

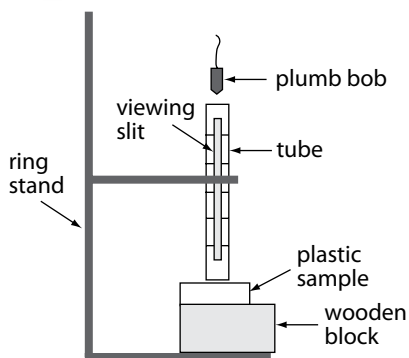
Impact and Puncture Testing of Polymers

FYI...

Plastic samples can be cut from the sides of detergent bottles (polyethylene). Lids from plastic food jars are often polypropylene. You can obtain pieces of Lexan (polycarbonate) from scrap at glass shops. Plexiglas is available in hardware stores.

Many sports require the use of equipment to protect the player from injury due to projectiles and other impacts. Most of this equipment is made of synthetic polymers. In this activity, you'll perform tests on various plastic samples to determine how resistant they are to impact and puncture.

Stuff You'll Use: ▶samples of a variety of plastics cut to nearly the same size ▶clear plastic or stiff cardboard tube at least 1 inch in diameter and 30 inches long (Tubing made to cover fluorescent lights is ideal. Cardboard tubing from a roll of gift wrap also works.) ▶0.5-lb plumb bob ▶36-inch-long string ▶wooden block ▶marker ▶ruler or meterstick ▶(optional) ring stand and clamp



What to Do:

- 1 Use a marker to mark the tube at 6-inch intervals. (Note: If you use a cardboard tube, you need to cut a viewing slit in the side of the tube.)
- 2 Set up the testing apparatus as shown at left. The end of the tube should be just above the plastic sample. (Note: You can hold the tube by hand if a ring stand is unavailable.) *Which sample do you think will be the most resistant to puncture or impact?*
- 3 Unscrew the cap of the plumb bob. Thread the string through the center hole of the cap and tie a large knot so that the string is securely attached. Screw the cap back on, and lower the plumb bob and string through the tube so that the plumb bob is suspended 6 inches above the plastic sample.
- 4 Release the string so that the bob falls freely onto the plastic sample. Inspect the sample for evidence of failure. Failure of a sample is indicated by beginnings of crack formation, complete puncture (hole goes all the way through), or complete breakage.
- 5 If the sample has not failed, increase the height from which the bob is dropped by 6 inches and repeat step 4 until the sample fails or until you reach a maximum of 30 inches. Record the height at which the sample fails or the maximum height used to test it. (See sample data table at left.)
- 6 Multiply the height of the drop by the weight of the bob (0.5 lb) to obtain impact in inch-pounds. *Which sample had the greatest impact/puncture resistance? Which had the least? If you could choose any of the samples for use in a football helmet, for example, which would you choose? Why?*

Example of data table

Sample	Did Sample Fail? (Y/N)	If Yes, Failure Height	Impact (in-lb)

How It Works:

Product engineers do a variety of tests to determine the most suitable material for a product. The Gardiner Impact Test describes how a material reacts to shock or sudden stress. In this test, a standard weight is dropped from a specified height onto test samples until the sample breaks. Another test, commonly used on sheet and film materials, measures puncture resistance. All impact standard testing in the United States is done in the English system. Therefore, the English system is used exclusively in this activity. The unit of measure for the impact test is inch-pounds.



More Fun?

Learn more about the amazing properties of polymers. Terrific Science Press (www.terrificscience.org/sciencestore) offers the following books that include activities about polymers:

- ▶▶ [Chain Gang: The Chemistry of Polymers](#)
- ▶▶ [Polymers All Around You!, 2nd ed.](#)

Activity based on a lesson developed by Sandy Van Natta, White Oak Middle School, Cincinnati, Ohio (retired).

