Category III Physical science examples

Providing variety of phenomena

Matter and Molecules

Matter and Molecules provides a large number and variety of phenomena that match the key idea that "molecules are in motion" but provides only one phenomenon for the idea that "molecules are perpetually in motion." The material provides experiences with different substances: sugar, water, perfume, ammonia, different smells, and air. In each case, students are asked to explain the phenomenon in terms of the motion of molecules.

- Students observe the release of perfume (*Science Book*, p. **24s**)
- Students read about ammonia and lemon smells moving across a room (*Science Book*, p. **24s**)
- Students sit on a basketball and observe that the ball does not get flat. Then they consider what is holding them up. (Suggested response: The air inside is made of molecules, which hit the inside of the ball and push back out on it.) (*Science Book*, p. **27s**)
- Students place their thumb firmly over the end of a syringe, push it in as far as it will go, let go of the plunger, and observe the plunger moving back out. (*Science Book*, p. **28s**)
- Students are asked to consider what will happen if a scuba tank full of air is opened.
  Students read that when the valve is opened, the air rushes out – one can hear it making a rushing noise. (*Science Book*, pp. 30-**31s**)
- When a tea bag is put into a cup of water, students observe wavy lines under the tea bag and taste the water. (*Science Book*, p. 34-35s)
- Students are asked to predict what would happen if they let the cup stand overnight:
  Would the sugar rise to the top, settle to the bottom, or spread evenly throughout the water? (This is the only "experience" that supports the idea that molecules are *constantly* moving) (*Activity Book*, p. **26s**)
- Students read about the smell of vinegar spreading out (*Activity Book*, p. 48s)
- Evaporation of water (The idea of constantly moving molecules is explicitly linked to the evaporation of water. To explain evaporation, though, many additional ideas are needed.) (*Science Book*, p. 54-55)

However, there are no phenomena that relate to the motion of particles in solids.

As you see in the picture, a speck of dust which you can barely see with your eyes is much, much, bigger than a molecule (trillions of times bigger!). The speck of dust is made of trillions of molecules itself; it is a solid while air is a gas.

If you look at the air molecules in the picture, you will see that they are mostly nitrogen and oxygen molecules. Air is about 4/5 nitrogen and 1/5 oxygen. Water, carbon dioxide, and other gases make up only two or three percent of the molecules in the air. Can you think of any substances other than dust that mix in air? There are many, including dirt, germs, bacteria, smoke, and many other substances. Most substances that you can see in the air, like dust or smoke, are made of solid particles that contain trillions of molecules each. But sometimes substances that you can't see also mix with air.

What else is sometimes in the air? Did you think of smell?

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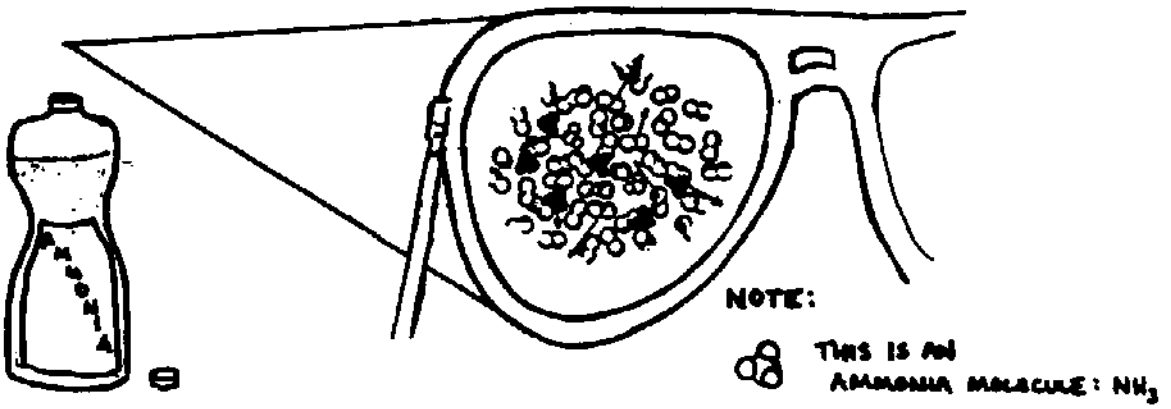
Do Question Set 3.2 in your Activity Book

What is the smell of perfume? First of all, smell is a gas and made of molecules. When a bottle of perfume is opened, some molecules of the perfume leave the bottle, go into the air, and mix in the air. These molecules of perfume in the air are constantly moving, so they spread out. They spread out until the perfume molecules reach and affect your nose. Then you can smell them.

The same thing happens when you open a bottle of ammonia or you cut into a lemon. Molecules of the ammonia or lemon spread out in the air until they reach your nose. Ammonia, lemon, and perfume molecules are smelly because they affect your nose.



You smell ammonia when you breathe air with ammonia molecules in it

In this lesson you answered questions such as "What is air made of?", "What are smells?", and "How do smells travel?" In Lesson 3.3 you will study more about air and breathing.

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Do Question Set 3.2 in your Activity Book

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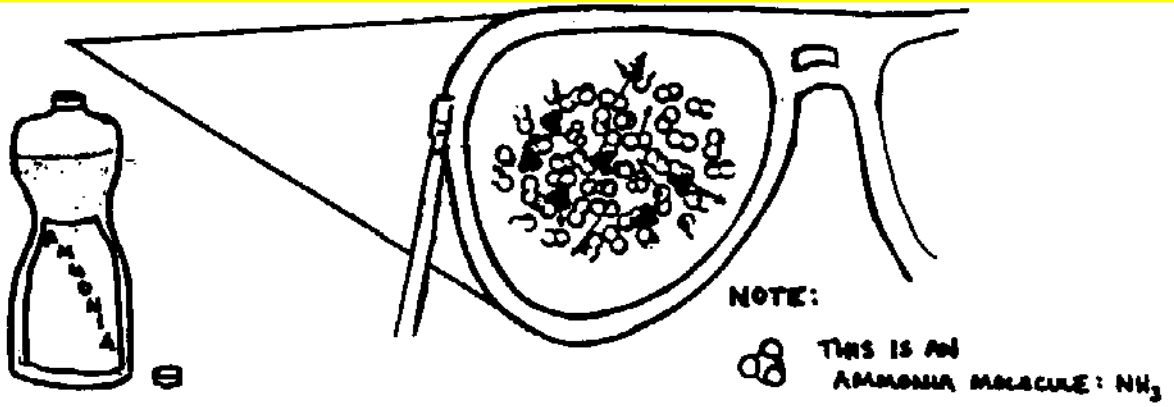

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LESSON CLUSTER 4
Compressing and Expanding Air

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).

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Do Question Set 4.1 in your Activity Book

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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.

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Do Activity 4.2 in your Activity Book

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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.

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.

a. What do you see happening underneath the tea bag? (You can draw on the picture on the previous page to illustrate your answer if you want.)

b. Taste the water. What do you taste? _____

c. Why can't you see the sugar anymore? _____

d. How do you think the sugar got out of the tea bag?

Now look back at your text. See how your explanation compares with the one there!

e. If you let this cup stand overnight, would the sugar rise to the top, settle to the bottom, or spread evenly throughout the water?

_____

Talk about molecules to explain your answer. _____