CONSERVATION OF MASS

PROBLEM PRESENTATION / EXPLORATION:

A. Each group will be given 4-5 minutes per station to observe the outcome of the specified activity and make as many measurements as they can think of. Tell the students that after they have been to all of the lab stations that they will be asked to figure out what each activity had in common, or what happened in each case that was the same.

B. Station Setup

1. Station #1
   - a) Materials: balance, a metric rule, a magnifying glass, a thermometer, a beaker of warm water, an English walnut, a hammer
   - b) Directions: *"Without opening the Ziploc® bag, crack open the walnut by hitting with the hammer."*
2. Station #2
   - a) Materials: balance, a metric rule, a magnifying glass, a thermometer, a beaker of warm water, paper towels, a sealed Ziploc® bag containing an ice cube
   - b) Directions: *"Melt the ice cube by putting the Ziploc® bag containing the ice cube into the beaker of warm water."*
3. Station #3
   - a) Materials: balance, a metric rule, a magnifying glass, a thermometer, a beaker of warm water, a sealed Ziploc® bag with two sealed test tubes of liquid inside. [In one test tube is lead nitrate solution and in the other test tube is sodium iodide. When mixed together, these two solutions will produce a bright yellow solid.]
   - b) Directions: *"Without unzipping the bag, uncork the tops of the two test tubes and allow their contents to pour out into the bag. DO NOT UNZIP THE BAG."*
4. Station #4
   - a) Materials: balance, a metric rule, a magnifying glass, a thermometer, a beaker of warm water, a sealed Ziploc® bag containing 25 mL of water and a sealed bottle with 5 grams of NH_4NO_3 in it.
   - b) Directions: *"Without unzipping the bag, unstopper the bottle and allow the solid to come in contact with the liquid in the bag. Shake the bag. DO NOT UNZIP THE BAG"*
5. Station #5
   - a) Materials: balance, a metric rule, a magnifying glass, a thermometer, a beaker of warm water, a hot plate, a filter flask fitted with a rubber stopper, two kernels of pop corn , a rubber balloon
   - b) Directions: *"Place the pop corn in the filter flask. Place the rubber stopper back into the flask. Attach the balloon to the side arm of the filter flask. Place the apparatus on the hot plate and leave it there until the kernels pop."*

CLASS RESPONSE / CONCEPT INVENTION

A. Have each group report its findings on an observation sheet. If possible have one member of the group transfer the group's findings to an appropriate table on the board or a transparency so that the whole class can see the outcomes of the other groups.

B. After all groups have reported their observations, try to get the class to come to consensus about all the things that the five activities had in common. Possibly they will try to draw conclusions on the basis of physical and chemical reactions. This is a good way to reinforce the lesson on properties, but all five stations did not have just chemical, or just physical reactions. If they can't agree on the common event, ask them what one thing remained the same, before and after each transformation, for the materials at each lab station. If no one mentions the use of the balance, see if you can get them to concentrate on the mass of each system.

C. Assuming that there might be some measurement error that might make the conclusion harder to visualize, work with the class to see if they can come up with the idea that the mass remained constant in both the physical changes as well as in the chemical changes. Common errors might be weighing the system when it is either colder or hotter than before the transformation. Some students might not carefully dry the Ziploc® bags after they have been in the water. Reading the balance wrong will probably take care of itself since more than one student in a group will probably be involved in the massing process. Also, all groups will be carrying out the activities and the repetition of data can serve to point out erroneous measurements. The observation that the mass remains constant throughout a chemical or physical reaction is generally known as The Law of Conservation of Mass. Another way of looking at this law is that no matter is destroyed during a chemical or physical reaction.

D Because some of the exploration activities carried out by the groups may not have utilized the balance to its fullest benefit, a few more activities where the Law of Conservation of Mass can be experienced may be needed to reinforce the concept.

1. Examine a new flash bulb and one that has been flashed. Which one looks like it has a greater mass? (Most students would say the used one because it has additional products of oxidation visible.) Put a new bulb on the balance and record its mass. Flash the bulb, let it cool, and put it back on the balance. The mass should remain constant.
2. A similar demonstration would be to put two or three kitchen matches into a 500 mL Erlenmeyer flask and tightly stopper it with a rubber stopper. Put on a balance and determine the mass and record it. Remove the flask from the balance and carefully bring a Bunsen burner close to the flask so that the heat will come in contact with the matches in the flask and ignite.

   > CAUTION: Heat only for a short time. Extreme caution should be used when ever a closed container is heated.

   After cooling back to room temperature return the flask to the balance and record its mass. Have students predict what the mass will be. [Once again, the mass should be the same. The flask must cool before determining its mass.]
3. Next demonstrate three situations where by mixing two substances together it may appear that mass is disappearing.
   - a.) Place 25 g of rock salt in a 100 mL graduated cylinder. Carefully fill the cylinder to the 100.0 mL mark with water, put a rubber stopper in the mouth of the cylinder, and place it on a balance. Record its mass. Take the cylinder off the balance, shake it vigorously until all the rock salt has dissolved. Observe the level of solution now in the cylinder. Where has the missing liquid gone? What should the students predict will be the mass when it is now put back on the balance? [The mass should remain constant. As the salt dissolved, the ions mixed between the spaces of the water particles and the volume decreased slightly.]
   - b.) Into one 100 mL graduate cylinder place 50 mL of water. Into another 100 mL graduate cylinder place 50 mL of alcohol (ethyl alcohol works best). Place both graduated cylinders on a balance and record the mass. Now, slowly pour the contents of cylinder #2 into cylinder #1. Place both graduated cylinders back on the balance. Notice the combined volume and the total mass. Once again the mass is conserved but the volume shrinks.
   - c.) You will need three identical balances and three balls of Play-Doh®.

Each of the balls of Play-Doh® must have the same mass. While the students are watching flatten one of the balls out into a pan cake. Roll the other one out lengthwise and join one end to the other end to make a doughnut. Now, have the students predict which one has the greatest mass. Even though Piaget says that students in your class should have developed to the point that they can conserve mass, it might be interesting to see if some still think that the altering of the shape has altered the mass.

4. Finally, demonstrate an example of where mixing two substances together appears to create mass.
   a.) Into one 100 mL graduate cylinder place 50 mL of carbon disulfide. [A word or caution: carbon disulfide smells terrible. If you have a fume hood, use it. If you don't, do it outside or next to an open window.] Into another 100 mL graduate cylinder place 50 mL of ethyl acetate (fingernail polish remover). Place both graduated cylinders on a balance and record the mass. Now, slowly pour the contents of cylinder #2 into cylinder #1. Place both graduated cylinders back on the balance. Notice the combined volume and the total mass. Once again the mass is conserved but the volume increases.

CONCEPT EXTENSION

A. The Law of Conservation of Mass can be used to determine the mass of a reactant or product in a chemical reaction. For example, how could you determine the mass of carbon dioxide that is generated when two Alka-Seltzer tables are dissolved in 100 mL of water at room temperature?
   1. Place on a balance an Erlenmeyer flask containing 100 mL of water.
   2. Break in half two Alka-Seltzer® tables and wrap them in a Kleenex tissue.
   3. Lodge the (Kleenex® + tablets) in the neck of the flask Place the flask + Kleenex® + tablets on a balance and record the total weight
   4. With a pencil gently push the Kleenex®+ Alka-Seltzer® tablets down into the water and watch the mass of the system indicated on the balance.
   5. As the reaction takes place the carbon dioxide should form and leave through the top of the flask.
   6. The difference in the mass is the mass of the carbon dioxide formed.
   7. Repeat the experiment with the following change. Don't put the broken Alka-Seltzer® tablets in a Kleenex®, rather put them into a balloon. Carefully, without allowing the tablets to spill out of the balloon, attach the balloon to the mouth of the flask. With the whole system resting on the balance, adjust the balloon so that the tablets will now fall into the water.
   8. What difference would you expect to see this time. [Depending on how sensitive your balance is, you will probably see no change in mass since the carbon dioxide is being trapped in the balloon. However, if the balance is sensitive, there will be a slight decrease in what registers on the balance. This is due to the buoyant effect of the trapped gas which actually causes the weight to appear lighter.]

B Another important chemical principle is the Law of Definite proportions which says that chemical compounds of the same substance will always have the same proportion by mass without regard to where and how the compound originated. That means that water has the same proportion of oxygen and hydrogen in Russia, in Canada, in Africa, and in Tennessee. Furthermore, different brands of the same chemical substance should have the same proportion no matter where they were produced.
   1. Epson Salts is the common name for magnesium sulfate heptahydrate. If some Epson Salts is heated, it gives off water. Now, if all brands of Epson Salts have the same proportion of water, we should be able to experimentally verify this using the Law of Conservation of Mass.
   2. Purchase three different brands of Epson salts. Most drug store chains have

their own generic brand. Measure out different amounts of the three brands and assign them to the different groups.

3. You need some type of heat source to drive off the water. Bunsen burners would work, if you have them. The Epson Salts could be placed into a large test tube and heated slowly but thoroughly for about 10-15 minutes to drive off the water.
4. The Epson Salts could also be put into an oven and heated for a couple of hours at about 350°F (176°C).
5. Regardless of the way you drive off the water you must insure that it all has been driven off. If the Bunsen burner is used, the tube should be weighed after the initial heating and then heated again until two weighings are within 0.2 g. Remember, you must allow the tube to cool down to room temperature before you can weigh it on the balance. If the oven is used, a second heating of about thirty minutes is needed to insure that all the water has been driven off.
6. Individual groups could carry out the determinations on different brands of Epson salts and determine the percentage of water in each. (See the experiment on the Law of Definite Proportions for further information.)