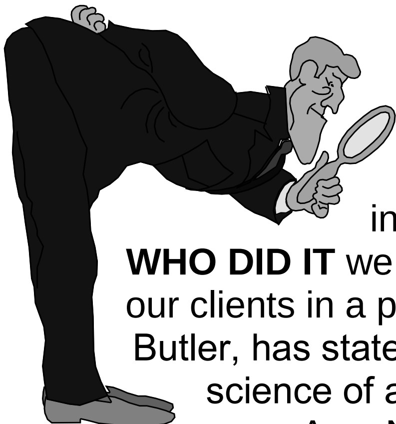
Powder Puzzles:

Kit #12

Student Journal

Student's Name: ______________________________

Feb. 2016
Safety references updated.

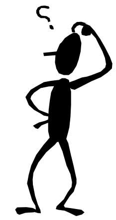


Welcome to your new adventure, an internship at the **WHO DID IT Crime Lab**. Here at **WHO DID IT** we pride ourselves in our ability to meet the needs of our clients in a professional manner. As our founder, Dr. T.E. Butler, has stated "There is the art of a crime lab as well as the science of a crime lab."

As a Newbie crime-solving scientist you'll need to study and analyze evidence in a scientific manner in order to learn the "art" of analysis. To be a part of our scientific team, all Newbies need to have a basic understanding of the science of chemistry. In the following activities you will be reviewing information, learning concepts and learning basic procedures for chemical analysis of substances. There are all types of possible evidence that your lab may be asked to work with. Your success here at **WHO DONE IT** Crime Lab will be determined by your ability to understand and apply this information.

We would like to introduce you to your Director, the world-renowned teacher of the art of inquiry Dr. von _______________. Your Director will help to guide you through this learning process.

Session 1: Does It Matter to a Newbie?



Activity:

1. In your Lab Journal answer the questions A, B and C.
2. Read "Is It Matter."
3. Look at your answers to questions A, B and C and rewrite them if necessary.
4. Look at the Picture Puzzler, write an explanation of what the picture is "saying"

A. What is matter?

B. What are some properties of matter? (list at least 6 general properties)

C. What is the relationship between matter and its properties? (Why do we focus on the properties of things?)

Is It Matter?

You're starting with the section that really matters. (Ha-Ha) Matter is everything. Anything that takes up space or has a mass of any kind is matter. Everything you can touch is made of matter. If it is made of anything, that anything is matter. Everything you will learn about in Chemistry will all be based on <u>how matter reacts and combines</u>.

Matter has many properties (characteristics).

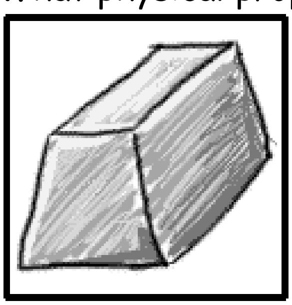
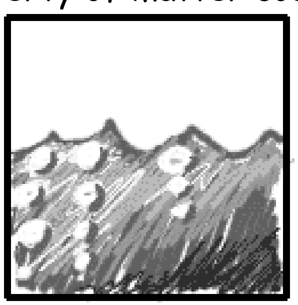
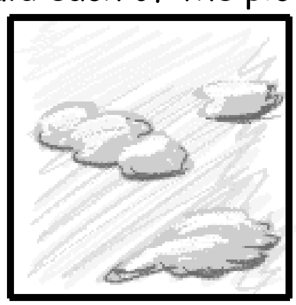
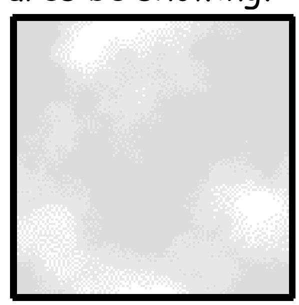
It can have PHYSICAL properties like different densities, hardness, melting points, boiling points, freezing points, color, taste, smells, its state (solid, liquid, gas) and whether it resists or conducts electricity. Physical properties can be measured or observed without changing the make up of the substance.

There are also CHEMICAL properties that define matter. This involves how a substance interacts with other substances. These properties are observed in chemical reactions. For example, being able to burn and what is left after being burned relates to the chemical properties of paper. When the chemical properties of a substance changes, as a result of a chemical reaction, the actual make up of the substance changes so it is no longer the same substance you started with. (Ashes have different chemical and physical properties than paper.)

Matter combines in the certain ways, physically and chemically, depending on what specific types of matter it is made up of.

Picture Puzzler

What physical property of matter could each of the pictures be showing?

Session 2: It's Elemental My Dear Newbie!

Activity: For this Session, you'll need to carefully read each step as you work through the Activity.

1. Your Director will direct you to the matter samples. When you evaluate a sample write down its **common name** and some **physical observations** about the sample in your Lab Journal. (create a data table for your information with 15 rows and 6 columns)

2. Based on your own knowledge base, identify each as an **"element" or "compound"**. You may have to start here by "guessing". (For help, read the It's Elemental section called "Elements and Compounds")

3. After you have evaluated all the samples you will either research the chemical names for each substance or get a list from your Director. Chemical names are created from the names of the elements that make up a substance (some names are very simple, some are very complex).

   Record the **chemical name** for each sample on your data table. Look at the chemical names, think about your assignment of "**element**" or compound" to each sample.

4. After you have reevaluated your list either research for the **chemical formula** for each sample or get a list from your Director. Scientific or chemical formulas are created using the "Letters" assigned to the elements that make up a substance.

   Record the formula for each sample on your data table. Using the chemical formula for each sample, think about your assignment of "**element**" or "compound" to each sample.

5. Pick up a "**List of Elements**" sheet, using the LETTERS from the chemical formula or the chemical name try to find each sample you labeled as an element. See if any of the samples you labeled as a compound appear on the element list. Reevaluate your assignment of "**element**" or "compound" to each sample.

6. Ask for the "Periodic Table" sheet, using the samples that you labeled **elements** formula (LETTERS) find each on the Periodic Table and circle it.

7. Using the chemical formula for each samples you labeled as compounds, find the elements that make up that compound on the Periodic Table (circle them on the table).

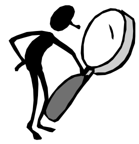
8. In your Lab Journal, describe what you think a Periodic Table is.

9. Read the It's Elemental! section called "The Periodic Table." After reading about the Periodic Table, reread your description and make any needed changes.

Discussion Questions:

1. What makes each of the samples (substances) different from each other? (what they're made of, the elements they're made of)
2. What are some elements that are common to many of the samples?
3. Finish the statement: A substances' properties are determined by …
4. Using the samples as a guide, are there more elements found in the natural world as pure elements or in compounds? Think about WHY.

Challenge question: The element Lead (Pb) and the word "plumbing" (as in household pipes or plumbing) are related, can you discover what that relationship is.

Reading for Information:  **It's Elemental!**

Elements and Compounds

Everything in our world is made up from types of matter called "elements". An **element** is any substance that contains only one kind of atom. All chemical substances are **elements or compounds** (combinations of elements). For example, hydrogen and oxygen are elements. Water is a compound of hydrogen and oxygen. Oxygen and silicon are the most plentiful elements in the earth's crust. Oxygen accounts for about 47 percent and silicon for 28 percent of the crust's weight.

The International Union of Pure and Applied Chemistry (IUPAC) recognizes the existence of **109 elements**. Scientists have claimed the discovery of six additional elements, known as element 110, element 111, element 112, element 114, element 116, and element 118. IUPAC is the recognized authority in crediting the discovery of elements and assigning names to them. For a discovery to be recognized by IUPAC, scientists must produce a sample of the element and measure some of its characteristic properties. In addition, it is desirable that another experiment confirms the discovery.

The Periodic Table

The **Periodic Table** of the elements lists the 109 recognized elements. Of these, 91 occur naturally on or in the earth, almost all of them only in compounds. Scientists produced most of the 18 remaining elements, as well as elements 110, 111, 112, 114, 116, and 118, in machines called particle accelerators. Elements not found in nature also are produced in nuclear reactors or as the debris of nuclear explosions.

Symbols of elements.

Each officially named element has a **chemical symbol** consisting of one or two letters. In some cases, the symbol is the first letter of the name. For example, C is the symbol for carbon. If the first letter is already the symbol for another element, another letter of the name is combined with the first. For instance, calcium has the symbol Ca. Some symbols come from an old name of the element. The symbol for lead, Pb, comes from plumbum, the Latin word for lead. Chemists use the symbols to write formulas for compounds. The **chemical formulas** tell which elements and how many atoms of each are in a compound.

In summary, whether something is a pure substance, a mixture or a compound, everything in our world is composed of this same set of elements (which are listed on the Periodic Table).

Session 3: Matter is Atoms and Molecules (and Newbies)

Materials: balloon

Hey Newbie, **Read through the Activity before starting**

Activity: (Student) Observing isn't always "seeing".

1. Blow up the balloon and hold the end shut (don't tie it)
2. In your Lab Journal, record your observations of the balloon as you blow it up.
3. Slowly release the opening, use your senses to make observations as the balloon "neck" is opened. (record observations)
4. Using your observations, conclude whether you agree with the statement "If we can't see something then it doesn't exist." (give details)
5. Bring your attention to the class Balloon Demonstration. In your Lab Journal write about the demonstration (as described to you by your Lab Director). Next, check with your Director for a "Thought Question".
6. Read the paper titled "Atoms and Molecules". Answer the questions.

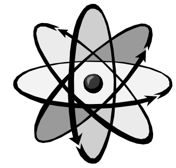
Balloon Observations:

Conclusion about "If we can't see something then it doesn't exist."

Balloon Demonstration: (Thought Question)

Description:

Thought Question "Theory":



Reading for Information: **Atoms and Molecules**

Atom is one of the basic units of matter. Everything around us is made up of atoms. An atom is incredibly tiny—more than a million times smaller than the thickness of a human hair. The smallest speck that can be seen under an ordinary microscope contains more than 10 billion atoms. The diameter of an atom ranges from about 0.1 to 0.5 nanometer. A nanometer is a billionth of a meter, or about 1/25,400,000 inch.

Atoms form the building blocks of the simplest substances, the chemical elements. Familiar elements include hydrogen, oxygen, iron, and lead. Each element consists of one basic kind of atom. The structure of that atom is the same for all the atoms of that element. (All Hydrogen atoms are alike but are different from Helium atoms.)

Compounds are more complex substances made of two or more kinds of atoms linked in units called molecules. Water, for example, is a compound in which each **molecule** consists of two atoms of hydrogen linked to one atom of oxygen. (chemical formula: H_2O)

Atoms vary greatly in weight, but they are all about the same size. For example, an atom of plutonium, the heaviest element found in nature, weighs more than 200 times as much as an atom of hydrogen, the lightest known element. However, the diameter of a plutonium atom is only about 3 times that of a hydrogen atom.

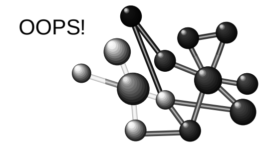
Provide answers to these questions:

1. Define the term "atom". (be sure to refer to its size)___________________________
   ____
2. Different types of atoms make up different types of __________________________.
3. Define the term "molecule". (be sure to refer to its size) _______________________
   ____
4. What is a water molecule made up of? ______________________________________
5. Find Hydrogen (H) on the Periodic Table and write down the number found under the name (H = ____)
   Find Plutonium (Pu) on the Periodic Table and write down the number found under the name (Pu = ____)
   Using this information and the information in "Atoms and Molecules", what do the numbers under the element names on the Periodic Table tell you about that element's atom?
6. Find each of the following elements on the Periodic Table and write down the weight of one of their atoms.

Copper (Cu)		Tin (Sn)		Aluminum (Al)		Iron (Fe)	
Nickel (Ni)		Iodine (I)		Oxygen (O)		Carbon (C)	
Sodium (Na)		Chlorine (Cl)		Helium (He)			

Challenge Question: What is an angstrom? ___________________

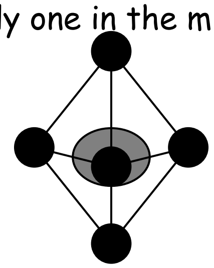
Session 4: Molecule Models by Model Building Newbies.



Draw some "molecule models" from the class activity:

Draw a basic crystal shape and place the atoms on the geometric shape (at the corners, and usually one in the middle (except for a cube)).

For Example:



You are now ready for your first crime lab assignment…matching the evidence from the scene of a crime to known samples.

Materials: slides toothpick pocket microscope

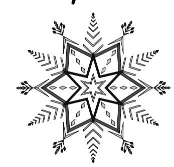
Read through the Activity before starting

1. Label the right side of your slide using a piece of masking tape.
2. Place a large drop of the "evidence" solution (assigned to your group) on a microscope slide. (little smaller than a dime)
3. Place your slide in a storage place for overnight drying.
4. Next day, check your slide for crystal formation using the pocket microscope.
5. Compare your crystals to the known sample and try to identify your "evidence".
6. Record your observations (draw what you see in the pocket scope) and conclusion in your Lab Journal.
7. **Read about "Crystals"**

(**Read "Forensic Chemist"**)

Reading for Information: **Crystals** 

Crystal is a solid that is composed of atoms arranged in an orderly pattern. Most nonliving substances are made up of crystals. For example, metals and rocks consist of crystals, as do snowflakes, salt, and sugar. Well-developed crystals have a distinctly regular shape due to the orderly arrangement of atoms. Such crystals are arranged to form definite geometrical shapes (such as cubes or pyramids). For example, snowflakes can generally be grouped by common shape. Most flakes are six pointed, six-sided or twelve-sided. This is the "snowflake rule" regardless of the size of the crystals. As for salt, it will always form cube shaped crystals.



The scientific study of crystals is called crystallography. Crystallographers measure angles between crystal faces and analyze arrangements of the surfaces.

Crystallization is the process by which matter forms crystals. Crystallization is just the opposite of dissolving. It occurs when the bits of solid in the solution come back together and stack themselves into a crystal. The dissolved solid may seem to appear out of nowhere! It comes from dissolved bits of solid in the solution when it cools or when we allow some of the water to evaporate. In the case of water, crystallization occurs when water slowly changes to a solid from a liquid.

When either temperature is lowered or evaporation occurs, certain atoms in such substances move close together and join. In most cases, they do so on a <u>crystallization nucleus</u>, an impurity or a tiny piece of crystal consisting of a particle or cluster of atoms. (Therefore, snowflakes are water crystals built around a speck of dust or crystallization nucleus.) The atoms collect on the nucleus and arrange themselves into structural units called unit cells to form a crystal solid. A crystal grows by adding atoms to its surfaces in a specific pattern. (Just as you added the salt cube models together to build a larger salt cube.)

Reading for Information:

Forensic Chemist

Forensic chemistry is the science of chemistry as it is applied to a crime scene. This would generally include bomb fragment analysis and various other types of chemical residue analysis.

Julia Dolan works in Maryland at the headquarters for the Bureau of Alcohol, Tobacco and Firearms. A forensic chemist is a scientist who analyzes physical evidence as found on a victim or at the scene of a crime. These scientists work in the field of criminalistics and deal with analysis, comparison, identification, and interpretation of physical evidence to prove the connections to or existence of a crime. Criminalists provide information to investigators, attorneys, judges, or juries to help determine the innocence or guilt of a suspect.

"One example is the chemical tests we do to find out what kind of explosives were used in a car bombing. Thin layer **chromatography** is a technique that helps us determine if there is an explosive material left on exploded bomb fragments. We can compare what we find to known explosive materials, and thereby determine what kind of explosives were used to commit a crime."

"In our lab we receive a variety of different kinds of samples, for example we can get a soil sample, a hair sample, or even a water sample. It is our job to find out what chemicals are in these samples."

Session 5: Elements, Compounds, Mixtures or Mixed Up Yet, Newbie?

The staff at **WHO DID IT** Crime lab is pleased with your progress! You have studied atoms, molecules, crystals, elements and compounds. Today we are going to add a new concept, the mixture. Let's start right off with an "inquiry" activity.

Read through the Activity before starting (You may have to add paper to your Lab Journal for the following inquiry.)

1. Place a small sample of sand, salt and sugar into three sample cups (about 1 level teaspoon).

2. Using a hand lens look at each sample (sand, salt, sugar) and think about whether you could physically separate each into any of its parts. Write your thoughts in your Lab Journal.

3. On a paper towel **mix** some sand and salt together. Using a hand lens look at the **mixture** and decide if you could physically separate it back into salt and sand. (Don't think of how long it would take you, just if you could or not.) Record your thoughts in your Lab Journal.

4. In your Lab Journal, create a "mixture" by telling what the parts of your mixture would be. (Mixture: a combination of two or more substances that are not chemically combined and can be separated. They are physically together like Peanut Butter and Jelly)

5. Select two of the following mixtures and think about how you could separate the substances. Write a procedure for separating the substances: (in your Lab Journal)

   Kool-Aid and water — Salt and pepper
   Sand, iron filings and salt — Blue, Yellow, Red marbles
   Sand, gravel, rocks
   Water vapor, from the other gases composing the air

6. Share your procedure with another group of students and ask for their suggestions or input. Modify your process if needed.

7. Look at the steel wool demonstration, what is the brown substance on the steel wool? Is it an element, compound or mixture? Tell why you think so. (If necessary, do some research to help you answer the question.)

Mixtures Part 2:

WOW, what a lot of thinking that was! But, now you should have a good idea of what a mixture is compared to what a compound (or an element) is. Now we're going to look at another type of mixture.

Often in crime investigations it is necessary to analyze evidence to discover the component parts so that comparisons can be made for similarities and differences.

Purpose: Your lab job is to perform a **chromatography** test on a liquid to see if it is a mixture and to separate out the component parts. You will then compare your sample to the other groups to look for similarities and differences.

Read through the Activity before starting

Materials:	test marker (see Step 4)	cup
	Paper towel	straw
	Tape	

Read all of the Procedures before starting.

Procedure:

1. Measure from the bottom of the cup to the top rim.
2. Cut a strip of filter paper 1 inch wide and as long as your measurement in Step 1.
3. Pour ½ inch of water into the bottom of the cup.
4. Get a test marker from your supervisor. Make a note of which marker you're testing.
5. Using the marker draw a horizontal line across the paper strip about 1½ inches from the bottom. (return test marker)
6. Attach the top of the strip of paper to the straw (pencil) with tape.
7. Set the straw (pencil) across the top of the cup so that the bottom of the strip just touches the water (do not let the marker line go below the water).
8. Remove the paper from the cup when the water has traveled about ¾ of the way up the paper strip.

9. Compare your strip to the other group's results and record observations in your Journal. From your observations draw a conclusion as to whether any of the other results matches your marker. Also, conclude if your liquid (marker ink) was a mixture or not (give a reason).

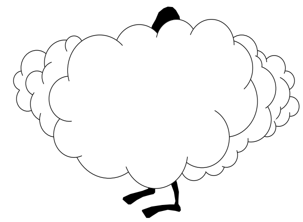
Chromatography

The separation of a **mixture** into its different parts helps scientists to learn what is in that mixture. The parts of a mixture may be an element mixed with other elements, elements mixed with compounds or compounds mixed with compounds. Many of the things that we eat are mixtures, like a granola bar or a salad.

Chromatography is a technique used for separating mixtures. It is a process used to separate substances that are found in liquids or gases. It can be used to study a solid only if the solid can be dissolved in a liquid. The chromatography process is based upon placing a substance on or in a medium and then a solvent is passed through the medium. Different types of molecules are transported different distances, causing them to separate.

In your activity the paper is the medium, the water is the solvent and the ink is the test substance.

Session 6: Solid, Liquid, Gas



Is a Newbie a solid, liquid or a gas?

Write a brief description of the class balloon activity.
Write how you think this demonstration would apply to molecules in a solid, liquid and a gas. (THINK ENERGY OF MOTION)

Session 7: Physical Change vs. Chemical Change

How Do You Change a Newbie? Send them to Crime Lab School

Procedure: (Student)

For this lab you will be using your powers of observation and learn more about changes to matter. Matter can undergo physical and chemical changes. Today we will look at the differences between the two.

1. There are 7 Stations set up in the room. Go to each station, read the instructions and record the requested information in chart form in your Lab Journal.

2. Add a section onto your chart to write whether you think each "Station" represents a physical change or chemical change.

3. Read the selection "**Changes in Chemistry**" then look at your choices for physical and chemical change (for each Station). Make any changes to your choices.

Reading for Information: **"Changes in Chemistry"**

Reactions are the basis of all Chemistry. If anything happens in Chemistry, it happens with a reaction. So you might be asking what is a reaction? When two chemicals are mixed and they interact with each other on an atomic level, that is the start of a chemical reaction. If you mix two chemicals and they don't react, that's called a MIXTURE. Mixtures are physical combinations of materials and can be separated by physical means.

An element or compound can undergo a physical change, which means it doesn't change its chemical make up, or properties. Examples of physical changes are: freezing, melting, condensing, boiling, evaporation (phase changes), tearing, crushing, and splitting.

An element or compound can undergo a chemical change, which involves it reacting to form new substances (with different physical and chemical properties than the original material). Evidence of chemical change includes: giving off heat, cooling (using heat), giving off a gas, giving off light, and forming a different substance. Examples of chemical changes are: burning of wood, cooking an egg, rusting of iron, souring of milk, using drain cleaner.

Section II: Testing Chemical and Physical Properties
Congratulations! Newbie. You're now a Class2Newbie

You have made it through the first phase of our company's training. Through your hard work you have earned a spot in Level 2 of our program. A job well done!

In Level 2 you will be identifying substances by their physical and chemical properties. By learning our testing procedures you will be able to test unknown substances and match them with known substances. In the case of our company, these unknowns are often evidence from crime scenes.

Many of our employees have done great things in the science of forensics (in the science of chemistry).

Throughout this identification process, be sure to keep good notes/charts for this information will be used later – for a final analysis.

Your Lab Director will review the safety rules before you start. Each team of students should remind each other of the safety rules as they work together.

Note: **You will find this information useful when setting up your data table.**

- ✓ Each team of students will analyze 6 substances, unless your Director tells you differently.
- ✓ Each substance will be subjected to 6 tests.

Before you start:

<u>A Case Study: Forensic chemist at work; Speedy, Sophisticated Sleuthing</u>

By the time the mouse and its Pepsi-can coffin reached FDA, Fred L. Fricke and his team of chemists and microbiologists they didn't have much to work with.

Pepsi officials had already examined the mouse, found dead in a can of Diet Pepsi in New York. From there it went to a veterinarian on the East Coast. Next stop was a pathologist in Utah. Finally, the dissected mouse was sent to Fricke at FDA's Forensic Chemistry Center in Cincinnati. The mouse was now in pieces.

Fortunately, the mouse's teeth were still intact. "We measured the spacing between the teeth and the pattern of bite marks on the can," explains Karen A. Wolnik, director of the center's inorganic chemistry branch. "From those measurements it was determined that his lower teeth had left marks on the inside of the can and his upper teeth had gnawed the outside, right at the pull-tab opening."

Wolnik says that pattern demonstrated the mouse had been inside the can when it bit the lid. But because the can lid with the pull-tab opening is in one intact piece throughout manufacturing, the mouse couldn't have bitten the lid or gotten into the can until after it was opened. The evidence was used to convict a tamperer who had falsely claimed to have found the mouse inside the can when she opened it. (Under the Federal Anti-Tampering Act, it is a felony to tamper with foods, drugs, devices, cosmetics, and other consumer products.)

Another Case Study:
While crossing the street, a woman is struck by a speeding car that leaves the scene of the accident. The woman expires at the scene, a quiet street in a residential area. Crime scene technicians collect the physical evidence left by the car after the collision while the only eyewitness is interviewed. The eyewitness states that he is unsure of the make and model of the car but thinks that "it was blue." Broken glass and pieces of plastic are gathered from the roadside and paint chips are found on the victim's clothing.

The driver of the car is eventually identified as a suspect in the hit and run. In addition to a broken headlamp and a cracked front plastic grill, the car has very small bloodstains visible on the hood. The last piece of evidence collected is a fabric impression from the woman's garment that was transferred to the car's rubber bumper. The physical evidence is the only link placing the vehicle at the crime scene and the forensic scientists' testimony ultimately convinces the jury of the driver's guilt.

Forensic scientists labor in the laboratory and in the courtroom. They carefully examine the evidence, perform the appropriate analysis and render an opinion based on their conclusion. Forensic scientists are aware of the responsibility stemming from playing an important role in determining the fate of an individual based on their testimony.
This feeling is tempered by their faith in the scientific method and the scientific principles utilized to reach their conclusion.

Session 8: Which Substances Are Crystals And Which Are Powders?

Materials: For each team of two students:

6 soufflé cups
1 Powders and Crystals Work Mat.
1 magnifier (hand lens or scope)
1 Lab Journal
Index Cards with holes
Transparent tape*
2 pairs of safety goggles

Procedure: (Student)

1. Research: Research the terms "powder" and "crystal".

2. Obtain an index card, to place your samples on, from your Director. (If the card needs to be "prepared" your Director will give you directions.)

(USE **SAFETY GOGGLES** WHEN HANDLING THE POWDERS/CRYSTALS)

3. There are six samples and six holes in the card, label each hole to match the sample to be placed there. Use the flat end of the toothpick to transfer a small portion of each substance to a taped hole on the index card.

4. Turn the card on its edge and gentle tap it to remove extra material.

(**GOGGLES** not needed to view sample using pocket magnifier)

5. Place the card in the pocket magnifier so that the holes will be viewable through the scope hole. Make observations of the substance samples using your senses (not taste). (Record data in Lab Journal; you will want to start a chart)

6. Based upon your research, identify each substance as a powder or crystal form.

7. Share your observations and classification, as a powder or crystal, with other lab teams/groups.

8. If needed, modify your labels of powder or crystal.

BE SURE TO WASH YOUR HANDS AFTER HANDLING THE POWDERS OR CRYSTALS

Session 9: Do Powders And Crystals Change When Mixed With Water?

Materials: For each team of two students:

- 1 Powders and Crystals Work Mat
- 6 soufflé cups
- 1 dropper bottle of water
- 6 toothpicks
- 2 pairs of safety goggles

Procedure: (Student)

1. Place one level tsp. of the substance to be tested in each cup.

2. Add 20 drops of water to a sample, stir the solution with a toothpick.

3. Continue to add drops (keep count) and stir until it is the consistency of ketchup.

4. Record in your Lab Journal the number of drops of water added and observations about the changes as you add the water drops.

5. Read "The Dissolving Solution"

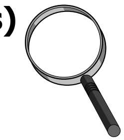
Reading for Information: **The Dissolving Solution**

Dissolving occurs when a solid, like sugar, breaks into tiny pieces and mixes in with a liquid, like water. If you can think of the sugar molecules as holding tight to each other in the solid sugar, when they dissolve in water they let go of each other and mix in with the water molecules. We call the mixture a solution of sugar in water. The sugar molecules are now holding lightly (not tightly) to the water molecules and not with each other. If all the sugar dissolves, it will have appeared to disappear into the liquid. It LOOKS like the sugar melted into the water, but it is not melting. Melting requires heat. Dissolving can be sped up by heat. Hot liquids often dissolve more solid than cold liquid, but heat is not always needed for dissolving to occur. When liquid water dissolves things it's called a <u>solvent.</u> Things that dissolve in water, like sugar, are called the <u>solute</u>. The solvent and solute together form a <u>solution</u>. When a solid doesn't dissolve very well in water it is called <u>insoluble</u>. Sand is insoluble in water. Sugar and salt are soluble in water.

Challenge Question:

How might the process be reversed so that the solids are taken out of the solution?

Session 10: What Reactions Will Occur When Vinegar Is Added To Each Of The Substances? (Testing for Carbonates)



Materials: For each team of two students:

- 1 Powders and Crystals Work Mat
- 6 souffle cups
- 1 dropper bottle of vinegar
- 2 pairs of safety goggles

Procedure: (Student)

1. Place one level tsp. of the substance to be tested in each cup.

2. Add a few drops of vinegar to a sample.

3. Record your reactions, stir the sample, record your observations (in your Lab Journal).

Results/Conclusions: (write about your observations, keeping the following in mind)

1. Which of the powders gave us the most noticeable reaction?

2. What was the evidence that a reaction?

3. If you were to add vinegar to samples of these substances tomorrow, would you get the same results? Give a thought as to why.

4. Using your training from Session 7, tell why you think this experiment represents a physical or chemical change for the substances.

Challenge Question:
How could we further test to determine from which substance the bubbles came (substance tested or the vinegar)?

Session 11: Testing For The Presence Of Starch

Materials: For each team of two students:

1 Powders and Crystals Work Mat
6 soufflé cups
1 dropper bottle of iodine
1 Lab Journal
2 pairs of safety goggles and gloves

Procedure: (Student)

1. Place one level tsp. of the substance to be tested in each cup.
2. Add a few drops of iodine to each cup and record your observations in your Lab Journal.
3. Stir the cups' contents and make any additional observations.

Results/Conclusions:

Look back at Session 2 in your Lab Journal, and find any compounds that you looked at that were named "starch." From this, what may you conclude about the chemical makeup of the samples that tested positive with iodine by changing in color from red to blue-black? (chemical formula, elements composed of)

Session 12: How Does Heat Affect The Properties Of A Substance?

Materials: For each team of two students:

- 2 pairs of safety goggles
- 6 pieces of aluminum foil 10 cm x 10 cm
- 1 candle
- 1 aluminum drip pie pan for candle
- 1 clothespin
- 1 box matches
- 1 Lab Journal

Procedure: (Students)

Students should collect materials needed and proceed with the heat test.

Use Safety goggles. (Do Not use gloves)

1. Construct **6** aluminum "frying pans" from a 10 cm x 10 cm piece of foil.

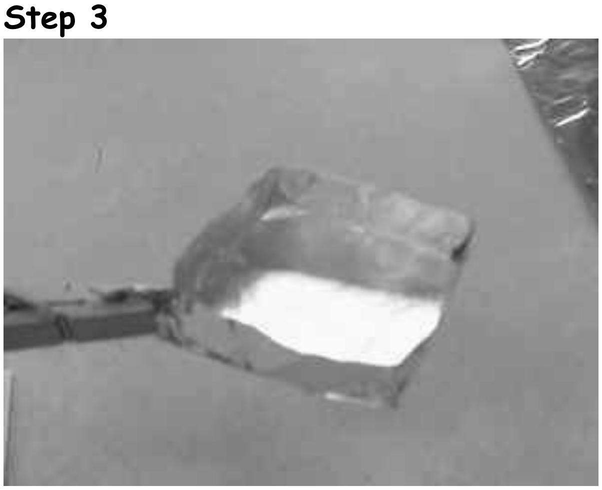
Step 1

Create a 2cm folded edge on all 4 sides.
Squeeze together the corners.

Step 2

After squeezing together the corners
Fold three of them to form box-like corners.

Step 3



Step 4

Using the clothespin you should be able to use the “fourth” corner to grab the pan and hold it over the heat source.

2. Place the amount of powder or crystals that will fit on the flat end of a toothpick into a frying pan (made from 10 cm x 10 cm squares of aluminum foil.)
3. Hold frying pan over candle for a minute or until no further changes occur. (To heat slowly, move the pan in a small circular motion over the flame.) Repeat procedure using different pans until all powders have been tested.
4. Record the heat test observations in your Lab Journal; be sure to note changes throughout the heating process.

Session 13: How Are Acids And Bases Recognized?

Materials: For each team of two students:
- 6 different powders
- 1 Powders and Crystals Work Mat
- 6 soufflé cups
- 1 dropper bottle of BTB
- 1 Lab Journal
- 2 pairs of safety goggles and gloves

Procedure: (Student)

Use Safety goggles and gloves

1. Use the flat end of the toothpick to transfer a small portion of each substance to a soufflé cup.

2. Add a few drops of BTB to each powder in the soufflé cup and observe.

3. Record your BTB test observations in your Lab Journal

4. Read: "pH: Acid or Base"

5. Write your conclusion about the substance tested based upon your test observations.

Reading for Information: **pH: Acid or Base**

Have you ever bit into a lemon? What a sour taste it has! Have you ever been squirted in the eye by a grapefruit or an orange? It sure stings. The reason for the sour taste and the stinging is acids. Citrus fruits contain citric acid. Acids taste sour, dissolve in water to form solutions that conduct electricity (as in "acid batteries" such as car batteries), turn acid/base indicator paper (litmus paper) red, are reactive and will neutralize bases. Neutralize means to change to a substance that is neither acid nor base. Some common weak acids are: lemon juice (citric acid) and vinegar (acetic acid). Some common strong acids are: hydrochloric acid (found in your stomach to help digest food), sulfuric acid (found in batteries).

Bases are the opposite of acids and can also be very reactive. Bases are substances that have a bitter taste, feel slippery, like soap, are conductors of electricity, turn acid/base indicator paper (litmus paper) blue, and neutralize acids. Many bases are poisonous so you should not taste them. Some examples of bases are ammonia (found in household cleaners), drain cleaner (sodium hydroxide), magnesium hydroxide (found in anti-acids for stomach problems commonly known as "heart burn").

There are many acid/base indicators (measurers) available. Some are very simple indicators, such as, litmus paper, BTB (bright yellow for acid, blue for base) and others are more complex, such as pH meters. pH measures the acid/base nature of a substance on a scale of 1 – 14. As the pH of a substance reads closer and closer to 1 the substance is a stronger acid. As the pH of a substance moves closer to 14, the substance is a stronger base. What about a pH in the middle, equal to about 7? That is considered neutral. Distilled water (pure water with no minerals or salts in it) should have a pH of 7. That is why aquarium owners often add distilled water to their fish tanks, it's neutral. Distilled water is also a good rinsing agent in a chemistry lab, it has a pH of 7 and it is not reactive. Natural water including rainwater is often slightly acidic (pH of ~6.5).

The pH of a substance is a measure of its acidic or basic character. This gives us information about the chemical identity of the substance or mixture, how reactive it may be and importantly how toxic it may be to living things. This is reflected in our concerns about acid rain and safety issues with household cleaners.

Challenge question: Why would you take Tums (or a similar product for stomach discomfort, such as "heart burn"?

A Case Study: Forensic chemist at work

An interesting case occurred on March 19, 1993, when Bobby Joe Johnston of Oklahoma City, suffered burns to his lips and tongue after drinking from a can of Pepsi. The hospital where he was treated took a sample of Pepsi from the can and determined it was highly caustic. The hospital called the fire department, which retrieved the can and the rest of the six-pack Johnston had purchased. The fire department treated the cans as hazardous materials instead of forensic evidence, however.

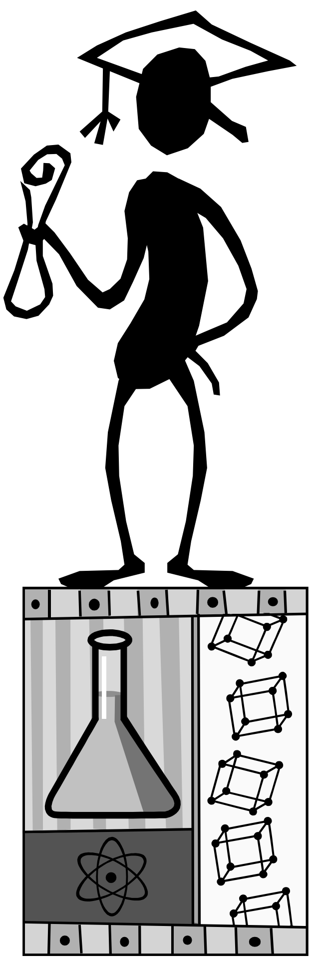
"They put the five unopened cans in a glass container, set the open can on top of the others, and went home for the weekend," says Wolnik. "When they checked it on Monday, the corrosive material had eaten through the open can and dribbled onto and through another can, causing the second one to explode. When we finally got the sample, we had to reconstruct what came from the contaminated can and what came from the other previously unopened can. It ended up being fairly tricky."

However, the lab was eventually able to confirm that sodium hydroxide (lye, a strong base in solution) had been added to the can after it was opened and could not have been in any of the unopened cans. "We did studies to see how long it would take [for sodium hydroxide] to eat through a can," says Wolnik. The FDA chemists found that highly caustic solutions such as lye ate through the can in a matter of hours. "That proved that it couldn't have happened during manufacturing." Johnston was convicted of fraudulently reporting tampering on June 3, 1993.

At this point you have experienced all of our test procedures and what an experience it has been!

You should request the “SUMMARY CHART” from your Director. Using this reference chart you should be able to compare its data to your testing data and be able to make conclusions as to the identity of the test substances.

Make a list of the test substances (using their identifying COLOR) and what you think their real identities are. Hand this list into your Director (be sure to put your name on the top of the sheet of paper).



You are now a non-Class2Newbie or more prestigiously known as a FIRST CLASS CRIME LAB CHEMIST!

TAKE A BOW.