NON-INTUITIVE DEMOS AND ACTIVITIES TO MAKE STUDENTS THINK

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Chemical demonstrations are an effective means of promoting student interest, as well as a means of presenting abstract concepts on a concrete basis. Student excitement, however, is particularly aroused when an unexpected event takes place. Such events will spark questions, stimulate discussion, and be remembered long after the chemistry course is over.

There are a number of demonstrations that produce startling chemical events or long lasting memories that I use in classes and programs. Some of these include:

> Putting marshmallow chickens, bunnies, or chocolate covered marshmallow cookies in a vacuum chamber and lowering the pressure.
>
> Adding equal volumes of absolute ethyl alcohol (absolute, may be denatured) and colored water (use food color) to a long glass tube, leaving a small air bubble at one end, and mixing by repeatedly turning the tube upside down and allowing the bubble to move to the top.
>
> Investigating why cans of diet soft drinks usually float while cans of regular soft drinks sink in water.
>
> Ice cubes sink in a liquid resembling water. (ethyl alcohol)
>
> Observing a liquid that has unequal levels in the sides of an open u-tube.
>
> Studying the differences in types of rubber materials and how they affect the bounce of a rubber ball. In this activity, one student is given a no-bounce ball.
>
> Bouncing soap bubbles off one's sleeve.

Each demonstration or activity usually results in a number of questions and further investigations. If properly presented, they are good ways to encourage observations and to develop critical thinking skills.

A CHEMICAL GENIE

1. MATERIALS NEEDED:

hydrogen peroxide, H_2O_2, 30%
flask, 1000 mL (or use a 2-Liter PET bottle)
tissue (Kleenex, Puffs, etc...)
manganese dioxide, MnO_2 (or dry yeast)
rubber stopper to fit flask (or cap for bottle)
string

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses

30% hydrogen peroxide is caustic to the skin and eyes. Handle with care. In case of skin contact, rinse the affected areas well with water. Store unused hydrogen peroxide in a freezer.

Manganese dioxide is a strong oxidant, avoid contact with organic material. Inhalation can lead to increased incidence of respiratory infection and effects on the central nervous system. It is assumed to be harmful if sallowed. Avoid dust. Wash hands well after handling.

This reaction generates heat. Use only Pyrex-type containers. Touching the container may result in a burn.

3. DISPOSAL:

Hydrogen peroxide can be disposed of down the drain with running water.

Manganese dioxide should be disposed of as solid waste in an approved landfill.

4. PROCEDURE:

Prepare ahead: Put a small amount of manganese dioxide, approximately 1/8 teaspoon, on a piece of tissue paper, and tie with string to make a small sack. Cut off excess paper.

Place about 100 mL of 30% hydrogen peroxide into a 1000 mL Florence flask. Place the tissue paper sack of manganese dioxide into the neck of the flask and use a rubber stopper to hold the string so that the sack does not fall into the liquid. Cut off excess string. DO NOT STOPPER TOO TIGHT.

When the stopper is removed, the paper sack containing the manganese dioxide will fall into the hydrogen peroxide solution and a chemical "genie" will be produced.

5. EXPLANATION:

This reaction is the catalytic decomposition of hydrogen peroxide:

$$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$$

Other catalysts that can be used are potassium iodide, KI, raw liver, and yeast.

The "genie" that is observed is actually a fog of condensing water vapor mixed with oxygen gas. This -particular reaction cannot be used to show the production of oxygen by the glowing splint test due to the large amount of water vapor produced.

6. UTILIZATION AND VARIATIONS:

This is an excellent "welcome" demonstration at the start of the semester or at the beginning of a program. This demonstration should be repeated on a smaller scale with some 3% or 6% hydrogen peroxide to show the production of oxygen by the glowing splint test.

Acknowledgement: The author wishes to thank Ron Perkins, Greenwich High School, for this demonstration.

HYPOTHESIS AND EXPERIMENT

INTRODUCTION:

Most every introductory textbook starts out with a discussion of the scientific method which is an approximation of how science works. Usually, there is an observation of some material, event, or phenomenon which leads to a hypothesis, or educated guess, to explain the observation(s). The hypothesis is the guide for further investigation of the observation. The investigation is the experiments which one must devise. If the experiments support the hypothesis, or modified hypothesis, along with additional support from independent investigators, then the hypothesis may be accepted as a theory. The theory is subjected to additional experiments for further verification and/or modifications, but it remains a theory. Theories do not become laws, but, occasionally, scientists may observe that a theory is always correct under all situations, and will realize that they had verified a law of nature, or, simply a law.

This activity is designed to help students visualize how experiments are devised to test a hypothesis.

MATERIALS NEEDED:

4 cards 3 in by 5 inch or larger, white or colored paper.
marker (black or other dark color)
tape, velcro, or magnetic tape to fasten cards to chalk board or wall.

SAFETY PRECAUTIONS:

There are no hazards associated with materials in this experiment.

DISPOSAL:

There is no disposal problems in this experiment.

EXPERIMENTAL PROCEDURE:

Label the cards on both sides as follows:

card 1: Vowel on one side and even number on the other side. (example: E and 8)
card 2: Vowel on one side and odd number on the other side. (example: A and 5)
card 3: Consonant on one side and even number on the other side. (example: H and 4)
card 4: Consonant on one side and odd number on the other side. (example: N and 7)

Hang cards on a vertical surface, in any order, as follows:

card 1: Vowel is visible
card 2: Odd number is visible
card 3: Even number is visible
card 4: Consonant is visible

Inform the class:

Each card contains a letter on one side and a number on the other side.

Write on chalk board (or use an overhead transparency or sign):

Hypothesis: Any card with a vowel on one side has an even number on the other side.

Pose the question to the class:

How many experiments must be carried out (i.e., cards must be turned over) in order to prove or disprove this hypothesis?

Proceed to gather information from the class, by discussion, as to how many cards must be turned over, which ones, and why? NOTE: Do not supply any information, just record the responses from the class.

At the conclusion of the discussion, turn over the cards one at a time. Explaining why the card turned over is important or not important to the hypothesis. Turn the cards over in the order of:

1. Card 4
2. Card 3
3. Card 1
4. Card 2

EXPLANATION:

This activity demonstrates how science works. We formulate a hypothesis, plan our investigation, and - conduct experiments to test that hypothesis. In testing a hypothesis, we cannot do all possible experiments, so we must plan our investigation carefully - this is the class discussion.

Some students will insist that all four cards must be turned over. You might want to tell the class that you have a research grant of $4,000.00 or $5,000.00 and that it must pay for all the work done along with the laboratory costs and the salaries and benefits for all the investigators. Also, the cost of an experiment (*i.e.,* turning over a card) is $1,000.

Of the possible experiments, turning over one card may prove or disprove the hypothesis or may be irrelevant to the problem. One experiment will be too few for a thorough investigation. However, if the one experiment chosen disproves the hypothesis, no further experiments are necessary. The hypothesis is either modified or discarded.

Two experiments will probably be the best choice if carefully thought out.

Three experiments should cover the best choices with a third less important experiment.

Four experiments will be too many.

The importance of the cards are:

Card 1: A necessary experiment - it supports the hypothesis.
Card 2: A necessary experiment - it disproves the hypothesis.
Card 3: Not important since consonants are not addressed in the hypothesis. Also, since the even number was visible in the original set-up, it is not necessary to do this experiment. Thus, it would either support the hypothesis or be irrelevant.
Card 4: This card is irrelevant to the hypothesis.

ACKNOWLEDGEMENT:

The author wishes to thank Dr. Henry Heikkinen, University of Northern Colorado, for this activity.

POURING WATER BETWEEN TWO GLASSES

INTRODUCTION:

What is an observation? What is a conclusion? How does one investigate those observations? This activity explores how science works by collecting observations and then investigating them to verify conclusions, by experiments.

MATERIALS NEEDED:

water.
two 6-8 ounce glasses (glass or plastic)
optional materials may be used for a classroom activity (see procedure)

SAFETY PRECAUTIONS:

Wear safety goggles or glasses

There are no hazards associated with materials in this experiment.

DISPOSAL:

All materials in this experiment can be disposed of in the trash or down the drain.

EXPERIMENTAL PROCEDURE:

Fill a glass about 3/4 with water. Begin pouring water from one glass to another in a steady stream.

Question your audience for observations: "What do you observe?". Differentiate between observations and conclusions/explanations. For example, the observation is "bubbles" not "air bubbles". (Note: air bubbles is a conclusion since we don’t know if the bubbles are filled with “air”.) Write the observations on the chalk board or large pad on an easel.

At this point, the experimenter may want to form the audience into small groups and provide each group with two glasses and water so that they may experiment with the system and determine additional observations.

After compiling observations, the experimenter will question the audience. As an example, questions and responses will take form similar to the following:

The experimenter will help the participants determine what the bubbles are by asking appropriate questions and performing appropriate experiments.

Some appropriate responses for "bubbles" are:

Question: From past experience, when have you observed bubbles in a liquid?
Response: Boiling.
Question: Is this boiling?
Response: No it is not hot.
Question: Can I boil water at room temperature?
Response: No
Demonstration: Boil water in a closed system by reducing the pressure.
Question: Is it hot?
Experiment: Have someone touch the container of water.
Response: It is not hot.
Statement: The water does not have to be hot to boil.
Response: The cups are open to the air. The system containing the boiling water was a closed system.
Conclusion: The water is not boiling.

Other responses include: Bubbles sometimes appear in a liquid on standing. Bubbles form in soda (carbonated beverages).

To demonstrate bubbles in a carbonated beverage, shake the beverage container then open it. Another alternative is to put some carbonated beverage in a baby bottle, cap it with a nipple without a hole (available from EvenFlo customer service at 1-800-356-BABY.) and shake. Repeat with pure water.

Let some tap water stand. Observe the bubbles that form after while. Where did they come from?

Eventually, all possibilities will be exhausted leaving only the explanation that the bubbles are air bubbles. The experimenter may want to add examples from nature on how gases get mixed with water in streams, rivers, or oceans.

Another observation is "The water falls down."

Question: Why?
Response: Gravity
Question: Can we pour up?
Response: No (some speculation may be offered).
Experiment: Pour a gas from one inverted glass filled with air up to a second inverted glass filled with water, under water in a large battery jar or aquarium. (Yes, we can pour a gas up under water. The question was "Can we pour up?")

Another observation is "The water makes a sound as it pours."

Question: Describe the sound (repeat the pouring)
Response: It changes.
Question: What causes this?
Response: Vibrations (varied responses).
Experiment: Talk with hand over throat.
Back into a corner while talking.
Demonstrate the mechanism of a music box in air and place against an object.

Eventually, the participants will associate sound with vibrations in objects and moving through the air.

Another observation is "The stream of water twists as it falls."

Examine the stream of water. What does it look like when poured out of the glass? How does it change as it falls? What happens when it falls a greater distance such as from someone standing on a desk to a bucket on the floor? (These are all surface tension effects.)

Continue with the questioning, experiments, demonstrations, and examples. There are many experiments you can devise to explain observations that you can develop with time. Follow the observations as suggested by your audience. Take the class in the wrong direction and end up at a point showing the path you followed was wrong, your class will learn from mistaken hypotheses. Always differentiate between observations and hypothesis/explanation. This process can continue for as long as there is available time.

ACKNOWLEDGEMENT:
The author wishes to thank the late Herb Strongin, author of *Science on a Shoestring*, for this activity which Herb presented in a exciting and informative workshop.

CONSERVATION OF VOLUME

1. MATERIALS NEEDED:

2 clear acetate sheets, 8½ x 11 inches
rice
Clear tape (Scotch tape or equivalent)
pan or tray

2. SAFETY PRECAUTIONS:

There are no safety hazards in the experiment.

3. DISPOSAL:

There are no disposal hazards in this experiment.

4. PROCEDURE:

Roll one acetate sheet into a cylinder 8½ inches high. Butt the ends and tape them.

Roll a second acetate sheet into a cylinder 11 inches high. Butt he ends and tape them.

Place the 11-inch cylinder on a tray. Fill the cylinder with rice (uncooked). Tap lightly to settle the rice.

Place the 8½-inch cylinder around the tall cylinder. Ask the class, *What happens to the rice when the tall cylinder is removed?*.

Remove the tall cylinder.

5. EXPLANATION:

Calculate the volume of the two cylinders using the formula:

$$V = \pi r^2 h$$

where:

V = volume of cylinder
r = radius of the cylinder
h = height of the cylinder (either 8½ or 11 inches)

use the substitution:

$r = c/2\pi$ (c = circumference of the cylinder, either 8½ or 11 inches)

Acknowledgement: The author wishes to thank Dr. Courtney Willis, Department of Physics, University of Northern Colorado, for this demonstration.

HOT AND COLD

1. MATERIALS NEEDED:

2 beakers, 600 mL
Density box demonstration (Flinn Scientific no. AP4784)
Water
Food color
Hot plate

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses

Do not heat the water to boiling. It should be warm, but not too hot to handle.

3. DISPOSAL:

All materials in this experiment can be disposed of down the drain.

4. PROCEDURE:

Heat about 500 mL of water, in a beaker, until it is warm.

Place about 500 mL of cold tap water into a 600 mL beaker (ice water can be used, but is not necessary).

Place food color in each beaker of water. (Suggested: red for hot, blue for cold)

Simultaneously, pour the water from both beakers into different sides of the water density box.

Allow the water to sit for about 30 to 60 seconds. Remove the separator from the box.

5. EXPLANATION:

The density of water decreases with increased temperature.

6. UTILIZATION AND VARIATIONS:

This demonstrates the difference in density between hot and cold water. Can be used to explain why water in a lake can be warm on top and cold on the bottom. Also to explain how water in a lake turns over when cooling.

IRON FOR BREAKFAST

1. MATERIALS NEEDED:

Iron fortified breakfast cereal such as Total, Special K, etc...
Instant Total Oatmeal (packets) or other cereal containing iron (read the lablel)
water.
magnetic stir bar, Teflon coated, or a magnet painted white
beaker, 2000 mL or other large container (glass or clear plastic preferred)
magnetic stirrer or wood spoon
plastic bag (1 gallon size)

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses

There are no hazards associated with materials in this experiment.

3. DISPOSAL:

All materials in this experiment can be disposed of in the trash or down the drain.

4. PROCEDURE:

A. Iron in Processed Cereals

Place one to two cups of an iron enriched breakfast cereal, such as Total, Special K, etc..., in a plastic bag and crush the cereal.

Pour the cereal into a large beaker (about 2 Liter) and add 1 to 1.5 liters of water. Place a Teflon coated magnetic stirring bar (or a magnet painted white) into the mixture. Stir the mixture for about 15 minutes using either a wood spoon or a magnetic stirrer.

Use a stir bar retriever or pour the solution into a large waste container, taking care not to pour out the stir bar, and retrieve the stir bar. Examine the stir bar. What do you observe?

B. Iron in Instant Cereal

Obtain a package of Instant Total Oatmeal and a Teflon coated stir bar or a magnet pained white.

Open the package of oatmeal and place the magnet into the cereal. Stir the cereal with the magnet or hold the top closed and shake the package. Retrieve the magnet. Examine the stir bar. What do you observe?

5. EXPLANATION:

Iron is often added to fortified cereals in the form of powdered iron (often listed as reduced iron in the ingredients). Powdered iron is easy to measure and has no stability problems in this form.

Upon ingesting the cereal, some of the iron is dissolved in the stomach acid and will be absorbed into the system as it passes through the intestines. Not all the iron (as well as the other nutrients) will be absorbed. Remember, a single serving *contains* the daily adult requirement of vitamins and minerals.

Iron is added to the Instant Oatmeal packages along with the cereal. It is not cooked in.

6. UTILIZATION AND VARIATIONS:

This demonstration can be used in a discussion of the elements and their use or in a discussion of food and nutrition.

It is suggested that the experiment using Total, or other brand of cereal, be done first. The impact of the Instant Cream of Wheat is greater after the iron has been discovered in the processed cereal.

Repeat this experiment using weighed amounts of different brands of cereals to compare iron content.

Have students call the Consumer Departments of the cereal companies for additional information.

Acknowledgement: The author wishes to thank the late Dr. Babu George, Sacred Heart University, for the experiment with instant oatmeal.

TURNING PHENOLPHTHALEIN RED WITH ACID

1. MATERIALS NEEDED:

sulfuric acid, H_2SO_4, 3 M. Prepare 100 mL of solution by pouring 16.7 mL of concentrated sulfuric acid into 83.3 mL of water. If necessary, add water to a volume of 100 mL after solution cools.
sodium hydroxide, NaOH, 3 M. Prepare 100 mL of solution by dissolving 12 g of sodium hydroxide in 90 mL of water. Add water to a volume of 100 mL after solution cools.
phenolphthalein, 0.5%. Prepare 100 mL of solution by dissolving 0.5 g phenolphthalein in 60 mL ethyl alcohol and dilute to 100 mL with water.
4 test tubes, 18 x 150 mm or larger.
litmus paper, red and blue
stirrer

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses

Sulfuric acid is corrosive. Avoid skin contact. In the event of skin contact, flush affected areas well with water.

Sodium hydroxide is caustic. Avoid skin contact. In the event of skin contact, flush affected areas well with water.

3. DISPOSAL:

The materials used in this experiment should be diluted and neutralized and can be disposed of down the drain with running water.

4. PROCEDURE:

Place 10 mL of 3 M sodium hydroxide in a test tube. Add 2 or 3 drops of phenolphthalein solution and shake gently from side to side or stir until the pink color fades to colorless.

Test the sodium hydroxide solution with red litmus to show that the solution is basic. Test the sulfuric acid solution with blue litmus to show that it is acid.

Add 3 M sulfuric acid to the sodium hydroxide-phenolphthalein mixture dropwise, with gentle shaking or stirring until the solution turns red.

5. EXPLANATION:

Phenolphthalein has two color changes one at pH 8.2, where it turns pink, and one above pH 12, where it turns colorless. The pH of 0.1 M sodium hydroxide is 14. The pH of 3 M sodium hydroxide, in water solution, is undefined, that is the H^+/OH^- ratio is overloaded. In order to determine the pH of 3 M sodium hydroxide, the solvent must be changed to a weak base and the pH determined by the effect of the high OH^- concentration on the weak base equilibrium. Thus, in 3 M sodium hydroxide, the phenolphthalein is in its upper color change range (colorless).

When sulfuric acid is added to the sodium hydroxide solution, the base is partially neutralized and the pH is lowered sufficiently to turn the phenolphthalein pink.

The reaction for the neutralization is:

$$H_2SO_4 + 2\ NaOH \rightarrow Na_2SO_4 + 2\ H_2O$$

6. UTILIZATION AND VARIATIONS:

This demonstration is appropriate in a discussion of acids and bases and indicators. It is particularly effective since many students have been exposed to phenolphthalein as an indicator.

THE FIREPROOF BALLOON

1. MATERIALS NEEDED:

black balloons, 9 inch round or larger
water
flame proof board (a ceramic board or equivalent)
candle
250 mL beaker or plastic cup
trash can or bucket

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses

The burning candle presents a fire risk. A fire extinguisher should be available.

3. DISPOSAL:

There are no disposal hazards in this experiment.

4. PROCEDURE:

Prepare ahead: Place approximately 25 mL water into a black balloon. Put the balloon into a container such as a clean 250-mL beaker, or a clear plastic cup. Add a some additional balloons to the container, but make sure that the balloon containing the water can be easily removed.

Place a lighted candle on a flame proof board. Ask for a volunteer. Ask the volunteer to take a balloon, blow it up, and tie the end in a knot and demonstrate the process to him/her using the balloon containing the water. (Note: When picking up the water filled balloon, the experimenter should keep his/her hand in front of the balloon to conceal the mass of water in the balloon.)

Hold the balloon containing the water in the flame of the burning candle and ask the volunteer to repeat the experiment with his/her balloon.

5. EXPLANATION:

The water in the balloon will absorb the heat from the candle flame and will prevent the balloon from breaking. This is similar to the experiment where water is boiled in a paper cup.

6. UTILIZATION AND VARIATIONS:

At the conclusion of the demonstration, heat the balloon containing the water on the side while holding it over a trash can or bucket.

Demonstrate how water can be boiled in a paper cup.

Acknowledgement: The author wishes to thank Dr. Arthur Breyer, Beaver College, for this demonstration.

DISAPPEARING WATER

(SUPERABSORBANT MATERIAL)

Superabsorbents were originally developed by the United States Department of Agriculture in 1966. This material consisted of a grafted copolymer of hydrolyzed starch-polyacrylonitrile (polyacrylonitrile is commonly known as Acrilan, Orlon, or Creslan). The intended use was for additives for drilling fluid in off-shore secondary oil recovery operations and as agricultural thickeners. These materials were followed by synthetic superabsorbants that are polyacrylic and polyacrylonitrile based. Some of these materials are capable of absorbing up to 2000 times their weight of distilled water. The superabsorbent used in this demonstration, sodium polyacrylate, is capable of absorbing over 800 times its weight of distilled water. Due to the large amount of water these substances can absorb, they are know as "Super Slurpers". One of the most common applications of "Super Slurper" is in the liners of Ultra absorbent disposable diapers and other diapers labeled as being superabsorbant. Under this application, the polymer gel can absorb up to 80 times its weight in liquid.

1. MATERIALS NEEDED:

8 oz, or larger, white foam cup
water
piece of heavy card stock about 14 cm x 22 cm (5.5 in x 8.5 in)
sodium polyacrylate (available from Flinn Scientific Inc.)

2. SAFETY PRECAUTIONS:

The superabsorbant material may be a mild skin and body tissue irritant. Wash hands after using this material.

3. DISPOSAL:

Dispose of superabsorbant material in the trash.

4. PROCEDURE:

Add approximately 1/2 teaspoon (2.5 mL) of superabsorbant material to an 8 oz white foam cup.

Add between 50 and 100 mL of water to the cup.

Place a piece of heavy card stock over the top of the cup and turn it upside down. Ask the audience what is happening.

Remove the card from the cup. What happened?

5. VARIATION:

Print on the heavy card stock the phrase "DO NOT REMOVE". Keep this face down on the table to keep the print hidden from the audience.

After adding the water to the cup, place the card over the cup and turn the cup/card upside down. Ask someone to hold the cup and card. Then, place the cup/card on the volunteer's head and have then hold it in place.

Pause, and say to the audience "There's something written on the card." Carefully, but quickly, remove the card from under the cup. Hold it up for the audience to see. The problem is to now replace the card under the cup without "spilling the water" all over volunteer.

Hold the cup. Put the card next to the cup. Pick up the cup and place it on the card.

How sodium polyacrylate works:

Produce an ultra absorbent disposable diaper. Pour approximately 1 Liter of water onto the diaper. (The water may be colored yellow for extra effects.)

THE NON-BURNING PAPER

1. MATERIALS NEEDED:

ethyl alcohol, 95 %
beakers, 2, 400 mL
tongs
paper. Cut in strips about 6 cm x 15 cm (2.5 x 6 inches)
water
beaker, 800 or 1000 mL
candle

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses

Ethyl alcohol is flammable. Keep the container covered when not in use or when flames are nearby.

This experiment presents a fire risk. A fire extinguisher should be available.

3. DISPOSAL:

There are no disposal hazards in this experiment. Solid waste, when cool can be disposed of in the trash. The liquids can be poured down the drain.

4. PROCEDURE:

Pour 100 mL of ethyl alcohol into a 400 mL beaker. Cover the beaker with an inverted 800 of 1000 mL beaker.

Pour 100 mL of water into a 400 mL beaker.

Pick up a piece of paper with the tongs and hold it over a burning candle. What happens?

Pick up a piece of paper with the tongs, dip the paper into the water, and hold it over a burning candle. What happens?

Pick up a piece of paper with the tongs, dip the paper into the alcohol, and hold it over a burning candle. What happens?

Apparently, the wrong kind of paper was used. Try a dollar bill (does anyone have a twenty?) While the audience is searching for a dollar bill, pour the WATER INTO THE ALCOHOL without any comment.

Hold the dollar bill with the tongs, dip it into the water-alcohol mixture, and hold it over a burning candle. What happens?

5. EXPLANATION:

Paper burns when held in a flame. When wet (with water) paper will not burn. When wet with alcohol, both the alcohol and the paper will burn. When wet with a mixture of about 50% alcohol and water, the alcohol will burn, but there is sufficient water so that the paper will not burn.

Generally, about 50%, or more, of the audience will not realize you poured the water into the alcohol.

6. UTILIZATION AND VARIATIONS:

This can be made more visible by adding a small amount of salt, NaCl, to the alcohol.

CUT AND HEAL

1. MATERIALS NEEDED:

large kitchen knife (edge must be dull)
0.3 M iron(III) chloride solution, $FeCl_3$
0.3 M potassium thiocyanate solution, KSCN
0.3 M sodium thiosulfate solution, $Na_2S_2O_3$
cotton balls or absorbent cotton

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses

The edge of the knife must be dull so you cannot cut your skin.

Iron(III) chloride solution can cause illness if ingested and can irritate the skin. In the event of skin contact wash the affected area with water.

Label each bottle of chemical with the actual contents of the bottle. For the demonstration only, you can add a temporary label of "iodine" to the $FeCl_3$ container, "alcohol" to the KSCN container, and "antiseptic" to the $Na_2S_2O_3$ container.

Wash the areas of skin treated with chemicals from this experiment with water.

3. DISPOSAL:

Cotton balls that are wet with chemicals from this experiment, can be disposed of in the trash.

4. PROCEDURE:

Show your audience the large knife.

"Sterilize" your arm with "iodine" (the $FeCl_3$ solution) on a cotton ball.

"Sterilize" the knife blade with "alcohol" (the KSCN solution) on a cotton ball.

Slowly and carefully, "cut" your arm. The area will turn dark red.

Heal your arm by applying the "antiseptic" (the $Na_2S_2O_3$ solution) on a cotton ball.

OBSERVATIONS OF A BURNING CANDLE

1. MATERIALS NEEDED:

a potato
Brazil nut or pecan
lemon juice
knife
cork borer, about 3/4 inch diameter
cup

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses

This experiment presents a fire risk. A fire extinguisher should be available.

3. DISPOSAL:

There are no disposal hazards in this experiment.

4. PROCEDURE:

Prepare ahead: Using the cork borer, cut a few sections from a potato. Put the cylindrical pieces of potato in lemon juice to prevent discoloration. Obtain some Brazil nuts. Using a sharp knife, carve the nut into a thin sliver about the size of a candle wick. Remove a potato section from the lemon juice, dry it, and cut the ends square. Make a small slit or hole in one end and insert the Brazil nut sliver. Use a match to blacken the piece of nut.

Put the "candle" on a clean table top. Light the wick. Ask the audience to record observations on the object on the from table (do not call it a candle). As the flame starts to decrease in size (after 1-2 minutes), blow out the flame and ask the audience to continue making observations.

Quiz the audience, collecting the observations which may be written on a chalkboard or an acetate overhead transparency.

As the session ends, remind the group that "things are not always what they appear to be" and EAT THE CANDLE. Walk out of the room.

5. EXPLANATION:

This works well if it follows other experiments that have used a candle in the same session. However, once the word gets out, the surprise aspect is lost. This should only be done on an occasional basis, not as a regular demonstration.

A Brazil nut contains sufficient oil to burn for about two minutes.

I have had people tell me that they have seen the wax melt and drip down the sides.

I never refer to this experiment again in class.

6. UTILIZATION AND VARIATIONS:

Other kinds of nuts have been used successfully by others. Candles have also been made from apples, bananas, and other fruit.

Acknowledgement: The author wishes to thank Lee Marek, Naperville High School, for this demonstration.

RED SUNSET

1. MATERIALS NEEDED:

sodium thiosulfate, $Na_2S_2O_3$
2000 mL beaker
paper to cover the overhead projector
1 M hydrochloric acid, HCl
overhead projector

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses

The dilute hydrochloric acid used in this experiment is mildly corrosive. In the event of skin contact, wash well with water.

3. DISPOSAL:

This procedure generates colloidal sulfur. Dispose of the solution according to local regulation.

4. PROCEDURE:

Cover the glass of an overhead projector with a sheet of paper with a circular hole in it approximately 3.5 to 5.0 cm in diameter.

Using a 2000 mL beaker, add 1500 mL water and 10 g sodium thiosulfate, $Na_2S_2O_3$, to 1500 mL water. Stir until dissolved.

Place the beaker over the hole in the paper covering the overhead projector, turn on the light and add 100 mL 1 M hydrochloric acid, HCl.

Observe the changes of the light beam as it passes through the liquid and the color of the projected light spot on the wall or screen.

Vary rate by changing amount of hydrochloric acid.

5. EXPLANATION:

The sodium thiosulfate decomposes in acid solution to produce colloidal sulfur. As the reaction proceeds, the beam of light can be seen as it passes through the solution. This is known as the Tyndall effect.

As the concentration of the colloidal sulfur increases in the solution, the shorter wavelength light (blue) is scattered while the longer wavelengths (red) passes through. Thus, the projected light beam becomes more red in color. Eventually, the concentration of the colloidal sulfur becomes so great that no light is transmitted.

This process simulates the effect of the sun setting in the west. As the sun moves lower to the horizon, relative to the observer, particulate matter in the air scatters the light allowing the longer wavelengths to be transmitted and producing a red sunset.

6. UTILIZATION AND VARIATIONS:

Mount cutouts of palm trees, city skylines, trees, snowmen, etc... over the hole in the paper to produce special effects. Use appropriate music for the special effects (*i.e.,* Hawaiian music with palm trees, Christmas music with evergreens and snowmen, etc...). NOTE: This demonstration is available in kit form from Flinn Scientific under the name *The Aloha Chemical Sunset*)