How Does Air Move?

A lesson on air molecules, density, and convection.

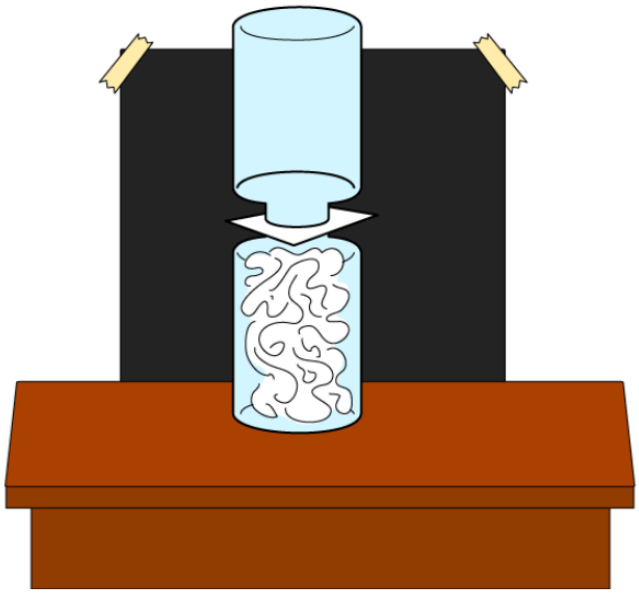
When you go outside and feel a gust of air, that's wind. When you turn a ceiling fan on and it blows air down on you, that's a **downdraft**. When you warm your hands over a warm bonfire, that's called an **updraft**. The way air moves is called **convection,** and changes in convection are caused by changes in air density. **Density** is the amount of matter in a certain amount of space. One key idea to remember when observing this experiment is that dense air sinks and less dense air rises.

Materials

1. Two-inch mosquito coil and stand
2. Matches
3. Two one-quart glass jars with lids
4. Lamp
5. 9"x12" black construction paper
6. 3"x5" index card

Activity

1. Place one jar in the freezer (leave until step 7) and place the other on the table.
2. Plug in the lamp and set it on the table.
3. Tape the black construction paper upright behind the jar.
4. Take the jar, one index card, mosquito coil, and matches outside.
5. Ignite the mosquito coil and cover it with the jar. Let the coil fill the jar with smoke, which should take about 2-3 minutes.
6. Turn the jar right side up and immediately cover it with the index card. Take it to the table and set in front of the black paper and the lamp's light.
7. Retrieve the jar from the freezer and set it on top of the smoky jar. Leave the index card between them.
    a. Ask, what's going to happen?
8. Slowly remove the index card and observe what happens.

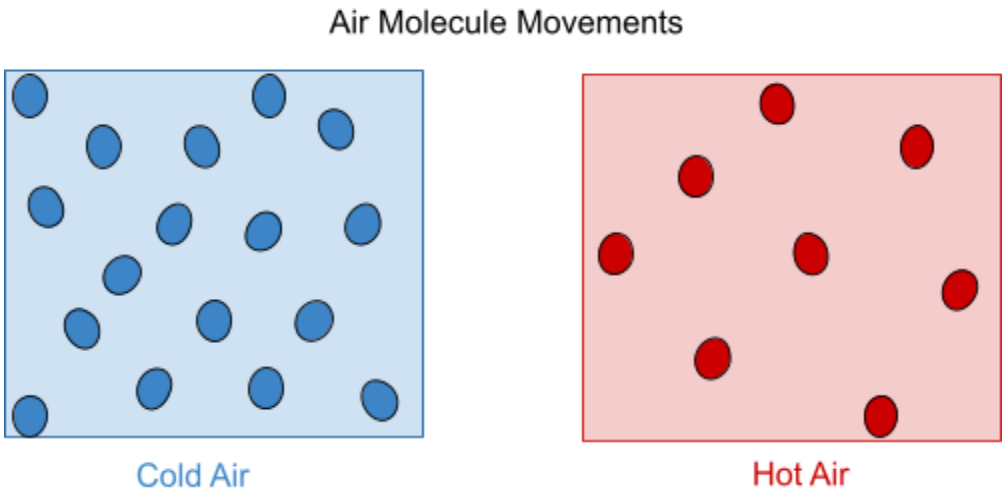


Results

The smoke rises into the top jar!

Why does this happen?

We can't see air particles, but we can see smoke particles. Watching what the smoke does tells us what the air is doing. When we removed the index card, the smoke-filled air rose to the top jar because it was less dense than the air in the cold jar. If you try to hold up a brick with a straw, it will collapse because the brick is heavier. This same thing is happening with the cold air and the smoky air. The cold air is heavier, so it falls to the bottom jar, and the smoky air gets pushed out. What makes the cold air heavier than the smoky air? The density! The particles of the cold air aren't moving very fast; they're sticking close together. The smoky air particles are moving super fast, spreading them out further. The cold, dense air falls because it's heavier, and the less dense, smoky air particles rise because they want more room to move around.



What is Air Pressure?

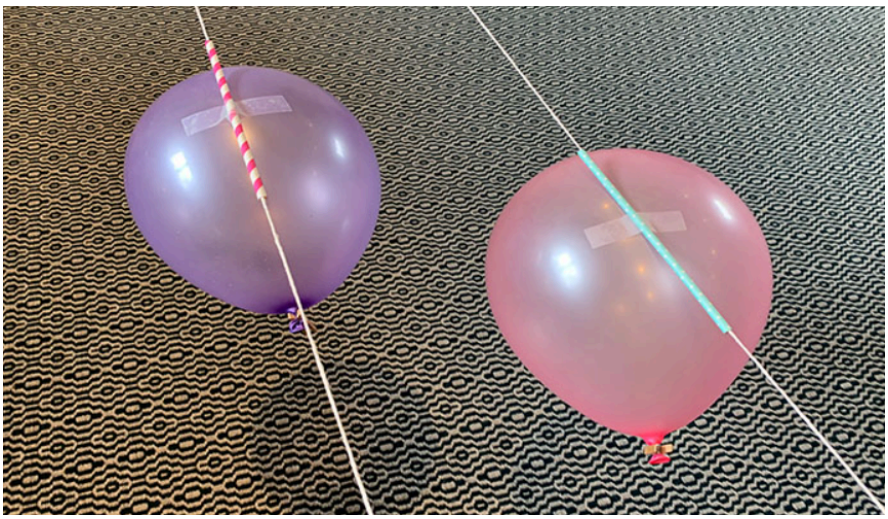
A lesson on the basic principles of air pressure.

When you release an inflated balloon, it flies away. The air inside a balloon is under a lot of pressure, so when you slowly open the balloon, the air wants to escape that high pressure. **Pressure** is the amount of force applied to an object. **Air Pressure** is the amount of force applied to air molecules. We can't see the air molecules being pushed around, but most of the time, the pressure is great enough that we can feel it. In some cases, the pressure is even great enough to move other objects!

Materials

1. String, 20ft
2. Balloons
3. Straws
4. Tape
5. Scissors
6. Two tables of the same height

Activity



1. Place the tables 20 feet apart.
2. Tape one end of the string to the table.
3. Cut the plastic straw to 5 inches long.
4. Insert the string into the plastic straw.
5. Tape the loose end of the string to the other table, making sure the string is taught.
6. Blow up a balloon and pinch the end closed, don't tie it off.
7. Hold the balloon under the straw, then drape tape over the straw and onto the balloon. Don't let go of the end.
    a. This step might take two people.
8. Release the balloon and observe what happens.

Result

The straw/balloon moves, even though we didn’t touch it!

Why does this happen?

Inside the balloon was high air pressure. When a balloon is inflated, lots of air molecules are forced into a small space, putting them under lots of pressure. The air molecules push against the walls of the balloon, forcing it to expand. The air molecules are stuck in a little space and would rather be in low pressure where they have room to move around. So, when we open the end of the balloon, the air molecules rush out because the outside is at a lower pressure. The molecules are in such a rush to get out that they push whatever is blocking their exit; that’s why the straw moves. If we didn’t inflate the balloon so much, the air molecules would be in less of a rush to get out, so the straw wouldn’t move as far. If we inflated the balloon more, the air molecules would speed out of the opening and push the straw even further down the string. The bigger the change in pressure, the bigger the result.

Let the Sunshine In!

A lesson on solar heat.

When you stand in the sunshine, it feels warm because light has heat properties. How might we use that information in our homes?

Materials

1. Two thermometers
2. Mirror
3. Modeling clay
4. Two tables
5. Sun shining through a window

Activity

1. Be sure the thermometers read the same temperature. Do this by letting them sit in the same area for five minutes and checking that the results are the same.
2. Place one table in front of the window in direct sunlight.
3. Place the second table away from the window out of direct sunlight.
4. Place the mirror on the first table, and position it so the light hits the second table.
5. Place one thermometer on the first table in direct sunlight.
6. Mold a clay stand for the second thermometer and place it in the reflected light on the second table.
7. Leave them for ten minutes.
8. Record your observations.

Result

The direct sunlight is warmer than the reflected sunlight.

Why does this happen?

The particles of the direct sunlight are uninterrupted, whereas the particles in the reflected light have been dispersed. Repeat the question: how can we use this knowledge in our homes, e.g., should we be more intentional about when we close our curtains and where we place our furniture?

Build a Waterwheel

A lesson on types of energy.

There are lots of forms of energy, like electricity, oil, and water. A waterwheel uses the kinetic energy of falling water to capture energy for another task. Today, we're going to make a model of a waterwheel.

Materials

1. Empty thread spool
2. Disposable cup
3. Duct tape
4. Empty 2-liter soda bottle
5. Dental floss or strong thread
6. Metal washer
7. Scissors
8. Plastic straw

Activity

1. Measure the length (top to bottom) of your spool.
2. Mark the disposable cup using the measurement from Step 1, measuring from the top of the cup down.
3. Cut around the cup at your mark until you have a separate ring.
4. Cut the ring into six equal rectangles.
5. Tape the rectangles from Step 4 onto the spool at even intervals, making sure the curve of each rectangle is going in the same direction.
6. Thread the straw through the spool. Secure the spool in the middle of the straw with tape. Set aside.
7. Cut the empty 2-liter soda bottle at the top of the product label so you're left with a tall cylinder.
8. At the bottom of the cylinder, poke holes about 1 inch apart for drainage.
9. Cut a 'v' shape on the top edge of the cylinder. Make another 'v' cut directly opposite the first one.
10. Cut a 12-15-inch piece of thread and tie a metal washer to the end. Set aside.
11. Place the straw and threaded spool across the top of the cylinder, resting it in the 'V's.
12. Tie and/or tape the thread with the metal washer to the straw away from the center. The metal washer should be resting on the table after you attach it to the straw.
13. Put the cylinder under a faucet, slowly turn the water on, and watch what happens.

Result

The metal washer gets pulled up to the straw.

Why does this happen?

Energy transfer between objects. The falling water pushes the blades around in a circle. The force of the water is strong enough to make the blades move because falling water has kinetic energy. When the water hits the blades, the energy is transferred to the blades. Since the blades are connected to the straw, the straw is connected to the string, and the string is connected to the washer, when the blades move, the washer moves. When we understand how energy moves from one object to another, we can start thinking about how to produce, harness, and use energy from different sources. In other words, we can harness and use renewable energy. What other forms of renewable energy do you know of?

Energy Efficient Homes

A lesson about how and why homes use so much energy.

Materials

1. Cardboard box
2. Scissors
3. Hot glue gun
4. Tape
5. Pictures of windows, doors, and other home elements, cut out from magazines or printed.
6. Blow dryer (optional)

Activity

1. Construct a home out of cardboard using all the gathered materials. It can be as fancy or as simple as you like.
2. Use materials of your choosing to seal the areas where you feel air movement. Here are some ideas to get you started:
    a. Insulate the roof by gluing cotton balls to the inside of the roof.
    b. Insulate the inside of the cardboard box using scrap fabric or paper. Simply use glue to adhere.
    c. Wrap tape around the outside four corners of the house.

If you'd like to test the energy efficiency of your home, follow the steps below to check for air leakages.

3. Cut a hole in one side of your home that's big enough to fit the opening of a blow dryer.
4. Attach the blow dryer and turn it on to a cool setting. Observe where you feel air escaping.
5. Continue weatherizing and air sealing wherever it's needed.



Result

Air will leak out of unexpected places even though the home seems sealed tightly.

Why does this happen?

Air can sneak through the tiniest gap or crack because air particles are so small. When cold air leaks into a home during the winter, you turn the furnace up to make it warmer. But turning up the furnace won’t solve the problem because there’s still air leaking in. The furnace will simply work harder and use more energy while cold air continues to sneak in. To solve this problem, the gaps and cracks must be sealed first. A properly sealed house will save more energy because its energy systems don’t have to work as hard. As a result, your utility bills aren’t as expensive, and you reduce your natural resource consumption.