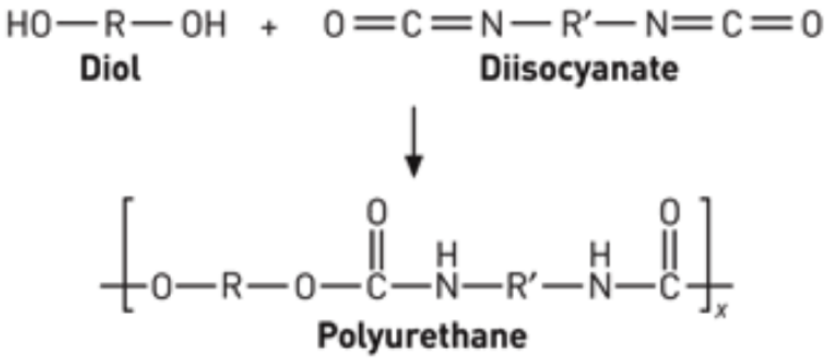
Student Name: _____ Date: _____

Activity Sheet

Polymerization Reactions

Polymer chemistry is a branch of materials science that deals with the synthesis and properties of macromolecules. Single molecular units or "monomers" can be linked together in long chains to form "polymers."

According to the US Department of Energy, heating and cooling costs amount to approximately 56% of the energy used in the average American home. Polyurethanes are used extensively in heating and cooling products. Polyurethanes are typically produced by a polymerization reaction. In this reaction a polyol (an alcohol with more than 2 reactive hydroxyl groups per molecule) reacts with diisocyanate in the presence of catalyst and additives.



There are 2 major types of polyurethane. Flexible and rigid. Flexible polyurethane foam is widely used as cushioning in consumer and commercial products, including bedding, furniture, automotive interiors, carpet underlay and packaging. Flexible foam is light and durable. Meanwhile, rigid foam is commonly used for insulation. Rigid foams can significantly cut energy costs and increase heating and cooling efficiency. Moreover, rigid foam maintains an uniform temperature and lowers noise levels in homes and businesses. Rigid foams can also be used in roof and wall insulation, windows, doors and sealants.

Student Name: _____ Date: _____

In the polymerization reactions module, students will complete a "Think, Pair and Share" activity. Then, students will synthesize a polyurethane foam. Ultimately, students will design their own experiment to test properties of polyurethane foam. These properties are cell size and density.

Activity #1

Think, Pair, Share

Students will discuss and propose reasons for structural differences in flexible and rigid polyurethane. Template below will be completed with salient information from discussion.

What I think...	What my partner thinks...	What we will share...

Student Name: _____ Date: _____

Activity #2

Synthesis of Polyurethane Foam

Materials:

- Polyurethane Foam Kit (Part A and part B)
- Glass vials
- Disposable pipettes
- Food coloring
- Plastic cups
- Wooden sticks

Procedure:

1. Put on gloves and goggles. Wear them at all times when handling chemicals.
2. Take 3 glass vials and label them. Each groups will be asked to perform 3 different reactions.
3. Add 1 drop of food coloring to each vial.
4. Add 1 full pipette (1 mL) of diisocyanate (part A) to each vial.
5. Add the following amounts of polyol (part B) to each vial:
    a. Vial 1: ½ pipette (0.5 mL)
    b. Vial 2: ¾ pipette (0.75 mL)
    c. Vial 3: a full pipette (1 mL)
6. Stir each vial with the wooden stick for a minute or so to mix the components.
7. Avoid touching the foam as is still tacky. After 10 minutes, the foam should be hard.
8. Record the volume used of diisocyanate and polyol. Furthermore, include time, endothermic or exothermic and any pertinent observations in table 1.

Student Name: _____ Date: _____

Table 1

Diisocyanate mL	Polyol mL	Time Observations	Exo/Endo thermic	Observations

Answer the following question:
What produces the foaming in the reaction? *

Student Name: _____ Date: _____

Activity #3

Design your own experiment to determine the cell size and the density of a sample of polyurethane foam.

Guidelines:

- Experiment must utilize equipment and supplies available in the lab.
- Experiment should contain a hypothesis, materials, detailed procedures and safety considerations.
- Students must be able to defend their proposal and answer any questions raised by classmates or teacher.

* Refer to Common Student Misconceptions in "Science Content for the Teacher."

Part A. Cell Size Determination

Hypothesis:
Materials:

Student Name: _____ Date: _____

Procedures:
Safety:

Part B. Density Determination

Hypothesis:
Materials:

Student Name: _____ Date: _____

Procedures:
Safety:

Student Name: _____ Date: _____

Assessment

Group work

Module is designed to be completed in two 80 minutes periods. Students are responsible for completing the "Think, Pair and Share" template. Groups will conduct polyurethane foam synthesis and enter related information and the answer for the posed question at the bottom of Table 1. These two tasks may be completed in the first lab day. Depending on completion time, students may begin brainstorming and researching different ways of testing their polymer. Written experimental design and approval are required prior to initiating the investigation. Experiments for cell size and density determination must be completed by the second lab day.

Individual work

Each student is responsible for completing a reflection. Reflection must include new content learned and an explanation of noteworthy observations. Reflection will be submitted via Google Classroom.