LESSON CLUSTER 8

Explaining Evaporation and Boiling

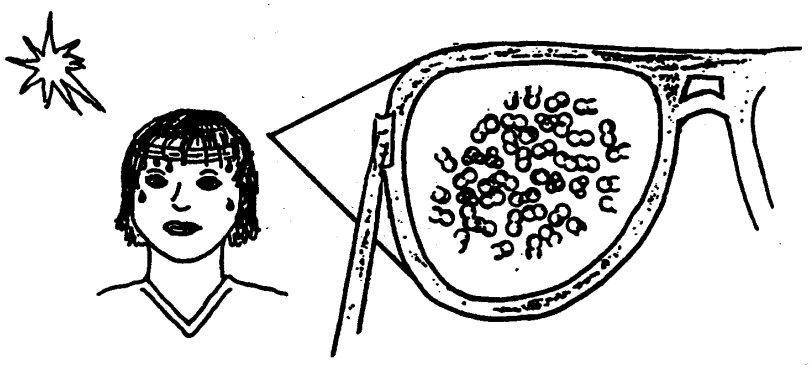
Lesson 8.1: Where Did the Water Go?

You see things drying out around you all the time; puddles dry up; clothes dry on a clothesline or in a dryer; your hair dries out after a shower; towels dry when they are hung up. Have you ever wondered what happens to the water when something dries up? It takes trillions of water molecules to make something wet. Where do they go when something dries out?

You probably already know the answer to this question. The water does not just disappear; things dry out when water changes from liquid water to water vapor. This is called evaporation. The liquid water changes to water vapor that mixes with the air.

You probably also know that clothes and towels dry out more slowly when the air is humid. Sometimes you feel sticky because sweat evaporates from your skin more slowly. What do we mean when we say that the air is humid?

The air is humid when there is a lot of water vapor in the air. You may remember from Lesson Cluster 3 that there is always some water vapor in the air. After a summer rain, you may say that it is hot and humid. That means that the temperature is high and the amount of water vapor in the air is also high. Sometimes, there is so much water vapor in the air that our homes become uncomfortable. We may use a device called a dehumidifier, which takes some of the water vapor out of the air.

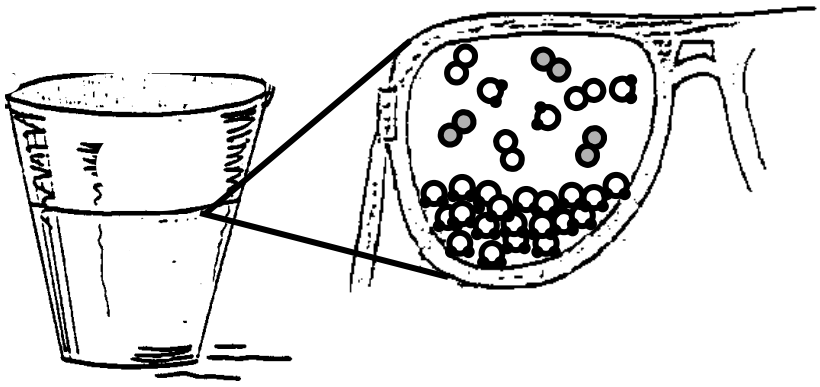


Humid air has many water molecules in it

In the wintertime, there is usually less water vapor in the air, and we may become uncomfortable because water is evaporating too fast from our skin, causing our skin to feel dry. To become more comfortable, we may add water vapor to the air. That is why many furnaces have a humidifier, which adds water vapor to the air when the air is very dry. This makes us feel more comfortable.

How does evaporation happen? Let's try explaining it in terms of molecules. You know that the molecules in liquid water are constantly moving. In a liquid, though, the attractive forces between molecules keep them close together. What you might not know is that the molecules in a liquid move at different speeds. Some molecules are moving very fast, while other molecules are moving more slowly.

What do you think would happen if a fast-moving molecule reached the surface of a drop of water? Yes, it would escape! It would break away from the strong attraction of the other water molecules and become a molecule of water vapor in the air. If all the water molecules escape in this way, we say that something has "dried out." The liquid water has turned into water vapor in the air, and the water vapor makes the air more humid.



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Do Question Set 8.1 in your Activity Book

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Lesson 8.2 Where Does the Water in the Air Come From?

You learned in the last lesson that when things dry out, the water goes into the air. When you dry your hair, when clothes dry, or when puddles of water dry up all the water eventually goes into the air.

Sometimes the air is humid, though, even if there is no liquid water nearby. In fact, there is some water vapor in all air, even air in a desert that is far away from any liquid water. Where does all that water vapor come from?

To answer this question you have to think of the entire earth, not just of what you see around you. There is lots of liquid water on the earth. In fact, most of the world is covered with liquid water. Three-fourths of the earth is covered with oceans, rivers, and lakes and only one-fourth with land.

Think of the hardest rain you can remember. Sometimes it rains for several days, and rains very hard. Millions of gallons of water are falling around you, and most of them evaporated from the oceans, rivers, and lakes far away. Moving air, or wind, moves the water vapor from one place to another. For example, water molecules are constantly escaping from the surface of the ocean and moving into the air. The moving air sometimes carries these water molecules high into the atmosphere, where they may be carried thousands of miles. In this way the water vapor can move from oceans over the land. Some of this water vapor is always in the air.

Water is always evaporating from the land, too, from trees and other plants. Plants, like all living things, are mainly water. Some of the water molecules from the plants are moving fast enough to escape the surface of the leaves and other parts of the plant. If you've ever been in the middle of a deep forest or in a cornfield where the corn plants are higher than your head, you might have noticed that the air was unusually humid. In other words, the air has a lot of water vapor in it. Most of this water vapor comes from the evaporation of water from plants.

Even you are a source of water vapor in the air. When you sweat, the liquid water on your skin evaporates and becomes water vapor in the air. You add water vapor to the air in another way, too. Every breath that you breathe out contains water vapor from your lungs. A little bit of the liquid water from your lungs evaporates and leaves your body with each breath.

So there are always water molecules in the air, molecules that have escaped from liquid water in the oceans, in lakes and rivers, in plants, and even from liquid water in your blood. After you have answered some questions about the many ways that water can evaporate, you will get to try making another liquid evaporate: alcohol.

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Do Activity 8.2 in your Activity Book

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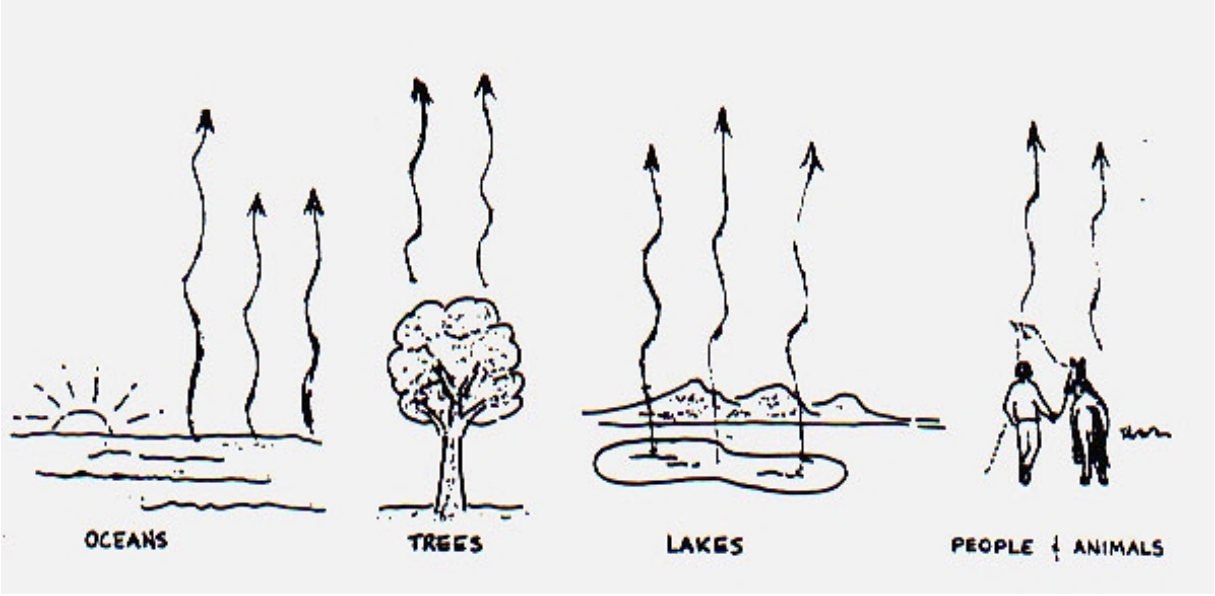

Sources of water vapor in the air

Lesson 8.3: Fast Evaporation and Boiling

Suppose you want to make water--or some other liquid--evaporate faster. How could you do it? You discussed one way in Lesson 8.1: water evaporates faster in dry air than in humid air. There are other ways, though. See if you can figure some of them out.

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Do Activity 8.3 in your Activity Book

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You probably thought of a lot of different ways to make the alcohol evaporate faster. Some of these ways help more air move by the alcohol. You might blow on the alcohol, for example, or swirl it around, or pour it out and spread it around.

Another thing you might have done is to figure out ways of warming the alcohol. You might have used your hands to make it warmer, for example. Can you explain why heating a liquid makes it evaporate faster?

It makes sense if you think about it. When you heat a liquid, there are more fast-moving molecules, so more molecules can break away from the attractive forces and escape.

Some appliances, like clothes dryers and hair dryers, use both heat and blowing to speed up evaporation. For example, a clothes dryer heats up the clothes so that more molecules are moving fast enough to escape from the surface of the clothes. The large drum inside the dryer tumbles the clothes through the air so that the hot air comes in contact with all the pieces of clothing. If the clothes were not tumbled, only the ones on the top would dry. The water molecules could not escape from the clothes on the bottom.

Now let’s think about what happens if the molecules of a liquid start moving really fast. If you continue to heat a beaker of alcohol (or any other liquid), the molecules at the bottom move faster and faster until the attractive forces can no longer hold them together and they fly apart. The alcohol changes to alcohol vapor down at the bottom of the beaker! This alcohol vapor forms bubbles that rise to the surface of the alcohol. This process is called boiling.

So evaporation and boiling are both changes of state from liquid to gas, but they don’t work in quite the same way. Let’s compare the two processes.

1. When molecules escape from a liquid's surface and mix with the molecules of air, it is called evaporation. In evaporation, individual molecules escape from the liquid.

2. When molecules of a liquid move faster and faster at the bottom of a heated container, they eventually move fast enough to overcome the attractive forces between them and fly apart. The liquid changes to a gas at the bottom. The gas forms bubbles that rise to the top of the liquid. This is boiling.

The gas inside the bubbles of a boiling liquid is invisible. It looks like air, but it is not air. Air is a mixture of different kinds of molecules: nitrogen, oxygen, and so forth. The bubbles in boiling water contain only water molecules; the bubbles in boiling alcohol contain only alcohol molecules.

Lesson 8.4: Evaporation and Smells

You know a lot, now, about evaporation and boiling. Let's try using what you know to explain something else that is all around you: smells. Do you remember studying smells in Lesson Cluster 3? We said that you smell something when your nose detects molecules that are mixed in with the other molecules in the air.

That explains how you smell gases, but lots of the things we smell are solids like cookies or liquids like perfume. How do you smell them? For an example, let's think about something really smelly. How about a skunk?

Skunks make their scent by spraying out a liquid that contains many different kinds of molecules. The liquid that skunks spray out begins to evaporate. Some of its molecules escape from the liquid and mix with the air, then they move around with the breeze. Our noses are very sensitive to these molecules so we can smell a skunk even if there are only a few of it's smell molecules mixed with the air. It takes a long time for all the liquid to evaporate, so if you are sprayed by a skunk, people will know it for a long time!

Many other substances are made of molecules that our noses can detect. What did the room smell like during the alcohol evaporation race? Can you explain why?

Many of the things we smell are actually complex mixtures that only allow some of their molecules to escape. Cookies, for example, contain many different kinds of molecules. When cookies are baked, some of the substances in them remain solids, but other substances melt and start to evaporate. Then the molecules of those substances reach our noses. Aaaah!

When molecules of a substance mix with air, they bounce around and move through space just like air molecules. One way to see how much the molecules are moving, even in "still" air, is to see how smells spread through a room. Perhaps you can try it.

So when you smell a solid or a liquid, it isn't really the solid or liquid that you smell. You smell molecules that escape from the solid or liquid and come to your nose by bouncing through space like the other gas molecules in the air. Our noses wouldn't have much to smell if it weren't for evaporation!

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Do Review Question Set 8.4 Now

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