DEMONSTRATION 4.1

MOLECULES HITTING EACH OTHER

Directions for doing the demonstration are in the Science Book Teacher's Guide.

1. Students should include these ideas: The air moving out of the hair dryer is a stream of molecules moving mainly in one direction. The molecules hitting the ball from the bottom and sides cause the ball to be lifted and held on the stream of air. The molecules hit the ball hard enough to lift it.

2. The inflated ball does not get flat because the air inside is made of molecules which hit the inside of the ball and push back out on it.

3. a. Yes. Molecules of air are hitting the chimes when air is still; molecules are always moving.

   b. The molecules of still air are moving, but they hit on all sides of the chimes with equal force. When the wind is blowing, more molecules are hitting the chimes on one side than the other.

ACTIVITY 4.2

COMPRESSING AIR AND WATER

TEACHING SUGGESTIONS:

Have the students complete questions 1 and 2, page 18 before you proceed with the activity.

STUDENT RESPONSES:

1. Compared to the water molecules, the air molecules in the student drawings should be very far apart. Both drawings should indicate molecular motion.

2. Students should predict that it would be easier to push air molecules together. The molecules of a gas are very far apart compared to a liquid. The gas molecules can be pushed together but the molecules of a liquid are already close together and cannot be pushed much closer together.

3. Students' drawings should show that molecules of air in the syringe are distributed all over the syringe, not bunched up at one end or the other. They should have a lot of space between them. (Some students think that the molecules are closer together either near the plunger or near the end by the opening. Be sure to point out that the molecules are evenly distributed around the inside of the syringe.)

4. No. The water cannot be compressed because the molecules are very close together and cannot be pushed any closer together.

5. Now the plunger will go in about halfway.

6. You can push in the plunger with air because the molecules are far apart and can be pushed closer together. The molecules of a liquid are already close together so the molecules cannot be pushed closer together. (Some students explain, in a simplistic way, that water is "harder" than air. You should ask them to think about <u>why</u> water is "harder.")

7. You cannot push the plunger all the way in because when you push the molecules closer together, they hit each other and the plunger more often. Therefore, they push out harder on the plunger.

8. The plunger moves back to the original position. This is because the molecules that were forced into a smaller space hit each other and the plunger more frequently. The molecules hitting the plunger push the plunger back to its original position.

Use Transparency 7 here:

TRANSPARENCY 7: WHAT HAPPENS TO AIR MOLECULES WHEN THE PLUNGER IS PUSHED IN?

BOTTOM LAYER:

Many students believe that air molecules will escape or try to escape when the plunger of a syringe is pushed in. Some think all or most of the molecules are pushed to the opening of the syringe.

OVERLAY:

Students hold the above misconceptions because they do no understand the idea of compressibility of air. You should point out to students that molecules of air have large, empty spaces between them. This means that when air is compressed, molecules merely move closer together. The molecules remain evenly distributed and are not all at one end of the syringe.

QUESTION SET 4.3

THICK AIR AND THIN AIR

1. The molecules in the syringe to the right should be drawn closer together. Both drawings should show about the same number of molecules. Students may draw different types of molecules.

2. The molecules in the scuba tank are much closer together than the molecules in the mountain air. (Students should also remember to use arrows to show that molecules are always in motion.)

3. A gallon of air from a valley. In a valley, molecules of air are closer together, so there would be more in a gallon than on top of a mountain. The higher you go in the atmosphere the fewer molecules you have in a gallon.

4. Air will escape. The air in the scuba tank is compressed and the molecules are pushed close together. They are moving fast and hit each other quite often. When the valve is opened, the molecules of air push each other out of the valve. The air inside the tank expands out of the tank.

You may have students try to explain, after having heard this explanation, how other phenomena work, such as the commercial airliners discussed at the beginning of this lesson.

QUESTION SET 4.4

EXPLAINING BICYCLE TIRES

STUDENT RESPONSES:

1. The molecules of air are being pushed closer and closer together. The air in the tire is being compressed.

   (Some students might say that it is expanding, because the tire expands a little when it is pumped up. But the air is being compressed. This confusion illustrates why it is important to identify the appropriate substance as part of the explanation.)

2. No. The molecules of air are constantly moving. This causes the molecules of air to spread out evenly throughout the tire.

3. The air is expanding as it escapes. When the valve is opened, the molecules of air rush out, move more freely and farther apart.

4. Should be similar to the statement in the Science Book, Lesson 4.4. A good explanation answers at least two questions:

   a. A question about substances: What substance is changing and how is it changing?

   b. A question about molecules: What is happening to the molecules of the substance?

QUESTION SET 4.4

CLUSTER REVIEW

1. Students can copy the answers to this question from the text.

   a. A question about substances: What substances are changing and how are they changing?

   b. A question about molecules: What is happening to the molecules of the substances?

2. An example of a good explanation: The air (substance) is being compressed as it is pushed into the tire. The pump pushes the molecules of air closer together. The teacher should remind students that a good explanation answers the two questions listed in number 1.

3. An example of a good explanation: The air (substance) escapes through the hole in the tire and expands. The molecules of the air move farther apart when they get out of the tire.

   (Some students will say that the molecules move through the hole in the tire, but they will not say that they move farther apart. The reason they move farther apart is that they were pushed close together when the tire was inflated.)

4. An example of a good explanation: The compressed air (substance) inside the syringe pushes against the plunger and forces it back out. The molecules of the air push by hitting the plunger and bouncing off.

5. An example of a good explanation: Helium (substance) is compressed and put into the tank. The molecules of helium are pushed closer together.

   (Helium gas actually consists of individual atoms rather than molecules containing two or more atoms. Most students will not know this, however, and the distinction is not important for this unit. What is important is that there are the same number of molecules--or atoms--of helium in the tank as in the balloon!)

6. An example of a good explanation: Helium (substance) expands as it leaves the tank and goes into the balloon. The helium molecules (or atoms) are moving further apart as the gas moves out of the tank and into the balloon.