INTRODUCTION TO LESSON CLUSTER 2

OTHER SOLIDS, LIQUIDS, AND GASES

A. Lesson Cluster Goals and Lesson Objectives

Goals

Students should be able to describe solids, liquids, and gases of a variety of substances in molecular terms.

Students should be able to contrast pure substances and mixtures in terms of their molecular composition.

Lesson Objectives

2.1 Explain that different substances are made of different kinds of molecules.

2.2 Contrast pure substances with mixtures, substances that contain more than one kind of molecule.

2.3 Contrast solids, liquids, and gases of different substances in terms of motion and arrangement of their molecules.

B. Key Elements of a Good Description

Students should explain that different substances are made of different kinds of molecules and that pure substances contain only one kind of molecule, while mixtures contain two or more kinds of molecules. Students should contrast solids, liquids, and gases of all substances in terms of motion and arrangement of molecules:

- Solids: Molecules vibrate while locked together in a fixed pattern.

- Liquids: Molecules move about while remaining close together, sliding past each other and constantly colliding.

- Gases: Molecules move freely about in space, sometimes colliding with each other or with objects.

C. Students' Conceptual Learning

Much of this lesson cluster focuses on the application of ideas from Lesson Cluster 1 to substances other than water, particularly ideas about molecules' small size and constant motion, and the motion and arrangement of molecules in different states of matter. Students should come

to recognize that molecules are the basic components of all substances. Some students may still think that molecules are in substances, rather than substances are made of molecules.

D. Conceptual Contrasts

The chart below contrasts common patterns in student thinking with scientific thinking about some of the important issues for this lesson cluster.

Issue	Goal Conceptions	Students' Conceptions
Molecular constitution of matter	All matter is made of molecules.	Molecules are in substances.
Size of molecules	Molecules are too small to see.	Molecules may be seen with a microscope.
Motion of molecules	All molecules are constantly moving.	Molecules may be still, especially in solids.
Visibility of molecular motion	Molecular motion continues independently of observable movement.	Molecules simply share in observable movements of substances.
Different kinds of molecules	Different substances are made of different kinds of molecules.	Substances are made of the same kind of molecules.
Pure substance vs. mixture	Pure substances are made of one kind of molecules; mixtures, two or more kinds of molecules.	Distinction based on observable properties, such as taste, color, etc.
Molecular explanation of states of matter	States of matter are due to different arrangements and motions of molecules.	States of matter described only in terms of observable properties of substance or properties of individual molecules.

LESSON 2.1

WHAT ARE OTHER SUBSTANCES MADE OF?

PURPOSE:

To help students explain that different substances are made of different kinds of molecules.

MATERIALS LIST:

Transparency 2: Why can you change liquid water into ice but not alcohol?

TEACHING SUGGESTIONS:

Some students may know that lead and solder are used by plumbers to seal pipes. Lead is an excellent substance for this because it melts at 327^{o} C (620^{o} F) and boils at 1620^{o} C (2948^{o} F). Solder is 2/3 lead and 1/3 tin and melts at 275^{o} C (527^{o} F). Because of its relatively low melting temperature, solder is also used to connect or solder electrical wire.

After Lesson Cluster 1, some students may think that different substances are made of the same kind of molecules (for instance, that water, sugar, and alcohol all are made of the same kind of molecule). This lesson is designed to help students realize that different substances are different because they consist of different kinds of molecules.

To stress the impossibility of changing one substance to another, you might want to refer to Midas, a legendary Phrygian king who for a time was give the power of turning to gold everything he touched. The only way he could have done that was by substituting gold molecules for the molecules of the substance.

Stress that water molecules are different than alcohol molecules. Each substance has molecules unlike any other substance.

Compare the drawing of the water molecule with the formula H_2O.

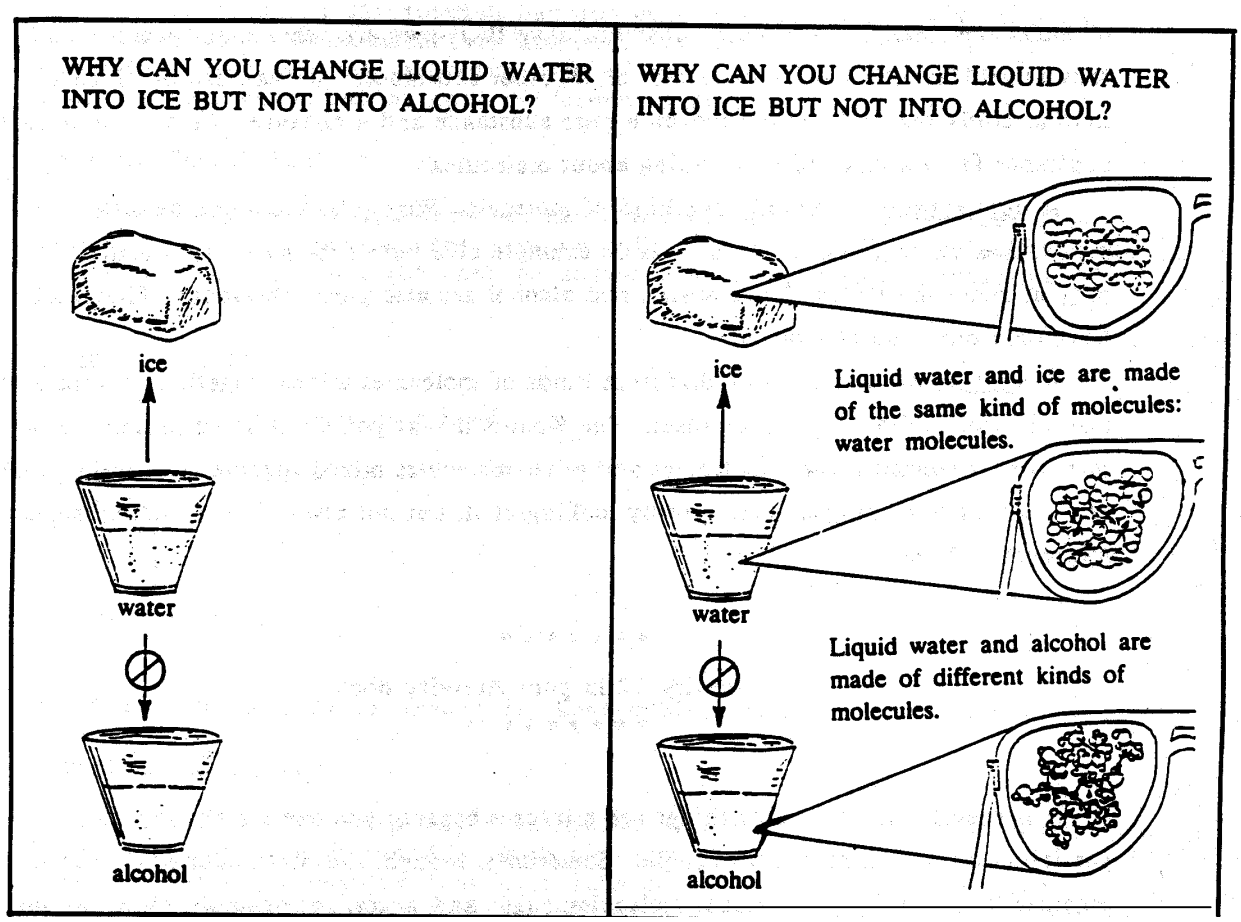
Compare the drawing of alcohol with water. You may want the students to describe how they are the same and how they are different.

At the grade 6 level we do not distinguish the various kinds of alcohol. If students ask, there are many kinds of alcohol such as methyl (wood alcohol), ethyl (grain alcohol), isopropol (rubbing alcohol), etc.

Another way to write the formula for alcohol is C_2H_5OH.

In discussing the drawings of molecules, stress that there are different combinations of atoms that make up various different molecules.

Use Transparency 2 here:



TRANSPARENCY 2:WHY CAN YOU CHANGE LIQUID WATER INTO ICE BUT NOT INTO ALCOHOL?

BOTTOM LAYER:

Many students will know that you cannot change water into alcohol, but will not be able to correctly explain why. They will be able to tell you on a macroscopic level, that, "Water and alcohol are not the same stuff" but not how the two substances are, in molecular terms, different.

OVERLAY:

It is important to point out through the overlay the scientific idea that water and alcohol cannot be changed into one another because their molecules are different. [In connection with this transparency it may also by useful to have students look at the illustrations on page 15 of the Science Book.]

LESSON 2.2

PURE SUBSTANCES AND MIXTURES

PURPOSE:

To help students distinguish between pure substances and mixtures and to realize most common materials are mixtures not pure substances. To describe pure substances as being made of one kind of molecule, and mixtures as made of two or more different kinds of molecules.

ADVANCE PREPARATION:

For each group of students you need to prepare six plastic cups, salt, pepper, sugar, oil, syrup, and dirt or soil. Because each group will need six plastic cups, you might want to assign each group member particular tasks.

MATERIALS LIST:

For each group you will need:
six plastic cups salt
pepper sugar
syrup dirt or soil
water metric measuring spoons
50 ml graduated cylinder
Transparency 3: What would ocean water look like?

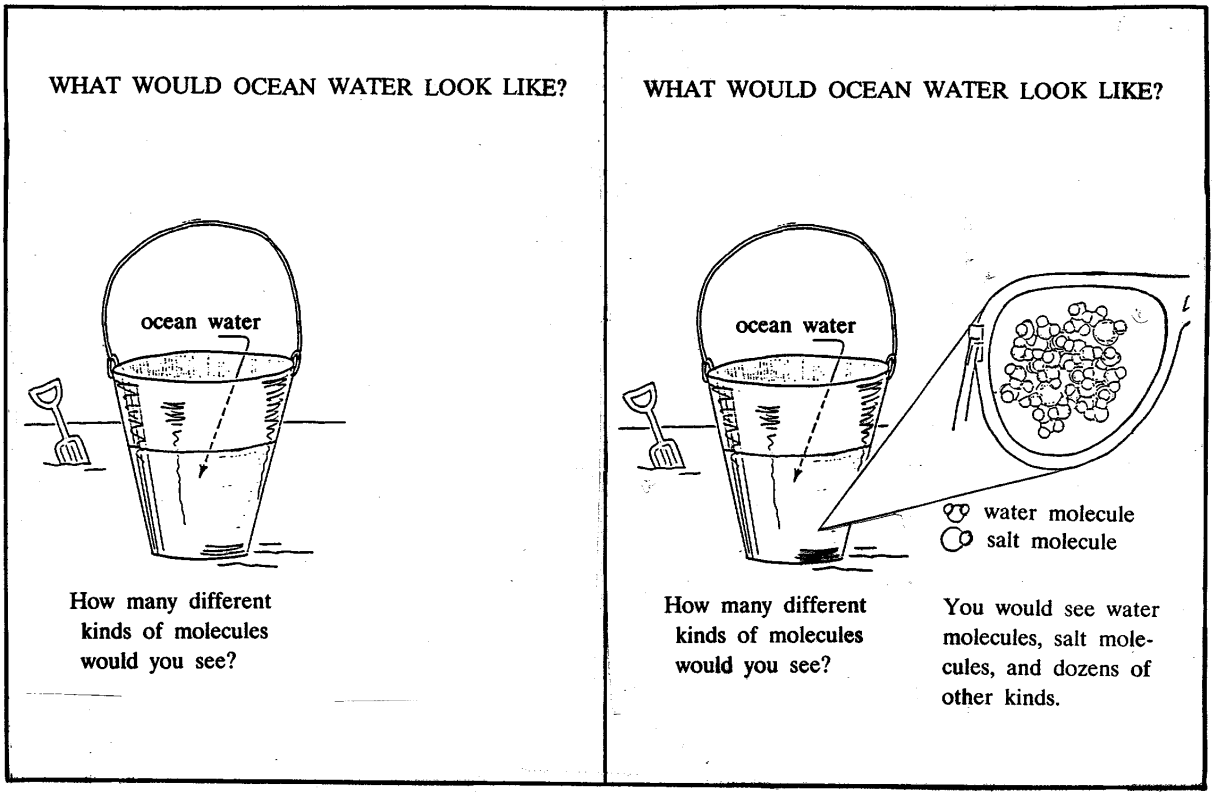
TEACHING SUGGESTIONS:

A majority of students may distinguish mixtures from pure substances based on observable properties, such as taste, color, texture, etc. Students need to recognize that even substances that appear "pure" may actually be mixtures of different kinds of molecules. There is often no way to tell a pure substance from a mixture by only observable properties.

1. After reading the definitions of pure substance and mixtures but before you do Activity 2.2, you may want to have the students list as many pure substances and mixtures as they can. Discuss their examples.

2. After the students discuss the remaining Science Book Lesson 2.2, emphasize that pure substances are made of only one kind of molecule while mixtures are made up of two or more different kinds of molecules.

Use Transparency 3 here



TRANSPARENCY 3: WHAT WOULD OCEAN WATER LOOK LIKE?

Bottom Layer
Often students make distinctions between mixtures and pure substances based on observable properties only; they believe that if something looks clear, then it is a pure substance. Thus, they will say that ocean water is pure because it looks clear. This would imply that ocean water has only one kind of molecule, even though most students will not answer in terms of molecules.

Overlay
Ocean water, even though it looks clear, has several different kinds of molecules, thus making it a mixture and not a pure substance.

Emphasize this difference to your students. Although ocean water is admixture of a number of different substances, only salt is shown in this transparency, as it is the most familiar to students.

LESSON 2.3

MOLECULES AND STATES OF MATTER

PURPOSE:

To help students contrast solids, liquids, and gases in terms of motion and arrangement of molecules.

MATERIALS LIST:

Transparency 4: How are molecules arranged and how do they move?

TEACHING SUGGESTIONS:

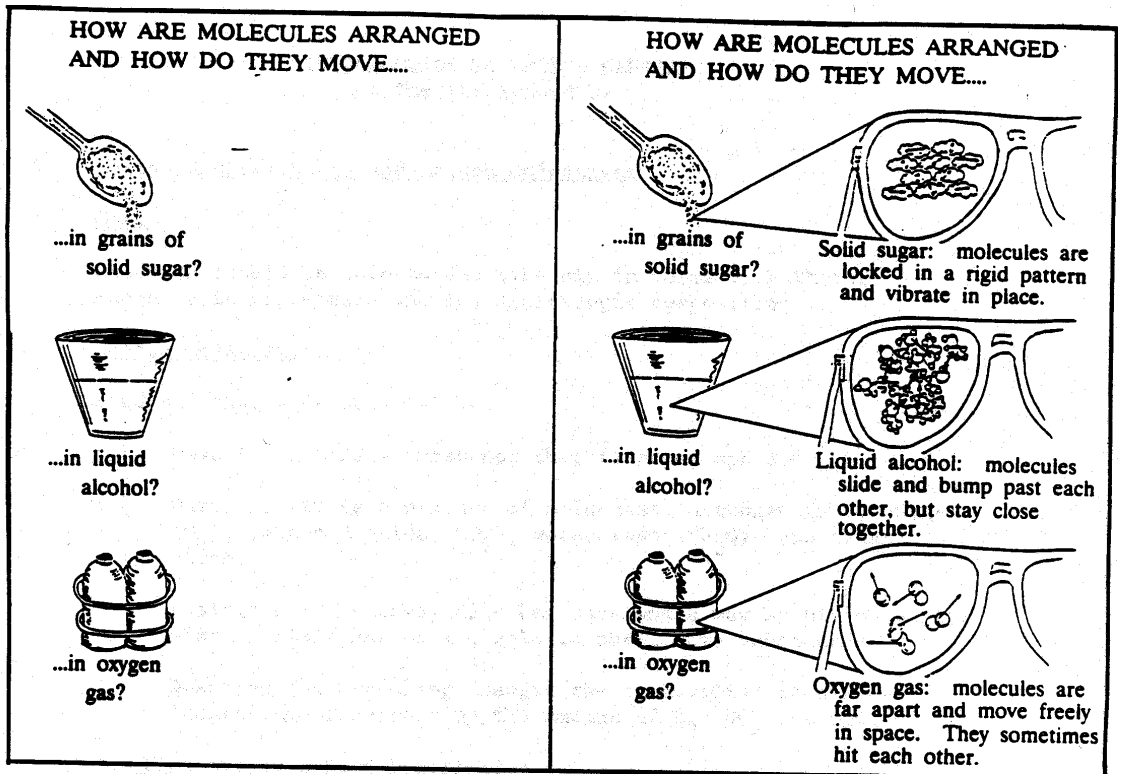
Solid: Some students may think that molecules in solids are not moving or that molecules themselves are hard. You should help these students distinguish observable properties of substances from invisible properties of molecules. Use the transparency to elicit the students' ideas about the arrangement and movement of molecules before you use the overlay. Then contrast the students' thinking with the overlay.

In discussing the molecules of a solid, you might want to use the analogy of students in their seats in your class. The students are in their chairs (fixed position) but they are constantly moving within this place. They do no move past each other.

Liquid: You might want to continue the analogy by comparing the movement of molecules of a liquid with the students moving around the room before or after class. Students are not in a definite array or pattern but moving past each other in a random manner.

Gas: The student analogy of a gas would be students moving very far apart after school is out. They move freely in all directions. (School buses are not a good analogy.)

Use Transparency 4 here:



TRANSPARENCY 4: HOW ARE MOLECULES ARRANGED AND HOW DO THEY MOVE?

BOTTOM LAYER:

Even though students have learned about how molecules move and how molecules are arranged in water, they often cannot transfer these ideas to other substances. Also, many students still have difficulty with movement of molecules in solids.

OVERLAY:

You should contrast students' naive thinking with the overlay, which gives a scientific view of molecules. Emphasize that even though the molecules of one substance (like sugar) may be different than the molecules of another substance (like ice), the molecules are still arranged and move in the same way in the solid state. This is what makes substances solids, liquids, or gases. Pay particular attention to movement of molecules in solids, as students have difficulty with this concept.

SUPPLEMENTAL ACTIVITIES:

1. Look up the molecular formulas of other pure substances, such as propane gas, ammonia, salt, baking soda, and make or draw models of a molecule of each.

2. You can show that milk (and other substances) are mixtures by freezing them. The water freezes before other substances in the mixture freeze.