Science Unit: ***Plastics***

Lesson 4: ***What is Plastic?***

School year:	2008/2009
Developed for:	Tyee Elementary School, Vancouver School District
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Grade level:	Presented to grades 4, 5, & 6; appropriate for grades 1 – 7 with age appropriate modifications.
Duration of lesson:	1 hour and 15 minutes
Notes:	Prior to the lesson, students should watch the CBC Documentary Forever Plastic. The documentary can be ordered from CBC or viewed online at: http://www.cbc.ca/documentaries/doczone/2009/foreverplastic/index.html.

Objectives

1. Make a simple polymer using borax and white glue.
2. Discuss the differences between various types of plastics and discover the meaning behind the resin identification code developed by the Society for the Plastics Industry.
3. Discuss recycling options and limitations of plastics.

Background Information

The majority of plastics are synthetic and composed of petrochemical products. Petroleum is refined into its components, crude oil and natural gas. The natural gas is further refined to give a variety of hydrocarbons, mainly methane, ethane, propane and butane which can be used to make plastic. Plastics can be made from one compound (e.g. ethylene) or a mixture of different compounds (e.g. ethylene is combined with chlorine to produce polyvinyl chloride). In order to make plastic the petrochemicals must be heated at high pressure. Plastic production requires a great deal of energy.

Plastic is a polymer. Polymers are long, chain-like molecules comprised of many, many smaller units known as monomers. A monomer is a large molecule that is capable of reacting with and bonding to other monomers in order to form a polymer. Some of the more common monomers used in plastic production are ethylene, propylene and vinylchloride. The Society of the Plastics Industry (SPI) has developed a resin identification code system to identify what components are contained in finished plastic products. Use of the resin identification code aids in the recovery of materials for recycling, but the presence of the code does not actually indicate if a particular type of plastic is recyclable. This latter point is a common misconception.

Vocabulary

Plastic:	A synthetic polymer most commonly made from petrochemical products.
Petroleum:	A naturally occurring mixture of crude oil and natural gas.
Resin:	Synthetic or natural polymer used to form plastics. (*other definitions can apply when the term is used in a different context)
Monomer:	A relatively short chain-like molecule that is the building block of a polymer (not all molecules are capable of becoming polymers).

Polymer:	A substance made up of many smaller molecules (monomers) linked together in long chains.
Bioplastic:	Plastic produced from organic and generally biodegradable compounds. Bioplastics generally contain little to no petroleum products.
biodegradable plastic	Plastic that can be degraded, decomposed, or broken down by microorganisms into simple compounds such as water and carbon dioxide.

Materials

- Borax
- Water
- Samples of various types of plastics (one for each resin code)
- White glue
- Small paper cups (1 per student)
- Small Ziploc bags (1 per student)
- Food coloring
- Plastic spoons (1 per student)

In the Classroom

Introductory Discussion

1. Introductory discussion/brainstorm
    - Today we are going to talk about plastics.
    - What do we use plastic for? What objects do you use at home? In the classroom? (Record answers on the blackboard) Point out the various types of plastics, all with different properties.
    - That's a lot of plastic. What is plastic? Where does plastic come from? (record ideas)
    - Does anyone know what (synthetic) plastic is made from? (Keep the focus on synthetic plastics and let the students know that we will discuss bioplastics in the next lesson.)
    - Record ideas and then discuss the following in an age appropriate manner.
        - Petroleum is separated into crude oil and natural gas. Natural gas is separated into its components (mainly methane 80%, ethane, propane, & butane). The various components are used alone or in combination to make different kinds of plastics.
        - Natural gas is a gas but plastic is solid. How does the gas turn into something solid? (ask for ideas). In order to make natural gas into plastic you need heat and pressure. The heat and the pressure change the substances. (Use cooking an egg as an example.)
        - To make different types of plastic different substances can be mixed together. Two (or more) substances can react with each other to make a new substance with different properties.
    - The experiment we are going to do today is a good example of that. We are going to mix two substances together to make a new substance. We are going to make a simple plastic. However, we are going to be using something much safer and easier to work with than petroleum.
    - How many different kinds of plastic do you think there are? Let's look at some different types of plastic. (Pass out samples). Do they all have the same characteristics? What differences do you notice? (rigidity, flexibility, strength, thickness, clear versus opaque, etc.)
    - How do we know what type of plastic is used to make each item? (Someone will likely suggest the resin codes as they are discussed in Forever Plastic.)

- Discuss/review what the resin codes mean. Briefly describe the properties of each type of resin/plastic.
    - Type 1 = PET Polyethylene terephthalate (pop bottles, food jars, water bottles)
    - Type 2 = HDPE High-density polyethylene (milk jugs, bleach bottles, plastic bags)
    - Type 3 = V Vinyl (or polyvinylchloride, PVC) (plastic pipes, shampoo bottles, vinyl siding)
    - Type 4 = LDPE Low-density polyethylene (cello wrap, bread bags, garbage bags)
    - Type 5 = PP Polypropylene (yogurt containers, lids, caps)
    - Type 6 = PS Polystyrene (Styrofoam, packing peanuts, egg cartons, plastic cutlery)
    - Type 7 = other, mixtures

2. Short description of other items to discuss or review.
    - The Borax solution can be toxic if ingested. It can also be irritating to the eyes.
    - Remind the students of basic safety procedures to follow when doing an experiment (see below)
3. Briefly describe science experiment/activity.
    - The students will make a simple polymer using white glue, water and borax. Food coloring can be used to color the polymer.
4. Briefly describe the processes of science that the students will focus on: For this activity the students will make a simple prediction and focus the majority of their efforts on observing and recording their observations.
5. Briefly describe safety guidelines.
    - Borax can be toxic if ingested or irritating if rubbed into your eyes.
    - Be careful not to get any chemicals into your eyes or mouth.
    - Wear gloves when appropriate (not necessary for this experiment as the students can safely handle the final product).
    - Once you start using the chemicals do not touch your face or eyes until have washed your hands.
    - Wash your hands when the experiment is finished. Be sure to wash your hands before you eat or touch your face.
    - Once they have made the polymer remind them of the following:
        - Do not throw the product at anyone.
        - Do not leave the product on the rug, clothing or important papers. It may stick to them and ruin them.

Science Activity

Activity Title: Making a polymer

Purpose of Activity: To make a simple polymer and discover how varying the proportion of the ingredients can influence the characteristics of the polymer.

Experimental Observations: This is not an experiment with controls and treatments.

Prediction or Hypothesis: What do you think will happen when we mix the two solutions together? What do you think will happen if we use more/less of the Borax solution?

Methods and Instructions:

Set-up prior to experiment: (Make enough glue solution and Borax solution for the entire class)

- To make the glue solution dilute the glue 1:1 with water and mix well (i.e. mix equal parts glue and water).
- To make the Borax solution use 20 ml of borax per litre of water (1 tsp per cup). Mix well (some of the Borax may not dissolve).

Have the students work in small groups so that they can compare the properties of their polymers with one another. If possible, each group should have its own bottle of glue solution and Borax solution.

1. Each student should have a worksheet, 1 paper/plastic cup, 1 spoon and one small ziplock bag.
2. Each group should have 1 bottle of Borax solution and 1 bottle of glue solution.
3. Discuss the basic procedure (they will mix the two solutions together to get a new substance).
4. Have the student fill their cups approximately 1/3 full of glue solution. Demonstrate how much.
5. Have the students fill out the pre-experiment observations. Discuss the characteristics of the two components as a class to give them ideas.
6. While the students are recording their observations the scientist or teacher can go around to each group and add 2-3 drops of food coloring to each cup. Let the students pick the color of their polymer.
7. Have the students stir the food coloring into the glue solution.
8. Ask the students to record what they think will happen when they mix the two solutions together. Ask them if they think the new substance will have the same properties as the two components.
9. Have the students add several spoonfuls of the Borax solution to their cup of glue solution. Have some students in each group add a small amount (1-2 spoonfuls) and some add a larger amount (4-5+ spoonfuls). Assign/determine who will add which amount in advance.
10. Have the students stir the mixture for 1-2 minutes until it begins to clump and pull away from the sides of the cup. At this point the students can knead the polymer using their hands, or knead it in the Ziploc bag if they prefer.
11. Have them record their observations on the worksheet.
12. The students can take their plastic home in the Ziploc bag.

Closure Discussion

1. How did using more/less borax change the characteristics of your plastic?
2. What applications could your plastic be used for? Anything?
3. Are all types of plastic created equal? Can they all be used for the same purpose?
4. Are all types of plastic recyclable?
5. Can they be recycled for the same use? Why or why not?

References

1. Forever Plastic – CBC Documentary. Available at: http://www.cbc.ca/documentaries/doczone/2009/foreverplastic/
2. McKinney, Michael and Robert Schoch. 1998. Environmental Science: Systems and Solutions. Jones and BartlettPublishers.
3. http://www.plasticsindustry.org SPI: Plastics Industry Trade Association. Accessed June 1, 2009.

Extension of Lesson Plan

1. Journal exercise. Describe how your life would be different if all of the plastic in the world suddenly disappeared.
2. Discuss the pros and cons of plastic alternatives.
3. Research the recycling limitations of different types of plastics.
4. Recycle sort (as seen in Forever Plastic).

Name:_____

Making Plastic

MATERIALS

- Glue solution (half glue, half water)
- Borax solution (approximately 20 ml Borax in one litre of water)
- Food coloring
- Cup
- Spoon
- Ziploc bag

PROCEDURE

1. Fill 1/3 of your cup with the glue solution
2. Use the spoon to mix in the food coloring

Describe the glue solution: _____

_____

Describe the borax solution: _____

_____

What do you think will happen when we mix the two solutions together?

Describe what you think the new substance will look like:

_____

_____

_____

_____

_____

Name:_____

3. Record how many spoonfuls of borax solution you are going to use (from 1-5). I am going to add _____ spoonfuls of borax solution.
4. Carefully add the borax solution to the glue solution.
5. Carefully stir the two solutions together for 1-2 minutes.

What does your new substance look like? How is it different from the two solutions you started with?

_____

_____

_____

Take your plastic out of the cup and knead it with your hands. What does it feel like? Describe its other properties.

_____

_____

_____

Compare your plastic with someone else in your group who used a different amount of borax solution. How are they the same? How are they different?

Plastic with less borax solution (_____ spoonfuls)	Plastic with more borax solution (_____ spoonfuls)