Bernoulli Brain-Teasers

In the early 1700s, a Swiss mathematician named Daniel Bernoulli made a discovery. He noticed that when flowing air or water changed its speed, its pressure also changed. As you do these activities, can you figure out how the pressure changes? How does this help airplanes stay in the air?

Use Your Lips to Levitate

Try This:

Hold a piece of paper between your thumb and forefinger, as shown. Now take a deep breath and blow over the paper. What happens?

Materials

- **Strip of paper or dollar bill**

WHAT'S GOING ON?

So why did the paper lift up when you blew over it? How did that change the air pressure? Air never pulls or sucks; it only pushes. It pushes on you every second, from every direction. This constant push is called air pressure.

Did you change the push of air on the top or bottom of the paper? When you blew over the top, the moving air had to squeeze between the paper and the air above it. As the air squeezed through, it sped up, lost pressure, and stopped pushing as hard. The still air below the paper had greater pressure and pushed the paper up.

Balloons That Boggle

Try This:

Blow up two balloons and tie each one to a string. Hold the balloons a few inches apart and try to blow them apart. Can you do it? What happens? Blow on the balloons in different ways and see what happens.

Hint: *Squirt a little water into the balloons before you blow them up and tie them shut. This will help steady them.*

Materials

- **String**
- **Two balloons**
- **Water**

WHAT'S GOING ON?

Like everything else, the balloons are surrounded by air pressure. When you blew between them, you changed the pressure. Either the air between them stopped pushing as hard, or the air on the outer sides began pushing harder. Which do you think happened? As air squeezed between the balloons, it sped up, lost pressure, and stopped pushing as hard. So the higher pressure of the air on the outer sides of the balloons pushed them together. What would happen if you blew along the outer side of one of the balloons?

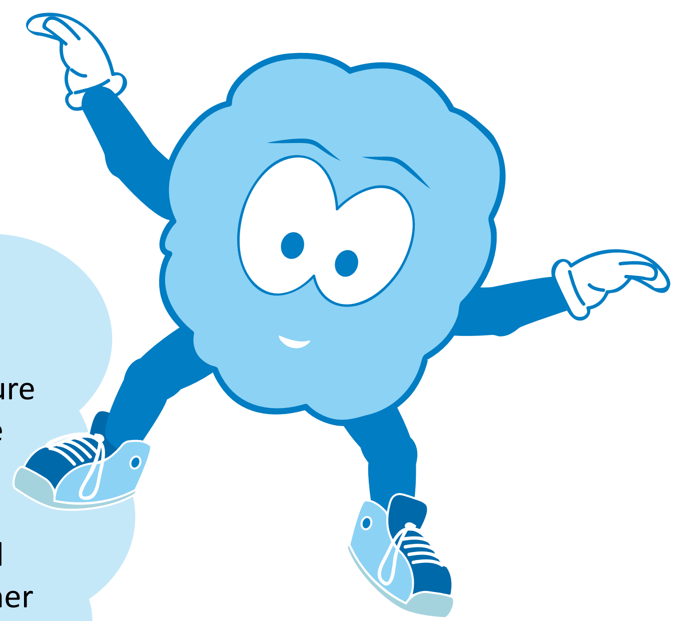
Suspended in the Air Stream

Try This:

Hold a Ping-Pong ball over a flexible straw as shown. As you blow into the straw, let go of the ball. What happens? Try holding the straw at different angles. Can you tilt the straw and still keep the ball in the air?

Materials

- Ping-Pong ball
- Flexible straw



WHAT'S GOING ON?

When moving air changes speed, its pressure also changes. As air speeds up, its pressure goes down. As air flows around the Ping-Pong ball, it forms an area of low pressure around the ball. When the ball starts to fall out of this pocket of low pressure, the higher pressure of the surrounding air shoves it back. Even if you gently nudge the Ping-Pong ball, it wobbles back into place. As long as you can keep blowing air through the straw, the ball will stay in the air.

Fool the Spool

Try This:

Stick a tack through the middle of a playing card from below. Place the spool over the tack. Hold the card in place with one hand; hold the spool with the other. Blow through the spool and let go of the card. What happens?

Hint: *Make sure the spool has only one hole in its center. If it has others, even pinholes, tape them shut. The tack is used just to keep the card centered over the hole.*

Materials

- **Tack**
- **Playing card**
- **Large spool of thread**

WHAT'S GOING ON?

Why did the card stay up? When you blew through the spool, the air had to squeeze between the spool and the card. As it squeezed through, the air moved faster and its pressure dropped. But the air pressure below the card didn't change. The higher pressure of the air below the card held it in place even as you blew hard against it.

Squeeze the Stream

Try This:

Fluids, such as air and water, change speed as they flow between and around things. To see how this happens, build this tiny stream channel. Tape pencils on a cookie sheet so they make a channel that starts out wide, then narrows. Drape the pencils and cookie sheet with plastic wrap to create a waterproof channel. Now, tilt the cookie sheet just slightly against a sink and slowly pour soapy water into the channel. Does the speed of the water change? How? When?

Materials

- Cookie sheet
- Pencils
- Tape
- Plastic wrap
- Sink or tub
- Soapy water

WHAT'S GOING ON?

To squeeze through a narrower space, something must either compress (imagine pulling a sponge through a bottle neck) or speed up. Freely flowing water does not compress easily. Instead, it speeds up as the channel narrows. Water also speeds up as it moves around an object, such as a rock in a river. Air is a fluid, and at slow speeds it behaves like water. When air moves through a narrow channel or around an object, it speeds up. As it speeds up, its pressure drops and it pushes less.

An airplane wing affects moving air much like a rock in a stream affects moving water. The space around each wing is already filled with air—there's no empty space for air to move into. So as the oncoming air reaches the wing and moves over or under, it speeds up to squeeze between the wing and the surrounding air. This push is a force called lift.

WHAT DOES THIS HAVE TO DO WITH FLIGHT?

An airplane pushes air out of the way as it flies. That air must go somewhere, so it squeezes between the wings and the surrounding air. A wing is shaped and tilted so the air moving over it has less room than the air moving below it. Because it has less room, the air moving over the wing speeds up more and loses more pressure than the air below the wing. The higher air pressure below pushes the wing and the airplane up. This push is a force called lift.