

## Strand II: Chemical Structures and Properties



### Synthetic Polymers

#### Laboratory Investigation Teacher Materials

This curriculum-embedded science performance task is related to the content standard and expected performances for high school, as described in the Core Science Curriculum Framework under Scientific Inquiry, Literacy and Numeracy, Strand II – Chemical Structures and Properties.

#### Targeted Content Standard

**9.6 - Chemical technologies present both risks and benefits to the health and well-being of humans, plants and animals.**

#### Targeted Scientific Inquiry, Literacy and Numeracy Standards

- D INQ. 1** Identify questions that can be answered through scientific investigation.
- D INQ. 3** Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.
- D INQ. 4** Design and conduct appropriate types of scientific investigations to answer different questions.
- D INQ. 5** Identify independent and dependent variables, including those that are kept constant and those used as controls.
- D INQ. 6** Use appropriate tools and techniques to make observations and gather data.
- D INQ. 7** Assess the reliability of the data that was generated in the investigation.
- D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**Learning Objective:**

Students will investigate a synthetic polymer (polyethylene) and how the polymer can be processed to produce products with different characteristics.

Listed below are the suggested materials for the laboratory exercise. You may use additional materials if they are available.

**Materials:**

plastic dry cleaning bags	sandpaper (coarse and fine)
markers	ruler
clear kitchen wrap	empty coffee cans
plastic sandwich bags	rubber bands
ball bearings (different masses)	ring stands or clamps
scissors	safety goggles

**Considerations:**

Students will need some background information on the structure of polyethylene and the terminology used to describe the different arrangements of the polymer, for example low density polyethylene (LDPE) versus high density polyethylene (HDPE). The differences in the stress-strain behaviors of polyethylene in the products the students are investigating are due in large part to how the materials are processed. Background information on the processing of plastics and specific information about polyethylene may be found at these and many other sites:

<http://www.teachingplastics.org>  
[http://americanplasticscouncil.org/s\\_apc/index.asp](http://americanplasticscouncil.org/s_apc/index.asp)

Teams of two students are ideal for laboratory work, but circumstances may necessitate teams of three students. Students will need a minimum of 90 minutes to complete this laboratory exercise if you expect their lab reports to be written during class time. You should allow at least 60 minutes of instructional time for the students to design and conduct their experiment and a minimum of 30 minutes for the students to write about their results. As an alternative, students can write the lab report for homework. These time frames are merely suggestions. Additional time is appropriate if the circumstances and the schedule at your school call for it. A sample scoring rubric is provided for your convenience or you can design one of your own.

This curriculum-embedded task can be integrated into a unit on polymer chemistry in any high school physical or Earth science course. The curriculum-embedded task is intended to be used as a formative assessment during the appropriate instructional unit. The Connecticut Academic Performance Test – Generation III will include some open-ended items that will assess scientific inquiry and communication skills in the same context as this task.

Student Name: \_\_\_\_\_

Class: \_\_\_\_\_



## Synthetic Polymers

### Laboratory Investigation Student Materials

Polymers are large molecules consisting of chains of small molecules called monomers joined together in a repeating pattern. In the early 1900s, scientists began to understand the chemical makeup of natural polymers and how to make synthetic polymers with properties that complement those of natural materials. One simple synthetic polymer chemists developed is polyethylene. They developed it by repeating units of the monomer ethylene ( $\text{H}_2\text{C}=\text{CH}_2$ ). Polyethylene is a very large, zigzag-shaped molecule. One small part of a polyethylene chain is shown below.



Chemists and engineers have learned to process and modify molecules of polyethylene in different ways to manufacture common household products with a variety of characteristics. Polyethylene is used to make plastic trash bags, dry cleaning bags, milk jugs and soda bottles. In industry, materials made from polyethylene are tested for what are called “stress-strain behaviors.” Stress-strain behaviors include:

- tensile strength** - the amount of pulling force placed upon a material before it breaks
- abrasion resistance** - toughness of material against scraping, scuffing or scarring
- puncture resistance** - ability of a material to keep moving objects from perforating the surface

## Your Task

You and your lab partner will design an experiment that investigates a stress-strain behavior among various plastic products made of the synthetic polymer polyethylene.

You have been provided with the following materials and equipment. It may not be necessary to use all of the equipment that has been provided.

### Suggested materials:

plastic dry cleaning bag	coffee can
plastic kitchen wrap	rubber bands
plastic sandwich bag	ring stands/ or clamps
plastic grocery bag	ruler
ball bearings (different masses)	safety goggles
scissors	
markers	
sandpaper (coarse and fine)	

## Designing and Conducting Your Experiment

- 1. In your words, state the problem you are going to investigate. Write a hypothesis using an “If ... then ... because ...” statement that describes what you expect to find and why.** Include a clear identification of the independent and dependent variables that will be studied.
- 2. Design an experiment to solve the problem.** Your experimental design should match the statement of the problem and should be clearly described so that someone else could easily replicate your experiment. Include a control if appropriate and state which variables need to be held constant.
- 3. Review your design with your teacher before you begin your experiment.**
- 4. Conduct your experiment.** While conducting your experiment, take notes and organize your data into tables.

**Safety note: Students must wear approved safety goggles and follow all safety instructions.**

**When you have finished, your teacher will give you instructions for cleanup procedures, including proper disposal of all materials.**

## Communicating Your Findings

Working on your own, summarize your investigation in a laboratory report that includes the following:

- **A statement of the problem you investigated. A hypothesis (“If ... then ... because ...” statement) that described what you expected to find and why.** Include a clear identification of the independent and dependent variables.
- **A description of the experiment you carried out.** Your description should be clear and complete enough so that someone could easily replicate your experiment.
- **Data from your experiment.** Your data should be organized into tables, charts and/or graphs as appropriate.
- **Your conclusions from the experiment.** Your conclusions should be fully supported by your data and address your hypothesis.
- **Discuss the reliability of your data and any factors that contribute to a lack of validity of your conclusions.** Also, include ways that your experiment could be improved if you were to do it again.