Supplement: Chemical & Physical Properties of Plastic

Grade Level:
Grades 6-12

Concepts Taught:
Chemical reactions, chemical and physical properties of matter, scientific investigations

Activity Time(s):
1 block period or 2 class periods (45-50 min. each)

Unit Essential Questions:

- Why are plastics numbered?
- What are some examples of the different types of plastics?
- What are the characteristics of each type of plastic?
- What is density and how does it effect the use of each plastic?
- What kind of experiment can you create to test for density?

NC CORE/Essential Standards:
Grade 6: Science: 6.P.2.1, 6.P.2.2, 6.P.2.3
Grade 8: Science: 8.P.1.3, 8.P.1.4,
Grades 9-12: Physical Science: PSc.2.1.2, PSc.2.1.3; PSc.2.1.2, PSc.2.2.4, **Chemistry**: Chm.2.2.2, Chm.2.2.3, Chm.3.1.1, Chm.3.2.1, Chm.3.2.2; EEn.2.7.3, EEn.2.8.4;

Unit Objectives:
- Students will recognize differences between plastics.
- Students will identify plastics by their number.
- Students will investigate the physical properties of plastics and evaluate differences between those properties for each type of plastic.
- Students will investigate chemical properties of plastics

Materials:
[see teacher notes following instructions for more information]
samples of plastics # 1-6
"Characteristics of Common Plastics" information sheet
observation worksheets A & B, teacher notes
6 beakers, water, isopropyl alcohol, vegetable oil, copper wire, acetone, Bunsen burner, glass Petri dishes, forceps, tongs, wooden stirring sticks, plastic spoons, safety goggles, fume hood (optional)

Preparation:
**Prior to the lesson, have students bring in various plastics from home. These should be collected by the teacher and kept aside until the day of the lesson.
Plastics on-line resources:
NEED Project booklet Museum of Solid Waste & Energy

American Plastics Council

PART 1:

1. Place collected variety of plastics in a location of the classroom that is accessible by the majority of students.

2. Ask students to hypothesize why there are so many different types of plastics. Have them look at the plastics and identify any types that are more common than others. Ask them to provide reasons for why this might be so.

3. Pass examples of plastics 1-6 around the room. Students will record observations on the Observations Worksheet about the properties of each plastic as they view them.

PART 2:

4. Students should work in cooperative lab groups of 3 or 4 to complete this activity. Materials should be distributed and set up at 6 stations (one for each test) so that student groups can rotate through the stations.

5. Instruct students that plastics can be sorted and identified by physical and chemical properties. One of the easiest ways to classify plastics is by their densities. **Density** is the amount of mass an object or substance has divided by the volume of that object or substance. Each type of plastic has a specific density range, and by observing what a plastic does when placed in various liquids (float vs. sink), density ranges can be determined for identification of plastic types. This technique is used to sort plastics during the recycling process.

6. Some plastics also react chemically with other reactants. By observing whether a reaction takes place, chemical properties of some plastics can be identified.

7. Discuss safety procedures specific to each test.

8. Distribute materials and worksheets to students.

9. Students will then follow the instructions to perform density tests and chemical tests on the plastic samples.

NOTE: The following densities should be used and provided to students:

Water (Density=1.0 g/mL)

sopropyl Alcohol (D=0.94 g/mL)

Vegetable Oil (D=0.90 g/mL)

As they complete the tests, students will record their observations in the provided data table and then use their observations and the information located in the "Characteristics of Common Plastics" information sheet to identify the plastics and fill-in the shaded boxes on the flow chart worksheet with the appropriate plastics number.

Extension:
Have students examine the "Characteristics of Common Plastics" information sheet to identify common uses for each of the 6 major types of plastic. Have them choose 1 or 2 types of plastic and using what they have just learned about their physical and chemical properties, explain why certain plastics are used to package certain items.

Then have students share their explanations and discuss in small groups why plastics have become the number one choice for packaging.

Instructions for Plastics Testing

NOTE: Make sure plastic safety goggles are worn at all times during completion of this activity!

Water Test

Place one piece of each plastic sample in 100 mL of water. Tap the samples with a wooden stirring stick to knock off any bubbles. Determine which samples float and which samples sink. Record results in data table. Scoop samples out with plastic spoon and allow to dry on paper towels.

Copper Wire Test

Use one sample of each of the plastics that ***sank*** in the water for this test.

Using forceps, hold a small (5cm) piece of copper wire in the flame of a Bunsen burner until hot. After removing from the flame, and before having a chance to cool, touch the hot wire to one of the plastic sample pieces to melt a small piece onto the wire. You may need to use another pair of forceps to pull the sample away from the wire if the entire piece sticks. Place the wire, making sure there is a small amount of the plastic sample attached, back in the flame. Observe the color of the flame (it should be orange or green). A green flame indicates presence of chlorine in the sample. Place the sample and wire in a beaker of water to stop all burning and cool. Repeat test for remaining plastic samples set aside for this test. Record results in the data table.

Acetone Test

NOTE: Acetone is highly flammable and should be done in a different area of the room from where the copper wire and heat tests are being performed!

Use one sample of each of the plastics that ***sank*** in the water for this test.

Place one sample of plastic in 50 mL of acetone. Leave for 40 seconds. Remove the sample with tongs and press firmly between your fingers. Try to scrape off some of the plastic with your fingernail. A reaction has occurred if the sample feels soft and sticky and can be easily scraped. This indicates that the structure of the polymer chains that make up the plastic has changed. Repeat test for the remaining plastic samples set aside for this test. Record results in the data table.

Heat Test

Note: Make sure that the water is boiling before performing this test!

Use one sample of each of the plastics that ***sank*** in the water for this test.

Using tongs, place one sample of plastic in boiling water and hold there for 30 seconds. Remove from water and carefully press firmly between your fingers to see if the sample feels softened after heating. Repeat test for the remaining plastic samples set aside for this test. Record results in the data table.

Isopropyl Alcohol Test

Use one sample of each of the plastics that ***floated*** in the water for this test.

Place one piece of each plastic sample in 100 mL of isopropyl alcohol. Tap the samples with a

wooden stirring stick to knock off any bubbles. Determine which samples float and which samples sink. Use density range values to identify samples. Record results in the data table. Scoop samples out with plastic spoon and allow to dry on paper towels.

Vegetable Oil Test

Use one sample of each of the plastics that ***floated*** in the water for this test.

Place one piece of each plastic sample in 100 mL of oil. Tap the samples with a wooden stirring stick to knock off any bubbles. Determine which samples float and which samples sink. Use density range values to identify samples. Record results in the data table. Scoop samples out with plastic spoon and allow to dry on paper towels.

Experiment Wrap-up

After all tests have been performed and all results have been recorded, examine and use the results and the information provided on the "Characteristics of Common Plastics" information sheet to fill in the shaded boxes on the flow chart worksheet.

Teacher Notes:

Materials for each test should be set up in separate areas of the room. Student groups can then rotate through these stations to complete the activity.

<u>Water Test</u>

Materials needed:

100 mL of water in a 250 mL beaker

samples of each type of plastic (1-6) (reuse samples for other groups)

wooden stirring stick

plastic spoon

paper towels

Copper Wire Test

NOTE: If available, you may want students to perform this test underneath a fume hood.

Materials needed:

Bunsen burner set up

forceps

3 pieces (5 cm length) copper wire for each group

samples of plastics 1, 3, and 6 for each group

samples cannot be reused for each group

100 mL of water in a 250 mL beaker

Acetone Test

NOTE: Acetone is highly flammable and should be done in a different area of the room from where the copper wire and heat tests are being performed!

Materials needed:

50 mL acetone in a 250 mL beaker covered with glass Petri dish when not in use

*Note: fingernail polish remover can be used if pure acetone is not available – students may need to leave samples in longer to get a reaction

samples of plastics 1, 3 ,and 6 for each group

samples cannot be reused for each group

tongs

paper towels

Heat Test

Materials needed:

100 mL of water in a 250 mL glass beaker

samples of plastics 1, 3, and 6

samples cannot be reused by each group

Bunsen burner set up OR hot plate

Tongs, paper towels

Isopropyl Alcohol Test

Materials needed:

100 mL of isopropyl alcohol in a 250 mL beaker covered with glass Petri dish when not in use

samples of plastics 2, 4, and 5 (reuse samples for other groups)

wooden stirring stick

plastic spoon

paper towels

Vegetable Oil Test

Materials needed:

100 mL of oil in a 250 mL beaker

samples of plastics 2, 4, and 5 (reuse samples for other groups)

wooden stirring stick

plastic spoon

paper towels

Observations Worksheet A

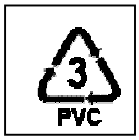
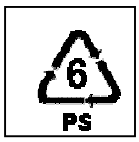
Team Member Name(s)

_____

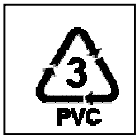
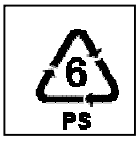
_____

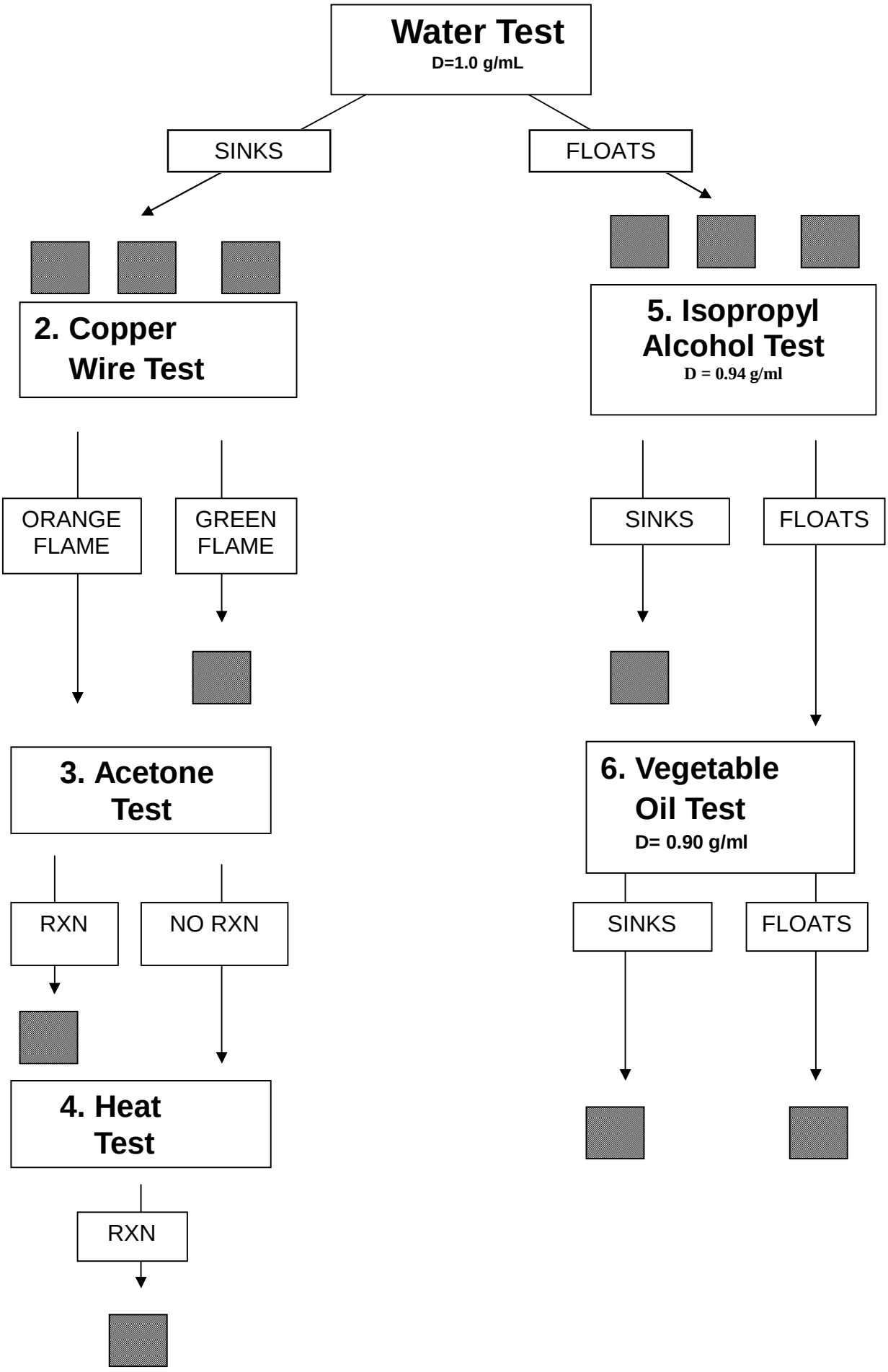
Plastics Type (#)	Observations
1 PETE	
2 HDPE	
3 PVC	
4 LDPE	
5 PP	
6 PS	

Observation Worksheet B

TEST TYPE	WATER Sink or Float?	COPPER WIRE Reaction/No reaction	ACETONE Reaction/No reaction	HEAT Reaction/No reaction	ISOPROPYL ALCOHOL Sink or float?	VEGETA-BLE OIL Sink or float?
						
						
						
						
						
						

Observation Worksheet B

Plastic type	Name	Properties	Density Range	Common Uses
	**Polyethylene Terephthalate**	Tough, rigid, shatter-resistant softens when heated	1.38-1.39 g/mL	Soda, water, juice, and cooking oil bottles
	**High Density Polyethylene**	Semi-rigid, tough, and flexible	0.95-0.97 g/mL	Milk and water jugs, bleach bottles
	**Polyvinyl Chloride**	Strong, semi-rigid, glossy	1.16-1.35 g/mL	Detergent bottles, shampoo bottles, shrink wrap, pipes
	**Low Density Polyethylene**	Flexible, not crinkly, moisture proof	0.92-0.94g/mL	Garbage bags, sandwich bags, 6-pack rings
	**Polypropylene**	Non-glossy, semi-rigid	0.90-0.91 g/mL	Yogurt cups, margarine tubs, screw-on lids/ caps
	**Polystyrene**	Often brittle, sometimes glossy, often has strong chemical reactions	1.05-1.07 g/mL	Styrofoam, egg cartons, packing pellets, take-out containers



ANSWER KEY