Lesson Title	Polymers: Reduce, Reuse, Recycle
Length of Lesson	1 day (90 minutes)
Created By	Hannah Box
Subject	Chemistry
Grade Level	10th
State Standards	Organic Chemistry 3a
DOK Level	DOK 2
DOK Application	Compare, distinguish, interpret, make observations, classify
National Standards	9-12: B: Physical Science
Graduate Research Element	Measures have to be taken when running reactions to prevent polymers from forming. If the polymer is made then the desired product cannot form.

Student Learning Goal:

Students will learn how everyday polymers can be recycled and the important role that chemistry plays in the process.

State Standards:

3. Discuss the versatility of polymers and the diverse application of organic chemicals.
   - Describe and classify the synthesis, properties, and uses of polymers.

National Standards: 9-12: B:

Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.

Materials Needed (supplies, hand-outs, resources):

Name	Abbreviation	Recycle Code	Example	Density (g/mL)
Polyethylene terephthalate	PET or PETE	1	Coke bottles	1.38-1.39
High-density polyethylene	HDPE	2	Milk jugs	0.95-0.97
Polyvinyl chloride	PVC	3	Trash bags, pipes, detergent bottles, STP gas additive	1.16-1.35
Low-density polyethylene	LDPE	4	6-pack beverage holds	0.92-0.94
Polypropylene	PP	5	Yogurt cups	0.90-0.91
Polystyrene	PS	6	Clear cups	1.05-1.07

*Check each product to see the recycle code number and symbol

Each lab station will need the following:

Samples of each polymer listed above, 4 half pint jars with tops (237 mL), 180 mL of 70% isopropyl alcohol, 75g of sucrose, 500 mL water, Forceps, Paper towels, Bunsen burners, cork stoppers, and copper wire

Lesson Performance Task/Assessment:

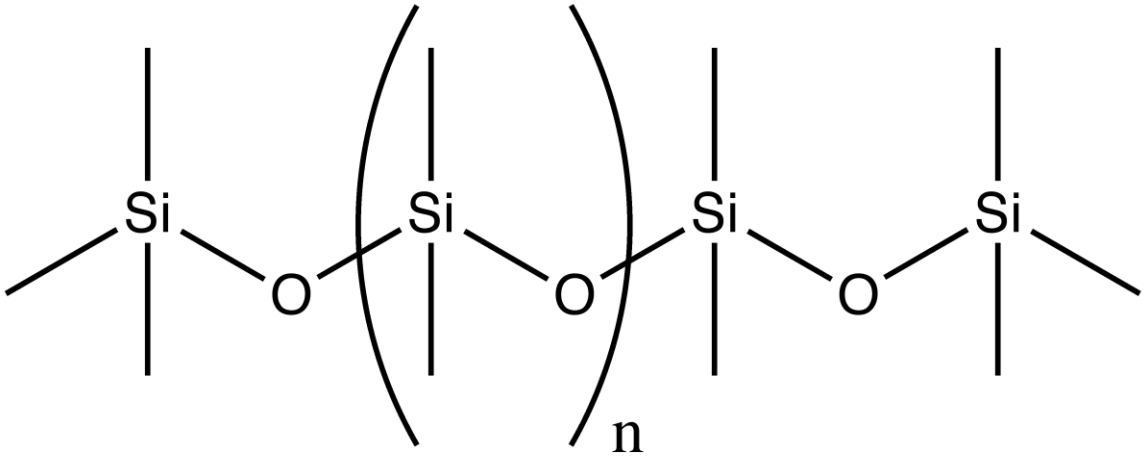
Students will be given household materials that are different polymers. They will place small samples of each polymer in different solutions and record whether they sink or float. Students will learn to categorize the samples using recycle code numbers.

Lesson Relevance to Performance Task and Students:

By separating the plastics using density, students will see how plastics that they recycle can be separated on a large scale using this same method.

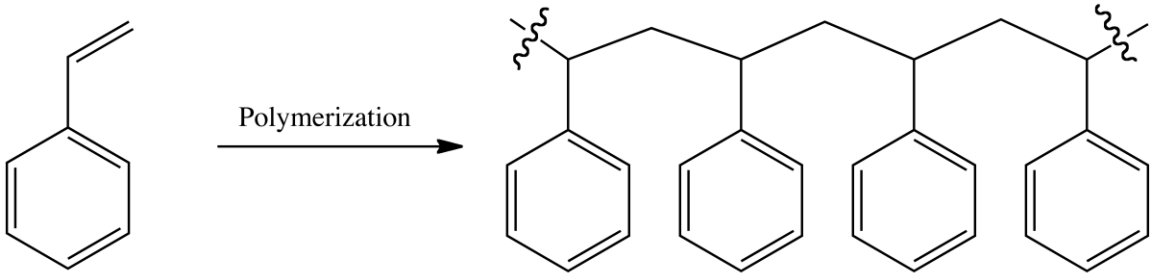
Anticipatory Set/Capture Interest:

Hand out pieces of Silly Putty to students. Allow time for the students to play with the putty and then have a brief discussion about the properties they observe. Then show the structure of Silly Putty and explain that it is a polymer containing Si, O, and C atoms. Have them brainstorm to see what other common polymers they can come up with.



Guided Practice:

Students will learn that monomers can undergo polymerization to form polymers. A polymer is a large molecule composed of repeating structural units (monomers). The monomers are connected through covalent bonds. There are both natural and synthetic polymers. The polymers that make up plastics have a carbon backbone, but there are many different types of polymers.



Styrene

Polystyrene

Discuss the problems that polymers cause for the environment and why it is vital that they be recycled. This open discussion will give the teacher an idea of the level of knowledge the group has when pertaining to the recycling process. Ask the students if they have ever seen a recycling code on something that they have purchased.

Before the start of the lab, the teacher should complete the following:

1. The teacher will develop a number code to label the samples based on their recycle code numbers.
2. Cut samples into 1cm x 2.5 cm pieces.
3. Place an assortment of samples from different recycle codes in plastic bags.

Independent Practice:

Students will prepare four solutions of known density.

Solution	Components	Density (g/mL)
A	40.0 mL water + 100.0 mL 70% isopropyl alcohol (rubbing alcohol)	0.91
B	40.0 mL water + 80.0 mL 70% isopropyl alcohol	0.93
C	150 mL water	1.00
D	150 mL water + 75.0g sucrose (table sugar)	1.14

Remediation and/or Enrichment:

Remediation: Individual IEP. The PVC sample may be eliminated so that the flame test does not have to be preformed.

Enrichment: Students can be given the structure of the monomer for each polymer within the lab and asked to draw the polymer that would be formed.

Check(s) for Understanding:

Each student will complete the lab handout that is attached to this lesson.

Why do you think that these polymers need to be separated?

Do you think there are similar processes for the other recyclables?

Closure:

Students will be told how a method very similar to the one that they have just performed is used on an industrial scale to aid in the recycling of plastics. When plastics are recycled, the first step is to shred the plastics into very small pieces. The pieces are then dumped into a solution with a very low density. The pieces that float are separated, the liquid removed, and the pieces that did not float are then placed in another solution with a slightly higher density. The pieces that float to the top are again separated. Two polymers have now been separated from the original mixture. The process is repeated continually. Through this process, the shredded pieces of mixed plastic can be separated into groups by density.

Possible Alternate Subject Integrations:

Biology: The three main classes of biopolymers, polysaccharides, polypeptides, polynucleotides, can be discussed.

Teacher Notes:

If you wash and dry the samples, you can reuse them the next year

References:

Chemistry in Context: Applying Chemistry to Society, A Project of the American Chemical Society, William C. Brown Publishers, 1994, page 277

The extraordinary Chemistry of Ordinary Things, 3rd Edition, carl H. Snyder, 1998, John Wiley and Sons, pages 558-590

Fun with Chemistry, Volume 2, Institute for Chemical Education (ICE), pages 107-112

World of Chemistry Essentials, M. D. Joesten, J. T. Netterville, and J. L. Wood, Saunders College Publishing, 1993, page 197