Charles Mahler's Chemistry Demonstrations, Immaculata Week 2014

Candle Demonstration
Put a candle in a shallow dish (I used modeling clay to hold the candle in place) and fill the dish with water. Light the candle and then cover it with an inverted beaker. The candle will burn for several seconds and the flame will eventually get smaller, then go out. The water in the dish is “sucked into” the beaker by the oxygen being used up. Variations include putting food color in the water to make it easier to see, and using a narrow tall glass in place of the beaker (so the water will rise higher for the same volume change). I play around to make sure I have just a little bit more water in the dish than is required.

Balloon on a Bottle Demonstrations
Put steel wool into a plastic bottle and add some vinegar (acetic acid in water). Put a balloon on the mouth of the bottle and shake vigorously. Ask what you expect will happen (most people assume gas will be generated, inflating the balloon). Let this sit as it takes time, but eventually the iron in the steel wool rusts and removes oxygen from inside the bottle. The decrease in the amount of gas causes the balloon to be sucked into the bottle by the outside atmospheric pressure. The water solution becomes yellowish from rust and some rust is visible on the steel wool. This worked best for me if I let it sit for close to an hour before showing the balloon being sucked in. A variant is to do this with the steel wool wrapped around a thermometer, as the reaction is exothermic and will warm up (do this out in the air, not in a bottle).

I also did baking soda and vinegar in a bottle with a balloon on top. Carbon dioxide gas is generated and the balloon inflates.

Chemistry in a Ziploc bag

Materials needed: Baking soda (sodium bicarbonate), Calcium chloride (Qik Joe ice melt, or Damp Rid), Phenol red (available from pool supply stores) OR red cabbage water, plastic cups (3 per group), teaspoons (2-3 per cup), small Ziploc or other sealable plastic bags (1 per student), small paper cup (1 per student). Candle and matches.

Give each student a Ziploc bag and paper cup. Have the students form small groups of 4 or 5 members each. Give each group one plastic cup half-filled baking soda, one plastic cup half-filled with calcium chloride, one cup half filled with phenol red solution, each with 2-3 spoons.

Stress that the students should not move to the next step before you tell them what to do, and before everyone in their group is done. The first step is to open the bag and add 2 spoonfuls of calcium chloride to it. Have students make observations – what does the calcium chloride look like? Does it do anything in the bag?

Next add one spoonful of baking soda to the bag. Again have the students make observations. Next add two spoonfuls of phenol red solution to the small cup. Once everyone has solution in their cup, have them carefully put the cup into the bag (do not pour the solution into the bag). Get as much air out of the bag as possible and then seal the bag.

Once the bag is sealed, carefully tip the cup and mix the contents. Try to keep the cup away from the mixture (in one corner). I do this with a countdown so everyone does it at the same time.

Have the students make observations. As the contents of the bag mix, there will be color changes (Phenol red, white baking soda and calcium chloride mix and change to yellow), some heat is given off (warm to the touch, not hot), and sometimes students will notice cooling too. Carbon dioxide gas is generated inside the bag (the bag puffs up and you can hear the sound if you hold the bag to your ear). Do not open the bags.

Ask for observations and discuss. Explain that the gas in the bags is carbon dioxide, which will not burn. We exhale it, and plants need it to respire. It is also denser than air and is used in fire extinguishers. Demonstrate the last two points by lighting a candle and asking for a few of the puffiest bags. Hold the bag about 6-8 inches above the flame and open it. The carbon dioxide should pour out and extinguish the flame (by displacing the air and oxygen the flame needs to burn). This can take several tries to work.

Cleanup: Do not have students open the bags. Simply throw them away (it is OK for the teacher to vent the bags before throwing them away). Any spilled material can be wiped up with damp paper towels. Do not eat the materials.

Tweak: Instead of phenol red, red cabbage juice can be used. Both are acid-base indicators, and will change color based on how acidic or basic the solution they are in is. To make the red cabbage juice, buy a small red cabbage, cut it up, and boil the leaves in water for about 10 minutes. Filter the reddish-purple solution (a coffee filter works) and store it in a sealable bottle in a refrigerator.

Making Molecular Models with Candy and Toothpicks

We made models of simple molecules using toothpicks for bonds, and soft candy or marshmallows for atoms.

<u>Reaction and Product M&M Equilibrium hands on activity (from the Central Region Follow-up)</u>

First divide the people into groups of two or three and give each group 40 M&Ms and at least one plate to start (I think that two plates work better). In each group, one person will be "R" (reactants) and one will be "P"; if there is a third person they can help with counting, math, and recording data. Explain the rules for each turn.

1) Count the number of M&Ms on the R plate and on the P plate.
2) Calculate ½ of the R M&Ms and separate these from the others. Also calculate ¼ of the P

M&Ms and separate these from the others. If there is any fraction / decimal/ remainder, round up (so half of 10 is 5, half of 11 is rounded up to 6, or ¼ of 24 is 6, but ¼ of 25 is rounded up to 7)
3) Simultaneously exchange the M&Ms separated in step 2 (so R gives ½ of what they had to start the turn to P, and P gives ¼ of what they had to start the turn to R).
4) Repeat steps one through three (make sure to record the starting amounts of R and P M&Ms)

Equilibrium is reached when the numbers for R and P do not change from turn to turn (or, in rare cases, change by only 1 back and forth).

Variations include starting with the same total number of M&Ms (40) but different numbers for R and P initially (wind up with the same 16 R and 24 P no matter what) or starting with different numbers of M&Ms (wind up with about the same equilibrium constant, K = R/P, for this rule K is 2 in the limit of large numbers of M&Ms). See also the notes for this lecture on Q, the reaction quotient (predicting which way the numbers will change to get to equilibrium).

Can talk about how equilibrium is dynamic (keep exchanging M&Ms, but total numbers or R and P do not change). Also point out that the system needs to be closed (can't lose or eat M&Ms – need 40 total) and that equilibrium does not mean that the amounts or R and P are equal. Can also show that changing the starting number should lead to the same equilibrium values for R and P and K, and that this rule always leads to a K of about 2 (closer to 1.9 if total number is small). Different rules can be used, but this rule (½ P and ¼ R) works well and is easier than some for the math.

Exploding Pringle's Can Demonstration

In the exploding Pringles can demonstration, burning hydrogen gas with oxygen from the air makes water. I filled a Pringles can with hydrogen gas and set it up on stoppers. There was a small hole in the metal end of the can (at the top, where I lit the escaping hydrogen) and a large hole in the plastic lid on the bottom (where air can go in to replace the escaping hydrogen gas). The flame burns steadily at first above the metal lid, then as it enters the can through the metal lid, a radical reaction leads to the loud explosion. This is an oxidation-reduction (or redox) reaction, where hydrogen is oxidized (each H loses an electron and goes from an oxidation state of 0 to +1) and oxygen is reduced (each oxygen gains two electrons and goes from an oxidation state of 0 to -2). Hydrogen is the limiting reactant, as there is much less of it than there is oxygen in the room air.

$2\ H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (l)$