# Chemistry for Scouts

MONTGOMERY COLLEGE

# Activity Patch for All Scouts

## ACS Chemistry Activity Patch

**Purpose**

- To interest young people in chemistry through activities held during National Chemistry Week and other chemistry-related events.
- To offer a mechanism by which participants can develop positive attitudes towards science and chemistry.
- To provide the opportunity for participants to explore interesting career opportunities in chemistry.

**Chemistry Patch Activities**

- Scout who complete the appropriate age/rank activities today have completed the requirements for the American Chemical Society Activity Patch.
- For more information  please visit: https://www.acs.org/content/acs/en/education/outreach/ncw/chemistry-activity-patch.html.

# **Cub Scouts -** *Signature Card*

## Tiger Scouts

## Explore Chemistry

1. Make **static electricity.**
   - ☐ Rub a balloon on a fleece blanket or wool sweater.
   - ☐ What happens when you hold the balloon close to your hair? Another balloon? Strips of mylar?

2. Do a **sink-of-float** investigation.
   - ☐ Build a Cartesian diver.
   - ☐ What happens when you squeeze the bottle?

3. Do a **color-morphing** investigation.
   - ☐ Make silly-putty and make it change color.
   - ☐ Explain what you learned.

4. Learn about **chromatography**.
   - ☐ Conduct a chromatography experiment using felt-tipped markers.
   - ☐ What did you learn?

5. Get your **fingerprints** taken.
   - ☐ What did you learn about your fingerprint pattern?

# Cub Scouts - *Signature Card*

## Bear Elective Adventures:
## Super Science

1. Make **static electricity.**
   - ☐ Rub a balloon on a fleece blanket or wool sweater.
   - ☐ Explain what you learned.

2. Conduct a **static electricity** investigation with an electroscope.
   - ☐ Explain what you learned.

3. Conduct **another static electricity** investigation.
   - ☐ Rub a plastic pipe on a fleece blanket and see what it does to thin strips of mylar.
   - ☐ Explain what you learned.

4. Do a **sink-of-float** investigation.
   - ☐ Build a Cartesian diver.
   - ☐ Explain what you learned.

5. Do a **color-morphing** investigation.
   - ☐ Make silly-putty and make it change color.
   - ☐ Explain what you learned.

6. Do a **color-layering** investigation.
   - ☐ Float an egg in a saltwater and pure water solution.
   - ☐ Why does the egg float?
   - ☐ What happens when the color layers start to mix?


## Bear Elective Adventures:
## Super Science


7. Make **static electricity.**
   - ☐ Rub a balloon on a fleece blanket or wool sweater.
   - ☐ Explain what you learned.

8. Conduct a **static electricity** investigation with an electroscope.
   - ☐ Explain what you learned.

9. Conduct **another static electricity** investigation.
   - ☐ Rub a plastic pipe on a fleece blanket and see what it does to thin strips of mylar.
   - ☐ Explain what you learned.

10. Do a **sink-of-float** investigation.
    - ☐ Build a Cartesian diver.
    - ☐ Explain what you learned.

11. Do a **color-morphing** investigation.
    - ☐ Make silly-putty and make it change color.
    - ☐ Explain what you learned.

12. Do a **color-layering** investigation.
    - ☐ Float an egg in a saltwater and pure water solution.
    - ☐ Why does the egg float?
    - ☐ What happens when the color layers start to mix?

# Cub Scouts - *Signature Card*

## Bear Elective Adventures:

## Forensics

1. Talk with your Den Leader about forensics and how it is used to solve crimes.

2. Analyze your **fingerprints**.
   - ☐ What did you learn about your fingerprint pattern?

3. Learn about **chromatography** and how it is used to solve crimes.
   - ☐ Do a chromatography experiment using different types of felt-tipped markers.
   - ☐ Explain what you learned.

4. **Analyze** four different substances.
   - ☐ salt, sugar, baking soda, and cornstarch
   - ☐ Explain what you learned.

***Complete these requirements with your Den Leader:***

1. *Make a shoe imprint.*
2. *Visit the sheriff's office or police station in your town.*
   - *Find out how officers collect evidence.*
3. *Learn about the different jobs available in forensic science.*
   - *Choose two, and find out what is required to work those jobs.*
   - *Share what you learned with your den.*
4. *Learn how animals are used to gather important evidence.*
   - *Talk about your findings with your den.*


## Bear Elective Adventures:

## Forensics


5. Talk with your Den Leader about forensics and how it is used to solve crimes.

6. Analyze your **fingerprints**.
   - ☐ What did you learn about your fingerprint pattern?

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# Cub Scouts - *Signature Card*

## Webelos/AOL Elective

## Adventures in Science

1. An experiment is a "fair test" to compare possible explanations. Draw a picture of a fair test that shows what you need to do to test a fertilizer's effects on plant growth. *(Complete with Den Leader.)*

2. **Visit** a museum, **a college, a laboratory**, an observatory, a zoo, an aquarium, or other facility that employs scientists. Prepare three questions ahead of time, and talk to a scientist about his or her work.

3. Complete the following:
   g. With adult assistance, **explore safe chemical reactions** with household materials. Using two substances, observe what happens when the amounts of the reactants are increased.

Complete *3 additional activities* with your Den Leader to complete this badge:

a. Carry out the experiment you designed for requirement 1, above. Report what you learned about the effect of fertilizer on the plants that you grew.
b. Carry out the experiment you designed for requirement 1, but change the independent variable. Report what you learned about the effect of changing the variable on the plants that you grew.
c. Build a model solar system. Chart the distances between the planets so that the model is to scale. Use what you learn from this requirement to explain the value of making a model in science.
d. With adult supervision, build and launch a model rocket. Use the rocket to design a fair test to answer a question about force or motion.
e. Create two circuits of three light bulbs and a battery. Construct one as a series circuit and the other as a parallel circuit.
f. Study the night sky. Sketch the appearance of the North Star (Polaris) and the Big Dipper over at least six hours. Describe what you observed, and explain the meaning of your observations.
g. *Safe chemical reactions (see other side of card).*
h. Explore properties of motion on a playground. How does the weight of a person affect how fast they slide down a slide or how fast a swing moves? Design
i. Read a biography of a scientist. Tell your den leader or the other members of your den what the scientist is famous for and why his or her work is important

# Boy Scouts
## *Chemistry*
### *MC Signature Card*

MONTGOMERY COLLEGE

Department of Chemistry
Montgomery College
Rockville, MD 20850
chemistry@montgomerycollege.edu

Chemistry Signatures:
Laura Anna, Ph.D.
Orna Kutai, Ph.D.
Alycia Palmer, Ph.D.
Patricia Takahara, Ph.D.
Timothy Watt, Ph.D.

| CHEMISTRY– Merit Badge Activities |   |
|---|---|
| | MC Faculty Signature |
| 1. **Laboratory Safety**<br>a. Describe three examples of lab safety equipment.<br>b. Explain the information contained in a Safety Data Sheet.<br>c. Compare SDS for a paint and an insecticide.<br>d. Describe the safe storage of chemicals. | |
| 2. **Chemical and Physical Properties**<br>a. Explore what happens when an iron nail is placed in a solution of copper sulfate.<br>b. Describe various physical/chemical separations.<br>c. Differentiate between physical and chemical changes. | |
| 3. **Cartesian Diver** | |
| 4. **Chemical and Physical Changes**<br>*a. Cooking an onion (do this on your own)*<br>b. Describe the difference between toothpaste and an abrasive household cleanser.<br>c. Mix oil and water and describe the result. Use a substance to help the oil and water combine. Explain. | |
| 5. **Four Divisions of Chemistry** | |
| 6. **Chemistry and the Environment**<br>a. Government agencies and describe responsibilities<br>b. Define pollution and explain what is being done to address the problem. | |
| 7. **Talk to a Practicing Chemist** | |

# Boy Scouts

## *Nuclear Science*

### *MC Signature Card*

MONTGOMERY COLLEGE

Department of Chemistry
Montgomery College
Rockville, MD 20850
chemistry@montgomerycollege.edu

Nuclear Science Signatures:
Laura Anna, Ph.D.
Orna Kutai, Ph.D.
Alycia Palmer, Ph.D.
Patricia Takahara, Ph.D.
Timothy Watt, Ph.D.

| NUCLEAR SCIENCE – Merit Badge Activities | MC Faculty Signature |
|---|---|
| **1. Radiation**<br>a. Define radiation.<br>b. Describe hazards of radiation, ALARA principle.<br>c. Describe radiation hazard symbols, radiation safety. | |
| **2. Subatomic Particles**<br>a. Describe subatomic particles.<br>b. Locate the element carbon on the periodic table. Construct a model of $^{12}C$, $^{13}C$, and $^{14}C$. | |
| **3. Visit a research lab where people study the properties of the nucleus or nucleons**<br>Explain how and why the scientists study the nucleus. | |
| **4. Types of Radiation**<br>a. Build an electroscope.<br>b. Visit a place where radioisotopes are being used. Explain how and why they are used. | |
| **5. Radiation Safety**<br>a. Use a radiation survey meter to measure radioactive source<br>Explore how time, distance, and shielding affect dose. | |
| **6. Nuclear Science and Energy**<br>a. Make a drawing depicting nuclear fission.<br>Make a drawing showing how to start/stop a chain reaction.<br>Explain what is meant by "critical mass." | |
| **7. Applications of Nuclear Science** | |
| **8. Careers in Nuclear Science** | |

# Girl Scouts – *Signature Cards*

## Brownies
## Home Scientist

1. **Kitchen Chemist**
   - ☐ Make a salad dressing.

2. **Static Electricity**
   - ☐ Follow the balloon leader.

3. **Density**
   - ☐ Try to keep an egg suspended in salt water.
   - ☐ Place raisins in clear soda. What happens? Why?

4. **Bubble Up**
   - ☐ Make a mini-volcano. Observe what happens and explain the chemical reactions involved.

5. **Play with Science**
   - ☐ Create some homemade silly putty.

## Juniors:
## Detective

**Complete *this activity* at home to complete this badge:**

1. Practice the Power of observation (choose one)
   - ☐ Ask an adult helper to find and watch a one-minute online video.
   - ☐ Shake up a room.
   - ☐ Take notice.

2. Communicate in Code
   - ☐ Make invisible ink and decode a message.
   - ☐ Use lemon juice and then use baking soda in water.

3. Fingerprint for Fun
   - ☐ Study the fingerprints in the Great Cookie Caper.
   - ☐ Get fingerprinted.

4. Detective Science
   - ☐ Use a magnifying glass or other tool to look at three other kinds of "evidence" from the Great Cookie Caper.

5. Solve a Mystery!
   - ☐ Inspect the Great Cookie Caper crime scene.
   - ☐ Use the evidence gathered to solve the mystery.

# **Girl Scouts** – *Signature Cards*

## Cadettes –
## Special Agent

cadettes

1. Investigations
   - ☐ Identify the forensic tools and techniques used by detectives.
   - ☐ Use some of these tools to collect information from the Great Cookie Caper crime scene.

2. Reveal Reality
   - ☐ Play detective and analyze some impressions and other physical evidence left at the crime scene.

3. Forensic Science
   - ☐ Use the forensic chemistry technique called chromatography to help identify a suspect in the Great Cookie Caper.

4. Voice Analysis
   - ☐ Use the microphone attached to a LabQuest device to analyze your own and others' voices. Explain how this might be used to identify a suspect.

5. The Art of Detection
   - ☐ Use all the evidence gathered from the Great Cookie Caper crime scene to identify a suspect. Discuss with other scouts to see if they agree with your conclusions.

## Seniors –
## Science of Style

seniors

1. Test skin care and makeup.
   - ☐ **Make and test a hand cream.**

2. Examine the science behind fabrics and accessories.
   - ☐ **Test sunglasses. Explain which pair of sunglasses you would choose in order to protect your eyes from ultraviolet radiation.**

3. Explore the science behind hair products and perfume.
   - ☐ **Soak some hair in dye and examine by using a microscope. Note what you see. What does this tell you about the chemistry of hair dye?**

**Complete *these additional activities* at home to complete this badge:**

4. Investigate the sociology of style (choose one)
   - ☐ Make a timeline of fashion trends
   - ☐ Conduct a style experiment
   - ☐ Host a wear-a-thon

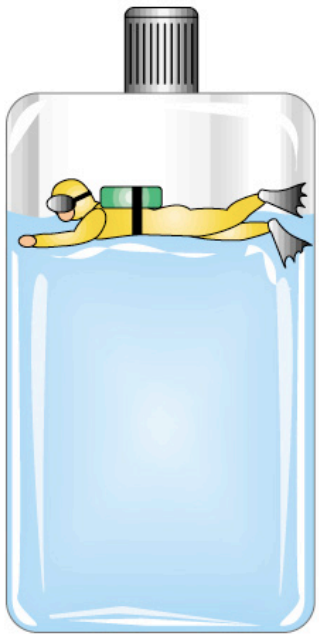
5. Formulate future style (choose one)
   - ☐ Make something eco friendly
   - ☐ Create your own science-of-style project
   - ☐ Forecast fashion, beauty or hair trends

# Graphics for Activity Stations

# Cartesian Diver

## *Archimedes Principle*

- The amount of water displaced by the object affects the buoyant force acting upon the object.
- Buoyant force is equal to the mass of water displaced.
- More displacement – more buoyant force and object floats.
- An object that is *less dense* than water will float.
- How does the scuba diver shown below sink?



## Procedure

1. Make a Cartesian diver by using a disposable pipet and a piece of metal. Cut off the long end of the pipet.
2. Fill a beaker or other small container with water.
3. Squeeze the pipet bulb and draw up a small amount of water.
4. Place the diver into the water. Does it float? Adjust the amount of water until it floats.
5. Place the diver into a plastic bottle filled with water. Fill to the top and close tightly.
6. Squeeze the bottle. Observe what happens.

## Observations and Analysis

Observe what happened during the experiment and try to answer the following questions:

- How did you make the diver sink? Why does this happen?
- How did you make the diver float? Why does this happen?
- What would happen if you heated up the water? Cooled it?
- How does the behavior of gases affect scuba divers?
- How does the behavior of gases affect mountain climbers?

# Iron and Copper Sulfate

What color is the iron nail? **Fe**

What color is solid copper? **Cu**

What color is copper sulfate? **$CuSO_4$**

What do you think is going to happen?

Iron is **Fe** (Latin: *ferrum*).
Copper is **Cu** (Latin: *cuprum*).

Fe(s) reacts to form $Fe^{3+}$ in solution.

Fe(s) loses some electrons! Where do they go?

$Cu^{2+}$ in solution reacts to form Cu(s).

$Cu^{2+}$ gains some electrons! Where did they come from?

$$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{3+}(aq) + Cu(s).$$

All charges and atoms must balance:

$$\mathbf{2}\ Fe(s) + \mathbf{3}\ Cu^{2+}(aq) \rightarrow \mathbf{2}\ Fe^{3+}(aq) + \mathbf{3}\ Cu(s).$$

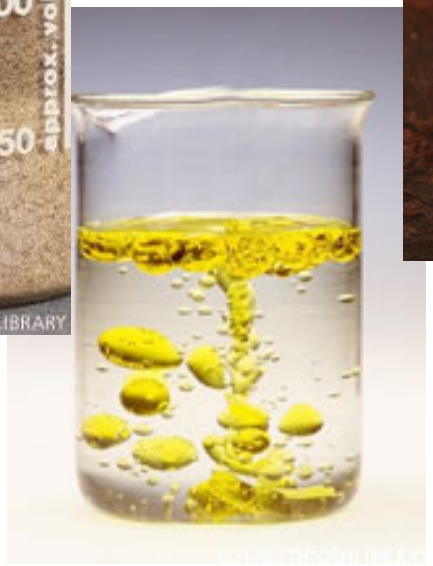
# Separating Substances

Sand and Water

Oil and Water

Salt and Water

Motor Oil and Gasoline


# Separating Substances

- Describe how you separate each of the mixtures.
- What lab equipment would you use?

# Physical *vs.* Chemical Changes

## Physical Change

*The phase may change, but the substance itself does not change.*

## Chemical Change

*A chemical reaction involves making/breaking bonds.*

Sort out the chemical and physical changes.

iron rusting

boiling water

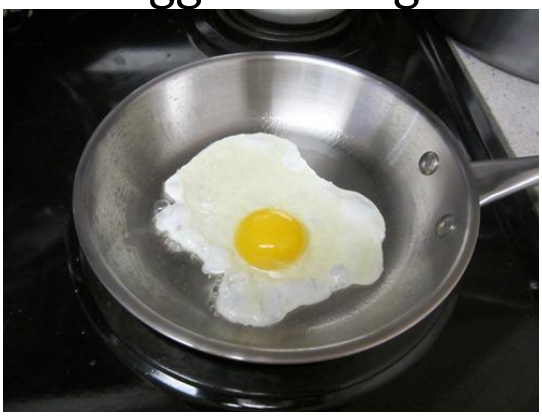
burning candles

gasoline burning


chopping potatoes

cooking steak on a grill

eggs cooking



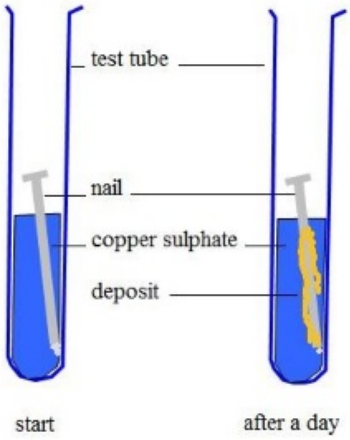
chopping wood

a campfire burning

magnetizing a compass needle

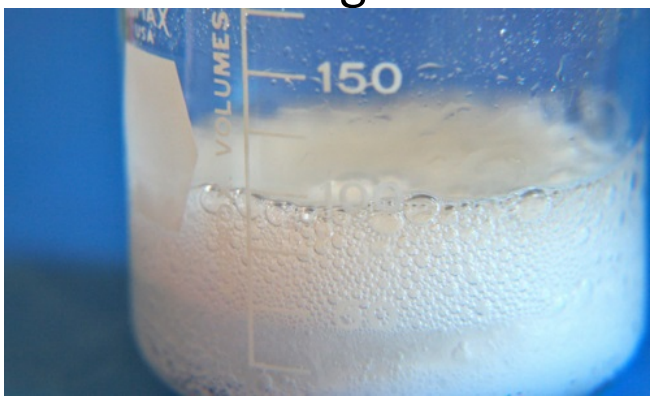

fireworks

iron nail in copper sulfate



making hot coffee

mixing baking soda and vinegar




dissolving sugar in water

baking a cake

melting ice

melting wax

# Challenge

Separate the cards into two piles.

One pile for **physical changes**.

The other pile for **chemical changes**.

# Graphics for Activity Stations

# Survey for Radiation

## Use a Geiger counter to survey several objects.

- Are any of the objects radioactive?
- What happens as you get closer to the object?
- What happens as you move away?

## How might you shield yourself from radiation?

- Try the materials available.
- Which one makes the best shield?
- Explain how time, distance, and shielding affects radiation dose.

U.S.NRC
United States Nuclear Regulatory Commission
*Protecting People and the Environment*

As defined in Title 10, Section 20.1003, of the Code of Federal Regulations (10 CFR 20.1003), **ALARA** is an acronym for "as low as (is) reasonably achievable," which means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest. For additional detail, see Dose Limits for Radiation Workers and Dose Limits for Radiation Workers.

# Chemical Formulation of Products

What are the similarities and differences between toothpaste and an abrasive cleaner?

Look under a microscope at each.

Why are these products formulated like they are? What do chemists have to think about when making such a product?

# Chemical Formulation of Products



- What other products do you have at home?
- What do you think they would look like under a microscope?

# Oil and Water

What happens when you mix them?

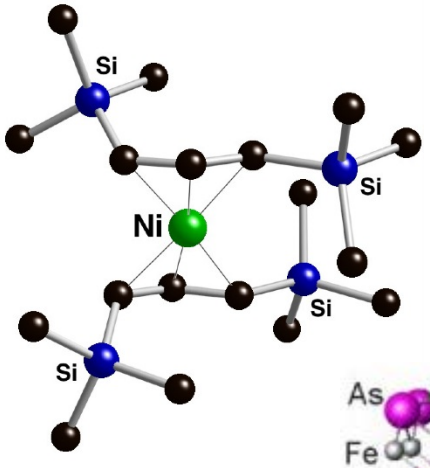
Why does this happen?

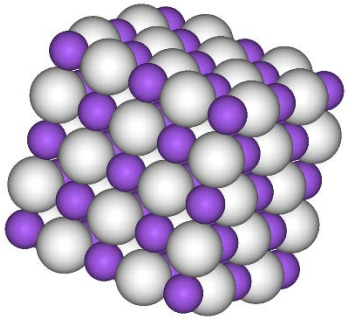
- *What is the chemical structure of oil?*
- *What is the chemical structure of water?*

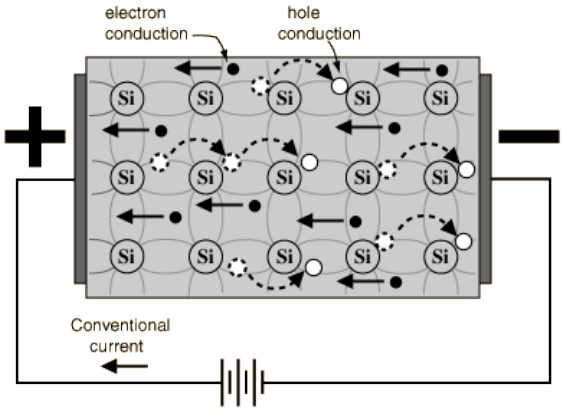
How can you make oil and water combine?

# Inorganic Chemistry

*is chemistry not involving carbon as the central atom. Many inorganic chemists study metals and their reactio*

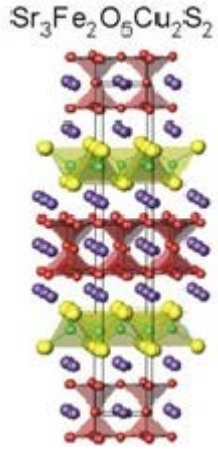


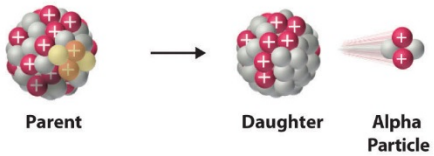
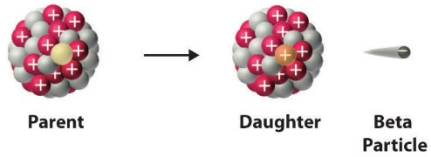
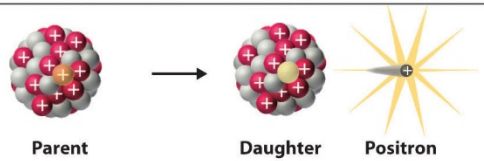
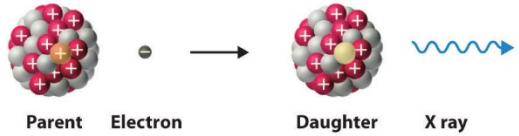
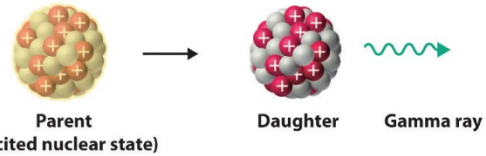
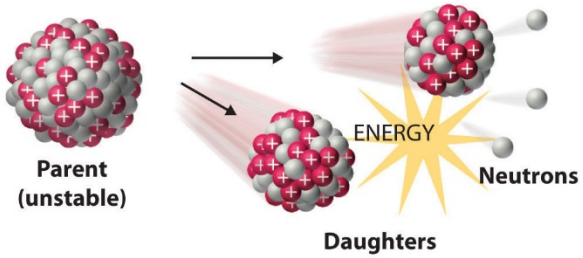







LiFeAs

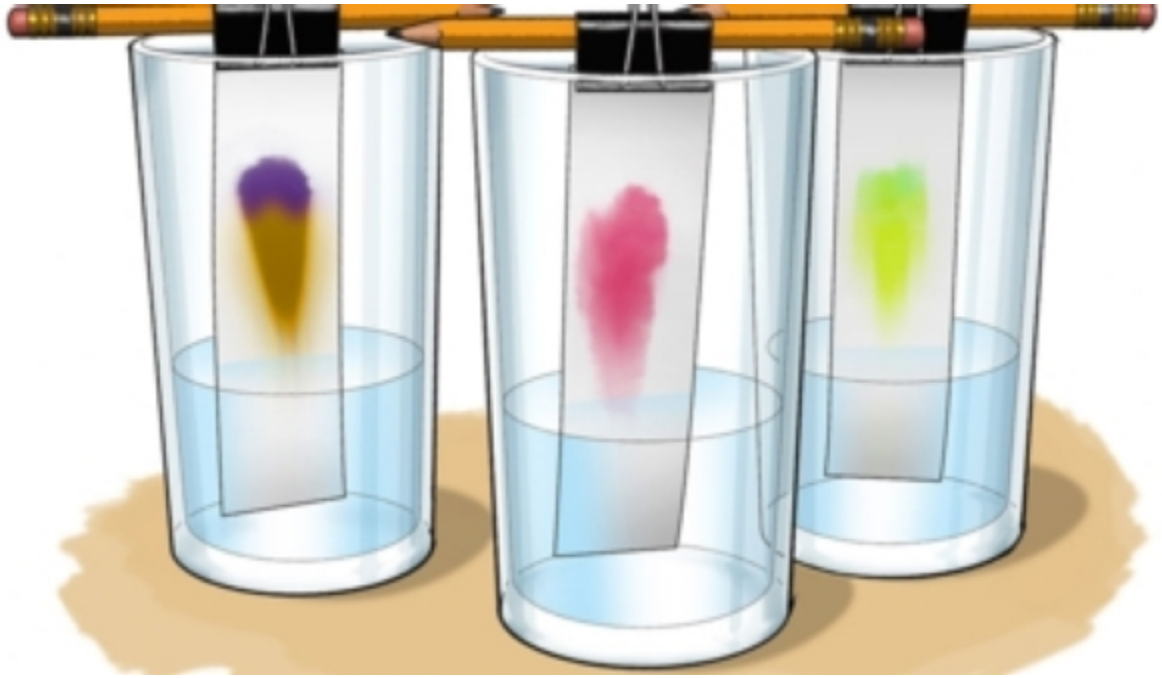


| Decay Type | Radiation Emitted | Generic Equation | Model |
|---|---|---|---|
| Alpha decay | ${}^{4}_{2}\alpha$ | ${}^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}X' + {}^{4}_{2}\alpha$ |   |
| Beta decay | ${}^{0}_{-1}\beta$ | ${}^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}X' + {}^{0}_{-1}\beta$ |   |
| Positron emission | ${}^{0}_{+1}\beta$ | ${}^{A}_{Z}X \longrightarrow {}^{A}_{Z-1}X' + {}^{0}_{+1}\beta$ |   |
| Electron capture | X rays | ${}^{A}_{Z}X + {}^{0}_{-1}e \longrightarrow {}^{A}_{Z-1}X' + \text{X ray}$ |   |
| Gamma emission | ${}^{0}_{0}\gamma$ | ${}^{A}_{Z}X^{*} \xrightarrow{\text{Relaxation}} {}^{A}_{Z}X' + {}^{0}_{0}\gamma$ |   |
| Spontaneous fission | Neutrons | ${}^{A+B+C}_{Z+Y}X \longrightarrow {}^{A}_{Z}X' + {}^{B}_{Y}X' + {}^{1}_{0}n$ |   |

# Graphics for Activity Stations

# Chromatography

Chemists use chromatography to separate substances. Paper chromatography can be used to separate inks. Most inks, even black ink, are made by mixing colors together.



**Procedure**

1. Try to separate an ink into its colors.
2. Choose a marker. What colors do you think make up that marker?
3. Perform a paper chromatography experiment.
4. Were you correct?

# Density

If you had two boxes of equal size and filled one with rocks and the other with feathers, which one would be heavier?

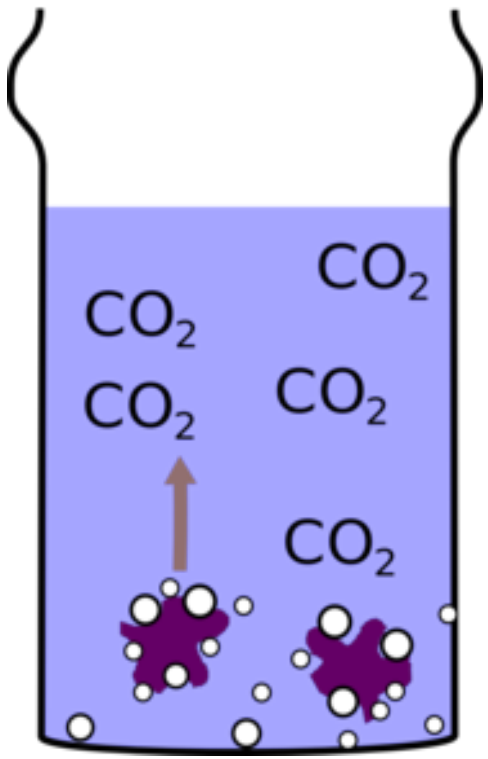
The boxes have the same volume but one is much heavier than the other. The heavier one has a higher *density*.

Density is defined as the mass of an object divided by its volume.

**Procedure**

1. Experiment with density by putting some clear soda in a beaker and then adding some raisins.

   What happens? Why?




Density

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Density is defined as the mass of an object divided by its volume.

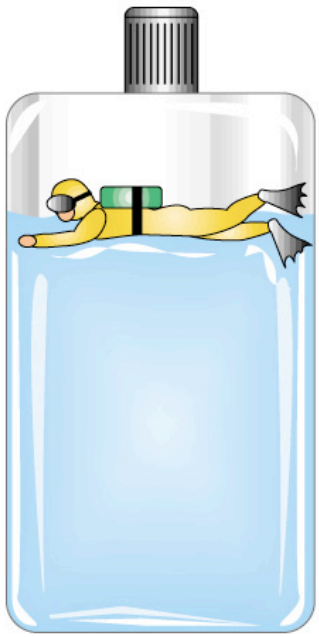
**Procedure**

1. Try to keep an egg floating in salt water. Test the egg in the same amout of regular water. Explain what happens.
2. Floating an egg and color layering.
    - Fill a beaker ~1/3 full with salt water. Add a drop of food color and mix.
    - Fill another beaker ~1/3 full with regular water. Add a drop of a different food color and mix.
    - Carefully layer the regular water solution onto the salt water. What happens? Why?
3. Place an egg in the layered, colored solution. Explain what happens.

# Cartesian Diver

## *Archimedes Principle*

- The amount of water displaced by the object affects the buoyant force acting upon the object.
- Buoyant force is equal to the mass of water displaced.
- More displacement – more buoyant force and object floats.
- An object that is *less dense* than water will float.
- How does the scuba diver shown below sink?



## Procedure

1. Make a Cartesian diver by using a disposable pipet and a piece of metal. Cut off the long end of the pipet.
2. Fill a beaker or other small container with water.
3. Squeeze the pipet bulb and draw up a small amount of water.
4. Place the diver into the water. Does it float? Adjust the amount of water until it floats.
5. Place the diver into a plastic bottle filled with water. Fill to the top and close tightly.
6. Squeeze the bottle. Observe what happens.

## Observations and Analysis

Observe what happened during the experiment and try to answer the following questions:

- How did you make the diver sink? Why does this happen?
- How did you make the diver float? Why does this happen?
- What would happen if you heated up the water? Cooled it?
- How does the behavior of gases affect scuba divers?
- How does the behavior of gases affect mountain climbers?

# Salad Dressing

## *Mixing Oil and Vinegar*

The main ingredients in some salad dressings are oil and vinegar. You usually have to shake these dressings before pouring them onto your salad. Why?

**Procedure**

1. Mix a small amount of vegetable oil and a small amount of vinegar in an Erlenmeyer flask.
2. Carefully swirl to mix.
3. What do you see?
4. Cover the flask and shake a bit harder.
5. What do you see?
6. Is there any way to make these two substances mix?

   Would this be a good idea with salad dressing?

# Invisible Ink

1. Write message using a cotton swab dipped in lemon juice.
2. After the message dries, gently heat with a hair dryer.
3. Does the message appear after heating?
4. Try again with a 1:1 solution of baking soda and water.
5. Get a friend to write you a message and see if you can figure out what it says.
6. If there is a message associated with the crime scene, see if you can read it.

# Powder Analysis

Carefully analyze four different substances:

**Salt**


**Sugar**


**Baking Soda**


**Corn Starch**


What are the similarities? The differences?

Study the unknown sample. Identify its contents.

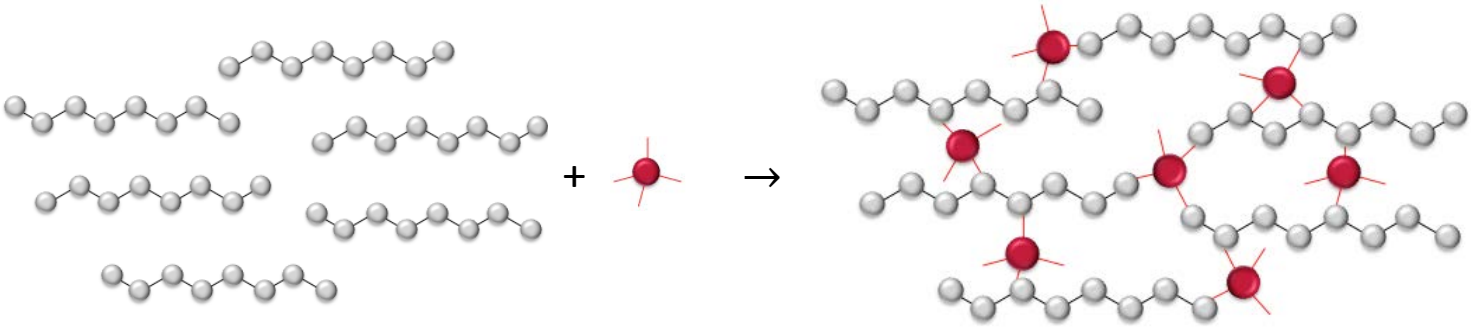
# Powder Analysis Data

| Powder | Color | Odor | Crystals? Powder? | Fine? Course? | Solubility | Other |
|---|---|---|---|---|---|---|
| Salt | | | | | | |
| Sugar | | | | | | |
| Baking Soda | | | | | | |
| Corn Starch | | | | | | |
| Unknown | | | | | | |

Did you identify your unknown correctly?

# SLIME

Elmer's glue is made up of a polymer called *polyvinyl acetate*. When Elmer's glue comes into contact with molecules of borate, a process called cross-linking occurs. After the polymer molecules are cross-linked, they can no longer slide past each other. Instead of acting like a liquid, the substance acts more like a rubbery, sticky solid.




Polymer: Elmer's Glue  Borate  Cross-linked Polymer: Slime

## Procedure

1. Spread a paper towel out on the desk/table in front of you. The paper towel will absorb any accidental spills or leaks.

2. Fill a plastic cup to the first line with water. Add a half-scoop of Borax.

3. Fill a separate plastic cup to the third line with 50/50 glue and water mixture.

4. Pick two food colors to add to your slime. What color will your slime be? Add one drop of each to the glue mixture.

5. While stirring the borax solution with a wooden stirrer, slowly pour in the glue mixture.

6. Keep stirring until you get one big slimy blob.

7. Use the stick to transfer the slime sample to the sandwich bag. Close the sandwich bag and roll the slime around until it does not look wet any longer.

8. Take the slime out of the bag and set it on top of an upside-down cup. Observe what happens.

9. Take your slime home in a plastic bag. It should last several days if you keep the bag closed.

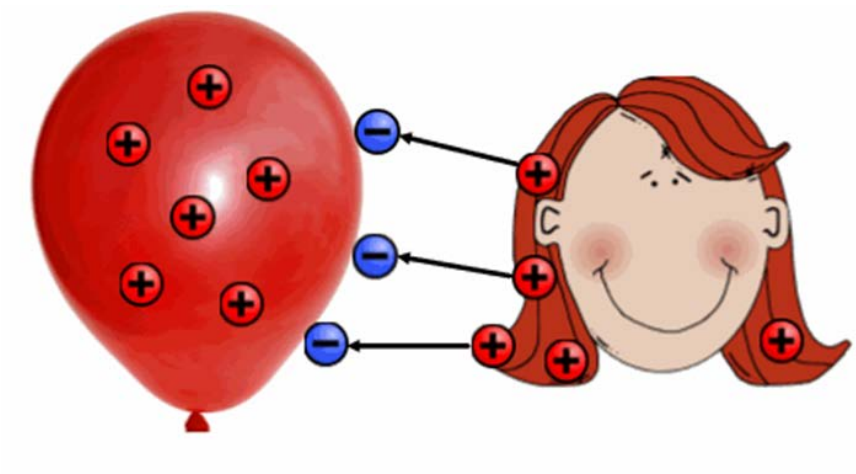
## Observations and Analysis

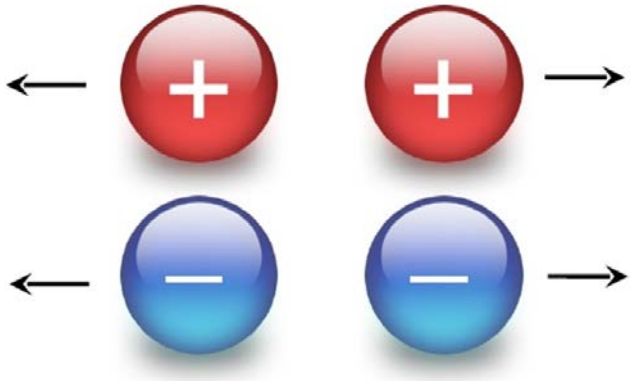
Observe what happened during the experiment and try to answer the following questions:

- How did the substances change?
- How does the slime behave?
- Is it a liquid? A solid?
- Pull your slime gently and stretch it out.
- Roll it back up and then pull it quickly and see what happens.

# Static Electricity

Static electricity occurs when there is a buildup of electric charge on a surface. The charges do not move, so it is called *static* electricity.





**Procedure**

1. Rub a balloon a fleece or a sweater.
2. Hold the balloon close to your hair. What happens? Why?
3. Hold the balloon close to thin strands of mylar. What do you observe?
4. Hold the balloon next to another balloon. Can you make one ballon follow the other?
5. Rub a piece of pipe on a fleece of sweater. Try the same experiments and explain what you see.
6. Analysis: Do you ever produce static electricity at home? What happens when you do?

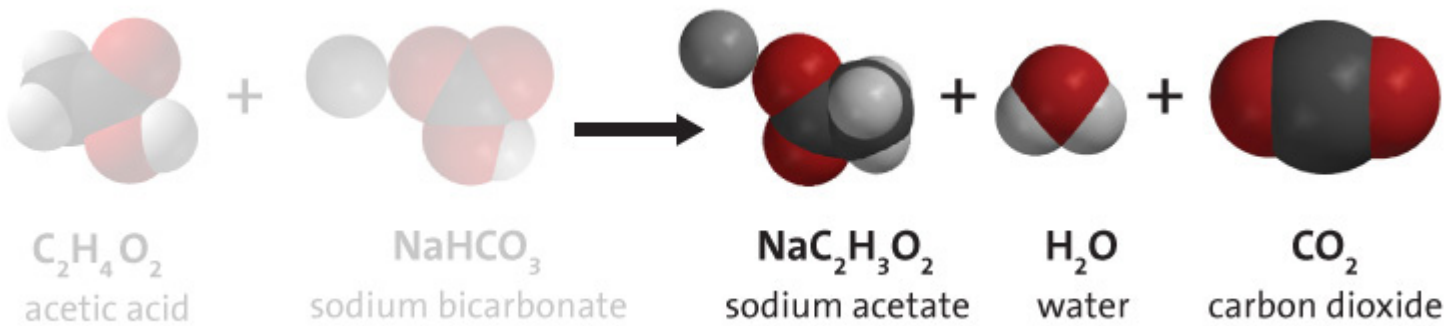
# Mini Volcano

## *Chemical Reactions*

Chemical reactions take place when two or more chemicals are mixed and bonds are broken and created. In this experiment, you will mix sodium bicarbonate (baking soda) and acetic acid (vinegar). See what happens!

## Procedure

1. Set up a minivolcano.
2. Place a small amount of sodium bicarbonate (baking soda) in the volcano.
3. Place a drop or two of food coloring in. You can mix colors!
4. Carefully add a small volume of acetic acid (vinegar).
5. Observe!




## Observations and Analysis

Observe what happened during the experiment and try to answer the following questions:

- What did you see?
- Why did the reaction bubble up? What caused the bubbles?
- Repeat the experiment at home with your parents!

**Girl Scouts**

*Juniors/Cadettes*

# Cookie Caper Materials

# The Great Girl Scout Cookie Caper Booklet

*This booklet describes the mystery that the Junior and Cadette Girl Scouts must solve.*

# The Great Girl Scout Cookie Caper

**The Crime**

Someone broke into the lab and stole the Girl Scout Cookie recipes! The morning cleaning crew found the door broken open and the glass on the door scattered all around the entrance to the lab. The entire lab was a mess. The police were notified immediately. It appears that the crime took place between 6:00 pm last night and 4:00 am this morning. The motive appears to be the recipes for all the Girl Scout Cookies. You are the detective assigned to the case. Collect evidence and identify the most likely suspect.

**Initial Investigation**

Initial police findings suggest the perpetrator entered the laboratory by breaking the window on the door. In the process, the thief got a cut and left blood droplets behind. The lab was left in disarray, suggesting that the perpetrator did not know where the recipes would be kept. To preserve evidence, police carefully collected bottles, binders, notebooks, papers, and other items on the lab benches and shelves. A slip of paper with stating the times that the lab would be unoccupied was also discovered.

**The Suspects**

All those in the building after 6:00 pm last night were questioned. Fingerprints and voluntary blood samples were collected. Most of the suspects also had pens or markers in their pockets; these were confiscated and stored with the evidence gathered thus far.

**Evidence Summary**

1) blood splatter on laboratory glassware
2) bottles, binders, books
3) slip of paper with information about lab hours
4) other slips/sheets of paper
5) markers and pens collected from suspects

| |
|---|
| **Name:** Ernie Keebler |
| **Profession:** Security Guard |
| **Background:** Ernie has worked as a security guard at the laboratory for over five years. Those at work describe him as easy going and optimistic. He claims he uses the marker found in his pocket to write down the foods he would like to eat in the future so as not to forget them. Others confirm that Ernie has a large appetite for all kinds of food, especially cookies. |

## Personal Samples

| |
|---|
| **Blood Type:** A+ |
| **Pen/ Marker:** Marker #4 |

## Fingerprints

| R Thumb | R Index | R Middle | R Ring | R Little |
|---|---|---|---|---|
|  |  |  |  |  |

| L Thumb | L Index | L Middle | L Ring | L Little |
|---|---|---|---|---|
|  |  |  |  |  |

| |
|---|
| **Name:** Belvidere Bounce |
| **Profession:** Building Manager |
| **Background:** Belvidere is the manager at the building where Girl Scout Cookies recipes are developed and kept. He is a pogo-stick champion in his age group, but he tends to bounce all over and get lost easily. Belvidere says the marker found on him is used for drawing maps to avoid getting lost. Others comment that they often find Belvidere in unsuspecting place at strange times bouncing around looking for exits. |

## Personal Samples

| |
|---|
| **Blood Type:** AB- |
| **Pen/ Marker:** Marker #5 |

## Fingerprints

| R Thumb | R Index | R Middle | R Ring | R Little |
|---|---|---|---|---|
|  |  |  |  |  |

| L Thumb | L Index | L Middle | L Ring | L Little |
|---|---|---|---|---|
|  |  |  |  |  |

| |
|---|
| **Name:** Gingy Breadman |
| **Profession:** Creative Recipe Intern |
| **Background:** Gingy's internship on the Creative Recipe Team began about three months ago. Having grown up a Girl Scout, she is very excited to be working on making new cookie recipes. Many of her ideas have not be received well by the team manager. She desperately wants to contribute and make a good impression, so she has been jotting down ideas constantly. She told the police that therefore she always carries a pen in her pocket. She believes she is nearing a successful new flavor and is eager to test the recipe. |

## Personal Samples

| |
|---|
| **Blood Type:** O+ |
| **Pen/ Marker:** Marker #3 |

## Fingerprints

| R Thumb | R Index | R Middle | R Ring | R Little |
|---|---|---|---|---|
|  |  |  |  |  |

| L Thumb | L Index | L Middle | L Ring | L Little |
|---|---|---|---|---|
|  |  |  |  |  |

| |
|---|
| **Name:** Cookie Monster |
| **Profession:** Security Guard |
| **Background:** Cookie is the captain of the security guards. He is the world's biggest cookie fan and fiercely protects the Cookie Lab. He keeps sharp by practicing his fighting skills at home, but he is clumsy and often bruises himself during workouts. Cookie does his best to bake cookies on his own, but his lack of distinct opposable thumbs means that his knife-handling skills are less-than-stellar; he has lots of cuts on his hands. Commenting on the marker found on his person, he mentioned writing, but also that pens make excellent defensive poking weapons. |

## Personal Samples

| |
|---|
| **Blood Type:** B+ |
| **Pen/ Marker:** Marker #1 |

## Fingerprints

| R Thumb | R Index | R Middle | R Ring | R Little |
|---|---|---|---|---|
|  |  |  |  |  |

| L Thumb | L Index | L Middle | L Ring | L Little |
|---|---|---|---|---|
|  |  |  |  |  |

| |
|---|
| **Name:** NomNom Ninja |
| **Profession:** Cleaning Crew |
| **Background:** NomNom is part of the cleaning crew that goes through the facility each night. She is an extremely hard worker and is willing to work additional shifts on short notice. She carries a marker to jot down her schedule each day. Other crew members mentioned that NomNom's life seems very difficult as of late: her pet dragon is sick and constantly requires fresh cookies and lots of attention. |

## Personal Samples

| |
|---|
| **Blood Type:** AB- |
| **Pen/ Marker:** Marker #2 |

## Fingerprints

| R Thumb | R Index | R Middle | R Ring | R Little |
|---|---|---|---|---|
|  |  |  |  |  |

| L Thumb | L Index | L Middle | L Ring | L Little |
|---|---|---|---|---|
|  |  |  |  |  |

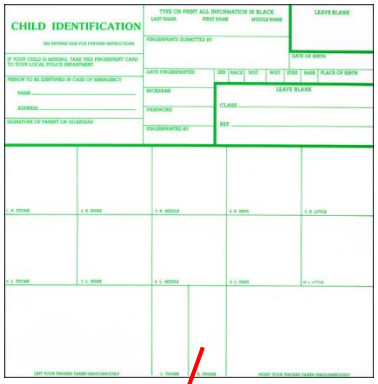
**Girl Scouts**

*Juniors/Cadettes*

# Graphics for Activity Stations

# Inkless Fingerprinting

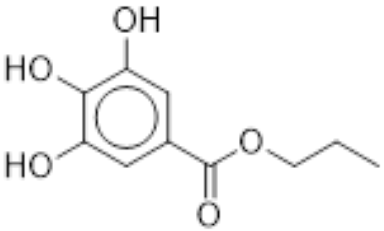

+



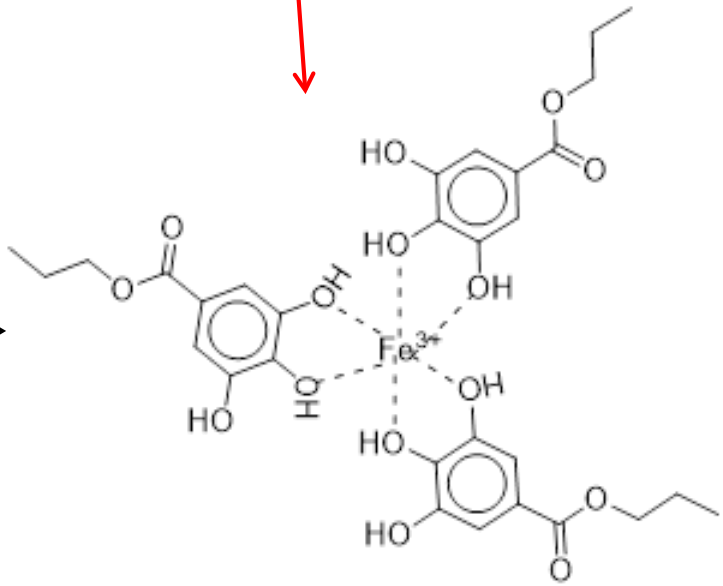


$FeCl_3$ +

**ferric chloride**



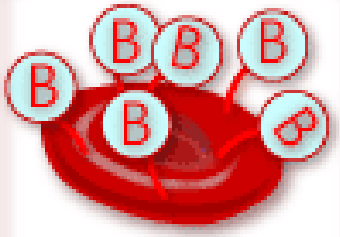
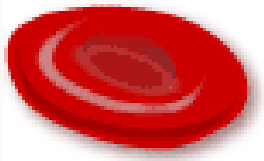
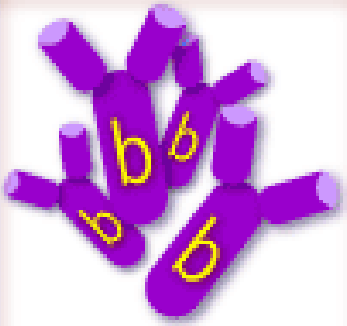
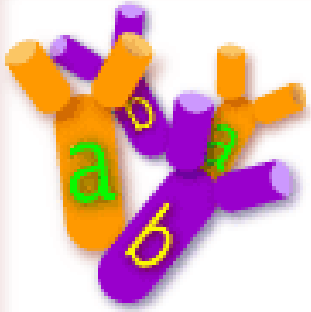

**propyl gallate**



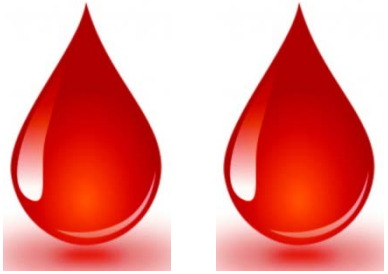

**Black Complex**

# Blood Typing

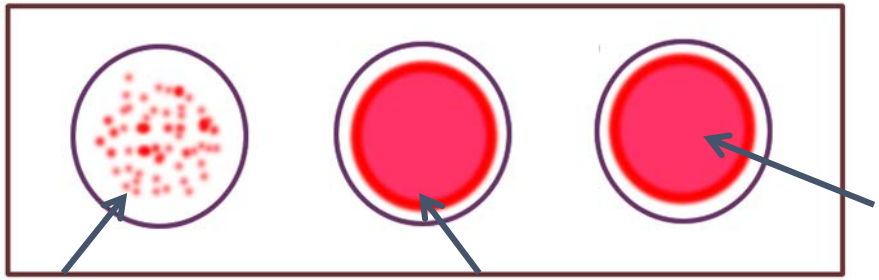
## The ABO Blood System

| Blood Type (genotype) | Type A (AA, AO) | Type B (BB, BO) | Type AB (AB) | Type O (OO) |
|---|---|---|---|---|
| Red Blood Cell Surface Proteins (phenotype) |  A agglutinogens only |  B agglutinogens only |  A and B agglutinogens |  No agglutinogens |
| Plasma Antibodies (phenotype) |  b agglutinin only |  a agglutinin only | NONE. No agglutinin |  a and b agglutinin |

# Blood Typing



## Interpretation



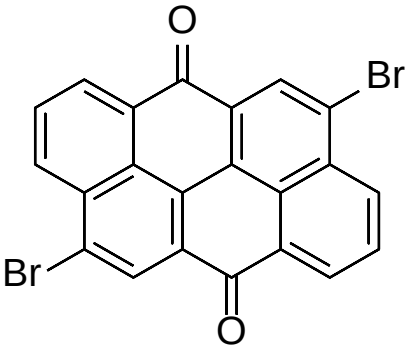

After 3 mins:

- If thickens like gel (**Positive**)
- If thin as water (**Negative**)

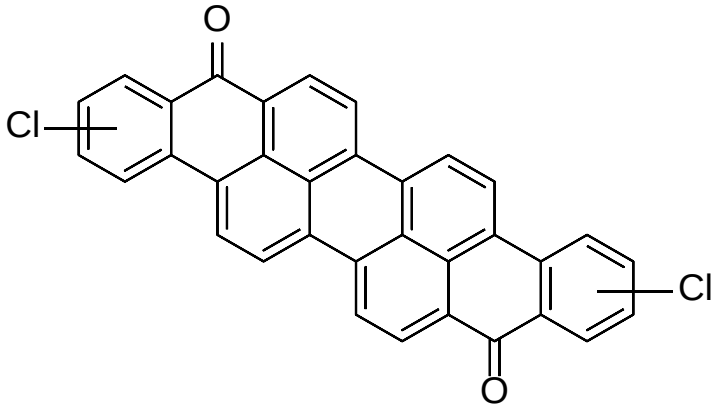
| Well A | Well B | Well Rh | Blood Type |
|---|---|---|---|
| + | - | + | A+ |
| + | - | - | A- |
| - | + | + | B+ |
| - | + | - | B- |
| + | + | + | AB+ |
| + | + | - | AB- |
| - | - | + | O+ |
| - | - | - | O- |

# Ink Analysis

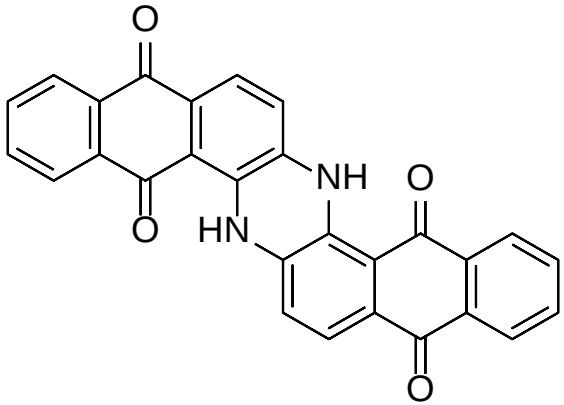
- Chromatography or "color writing" is a technique used to separate mixtures.
- Inks may look like single colors but are often composed <u>a mixture of different dyes</u>.




**Orange**




**Violet**




**Blue**

- These dyes are large organic molecules which can have <u>different relative charges on opposing ends</u>.

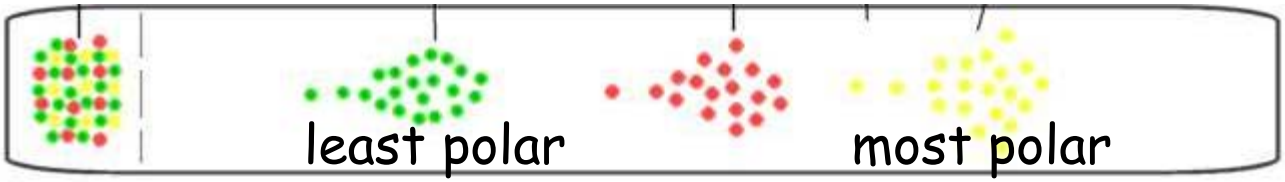
# Ink Analysis

- The difference in relative charges determines the polarity of the dyes
  - **very large difference**, the molecule is "**very polar**"
  - **small difference**, the molecule is "**less polar**"
  - **very small to no difference**, the molecule is "**nonpolar**"

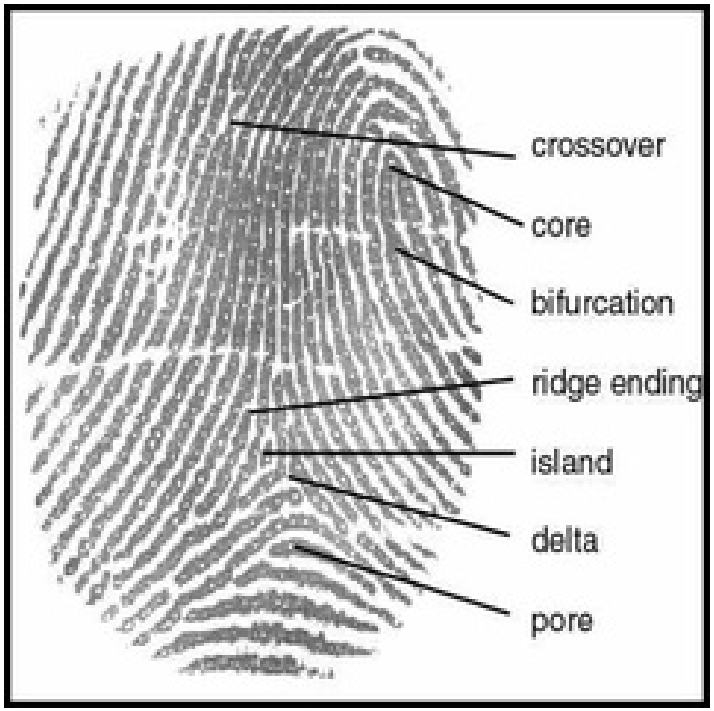

**Polar**

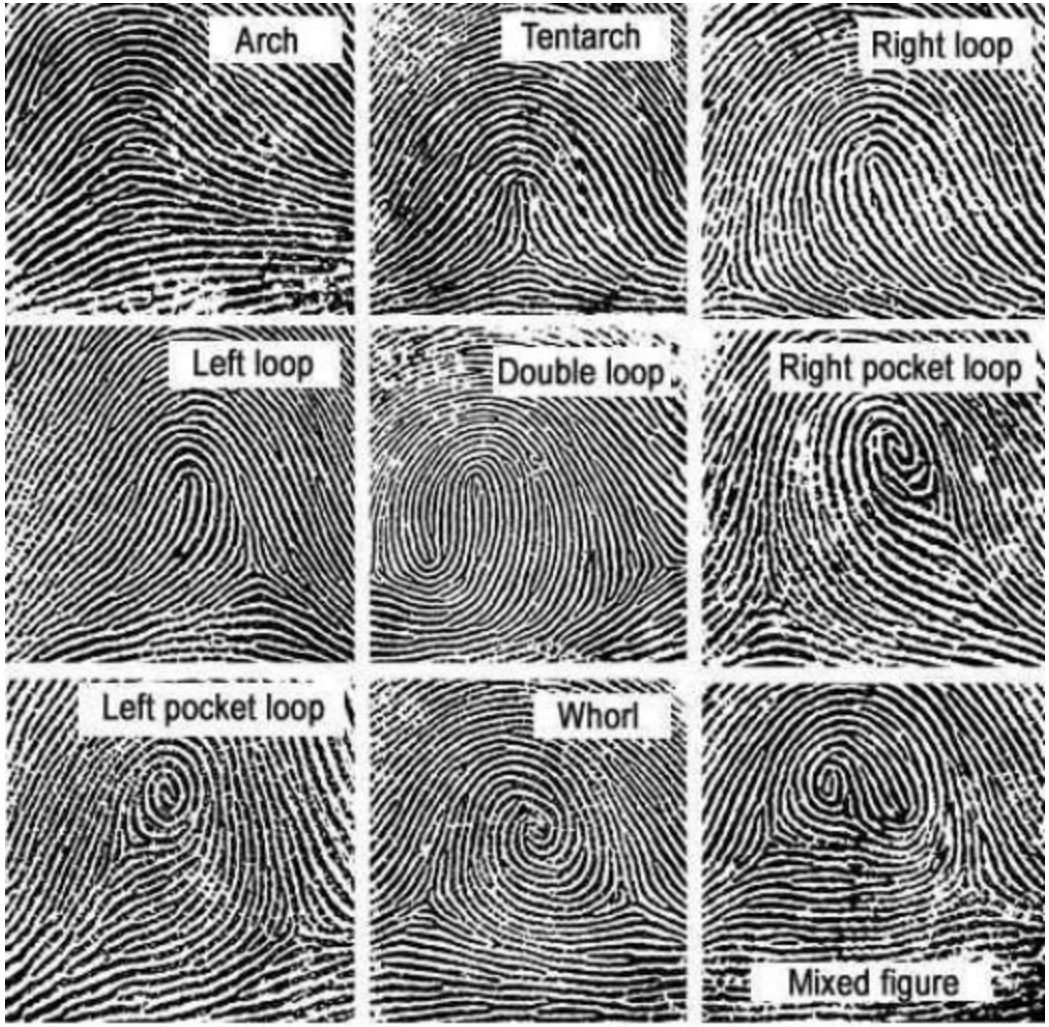
**Nonpolar**

- Using paper chromatography, we can separate the dyes:
  - **most polar dye** → travel with water (polar) → **higher on paper**
  - **least polar dye** → travel least with water → **lower on paper**

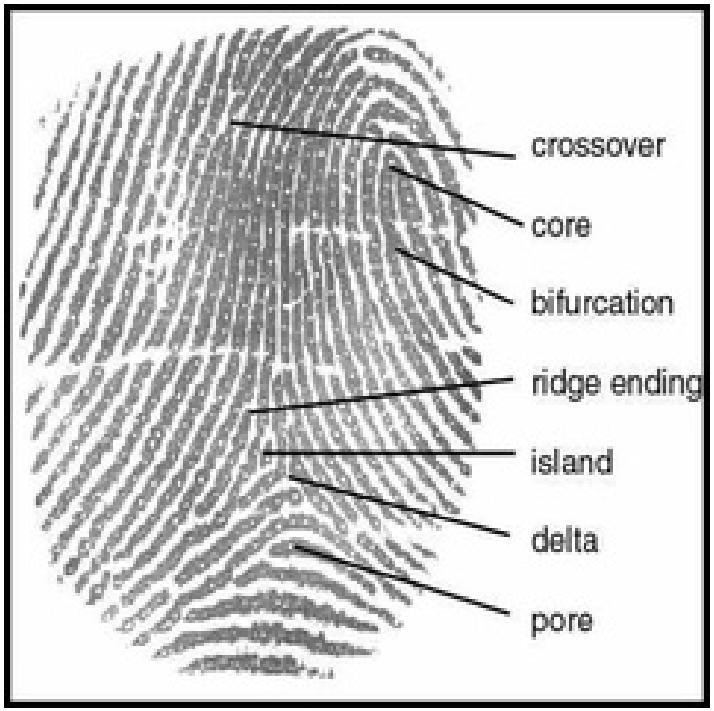


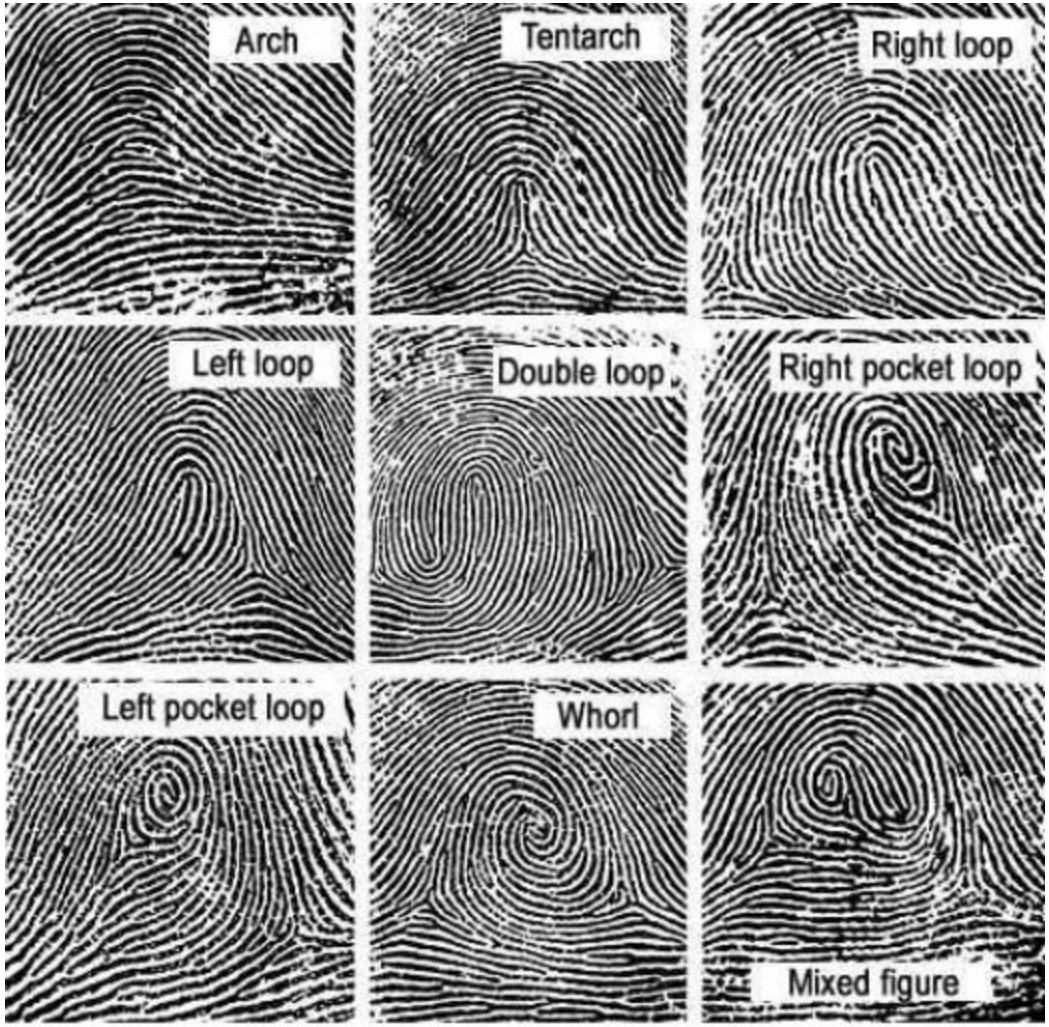
# Fingerprinting



# Fingerprinting

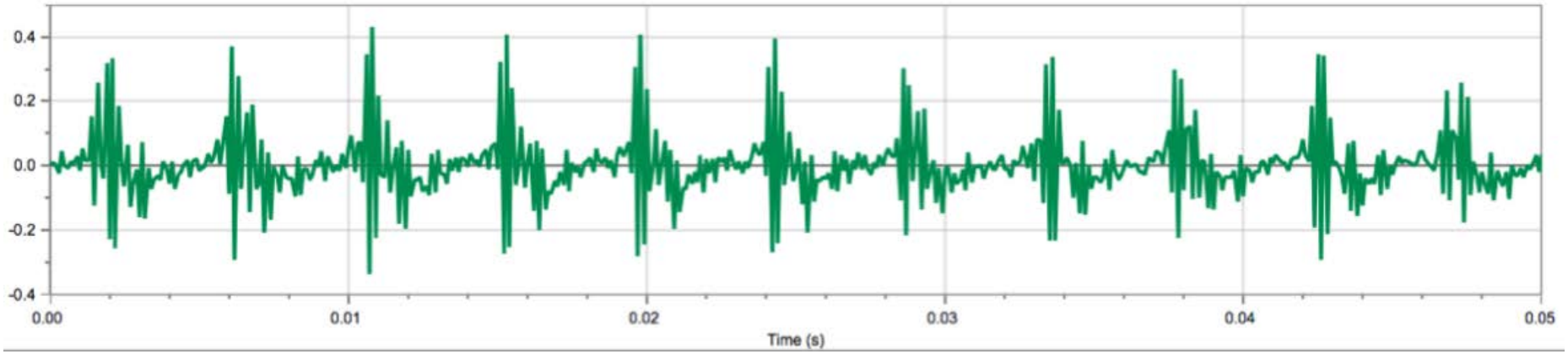


# Voiceprints

- Use the microphone attached to the computer and make a voiceprint. What do you see in the pattern?

- Have a friend make a voiceprint by saying the same words that you did. Can you tell your voices apart from the pattern?
- **How might you use a voiceprint to solve a crime?**



**Girl Scouts**

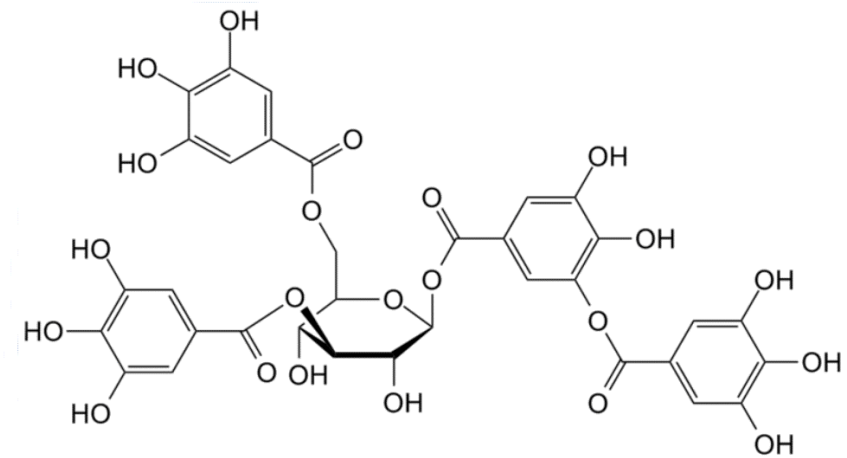
*Seniors*

# Graphics for Activity Stations

# Lotion

Mix together:

- 1 spoonful of lanolin
- 1 spoonful of $H_2O$
- 1 spoonful of beeswax
- 2 spoonsfuls of olive oil
- 1 pinch of borax


Lanolin is oil secreted by woolly animals such as sheep and contains long waxy chains of esters.

# Science Behind Accessories

1. Expose the ultraviolet detection card to sunlight. What do you see? What does the card tell you about the sunlight today?
2. Put some sunglasses between the card and the sun. Explain your observations. Do this with three types of sunglasses. Do you notice any difference?
3. Put a small amount of sunscreen in a Ziploc bag. Place the sunscreen between the sunlight and the card. Explain what you observe.

Explain why it is important to protect yourself from ultraviolet radiation.
Explain how you can use accessories to do this.

# Hair Dye

1. Several samples of hair have been soaked in a hair dye solution. Examine each sample under a microscope.
2. What does hair dye do to the hair samples?
3. Compare the human hair samples to dog hair and horse hair.
4. Compare the hair that was soaked in dye for different times.

Explain what happens when hair is dyed.

Can you explain why the samples look different?

# Lip Balm

1. Melt 1 spoonful of beeswax.
2. Add the following to you sample and mix with a wooden stick:
    - 3 spoonfuls of petroleum jelly
    - 2 drops of honey
    - 2 drops of lip balm flavoring
3. Pour into a clean small container and allow to harden.

Explain why the mixture you made is a good lip balm?
What other ingredients might you add?