Unit: Organic Chemistry
Time: 0.5 weeks
Topic: Polymers & Polymerization Reactions

Essential Questions: What are polymers and how do they form? What are their characteristics?

Benchmark: Know the two main types of polymerization reactions. Recognize the properties of polymers.

<u>Declarative Knowledge</u>:

1. **Types of polymerization reactions include:**

    A. **Addition reaction**
    B. **Condensation reaction[3.2e].**

2. Addition reactions of polymers take place when unsaturated monomer molecules join together as they break their double or triple bonds to form single bonds between themselves. These single bonds joining the monomers form the backbone of the polymer.

Example: $C_2H_4 + C_2H_4 + C_2H_4 + C_2H_4 + C_2H_4 + \ldots\ldots\ldots \rightarrow$ **----**$(C_{10}H_{20})$**----**

3. Condensation reactions of polymers take place when dehydration occurs between the two monomer molecules. Between both monomer molecules, which may be different from one another, a water molecule is lost. This process is also called dehydration synthesis because the removal of water joins the monomer molecules together. This ultimately forms the polymer.

Example: $C_2H_4(OH)_2 + C_2H_4(OH)_2 + C_2H_4(OH)_2 \rightarrow C_6H_{12}O_2(OH)_2 + 2H_2O$

5. Vocabulary:

a. monomer	**e. amorphous**
b. polymer	**f. crystallize**
c. addition reaction	**g. elasticity**
d. condensation reaction	**h. plasticity**

<u>Procedural Knowledge</u>:

1. Identify types of polymerization reactions [3.2iv].

2. Compare and contrast addition reactions and condensation reactions.

3. List examples of natural and synthetic polymers.

4. Understand the nature of polymers amorphous and crystalline phases and their applications in the world today.

5. Change the temperature of the polymers and observe their behavior.

6. Determine the temperature or temperature range over which phase changes take place, and how the elasticity and plasticity of a polymer changes with temperature.

Lab Activity: How Polymers Change

Purpose:

Show students how polymers can change when their environment changes and the limits of polymeric materials.

Equipment & Materials:

Liquid nitrogen (properly stored)
rubber ball
a rose (long stemmed)
honey
250 mL. beaker (4)
microscope and slides
hot plate
metal crucible & cover
metal tongs
thick vinyl gloves
goggles
apron
styrofoam cooler type container
freezer
ring stand and ring clamp

Procedure:

Rubber Ball & Rose

1. **Dispense enough liquid nitrogen into a styrofoam container to immerse a rubber ball.**
2. **Insert the rubber ball into the container, immersing it with the metal tongs for short periods of 5 to 10 seconds at a time. (Be careful not to allow the tongs to freeze to the ball).**
3. **After a minute remove the ball from the liquid nitrogen.**
4. **Then drop the ball to the ground.**
5. **Have students record their observations and give an explanation as to what changes occurred in the polymer making up the rubber ball.**
6. **Now repeat the same process using a long stemmed rose.**
7. **Have students compare the properties of the rose and rubber ball before and after freezing.**
8. **Ask students to describe what would happen if the rose and rubber ball were heated excessively, instead of cooled.**

Honey

Part A

1. **Take three honey samples of equal volume (no more than 50 mL.).**
2. **Dissolve the first sample in as little water as possible.**
3. **Allow students to observe the solution over a number of days to see sugar crystals begin to form over a period of time.**
4. **Once crystals have formed and have been separated from solution, have students describe their appearance, with the naked eye and under a microscope.**

Part B

1. **Another honey sample is to be placed into a metal bowl or Pyrex glassware and put in the freezer to cool overnight.**
2. **Finally, the third sample is to be heated very gently in a clean metal crucible or Pyrex glassware for no more than two minutes over a small flame or preheated hot plate. Then allow it to cool completely. Repeat this step four more times for two minutes (or until the sample begins to boil). Be sure to allow the sample to completely cool between each heating.**
3. **After the fifth heating allow the sample to cool completely.**

Conclusion:

1. **Compare the results of freezing, crystallizing and heating the honey.**

2. **Discuss what affects crystallization and temperature change over time had on the properties of the honey.**

3. **Does the presence of water play a role in how polymers behave.**

Bibliography

1. **Brown, Theodore L. (2003) Chemistry, The Central Science, 9th Edition. Pearson Education, Inc. Upper Saddle River, New Jersey pgs. 456 - 463.**

2. **Internet website: http://plc.cwru.edu/tutorial/enhanced/files/polymers/therm/therm.htm**