Scope, Sequence & Coordination

A National Curriculum Development and Evaluation Project for High School Science Education

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National Science Education Standard—Physical Science

Structure and Properties of Matter

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.

Teacher Materials

Learning Sequence Item:

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Oils and Plastic

March 1996
Adapted by: Keith Lippincott and Brett Pyle

Hydrocarbons, Polymers, and Organic Macromolecules. Students should observe the physical properties of useful organic chemicals, such as the viscosity of lubricating oils, the hardness and melting points of plastics, and the solubility of fats and oils. (*Chemistry, A Framework for High School Science Education, p. 62.*)

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Suggested Sequence of Events
Lab Activities
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3. The Coffee Cup from the Wizard of Oz
4. What a Sticky Mess!
5. Let's Make an Oily Sludge

Assessment
1. The Lost Spill
2. Plastics
3. Oil Viscosity

This micro-unit was adapted by **Keith Lippincott** (University of Iowa, Iowa City) and **Brett Pyle** (Grady Middle School, Houston, Texas)

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Learning Sequence

Hydrocarbons, Polymers, and Organic Macromolecules. Students should observe the physical properties of useful organic chemicals, such as the viscosity of lubricating oils, the hardness and melting points of plastics, and the solubility of fats and oils. (*Chemistry, A Framework for High School Science Education, p. 62.*)

Science as Inquiry	Science and Technology	Science in Personal and Social Perspectives	History and Nature of Science
Motor Oil Is Motor Oil **Activity 1** Watch Where You're Poking Me! **Activity 2** The Coffee Cup from the Wizard of Oz **Activity 3** What a Sticky Mess! **Activity 4** Let's Make an Oily Sludge **Activity 5** Oil Viscosity **Assessment 3** Erasers: Here's the Rub **Reading 1**	Plastics **Assessment 2** Polymers **Reading 2** Biodegradable Bags **Reading 3** Nylon **Reading 4**	The Lost Spill **Assessment 1**	

Suggested Sequence of Events

Event #1

Lab Activity

1. Motor Oil Is Motor Oil (45 minutes)

Event #2

Lab Activity

2. Watch Where You're Poking Me! (20–30 minutes)

Alternative or Additional Experiments

3. The Coffee Cup from the Wizard of Oz (40 minutes)
4. What a Sticky Mess! (45 minutes–1 hour)
5. Let's Make an Oily Sludge (15 minutes)

Event #3

Readings from Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives, and History and Nature of Science

Students should select two from the following list:

Reading 1	Polymers
Reading 2	Biodegradable Bags
Reading 3	Erasers
Reading 4	Nylon

The above readings can be found in the student version of this publication.

Assessment items can be found at the back of this volume.

Assessment Recommendations

This teacher materials packet contains a few items suggested for classroom assessment. Often, three types of items are included. Some have been tested and reviewed, but not all.

1. Multiple choice questions accompanied by short essays, called justification, that allow teachers to find out if students really understand their selections on the multiple choice.

2. Open-ended questions asking for essay reponses.

3. Suggestions for performance tasks, usually including laboratory work, questions to be answered, data to be graphed and processed, and inferences to be made. Some tasks include proposals for student design of such tasks. These may sometimes closely resemble a good laboratory task, since the best types of laboratories are assessing student skills and performance at all times. Special assessment tasks will not be needed if measures such as questions, tabulations, graphs, calculations, etc., are incorporated into regular lab activities.

Teachers are encouraged to make changes in these items to suit their own classroom situations and to develop further items of their own, hopefully finding inspiration in the models we have provided. We hope you may consider adding your best items to our pool. We also will be very pleased to hear of proposed revisions to our items when you think they are needed.

Teacher Sheet

Science as Inquiry

Motor Oil Is Motor Oil

What do the numbers on motor oils mean?

Materials:

Use materials from Activity 5 (Dive! Dive!) of unit 9.09, replacing the assorted liquids with various viscosities of motor oils.

Procedure:

Have the students repeat the experiment from Dive! Dive! using different motor oils in place of the assorted liquids used in that lab. They should follow the same procedure. Once the data have been collected, have them compare the results to the viscosity ratings of the oils.

Background:

The numbers on packages of motor oil are used to indicate the viscosity of the oil. The higher the number, the more viscous the oil. Many motor oils today are "multiweight" oils with numbers such as 10W-40, 5W-30, or 20W-50. These oils change viscosities depending on temperature. At higher temperatures these multiweight oils maintain a high viscosity in order to continue to lubricate the engine. The viscosity of a single-weight oil will decrease as temperature increases.

Adapted from Crow, L., *Streams*. Houston: Baylor College of Medicine, 1993.

Teacher Sheet

Science as Inquiry

Watch Where You're Poking Me!!

What happens to plastic bags when they are punctured?

Materials:

1 small paper bag
1 plastic sandwich bag
1 sharpened pencil
sink or bucket
water

Procedure:

Have students fill a sandwich bag three-fourths full with water (it is suggested that students do this over a sink or bucket). Then, while holding the bag at the top, they should insert a sharpened pencil into one side of the bag and on through the bag and out the other side. *Key point: Leave the pencil protruding from both sides of the bag.*

Background:

Most clear sandwich bags are made of polyethylene. Polyethylene is a kind of polymer. Polymer means "many parts." The smaller molecules composing a polymer are called monomers. Monomer means "one part." The process of joining together monomers is called polymerization.

The monomer used to make polyethylene is called ethylene. Ethylene is composed of two carbon atoms and four hydrogen atoms; it is a gas. Polyethylene is a solid that may contain tens of thousands of ethylene molecules joined together.

A sandwich bag contains many polyethylene molecules. The long polyethylene molecules in the bag are attracted to each other and are entangled with each other like cooked spaghetti. When the sharpened pencil is inserted into the polyethylene bag, the polyethylene molecules remain entangled and pull together around the pencil. This is why the bag doesn't tear or leak. An ordinary paper bag will tear and will, of course, leak.

Further Variations:

1. Try more than brand of sandwich bag.
2. Have the students predict which is the strongest or least likely to leak.

Adapted from Mebane, R.C., and Rybolt, T.R., *Adventures with Atoms and Molecules*. Hillside, N.J.: Enslow Publishers, 1987.

Teacher Sheet

Science as Inquiry

The Coffee Cup from the Wizard of Oz

The disappearing coffee cup.

Materials:

1 polystyrene coffee cup
1 petri dish
25–50 mL acetone
safety goggles

Procedure:

Have students put on safety goggles. They then carefully add acetone to the petri dish until the dish is about 3/4 full. Next they place the empty coffee cup in the center of the petri dish and observe and record what happens.

Reaction:

Some solvents actually dissolve the polymer material; others merely break certain bonds that give the polystyrene cup its shape. In these solvents, like acetone, you can reclaim the glob of material after the cup disappears.

Background:

Instead of the coffee cup, students may substitute polystyrene packing material. Polystyrene is one of the simplest and most common polymers. It has repeating units of the styrene molecule. Polymers like polystyrene are *thermoplastic*, which means they will soften when they are heated. In this softened state they can be molded into almost any shape. This plastic is ideally suited for use as an insulating material. In 1986, over six billion pounds of this substance were produced.

Further Variations:

An interesting additional activity for "The Coffee Cup from the Wizard of Oz" is to put styrofoam "packing peanuts" in a beaker that has roughly 100 mL of acetone in it. Challenge the students to fill the beaker with the peanuts. They should quickly discover that these peanuts "dissolve" almost as fast as you put them in the beaker.

Adapted from Summerlin, L.R., Borgford, C., and Ealy, J., *Chemical Demonstrations, Volume 2*. Washington, D.C.: American Chemical Society, 1988.

Teacher Sheet

Science as Inquiry

What a Sticky Mess!

Glue ball chemistry (and physics!)

Materials:

saturated solution of borax (20 Mule Team® is o.k.) and water
Elmer's® brand white glue
cup
stirring stick
50 mL graduated cylinder
triple beam balance
marking pen or pencil

Procedure:

The procedure in this experiment is simple but requires some thought. Students are expected to measure the mass and volume of a saturated solution of borax and of Elmer's white glue. Then the students mix the borax solution with the white glue, which react chemically to form a polymer. Finally they determine the density of the polymer formed by the borax and the glue, and they compare this density with the densities of the component materials. Although these results are of some interest, tracking the volume of the reactants and comparing that volume with the volume of the polymer formed and the left-over reactants should be more interesting.

Adapted from Rodecker, S. B., and Quon-Warner, M., *Laboratory Experiments and Activities in Physical Science.* Spectrum Publications, 1992.

Teacher Sheet

Science as Inquiry

Let's Make An Oily Sludge

Do different oils become solid at different temperatures?

Materials:

peanut oil
corn oil
tape
sunflower oil
1 felt pen
2 small paper cups
refrigerator freezer
1 measuring cup

Procedure:

Students should put a piece of tape on each cup. Then they can use the felt pen to label one cup "peanut oil," another "sunflower oil," and the third cup "corn oil." Writing on the tape assures that the oil does not obscure the label.

Next have students pour one-third cup of each of the oils in the appropriate labeled cup. They then should place the three cups of oil in the freezer section of the refrigerator, where they remain overnight. The next day they should remove the cups of oil from the freezer and make their observations of the appearance and condition of the different oils. If their parents do not object, they might set the freezer at different levels and repeat this experiment over several days for several different settings of the freezer.

Background:

If the freezer is not set too cold, the peanut oil will have become a solid, whereas the corn oil and sunflower oil will probably still be just viscous liquids. Students should formulate their own model of such oils structure and try to account for observed differences. They may need to make other measurements or observations to test their models.

Further Variations:

Would other oils freeze in the freezer, such as olive oil, avocado oil, soybean oil, and safflower oil?

Adapted from Mebane, R.C. and Rybolt, T. R., *Adventures with Atoms and Molecules*. Hillside, N.J.: Enslow Publishers, 1987.

Science in Personal and
Social Perspectives

The Lost Spill

Item:

Two oil tankers may have been responsible for an oil spill near the coast. Scientists were able to take samples of oil remaining in the holds of each tanker. They also took a sample of the spill scooped from the surface of the ocean. The samples were 25 mL each.

Describe simple tests that you might perform on the oil samples to find out which is responsible for the spill. Explain how you might tell if one of the tankers was transporting crude oil (taken directly from the ground) and the other was transporting motor oil that had been made in a refinery. A third tanker nearby was transporting gasoline. How might a sample from this third tanker preform on your proposed tests?

Answer:

Viscosity would be a simple way to tell. Oils should come in the order: crude (heaviest viscosity), motor oil, gasoline. Timing a dropped steel ball in a test tube of the oil would work. Measuring the time of pouring through a standard funnel would also work. Students who had studied more chemistry might suggest chemical tests. Oils rarely have sharp boiling or melting points, so using these would not be so easy, though comparing distillation behavior on heating would distinguish light and crude oils.

Oil tends to fractionate when spilled. This might make it difficult to use the spill sample for comparison; It will be important to see if some students recognize this fact and try to account for it.

Science in Personal
and Social Perspectives

Plastics

Item:
Explain why plastic water bottles do not make good containers for storing hot coffee.

Answer:
Plastic softens as the temperature rises and might even get close to melting. It has less strength as it softens, so may distort and leak.

Science as Inquiry/
Science and Technology

Oil Viscosity

Item:
The local gas station has some unlabeled bottles containing various motor oils. They need your help in determining which is which and which should be used for what kind of engine. Since oil viscosity goes down as the oil gets hot, higher viscosity oils must be used in engines running at high temperatures. The gas station has sent along samples in plastic vials.

You have a number of plastic beads and/or metal ball bearings, rulers, and a stop watch. You will need to establish how you are going to determine the viscosity of the various oils.

Design an experiment to test the different viscosities. Also tell how you would determine whether one or more of the oils was a multiviscous oil, like 10W-40. This might require that you measure viscosities at various temperatures.

A. Order the results from highest to lowest. The owner will then know which is which.
B. Based on your results, which oil do you think would help a high-powered racing car engine run best?
C. Which would you recommend for a slow running engine in a cold climate, such as a tractor for pulling an arctic sled? Explain why you made your choice.