

National Chemistry Week

October 16-22, 2005

"The Joy of Toys"

Discovery World Demonstrations

The theme this year is meant to focus on the use of toys and the chemistry associated with them. The demos will attempt to integrate this theme with notes prior on how you can segue from one demo to the next. In the interest of blowing a few things up, the correlation breaks down from time to time but the goal is to interest kids in the science while at least staying close to the theme and using variations of demos performed previously.

*All notes, order, etc are **suggestions** (and guidelines for volunteers who may not have experienced these shows before). If you prefer to change the order, what or how you discuss the demos – feel free to do so!*

Chemistry and Toys:

Begin this segment with a discussion of the simplicity of balloons, that is, they are a simple but playful toy, yet a lot of chemistry goes into the making of them and into the material which they are filled with. You can mention and discuss the terms such as polymers and gasses. What constitutes a polymer (in laymen terms for little kids) and a gas.

Fun with balloons:

1. H₂ balloons vs. He filled balloons.

Concept: By showing how a hydrogen and helium balloon behave physically, and comparing them chemically after igniting them.

Experiment: Setup: H₂ and He filled balloons, preferably 1 of only H₂ and one with H₂ and Mg..

Candle stick.

Source of ignition.

1. Ignite the He balloon first, mention how we use this in blimps.
2. If the audience is a bit close, maybe tell them to close their ears. Then ignite the hydrogen balloon.
3. Next ignite the hydrogen balloon which is laced with Mg metal.

Discussion: I would suggest that you talk about the balloons, in terms of polymers and the gasses within them. Polymers are important in many functions of our lives. Some are naturally occurring, i.e. DNA and some are synthetic. You may want to mention that He is called a noble gas, depending on the audience. Try to have a little discussion on the

difference that is experimentally shown. Combustion reaction is a term that should be discussed. Why does the metal laced balloon look like? I'm sure many of them see fireworks at Summerfest, etc, mention this of course.

2. Needle balloons

Concept: To show that a balloon does not pop when you stick a sharp object through it.

Experiment: Setup: A breath filled balloon will do.
A needle provided with a slight amount of oil placed on the tip.

1. Show the audience you have a normal balloon. If you wish you can blow it up with your breath in front of the audience, and tie the end.
2. Take the needle, place it through the balloon from the front in, and out of the back.
3. When done with your discussion, take the needle out and it should deflate a bit or it may completely deflate.

Discussion: Again, talking about balloons in terms of polymers, and how the polymers that exist "move aside" such that the needle may enter, assisted by a bit of oil.

3. Freezing of a balloon

Concept: By freezing a balloon and then letting it warm up on the counter, the relationship of pressure/volume/temperature can be discussed.

Experiment: Setup: LN₂
Dewar
Tongs

1. Take a balloon and a pair of tongs, lower the balloon into the LN₂ and wait until it significantly shrinks.
2. You can ask why they think this is happening.
3. Take it out of the LN₂ and voila, ask them some more questions.
You can use long balloons, or balloons with a test tube attached, and cooling the test tube shrinks the balloon.

Discussion: Again, a balloon which is a simple toy but an effective demo about the science of the gasses within it. Depending on your audience you may want to mention pressure, temperature, volume and their relationship to one another in this demo.

4. Super Ball vs. a Nerf Ball

Concept: Showing how different polymers that make up toys have different elasticity's.

Experiment: Setup: 3 balls provided
1. Just bounce the balls and make them take notice at the height they are bouncing.

Discussion: I would suggest that you talk about the balls in terms of polymers and the elasticity that each possesses. Depending on the audience, you can discuss how very little

energy is lost with the super ball in the form of heat, thus it is a good energy conserver. This is a short and easy demo, but it precedes the next nicely.

5. Freezing of the Super Ball and Nerf Ball

Concept: Showing how a frozen rubber ball turns solid and shatters.

Experiment: Setup: LN₂ dewar
Tongs

1. With the tongs, place the balls in the liquid N₂ for roughly about 15 sec. This should suffice. Remove.
2. Grab the ball with a glove or if you have tough hands, as such and smash it against a nearby wall, away from any audience members!

Discussion: You can discuss how the ball lost its elasticity due to the temperature and thus it shattered.

6. Making Nylon – Synthetic clothing

Concept: Making the polymer nylon.

Experiment: Setup: 50 mL of 0.5 M hexamethylenediamine in 0.5 M NaOH
50 mL of 0.2 M sebacyl chloride in hexane
250 mL beaker
Forceps or tweezers
Stirring rod

1. Pour the NaOH solution into the beaker.
2. Slowly pour the hexane solution into the beaker as a second layer (may be easier to pour down a stirring rod). You may want to do this on a pie pan or dish in case of spilling.
3. Place the beaker on the floor (in front of the table).
4. Gently grasp the interface with the forceps and slowly pull the nylon. Should be able to get a long string to pull out.
5. To clean up following the show – stir the solution to react and make a maximum amount of nylon. Remove the ball, wash and discard in trash. Liquid can now be poured down the drain.

Discussion: You can mention that polymers can be quite easy to make, and make up not only toys but the clothing we wear, plastics, etc.

7. Slime

Concept: Showing how slime is easily made and is non-toxic.

Experiment: Setup: Ziplock bag
Elmers glue
Green Borax Solution

1. Into a ziplock bag, eyeball a handful of elmers glue
2. Add an equal amount of borax solution.

3. Shake vigorously. If it appears too liquid in character, add more glue. If too gooey, add more borax.

Discussion: You can discuss how slime is relatively safe and is thus present in a lot of toys for kids. Also the simplicity of making it is also a plus.

8. Woosher Bottle

Concept: Methanol gas will ignite quickly in the presence of oxygen.

Experiment: Setup: Large and larger Nalgene jugs
Candle taped to end of meter stick or paper matches and tongs
Lighter
Methanol

1. Pour about 15 mL of methanol into smaller jug and roll it around the inside surfaces for about 10-15 seconds.
2. Pour out any remaining liquid. For drama, turn off the lights.
3. Light the candle on the meter stick and slowly move candle over the jug. You may need to tip the candle into the bottle. Instead of this you can also drop a lit match into the bottle with a pair of tongs (this will burn more rapidly, so be ready).
4. You will get a loud whoosh when the methanol vapors burn.
5. You will likely see the flame oscillate into and out of the bottle for several cycles caused by the pressure fluctuations due to the air in the bottle being heated and cooled.
6. You can ask if the bottle will relight (it shouldn't) and what was consumed (oxygen and fuel). By only adding fueling, the jug will not relight, but can repeat when you expel air into the jug (careful not to pass out).
7. Repeat with the jug that has the wings taped to it, now in the holder provided. Ask if they think it will take off or just make noise.
8. Optional. You may even repeat it with 33% enriched nitromethane methanol! Hold on to your goggles for this extension!

Discussion: You can talk about fuels in radio controlled airplanes. Methanol is the main component, along with oils and nitromethane for extra power. Too much of course is bad for their engines.

9. Methanol Plane and Shuttle

Concept Similar to above, but now blocking the reaction with a stopper and initiating with a spark.

Experiment Setup: 2 Nalgene bottles, one has a wood plane mounted on it, another has two "booster rockets" taped on it.
Telsa coil
Corks
Methanol

1. Pour a small amount (less than 5 mL) of methanol into the bottles. Put the cork into the bottle.
2. Vigorously shake the bottle. Open and pour out the liquid. Recap (remember – the tighter the cork is on, the farther the vehicle will travel!).
3. Warn the students it may be loud (protect ears).
4. Place the airplane on the counter or even on the floor, holding the “blast shield” that I provided against the cork. Make sure it is pointed in a safe direction, not towards the crowd!!
5. Turn on Tesla Coil and hold to one of the files.
6. POP!, and a crash landing ensues.
7. Repeat with the “space shuttle” but this time it is in a vertical direction, of course as far away from the crowd as possible!

Discussion: Similar to previous explanation, but you can mention how toys that we play with, radio controlled airplanes, fireworks, toy rockets, etc, all have to have a fuel as a source of energy, and overcoming the force of gravity is harder than that of friction since the shuttle does not travel very far and they are similar in mass (weight for the children!).

10. T-Rex and his case of bad breath.

Concept: Demonstrate the flammability of a solid powder that is dispersed in air.

Experiment: Setup: T-Rex figure

Bulb, hose, and attached funnel which is fed through the T-rex’s stomach.

Lycopodium powder, about 0.5 g or a tablespoon.

Matches and a lighter/candle as backup.

1. Place the powder in the funnel which is in the mouth. Make sure it goes down the tube to some extent and also that his stomach has its lid tightly fit. The pointed side of the plastic cover should be facing his tail.
2. Place a match/small candle in his mouth, securing it in between his teeth.
3. Stepping behind him, squeeze the bulb firmly and the powder will come out of his mouth and ignite. It may take a couple of seconds after you press the bulb for the powder to ignite. Be patient however you can press the bulb another time.

Discussion: The power is derived from club moss spores, however I think it is best if you just mention it is a powder from a plant. You can talk about the smell after the flame, it is a pleasant smell, at least to me. You can joke around that T-rex is cured of his original bad breath if you like, of course there is no smell though to neither him nor the powder since it is odorless and tasteless. It is easily dispersed and upon ignition its dust explodes in air. This explosion of a finely divided powder is a safety concern for explosions in coal mines and flower mills.

Optional. Placing a bit of powder on a watch glass and showing that it does not ignite, theoretically. ☞ If you agitate it or if there is a vent nearby it may!

11. Flammable Clothing – Gun Cotton

Concept: Demonstrate the flammability of cotton clothing, versus non-flammable treated clothing, versus cotton treated with nitric and sulfuric acid.

Experiment: Setup: Plain cotton
Cotton treated with borax
Gun cotton (treated with nitric and sulfuric acid)
Lighter
Three large Petri dishes

1. Prompt the children for what happens to cotton when ignited. Ignite the cotton.
2. Ask the children about flame retardant materials (pajama fabric for one) and what they would expect to happen when lit. Attempt to ignite the borax treated cotton.
3. Tell the children that chemicals can treat cotton in a completely different manner, rather than no or slow burning cotton, one can have fast burning cotton. (Turn off the lights for a dramatic effect here). Using a piece the size of a marble and fluffed to the size of a golf, ignite the gun cotton (it will ignite very quickly).

Discussion: Discuss the need for flame retardant materials in toys and even in the clothing we wear. Optional. Use Sponge bob as a figure holding some of the guncotton!

***Note:* If you want to end with a bang, I have 16" balloons provided that you can burst with or without metal and with H₂. You can put a few breaths of air into it before tying to give it a bit of O₂.**