PHYSICAL AND CHEMICAL PROPERTIES

PROBLEM PRESENTATION / EXPLORATION

A. Have each student pick out a peanut from a bag of peanuts.
   1. Examine your peanut carefully for 30 seconds. Make a list of all its characteristics. Give your peanut a name.
   2. Now, have all students at a table or a group of desks place their personal peanuts into a common pile and mix them up.
   3. Instruct each student to retrieve their personal peanut from the pile.

B. The identification or classification of an object is based on a specific set of properties that the object possesses. The characteristics that you used to identify you peanut were a set of properties.

C. Station Setup
   1. Each of five stations should be identically equipped with three glass bottles with stoppers. One bottle should contain sand or other similar solid; one should contain water; and the third should contain only air. Students should be asked to make and record observations of each bottle. If necessary, propose questions such as, "What is contained in each bottle? How would you classify each material? Are there similarities among the three materials? What are the differences?"
   2. Next, each of five stations should be identically equipped with a metric rule, a balance, a 100 mL graduated cylinder, three crayons of various colors from which the wrappers have been removed, and water. "Carefully observe each of the objects at your lab station. Using the equipment that has been provided and your own knowledge, make a list of the properties of the objects that would allow you to retrieve them from a container of similar objects."

CLASS RESPONSE / CONCEPT INVENTION

A. Each group should report back to the class about their observations of those materials in the three jars. (Hopefully, they will have discovered the three states of matter at this point. Some may indicate that there was nothing in the jar containing air. If so, ask them to recall what they learned about the properties of matter.)

B. Each group should then report their findings concerning the crayons. Record these findings on a transparency or on the chalkboard. "Which properties were the most helpful in identifying your objects?" [Characteristic properties will probably be: color, length, diameter, mass, floats or sinks in water.]

C. These properties along with melting point of solids, boiling point of liquids, coefficient of expansion, hardness, density, shape, odor, and taste are examples of **physical properties**. Notice that each of these properties can be investigated without changing the composition of the substance. If a large piece of paper is torn, there are smaller pieces but each of these pieces has the same makeup as the original large piece. After the melting point of a solid is determined it cools back down to give the same substance as before the heating. Measuring the density of an object does not change the composition of that object.

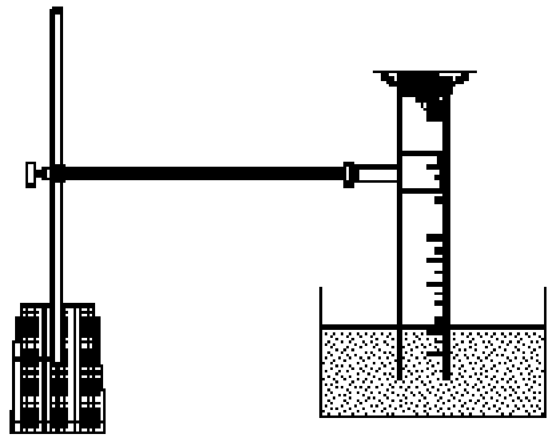
D. At this point, students will report to one of five stations and record all observations after completing the activities at that station. Each group should be given 5-10 minutes at each station. Instructions should be provided on cards at each station.
   1. Station #1
      a.) Materials should include a piece of paper, a match, forceps or tweezers, and a watch glass or glass dish.
      b.) "Record any properties of the paper that you observe."
      c.) "Tear the paper into two pieces and again record your observations."
      d.) "Hold one of the pieces of paper over the watch glass or dish, light the match, and burn the paper. Record all observations and any changes that have taken place. Which of these are physical changes?"

2. Station #2
   a.) Materials should include 1.0M copper (II) nitrate solution and 1.5M sodium hydroxide solution, a test tube, and a stirring rod.
   b.) "Mix 3 mL of each of the two solutions in the test tube, stir, and record all observations." (The copper (II) nitrate solution can be made by mixing 18.8 g of solute with enough water to make 100 mL solution. The sodium hydroxide solution can be made by mixing 6.00 g of the solute with enough water to make 100 mL of solution). Be careful when making the sodium hydroxide solution. **If you get any on you, wash it off with large amounts of water.**
3. Station #3
   a.) Materials should include 2 sugar cubes, 2 packages of granulated sugar, 2 paper towels, a 100 mL graduated cylinder, 4 paper cups, a microscope slide, 2 medicine droppers, a heat lamp or other similar heat source, and a microscope or magnifier.
   b.) "Place both a sugar cube and the granulated sugar from one of the packages on separate areas of a clean paper towel. Observe both types of sugar, then taste, and record all observations." (You might point out that normally nothing should be tasted in lab; however, today will be an exception.)
   c.) "Place each sample into a separate paper cup containing 25 mL of water and observe. Record any changes that take place.
   d.) "Crush a second sugar cube into crystals and place on a second paper towel. Place the contents of a second package of granulated sugar on a separate area of the towel. Note any differences in observations."
   e.) "Again, place each sample into a separate paper cup containing 25 mL of water and observe. Record any changes that take place."
   f.) "Place 3 or 4 drops of each of the samples that you just prepared onto separate areas of a microscope slide and place under a heat lamp to dry. Examine under a microscope or with a magnifier and record your observations."
4. Station #4
   a.) Materials should include a 1.00 g sample of ammonium nitrate in a tightly capped bottle, a Ziploc® bag, and 25 mL of water.
   b.) "Record observations of properties of ammonium nitrate and of water before beginning your experimentation."
   c.) "Place the sealed bottle of ammonium nitrate in the Ziploc® bag and add the sample of water. Seal the bag tightly. Next, remove the cap from the bottle containing the ammonium nitrate without opening the bag. Record all observations."
5. Station #5
   a.) Materials should include a small piece of chalk, 100 mL of 1.0 M hydrochloric acid, a test tube or flask, a one hole rubber stopper, a small dish or second test tube, rubber or glass tubing, and 100 mL of lime water (11.0 g calcium hydroxide / L of water).
   b.) "Record the properties of the chalk and the hydrochloric acid that you observe before beginning the experiment."
   c.) Carefully insert a flexible plastic straw into a one holed stopper. Add the piece of chalk to the test tube. Then add enough hydrochloric acid to completely cover the chalk. Quickly stopper the tube and place the end of the straw into another container filled with lime water. Record all observations." (The change of the lime water to a cloudy appearance is an indication of the presence of carbon dioxide.)
6. Station #6
   a.) Materials should include a clean piece of steel wool, a 100 mL graduated cylinder, a beaker, a ring stand or other support, a clamp,

a medicine dropper, and water.

b.) "Before beginning this experiment, record all observable properties of the steel wool."

c.) "Push a small wad of the steel wool to the bottom of a 100 mL graduated cylinder. Place a few drops of water in the cylinder and shake to moisten the steel wool. Invert the cylinder and place it in a beaker of water, supporting the cylinder with a ring stand and clamp. Adjust the cylinder so that the level of water inside and outside the cylinder are at the same height. Let stand overnight. The next day, record and changes that are observed."



7. Station 7

a.) Cut off a piece of Scotch® tape about 15 cm long. Cut off a piece of masking tape about 15 cm long. Tape the two sticky sides together so that you have one 15 cm long piece of "double tape".

b.) Grasp the "double tape" with a spring loaded clothespin and place it over the flame of an alcohol lamp or a cigarette lighter for a few seconds. Record what happens.

c.) After the tape cools, turn it over so that the other side of the "double tape" is above flame and watch what happens now. What physical property of the tape could account for this behavior? [Each of these two types of tape expands at a different rate. One side of the tape is expanding faster that the other side. That is why one time the "double tape" bends upward from the flame but when turned over bends downward toward the flame. This is the principle of the bimetalic strip in many thermostats. The name of the physical property responsible for this phenomenon is the coefficient of linear expansion.]

E. After all experimentation has been completed and observations recorded, have each group report back to the class their findings. Record these observations on a transparency or the chalkboard. As a class divide the properties into two groups based on whether the material under consideration was the same material both before and after your experimentation or if it was different after the experimentation. Those properties where no permanent changes were made to the substance are physical properties. Those properties that seemed hidden until some external agent came in contact with them and allowed the property to be seen are called chemical properties. For example: not until oxygen came into contact with the paper and with enough heat supplied did combustion or oxidation take place. The property of oxidation is therefore a chemical property. The hidden property of the copper (II) nitrate and sodium hydroxide to come together and form a precipitate is a chemical property. As you would suspect, along with chemical changes come physical changes. The new substances formed have different physical properties from the substances before the chemical change took place.

Physical	Chemical
Color	Combustibility
Size	Form a Precipitate
Texture	Produce a Gas
Liquid/Solid/Gas	
Solubility	
Endothermic or Exothermic Heat of Solution	

CONCEPT EXTENSION

A. Station Setup

1. Cut a potato in half. Add a few drops of iodine solution to the freshly cut surface of the potato. The blue/black stain that forms is a positive test for starch in the potato. This is a chemical property of starch.
2. "Observe carefully a piece of toast. Record your observations. Break the toast in half, exposing the inner portion. Again, record your observations. Add a few drops of the iodine solution to both the outer, toasted portion and the inner area. Observe and record what happens. On the basis of your observations, identify where any physical or chemical changes occur. List reasons for your explanation. [The heat will cause a chemical change in the starch contained in the bread breaking it down into less complex molecules. These portions of the toast will not give the starch test to the same degree as where the large starch molecules have not yet been degraded. This is why toast is recommended for people who have digestion problems. Now you know why your mother gave you toast when you were recovering from an illness!]

B. Station Setup

1. Materials at each identical station should include two pennies (one a pre-1982 and the other a post-1982 penny), a triangular file, 2 beakers or other similar containers, 50 mL of hydrochloric acid (3 M), and a balance.
2. "Observe carefully the two pennies at your lab station and record all visible properties in your notebook. Next, scratch the edges of both coins with the triangular file at 12, 3, 6, and 9 o'clock around the penny's circumference and place into separate beakers, containing 25 mL of hydrochloric acid. Observe and record any changes that occur within the class period. Allow the coins to remain in the hydrochloric acid overnight. During the next class period, have some of the students carefully remove some of the coins with forceps or tweezers from the hydrochloric acid and rinse in water thoroughly. Examine both coins carefully and record any changes that have taken place. Leave the other pennies in for one or two additional days. On the basis of your results, what kind of change has taken place in each case? List reasons for your answers." [In the post 1982 pennies approximately 95% of the penny is zinc covered with a thin copper shell. The cuts in the edge allow the acid to react with the copper forming hydrogen gas. Consequently the penny is eaten up from the inside. When sufficient zinc has been reacted, the penny will float in the acid solution. Because the pre 1982 pennies had only about 5% zinc in them very little reaction will take place and they should not float.]

C. Non-Newtonian Fluids

1. Fluids - Fluids are anything that flow, a gas, a liquid, or an avalanche. Fluids should not be confused with liquids.
2. Viscosity - All fluids have a property known as viscosity. It is the measurable thickness or resistance to flow in a fluid.
3. Newton's law of viscosity says that the viscosity of a fluid can be changed only by altering the fluid's temperature. A common example is honey. You

warm it up and it flows more easily [becomes less viscous].

4. Non-Newtonian fluids have the same dependence on temperature but their viscosity can also be changed by applying force or stress. Added force either increases (cornstarch/water, monster flesh, slime) or decreases the viscosity (spreading margarine over a piece of toast).
5. Because non-Newtonian fluids have the above property they are interesting to study. Do they act like liquids or solids?
6. Pour 1.5 cups of pure cornstarch slowly, with stirring into a plastic mixing bowl containing 1 cup of water. The mixture will get more viscous as more cornstarch is added. Slowly stick your finger into the white blob. Slam your fist down into the mixture. What happens when you apply pressure to the mixture? [Your finger will pass easily through the mixture when slow gentle pressure is applied. When much greater pressure is applied by slamming your fist into a pan of it, there is great resistance offered. In other words, the viscosity increases when subjected to greater pressure.] Roll some of the mixture up into a ball and set it on the table. What happens? [With almost no pressure being applied to it, it will slowly "melt" into a much more liquid-like material.]
7. Another non-Newtonian fluid is commonly referred to as Monster flesh.
   a.) Prepare a 4% solution of sodium borate (use 4 grams of 20 Mule Team Borax® and 96 grams of water).
   b.) Into a 100 mL beaker, carefully pour 20 mL of Elmer's glue. Add to this 20 mL of water. Stir with a pop sicle stick or spoon.
   c.) Pour 15 mL of the borax solution into the glue/water mixture. Stir for about 20 seconds. (The borax solution can be made different colors before adding to the glue/water mixture by adding a few drops of food coloring, or different colors of Elmer's glue are now available).
   d.) Remove as much of the product as possible (**it is entirely safe to handle**) from the beaker Pick it up in your hands and knead it.
   e.) Place it on a flat surface and watch what happens. Is what you have made a solid or liquid?
   f.) What are some of its physical properties? Does it bounce? Does it stretch? Does it pick up impressions from newsprint like Silly Putty?