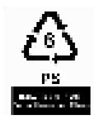
<u>Plastic Fantastic!</u>

<u>For the Teacher</u>

Shrinky Dinks are fun for all ages and make a great science and/or math activity.

<u>Target grades</u>: Grades 6-10, but any grade depending on what parts of the activity you include and what modifications you make.

<u>Science/Math Skills Used</u>: Weighing/Measuring, Using formulas to calculate area, Predicting/Hypothesizing, Organizing and Recording Data

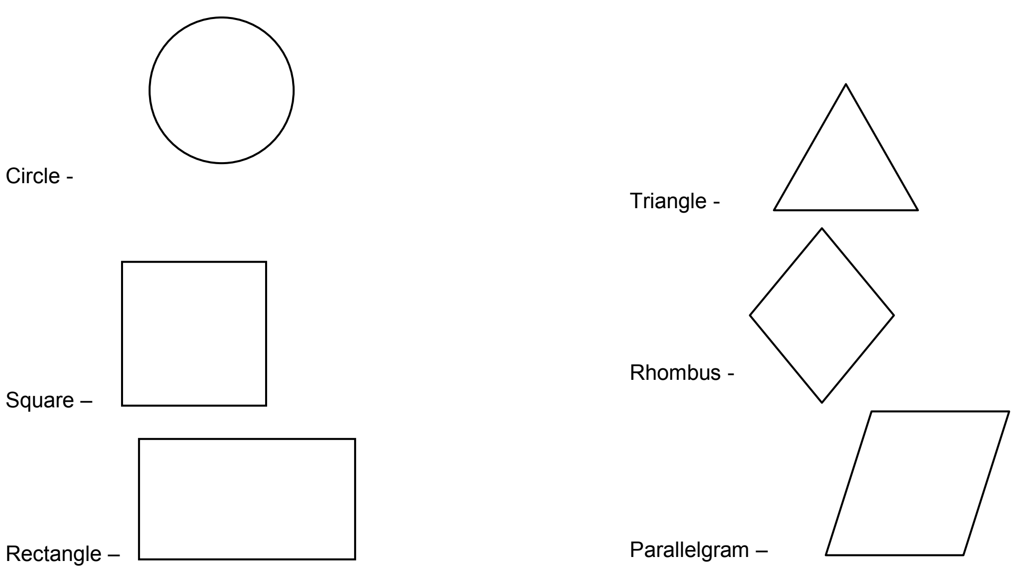
<u>Materials</u> (choose according to the part(s) of the activity you choose to do): Triple-Beam Balance, Ruler, Permanent Markers, Wooden craft sticks or tongue depressors, Scissors, Oven, Aluminum Foil, Pot Holders or Oven Mitts, hole punchers, split rings or chains (optional), Polystyrene Shrink Film. You may collect #6 Plastic, fast food containers, etc., rather than purchasing shrink film, but be sure it says #6 

. Other plastics will not work and may present a hazard if used.

<u>Duration</u>: One to two class periods, depending on the length of your class and the parts of the activity you include.

<u>Part 1</u>: Students experiment with percent reduction of polystyrene using different geometric shapes.

Draw the following geometric shapes on the board:



Divide the students into teams and assign each team one of the shapes. Give a sheet of #6 plastic to each group and tell each team to cut out the largest shape possible from their piece of plastic. Students should measure the dimensions and calculate the area. Using a triple beam balance, have students mass their plastic shape. Tell students to make observations about their plastic (color, thickness, rigidity, etc) and record all quantitative and qualitative data. Have students hypothesize about what would happen to their plastic if it is heated and record their 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:

Place the piece of polystyrene on an aluminum foil covered tray and place it in the oven at 350-375 degrees. Shrinking should take about a minute – maybe more. Plastic will sometimes curl up as it heats and 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 – just don't let it stick to itself. Once the plastic has uncurled, it can be removed from the oven.

Part 3:

Have students measure the dimensions, calculate area, and mass their geometric shapes again. They should record the "after heating" data. Have students make additional observations about the plastic in their journals.

Part 4:

Have students calculate the percent reduction and the percentage of plastic area remaining.

Help students organize and set up a before-and-after chart to present activity information clearly.

Part 5:

Have students design an individual project. Give each student a piece of shrink film and tell them to design a piece to make something - key chains, pendants, earrings, Christmas ornaments, luggage tags, etc. Permanent markers may be used to add color and create designs. A hole punch can be used to make key chains or luggage tags. Make sure you mention to them that 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 they finalize their creation, have them draw the design in their journals, mass and measure the item and, based on their previous experience, predict what percentage of shrinking will occur and what the size of their creation will be after shrinking. Record all information in their journals. By this time, students should know how to organize, record and present the data without prompting. Don't tell them this time to organize the data and mass and measure everything. See if they have learned how to proceed and present findings.

Concepts:

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.

Demonstration: Heat the side of a clean #2 bottle with a heat gun until it softens and becomes more transparent. Then gently blow into the opening and watch it expand. It is a simplified demonstration of blow-molding.

This activity can help illustrate the Law of Conservation of Matter (mass) - matter is neither created nor destroyed, but can be rearranged.

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.

Extensions:

Have students report on uses of thermosets.

Further Discussion:

This activity can help illustrate the Law of Conservation of Matter (mass) - matter is neither created nor destroyed, but can be rearranged.

More than likely, the plastic shrank by about 75% of its original size. The material did not vanish; it just got more compact. Heating this type of plastic (No. 6 recyclable) allowed the plastic molecules to slide around and reorient themselves into a more compact shape. When it cooled, the molecules became rigid again.