

LESSON CLUSTER 4

Compressing and Expanding Air

Lesson 4.1: Explaining Things with Molecules

In the lessons that you have already studied, you have been learning quite a bit about molecules; what they are, how small they are, how they move, how they are arranged, and so on. These lessons have been helping you explain things in terms of molecules, not just in terms of what you see, hear, or feel.

In science, we often explain how things happen by giving molecular explanations. By using what we know about molecules in our explanations, we can better understand why something happens in a certain way.

For example, we have already learned that molecules are constantly moving. Because air molecules are constantly moving, they are always hitting objects in the air. This helps to explain why certain things happen. See if you can use the idea of air molecules hitting things to help you explain the demonstrations that your teacher will now do. Watch and discuss the demonstrations, then answer questions about these events in your activity book.

1. Hair dryer and ping pong ball.
2. Sitting on inflated ball, basketball or football.
3. Blowing on wind chimes (optional).

Do Question Set 4.1 in your Activity Book

In talking about the demonstrations you just watched, you might give explanations that mention the air but not air molecules. But a much better scientific explanation would also talk about what the molecules are doing and how they are involved in what is happening. Talking about molecules gives a better, more complete explanation of how things happen.

Look at the explanations that you wrote in your activity book. Did the explanations mention how the molecules of air were hitting the objects? If you did not, then see if you can change your explanations so that they talk about molecules.

Lesson 4.2: Compressing Air

Can you push air closer together to get more air in a smaller space? This activity will help us answer that question.

Do Activity 4.2 in your Activity Book

A good explanation of why you can push the plunger partway in with air in the syringe, but not all the way, would go like this: Molecules of gases are far apart and have empty spaces between them. The molecules of air in the syringe are scattered all through the syringe. When the plunger is pushed in, the molecules of air are pushed closer together. When air molecules are pushed closer together, we say that the air is compressed.

Air and other gases can be easily compressed because their molecules are far apart. The molecules of solids and liquids, though, are already close together. This makes it almost impossible to compress solids or liquids such as water.

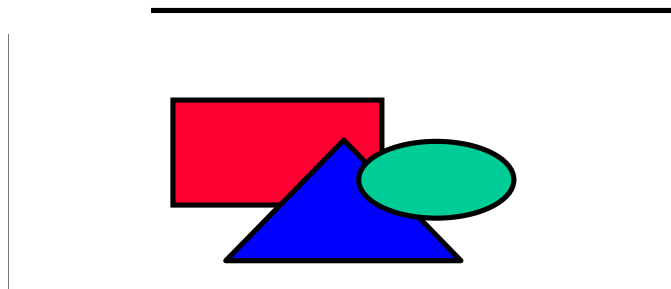
When you pushed the plunger in and then let it go, you should have seen the plunger move back out again. The plunger moves back out because air molecules are hitting it all the time, pushing on it, just like air molecules in the wind were pushing on the ping pong ball to hold it up. When you push in on the plunger, the air molecules are pushed closer together, and more of them hit the plunger. When you let go of the plunger, the air molecules push it back out.

The molecules that make up air and the molecules that make up water are always moving. Molecules of water are sliding past each other, moving all around. Molecules of air move quickly around inside the syringe, hitting each other and hitting off the inside of the syringe and plunger. This constant motion keeps the molecules spread evenly through the inside of the syringe.

Lesson 4.3: Breathing Thick Air and Thin Air

You have just learned about how air can be compressed in a syringe when its molecules are pushed closer together. Now we'll look at other examples of air that are more or less compressed, we'll call them thin air and thick air.

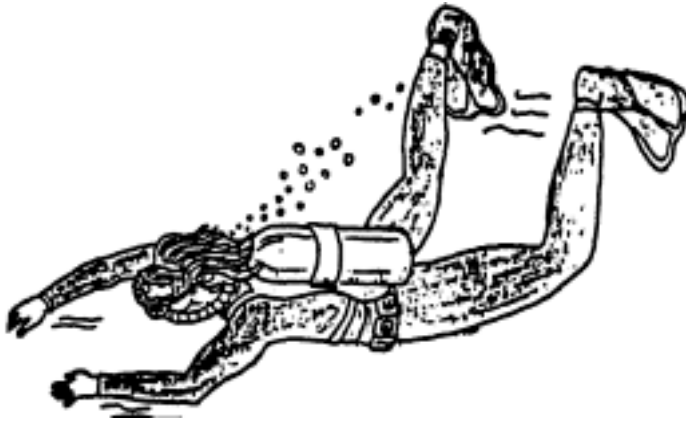
Thin air. One example of thin air is the air that is found in parts of the world where there are very high mountains. The air becomes much thinner high up in the atmosphere. When people climb really high mountains, they need to take extra oxygen with them in tanks. There is not enough air in every breath they take to let them climb the mountain without fainting.



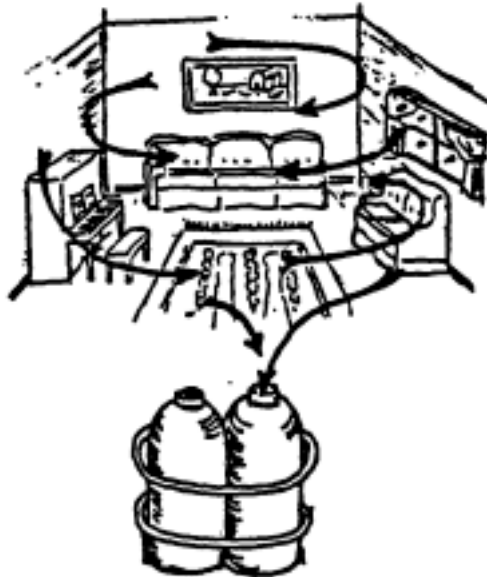
The air is thin up high in the mountains

A similar thing happened to runners in the 1968 Olympic Games in Mexico City. Mexico City is very high up in the mountains. Runners had to breathe very hard because they took in less air with each breath. In order to prepare their bodies for this, many runners did their training in mountain areas all over the world so that they could get used to the "thin air."

Thick air. An example of thick air is the air found in a scuba tank. A scuba tank is a tank of air that a person can use to breathe underwater for about an hour.



All of the air molecules in the room are forced into the tank



The tank itself is not that big. In order to breathe from it for an hour, a lot of air has to be pushed into it. In fact a whole room full of air is compressed into the tank.

Do Question Set 4.3 in your Activity Book

Why is it harder to breathe up in the mountains than down in the valleys? We have already said that mountain climbers and runners in the mountains take in less air with each breath they take. How can we use what we know about molecules to help us understand that?

Air is made of molecules. These molecules are always moving, and they are very far apart. Up in the mountains, air molecules are farther apart than down in the valleys.

Each breath we take in the mountains has fewer molecules in it because the molecules are farther apart. Our bodies need the same amount of air, so we have to breathe harder, or else we will not get enough oxygen. That is why mountain climbers need to take the oxygen tanks with them.

What happens when we release air from a scuba tank? The air molecules have been pushed very close together in a full tank. When the tank valve is opened, the air rushes out -- you can hear it making a rushing noise. Because the molecules inside the tank are pressed close together, they escape from the tank very quickly. As they escape, they move farther apart from each other. The air from the tank expands or spreads out, as it escapes into the room.

Lesson 4.4: Bicycle Tires

Up to this point in this cluster, you have seen that air can be compressed. We explained air compression by saying that air molecules are normally very far apart, with lots of empty space between them, and they can be pushed closer together.

You have also learned something about scientific explanations. To make a good explanation, you often need to talk about molecules. You need to talk about the way molecules move and the way they are arranged in solids, liquids, and gases. You also need to know what kind of molecules you are talking about. You need to identify the substance that is changing and tell how it is changing.

In other words, a good explanation answers at least two questions:

1. A question about substances: What substance is changing and how is it changing?
2. A question about molecules: What is happening to the molecules of the substance?

Let's think about the explanation of air escaping from an air tank and see if it answers those questions. We said that air (substance) comes out of the tank and expands into the room because the molecules of air inside the tank are pressed very close together, and they move farther apart. That explanation answers both the question about substances and the question about molecules.

Now let's try to explain something else: What happens when you fill a bicycle tire with air? This is a little more complicated than the scuba tank or the syringe, but it will help you learn more about air molecules and how to make good explanations.



Do Question Set 4.4 in your Activity Book

Here is one explanation that answers both the question about substances and the question about molecules: As the tire is pumped up, air (substance) in the tire is being pushed into the tire and compressed. The molecules of the air are being pushed closer and closer together.

Notice that the air is the substance that is making the important changes, not the bicycle tire. The tire is getting a little bit bigger, but not a lot bigger. For a lot of air to fit into a bike tire, the molecules have to move closer together. The air has to be compressed.

The air in a bike tire will be evenly distributed inside the tire. As the molecules of air are pumped into the tire, the molecules spread out evenly, so there will not be more molecules near the valve.

If you let the air out of a tire, the molecules that were pressed very close together will now spread far apart. When this happens, the spaces between the molecules get bigger, and the air expands.

In this lesson cluster, you have learned many things about air molecules. You have learned that air molecules are constantly moving and hitting things. You have learned that air molecules can be pushed closer together; that is, air can be compressed. Air molecules can also spread farther apart. When this happens, we say that the air expands. You have also learned that air molecules are evenly distributed--this means that they spread out evenly and that they don't bunch up together in one place more than another place.

Finally, you learned what the two parts are to a good explanation. To make good explanations, you need to answer two questions:

1. A question about substances: What substance is changing and how is it changing?
2. A question about molecules: What is happening to the molecules of the substance?

***** Do Review Question Set 4.4 Now *****