CHAPTER 4

WHAT ARE THE CHARACTERISTICS OF MATTER ?

OBJECTIVES

After dealing with and studying the concepts and sub-concepts of this chapter, the students should be able to:

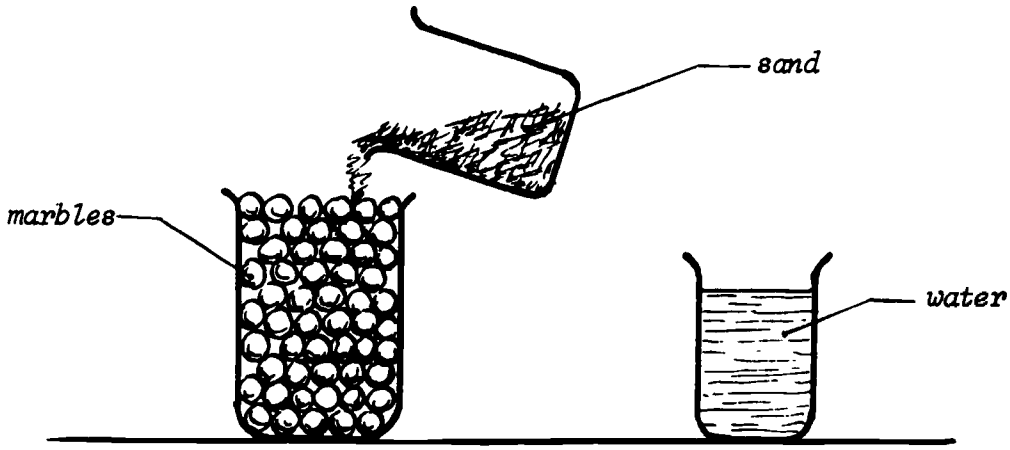
a. recognize the correct explanation of an observed event based on each of the sub-concepts;
b. explain in their own words which of the sub-concepts is determining the course of an event;
c. distinguish true from false statements concerning each one of the sub-concepts;
d. identify the correct explanation of an event in daily life applying one of the sub-concepts;

all in relation to the following sub-concepts:

-- Between the molecules of matter there exists space.
-- Matter exists in three states: solid, liquid, and gas.
-- Melting and boiling points are specific for pure substances.
-- Cohesion is a force that keeps like molecules attracted to each other.
-- Adhesion is an attracting force between unlike molecules.
-- The forces in a soap film pull at the frame equally in all directions.
-- Surface tension exists at the surface of a liquid.
-- Surface tension is drastically lowered by soap molecules.
-- Density is characteristic for different materials.

4.1. CAN THE CONTAINER HOLD MORE?

Materials: 1. A transparent container (glass or plastic).
2. Marbles, sand and water & a graduated beaker.



Procedure:

1. Fill the transparent container up to the brim with marbles.
2. Show the students that you still have sand and water; ask them: "Can I add any other material to this container?"
3. Add sand to the container (shake to settle the sand in between the marbles); ask the same question again.
4. Now add water to the mixture of water and sand.
5. Measure off the amount of sand and water added to the marbles (by measuring how much is left over in a graduated beaker).
6. Do not neglect to tell students that the marbles, sand, and water particles are only illustrating how molecules of matter are behaving and that they are not molecules themselves! It is only a model!

Questions:

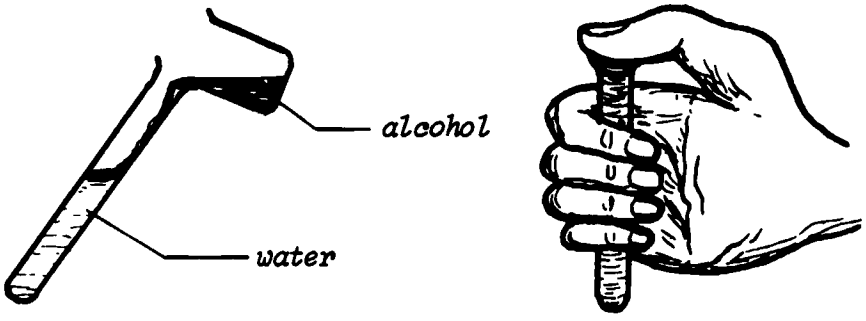
1. Why could the container that was already filled with marbles still hold more sand and water?
2. Could we have started with water, then sand and marbles?
3. What would you infer that the sizes of molecules of different materials or substances would be?
4. What other materials could be used to do this documentation?

Explanation:

The marbles, sand and water particles are used only as an analogy of how molecules of different sizes would behave. The smaller sized molecules can slip in between the larger ones. Thus it is possible to slip the sand or the water in between the marbles, but not the other way around. It is especially important to point out to students, that the marbles or sand grains are not molecules, but that molecules are so small that we cannot see them, not even with a microscope.

4.3. THE SHRINKING MIXTURE OF LIQUIDS

Materials: 1. A test tube and small beaker.
2. Alcohol - ethyl-, methyl-, or isopropyl-alcohol (methyl hydrate or rubbing alcohol may be used).



Procedure:
1. Fill the test tube half way with water.
2. Hold this test tube slanted and pour the alcohol slowly from a beaker until brim full.
3. Hold the test tube and place your thumb on the mouth of the tube, making sure that no air bubble is trapped.
4. Show the students that the tube is completely full.
5. Invert the tube several times (keep thumb on opening of test tube at all times; do not release the pressure).
6. Show to students that now the liquid level is lowered.

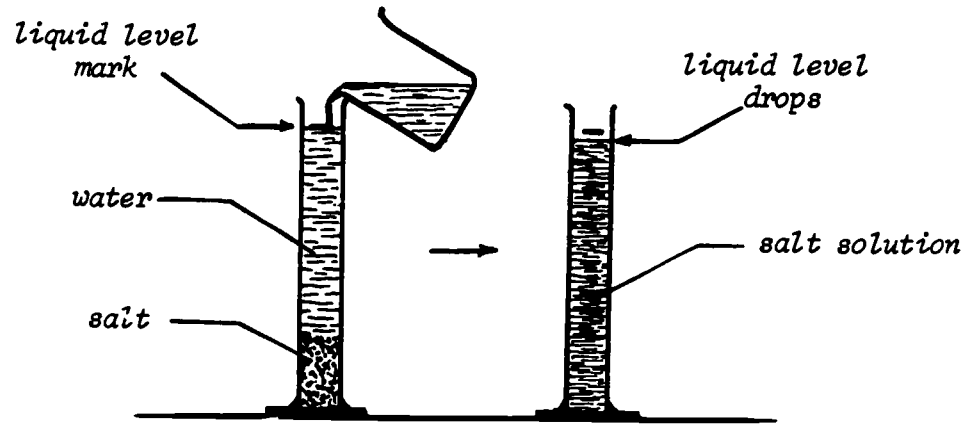
Questions:
1. Did the alcohol or water evaporate?
2. Was there any liquid spilled by inverting the tube?
3. Did the liquid shrink or contract?
4. Was there space between the water and alcohol molecules?

Explanation:

By closing the opening of the test tube tightly with the thumb, and not taking it off while inverting, no evaporation or spilling of the liquid could occur. By inverting the test tube, mixing of water and alcohol takes place, and because there are spaces between the molecules, the alcohol molecules slip in between the water molecules, thus making the total volume of the mixture become less. Although the spaces between the molecules cannot be seen by the naked eye, this demonstration shows that there must be room between the molecules. If ethyl alcohol is not available, methyl-hydrate (methyl alcohol) or rubbing alcohol (isopropyl alcohol) can be easily obtained from a drug store, and may replace it.

4.4. IS THE CONTAINER LEAKING?

Materials: 1. Water softener salt pellets or table salt.
2. A graduated cylinder and a beaker.



Procedure:

1. Fill the cylinder 1/3 full with water softener salt pellets or with table salt.
2. Add water until full and mark the liquid level with a grease pencil or tape or rubber band.
3. Let it stand for a few minutes and observe liquid level.

Questions:

1. Where did the water go?
2. Is the cylinder leaking any water?
3. What do the salt molecules do when they dissolve?
4. Can we use other salts to do this demonstration?
5. Can sugar be used to do this same demonstration?

Explanation:

Students might incorrectly infer that the water is absorbed by the salt. As a follow-up to a response like this you might pour out the water before all the salt is dissolved and re-fill it with fresh water: the water level will drop again! The main cause of the water level dropping is, that the salt molecules break down into ions: NaCl molecules into Na^+ and Cl^- ions, which are much smaller than the molecules, and these ions can slip in between the water molecules. This makes the total volume decrease. Other salts that dissolve in water will exhibit the same property. Most inorganic water-soluble salts will do this. The sugar molecule is large in size and does not ionize when dissolved in water, so that the water level will stay at about the same spot when sugar is used.

This demonstration shows students that there are spaces in existence between water molecules that are not detected by the naked eye.