Plastic Fantastic! - Student Activity Sheet

Part 1: Experimenting with heating polystyrene.

Using the sheet of #6 plastic, discuss with your classmates how to cut out the largest form possible in the shape that your teacher has assigned. When you all have decided what to do, cut out what you all have agreed upon. Measure the dimensions and calculate the area using the appropriate formula below. Using a triple beam balance, mass the plastic shape you have cut out. Make observations about the plastic (color, thickness, rigidity, etc) and record all quantitative and qualitative data. Make a hypothesis about what will happen to their plastic if it is heated and record your hypothesis.

Formulas for calculating area:

Circle: $a = pi (r^2)$	Where: a = area of the circle, r = radius of the circle, and pi = 3.14
Square: $a = s^2$	Where: a = area of the circle, s = side of the square
Rectangle: $a = h * w$	Where a = area of the rectangle, h = height, w = width
Triangle: $½ * b * h$	Where a = area of the rectangle, b = base, h = height
Rhombus: $½ * d_1 * d_2$	Where a = area of the rhombus, d_1 = length of one diagonal, d_2 = length of the other diagonal
Parallelogram: $a = b * h$	Where a = area of the parallelogram, b = base, h = height.

Part 2: Heat

Place the piece of polystyrene on an aluminum foil covered tray and place it in the oven at 350-375 degrees for 30 seconds to a minute. Plastic will sometimes curl up as it heats. Placing a tile on top of the plastic or pressing the piece with a spatula may prevent curling. Shrink film will curl and then uncurl. Once it has uncurled, it can be removed from the oven. See that it doesn't curl and "stick" to itself by pressing with wooden spatulas.

Part 3: Mass and Measure

Mass your shape again. Measure the dimensions, calculate the area, and mass the geometric shapes again. Record your "after heating" data. Make additional observations about the plastic and record.

Part 4: Calculations

Calculate the percent reduction and the percentage of plastic area remaining.
Set up a before-and-after chart to present activity information clearly.

Part 5: Individual Project

Use the shrink film given to you by your teacher to design something - key chain, pendant, earrings, Christmas ornaments, luggage tags, etc. Use permanent markers to add color and create designs. A hole puncher can be used to make holes for key chains or luggage tags. Note: One punch shrinks too much to fit most key rings so usually multiple over-lapping punches are needed. Be sure to punch the holes before the shrinking process. After you are finished, draw the design, mass and measure the item and, based on your previous experience, predict what percentage of shrinking will occur and what the size will be after shrinking. Heat as you did before and record all information you collect.

Learn something about polymers:

The plastic used in this activity (polystyrene) is easy to work with when heated. While hot, polystyrene can be stretched into any shape required. Normally, the polymer chains in a piece of polystyrene are jumbled together in an almost random way (think of wet spaghetti noodles dumped on a plate). When heated, the strands can be stretched into a more ordered pattern and "frozen" in place. If the polystyrene is reheated, it returns to its original shape (a type of "memory polymer".) A plastic that softens upon heating and can be reshaped is known as a thermoplastic. Thermoplastics can be melted or softened to make new products and thus are recyclable. They include polyethylene, polypropylene, polyvinyl chloride (PVC), and polystyrene (PS). Products and packaging made from one of these thermoplastics are stamped with the recycling symbol – a triangle of arrows with a number (1 – 7) inside.

Polystyrene is not the only plastic that behaves this way with heat. Soda bottles are also made from plastic with similar qualities (recyclable #1 - PETE). Soda bottles are transported as "pre-forms". A pre-form is a rigid piece of plastic the size and shape of a large test tube. When it gets to the bottling plant, it is heated and expanded by blow molding into the desired size.

High density polyethylene (HDPE) bottles help to demonstrate the concept of thermoplastics. HDPE is recyclable #2. Sunny Delight bottles and half gallon or one gallon juice, milk, and distilled water jugs are usually #2. If you heat the side of a clean #2 bottle with a heat gun it softens and becomes more transparent. You can gently blow into the opening and watch it expand. This is a simplified demonstration of blow-molding.

Not everything can be remelted. Substances known as thermosets, are liquid prior to curing and the curing process transforms the resin into a plastic or rubber by a cross-linking process. Once set, thermosets cannot be remelted. Catalysts are added that cause the molecular chains to react at chemically active sites (unsaturated or epoxy sites, for example), linking into a rigid, 3-D structure.

Thermosets will decompose before remelting if uncontrolled reheating of the material is applied. Therefore, a thermoset material cannot be melted and re-shaped after it is cured.

Thermoset materials are generally stronger than thermoplastic materials due to this 3-D network of bonds, and are also better suited to high-temperature applications up to the decomposition temperature of the material.