mix slowly and carefully with base before disposal.

4. **An Absorbing Experiment**
   Show a "pull-up" or diaper and explain that they hold water really well because of a substance called poly sodium acrylate. Then put a "scoop" of the polymer in a 400 ml beaker and add about 200 ml of distilled water. Swirl and invert the beaker -- nothing comes out! The water has gelled into the polymer structure. This polymer is designed to be very hydrophilic and is used in the diaper industry as well as by gardeners to hold water. Put the gel into a plastic zip-lock bag and pass it around. Kids love to swish it between their fingers. Is everything "gelling" for you in science? Don't put this material down the sink.

5. **Explosions are us - Variations on the methanol cannon**
   There are many variations of the explosion of methanol. One is a small plastic bottle with two large screws protruding from the sides. [screws are safer than nails, less prone to fly out] A cork is inserted into the top of the bottle. Put a few mL of methanol into the container and swirl and then stopper. Use a tesla coil to bring a spark to a protruding screw. Kaboom! You will have a brilliant explosion with a nice blue jet of flame coming from the top. Now stopper and

try it again. The result - no explosion. Why? You used all the oxygen that is needed for the combustion the first time. (methanol + oxygen ---> carbon dioxide gas and water vapor) You can unstopper and wave the bottle around for a few moments and usually get a little pop upon reigniting. [The tesla coil can also be used to light a fluorescent lamp by holding the lamp in the middle in one hand and bringing the spark from the coil to the end of the tube. The tube will glow.]

The direct application of this demo is that this is exactly what happens in the cylinder of an auto many times a minute. Gasoline and air are mixed and exploded with a spark. The production of heated carbon dioxide gas and water vapor increases the pressure on the inside and causes the movement of the piston, thus finally propelling the car. By the way, do not try the demo with gasoline. The hazards of flashback are too great!

6. **Liquid nitrogen – everyone's favorite**

What is not to like about a substance that is still a liquid at -321°F (or -196°C)? Talk about your weak intermolecular forces! Of course I do the classic demos of pounding a nail into a block of wood with a frozen banana, shattering a frozen racquet ball against a hard surface, and the like but the favorite is another food demo – liquid nitrogen ice cream. I love ice cream and I like to share bits of ice cream trivia such as the ice cream freezer was invented in 1846 (ice cream was a rarity before this) and the ice cream cone had its origin at the St. Louis Exposition in 1904. Ice cream freezes at -3°C or lower so a ice/salt mixture is commonly used in the home ice cream freezer. The chemistry is fascinating with four distinct regions of: (1) a syrup of sugar, salts, and proteins, (2) droplets of milk fat, (3) pockets of air, and (4) tiny ice crystals. Commercial ice cream has stabilizers that prevent the ice crystals from growing larger. In the ice cream freezer initial growth of the ice crystals is prevented and air is injected by the dasher.

Ice cream can also be made by pouring liquid nitrogen over an ice cream mix and stirring. In just a minute or two you have ice cream. The liquid nitrogen freezes the mix so rapidly that large ice crystals don't have time to form, and the boiling nitrogen injects gas into the ice cream. Although you can get liquid nitrogen at many welding gas supply houses, you must have a "dewar" (a very expensive "thermos bottle") to hold the nitrogen. **Caution**: If you think dry ice can give you a cold burn, just wait until you dip a finger in liquid nitrogen. You can easily loose it. To lose a wart is one thing, a body part is quite another. Be very careful handling this stuff! **Always use heavy gloves.**

7. Chemistry songs

With apologies to Michael Offutt and his copyrighted "mole song" we will do a slightly different musical version than you can find at http://www.roomd113.com/mole%20song.htm. We hope you will join us for a rousing "Gravity Song" as well.

A Mole Is a Unit

A mole is an animal that burrows in the ground,
Or a spot on your chin that you gotta shave around.
But there's another kind of mole of interest to me,
That's the kind of mole they use in chemistry.

Chorus: A mole is a unit, or have you heard,
Containing six times ten to the twenty-third,
That's a six with twenty-three zero's at the end,
Much too big a number to comprehend

Gravity, Gravity

Sung to the tune of Jingle Bells

A comet hits the earth,
It's made of methane ice
It makes a giant force
Now isn't that so nice

So what made it come here
What made it hit the earth
The answer's very clear my friends
It fills you up with mirth

Gravity, Gravity, keeps us on the ground
A apple fell on Newton
He said what goes up comes down

Gravity, Gravity, mass times 9.8
Remember travel very fast
If earth you must escape

Walk around the earth
Keep a steady pace
If gravity twern't here
You'd float away in space

Call it what you want
Call it any name
But this force is a heavyweight
Attraction is it's game

Gravity, Gravity, keeps us on the ground
A apple fell on Newton
He said what goes up comes down

Gravity, Gravity, mass times 9.8
Remember travel very fast
If earth you must escape

8. Let's get serious

I love to teach chemistry (and all physical science) but the best teaching advice I ever got was "You teach students, not chemistry".

An organized confident delivery + enthusiasm + sensitivity to students needs → MOTIVATION

TEL your students about science.

- Be TOUGH – expect much from them and from yourself
- Be ENTHUSIASTIC – if you are not, no one will be
- Be LOVING and CARING – no one cares how much you know until they know how much you care