BIG Little Science Centre Chemistry Show : April 5, 2002

Planning amounts for 3 shows, plus 3 trial runs

Summary of Demonstrations:

1. Luminol "Light Pipe"
2. Dragon's Breath
3. Elephant's Toothpaste
4. Shaving Cream in a Vacuum
5. Disappearing Orangeade
6. Self-Lighting Candle
7. Disappearing Water
8. Melting Styrofoam Cup
9. Dry Hands in Wet Water
10. Smoke Cannon
11. Methylene Blue Traffic Light
12. Superfast Ice
13. Neon Light and Fluorescent Light
14. The Black Witch Eats the Great Pumpkin
15. Guncotton
16. Organic Rainbow
17. Dissolving Styrofoam
18. Oscillating reaction: Yellow and Blue
19. Instant Fire
20. Lycopodium Exploder

1. Luminol "light pipe"

Equipment: big stand with clamps and tubing
2 L beaker
big glass funnel
small step–ladder

Solutions: 3–Bottle A (Dilute 4.0 g Na_2CO_3 to 500 mL, add 0.2 g luminol and stir to dissolve. Add 24.0 g $NaHCO_3$, 0.5 g $(NH_4)_2CO_3 \cdot H_2O$ and 0.4 g $CuSO_4 \cdot 5H_2O$ and dissolve. Dilute to 1 L.)
3–Bottle B (50 mL of 3% H_2O_2 diluted to 1 L)

To Perform: Pour equal amounts of bottles A and B into funnel, with lights off (adjust pouring rate to get maximum glow)

What is Happening: Luminol is a special molecule which reacts to form a product having electrons in a highly excited energy level. As the molecule loses energy and its electrons fall down to a lower energy state, the energy lost is in the form of light.

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2. Dragon's Breath

Equipment: Candle taped to the end of a meter stick
matches
spray bottle

Chemicals: Make a mixture of 100 mL of ethanol, 15 mL of water and about 3 g of lithium chloride. Shake to dissolve as much lithium chloride as possible.

To perform: Put about 50 mL of ethanol in the spray bottle**.** Hold a lit candle at arm's length**.** Hold the spray bottle about 4–6 inches from the candle and quickly spray ethanol through the flame**.** This should produce a nice little fireball that lasts for a second**.**

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3. Elephant's Toothpaste

Equipment: 500 mL graduated cylinder
gloves
sponges for clean up

Solutions: 300 mL of 30% hydrogen peroxide
45 mL of dish washing detergent
30 g of potassium iodide

To Perform: WEAR GLOVES! Pour about 100 mL of hydrogen peroxide into the graduated cylinder, add about 15 mL of detergent and add about 10 g of sodium iodide. Huge yellow worm springs out of cylinder!

What is happening: The hydrogen peroxide oxidizes the iodide ion to iodine, while simultaneously releasing oxygen gas. The gas is trapped in the detergent, creating a foam.

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4. Shaving Cream in a Vacuum

Equipment: Vacuum pump
bell jar with bell jar base
can of shaving cream
large petri plate supported over three pieces of wood (to avoid plugging of air exit hole)
vacuum hose.

To perform: Put a generous daub of shaving cream in petri plate, put bell jar over plate base, turn stopcock to off, connect vacuum pump to bell at stopcock and turn on pump. Open stopcock and watch shaving cream swell up and completely fill inside.

What is happening: The shaving cream is full of gas bubbles in equilibrium with the gas pressure of the atmosphere pushing down on the bubbles. When the air is removed, the bubbles expand.

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5. Disappearing Orangeade

Equipment: 4–400 mL beakers

Solutions: mercuric nitrate = 6.0 g/L
potassium iodide = 15.0 g/L

To perform: Pour about 50 mL of mercuric nitrate into a 400 mL beaker. Then pour about 150 mL of potassium iodide solution into a beaker and from it pour about 25 mL, while swirling, into the mercuric nitrate jar; the mixture turns orange. Ask if anyone wants a nice glass of orange juice, made with the best mercury compounds available – keep the beaker containing the potassium iodide in your hand, in visible view. When no-one takes up the offer, shrug and tell the audience that you will get rid of the orange juice – quickly pour the last 125 mL of the potassium iodide into the "orange juice", with constant swirling – the colour disappears.

What is Happening: When iodide ion is added to mercury(II) ion, a precipitate of solid $HgI_2(s)$ is formed. When more iodide ions are added, the colourless HgI_4^{2-} ion is formed (and the solid dissolves).

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6. The Self-Lighting Candle

***Equipment*:** 8 candles with holders
5 stirring rods

***Chemicals*:** very small bottle of concentrated sulphuric acid
GENTLY mix a pea-sized amount of potassium chlorate with an equal amount of sugar. DANGER: NEVER GRIND ANYTHING WITH POTASSIUM CHLORATE. IT IS A POWERFUL OXIDIZING AGENT AND MAY EXPLODE. GENTLY MIX THE SUGAR AND POTASSIUM CHLORATE BY PLACING THEM IN THE MIDDLE OF A SHEET OF PAPER AND ROCKING THEM BACK AND FORTH.

***To Perform*:** Make a 1/4 inch depression in the top of the candle, next to the wick and gently fill the depression with the sugar/potassium chlorate mixture. Carefully touch the top of the mixture at the top of the candle with a long stirring rod having a drop of sulphuric acid on the top. In a few seconds the flame will be produced and the candle will appear to light.

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7. Disappearing Water

Equipment: Part A: small glass (with even lip)
6–pieces of cardboard (About 15 cm x 15 cm)

Part B: styrofoam cup
15 cm square piece of cardboard having "Do not remove this cardboard" written on
400 mL beaker

Chemicals: jug of water
sodium polyacrylate powder

To Perform: Part A: Fill the glass 3/4 full of water, place the cardboard over the end of the glass and invert the glass. Let go of the cardboard and the water stays in the glass.

Part B: Put some sodium polyacrylate powder into a styrofoam cup (ahead of time, unseen). Have a student hold the cup in the air with both hands. Then pour water out of the pitcher into the cup and put the second piece of cardboard over the mouth of the cup. While the student is still holding the cup, turn it upside down over the student's head and lower the cup onto the student's head. Then, pull the piece of cardboard out and have the student read the card. Finally, lift the cup up off the student's head, showing that no water comes out.

What is Happening:

Part A: As the water tries to come down out of the glass, the pressure inside the cup is lowered. The greater pressure of the atmosphere outside then pushes the cardboard firmly against the rim of the glass.

Part B: The sodium polyacrylamide quickly forms a gel when water is added.

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8. Melting Styrofoam Cup

Equipment: 250 mL acetone in juice bottle, with small label
500 mL distilled water in juice bottle, with small label
4 new styrofoam cups

To perform: Pour distilled water into cup and drink. Ask if someone else wants a "nice strong drink" and quickly pour half a cupful of acetone (HOLD IT OVER AN ORANGE BUCKET WHEN OFFERING IT TO SOMEONE – you have 3 seconds before the bottom drops out!)

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9. Dry Hands in Wet Water

Equipment: 2 L beaker
jug of water

Chemicals: Lycopodium powder in a test tube

To Perform: Pour test tube of lycopodium powder onto the surface of the beaker of water. Slowly push hand below the surface of the water and then bring your hand back out. The hand will be dry.

What is Happening: Lycopodium powder is "hydrophobic" (it repels water, similar to oil). When a hand is pushed down into the water, a thin layer of air is trapped between the hand and the powder. Since the powder repels water, the hand remains dry. The beautiful silvery colour of the water against the hand is actually the reflection of light off the water–air interface. (This might be similar to how a fish sees the sky.)

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10. Smoke Cannon

Equipment: Smoke cannon
paper towel
extra elastics (large and long)

Solutions: Concentrated hydrochloric acid (in squirt bottle)
Concentrated ammonia (in squirt bottle)

To Perform: Place some ammonia and hydrochloric acid at different places on paper towel inside cannon. Pull back handle and fire.

What is Happening: Ammonia and hydrochloric acid give off fumes which combine to form a "smoke" made of solid ammonium chloride. As the air rushes out of the mouth of the cannon, a region of partial vacuum forms in the region behind the onward–rushing air. This partial vacuum pulls in the surrounding air and forms a doughnut–like "vortex" which is similar to a miniature "tornado".

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11. The Methylene Blue Traffic Light

Equipment: 500 mL florence flask with stopper to fit

Chemicals: 300 mL distilled water
8 g potassium hydroxide
10 g dextrose
6–8 drops of methylene blue indicator (indicator solution prepared by dissolving 0.20 g methylene blue in 100 mL water)

To perform: Dissolve 8 g KOH in 300 mL distilled water in 500 mL florence flask. Just prior to doing the demonstration, dissolve 10 g dextrose in the KOH solution and then add 6–8 drops of methylene blue solution. Swirl the flask and allow it to sit undisturbed until it becomes colourless (about one minute).

To do the demonstration, give the flask a quick shake or two. The blue colour appears again and then slowly fades. This process can be repeated many times.

What is Happening: The oxygen present in the flask oxidizes the methylene blue dye to its blue form. The basic conditions cause the dextrose to reduce the methylene blue dye to its colourless form. Shaking the flask reintroduces more oxygen into the solution and re-oxidizes the methylene blue to its blue form, continuing the cycle until the oxygen in the flask is used up.

12. Superfast Ice

Equipment: 6–250 mL flasks, with stoppers
2–yellow tote trays
600 mL beaker (to contain scrapings)
spatula

Solutions: In a clean 250 mL flask, dissolve 130 g of sodium acetate in 100 mL distilled water (with heating). Stopper and let cool COMPLETELY UNDISTURBED. Prepare 6 such flasks. Also have on hand a small beaker with a gram or so of sodium acetate crystals.

To perform: Carefully move the flask to where the demonstration will take place – DON'T JAR IT! Unstopper the flask and, while holding the flask up for the audience to see, add a couple of crystals of sodium acetate.

What is Happening: Sodium acetate has a peculiar crystal structure. When this compound is melted, it is difficult for the molecules to "remember" how to form a crystal again. The solution is "supersaturated" and when a crystal of sodium acetate is added to the liquified material, the sodium acetate suddenly "remembers" how to crystallize and BINGO!

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13. Neon Light and Fluorescent Light

Equipment: Old neon sign from sign company specializing in neon signs
stands and clamps for neon lights
fluorescent tube
Tesla coil

To perform: Touch one end of the neon light with an operating Tesla coil**.** A bright red light emission from neon is seen near the metal electrodes**;** the colour then changes depending on the coating inside the glass tube**.** (Argon lights give a blue emission**.**)

Have one person hold the fluorescent tube and another person touch the tesla coil to the tube, lighting up the tube.

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14. The Black Witch Eats the Great Pumpkin

Equipment: 3–25 mL graduated cylinders (labelled BW–A, BW–B, BW–C)
1–100 mL graduated cylinder (labelled BW)
3–250 mL beakers

Solutions: **A** = 15.o g potassium iodate / L
B = 3.0 g mercuric nitrate / L
C =15.0 g sodium metabisulphite + 4.0 g starch + 1.0 g salicylic acid + 10.0 mL ethanol / L

To perform: Add 20 mL of **A** and 15 mL of **B** to 100 mL water and stir well for 5 s**.** Then add 20 mL of **C** to the mixture and stir well for 5 seconds.

What is Happening: A reaction quickly produces orange–coloured mercury(II) iodide, but a second reaction starts to use up the mercury(II) iodide and produce iodine molecules. A third reaction is using up the iodine molecules as fast as they are made, but when the third reactant is finally used up the iodine being produced is available to react with a starch–salicylic acid mixture to produce a black colour.

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15. Guncotton

Equipment: candle and matches

Chemicals: pieces of guncotton

To Perform: throw the guncotton into a flame

What is Happening: The cellulose in the cotton has been treated with nitric acid to make nitrocellulose, which burns rapidly and leaves no residue.

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16. An Organic Rainbow

Equipment: 500 mL separatory funnel
2–400 mL beaker (one to contain HCl and one to catch liquid from separatory funnel)
1 L beaker to hold ice for cooling HCl
distillation apparatus (optional)
magnetic stirrer, with stir bar
500 mL graduated cylinder or (600 mL beaker and 250 mL graduated cylinder)
10 mL graduated cylinder
dropping pipet

Chemicals: 250 mL 70% ethanol (175 mL of ethanol + 75 mL of water)
1 mL of tert–butyl chloride
4 mL of universal indicator
a few millilitres of 1 M NaOH

To perform: Into either a 500 mL graduated cylinder or a 600 mL beaker place 250 mL of distilled water and 250 mL of isopropyl alcohol. Place the container on a magnetic stirrer and begin stirring. Add 1 mL of tert-butyl chloride and stir for another 15 seconds, add 4 mL of universal indicator and stir for another 15 seconds. Finally, add a few drops of 1 M NaoH and continue stirring. The initial blue colour will turn to green, orange and finally red. The process can be repeated by adding some additional NaOH to the reaction mixture.

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17. Dissolving Styrofoam

Equipment: Magnetic stirrer, with stirring bar
2 L beaker
large bag of polystyrene packing chips

Chemicals: 400 mL of acetone

To perform: Rapidly stir 400 mL of acetone in the 2 L beaker. As the foam chips are added, they rapidly dissolve. Students are usually amazed at the large volume of chips that can be reduced to a substantially smaller volume.

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18. Oscillating Reaction: Yellow and Blue

Equipment: Magnetic stirrer, stir bar, 500 mL beaker, 3–100 mL graduated cylinders, piece of white paper to serve as a backdrop, scotch tape.

Solutions: Solution **A** = 120 mL 30% hydrogen peroxide added to 300 mL distilled water
Solution **B** = 12.9 g potassium iodate and 1.5 mL concentrated sulphuric acid added to 300 mL distilled water
Solution **C** = Make a paste of 0.15 g soluble starch in some hot water and add, with stirring, to 500 mL water. Then add 7.8 g malonic acid and 1.7 g $MnSO_4 \bullet H_2O$.

To Perform: Put 100 mL solution **A** in 600 mL beaker and sit on magnetic stirrer at lowest setting. Then add 100 mL solution **B** and then 100 mL solution **C**.

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19. Instant Fire

Equipment: pile of ceramic pads, dustpan, brush, squeeze bottle of water, 2 spatulas

Chemicals: 6 sets of – vial containing 4.0 g powdered zinc
vial containing 4.0 g NH_4NO_3 + 1.0 g NH_4Cl + 0.5 g $Ba(NO_3)_2$

To Perform: Pour contents of one of each type of the 2 vials onto middle of ceramic pad. Mix very carefully with spatula. At arms length, squeeze a few drops of water on the mixture. Care: flares up quickly!

What is Happening: Powdered zinc has an enormous surface area. When water is added, the zinc is ionized and creates a substantial amount of heat in the process. The ammonium nitrate is a strong oxidizing agent which accelerates the reaction and eventually causes the zinc to burn in air.

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20. Lycopodium Exploder

Equipment: lycopodium exploder (see reference or below)
small birthday candle
match
rubber tubing**:** 3/8" OD**,** 5 feet
wide stem Beral pipette
sponge (for clean up)

Chemicals: Bottle of lycopodium powder

To perform: Insert the tubing into the bottom of the plastic bottle**.** Arrange the candle so the wick is in the centre of the bottle**.** Use the pipette to place 3–5 "loads" of lycopodium into the bottle end of the tubing**.** Make sure the end of the tubing is aimed at the end of the candle and light the candle**.** Turn off the room lights**:** take a large breath and blow into the other end of the tubing**.** A huge fireball erupts above the bottle**.**
