

## Zero Gravity

AIR-250

### Introduction

Your students will be primed to learn more about air pressure as they watch objects suspended in the air by a passing stream of air. Is it really the result of “zero gravity?” Of course not. It’s air pressure!

### How does the Zero Gravity device work?

The air stream supports the ball with these three forces:

#### 1. Impact

The air stream deflects off the ball, helping support it from below.

#### 2. Friction

The air stream slides along the ball's surface, acting like a sticky syrup which pushes the ball upward in the direction of the flow. This force is called **viscous drag**.

#### 3. The Coandă Effect

The air stream “pumps away” some of the air between the ball and stream, lowering the pressure there. The higher room pressure on the other side pushes the ball into the stream. A similar pressure difference bends the stream itself toward the surface of the ball!

Interestingly, all three of these forces contribute in complex ways to holding the ball up AND to keeping it in the stream.

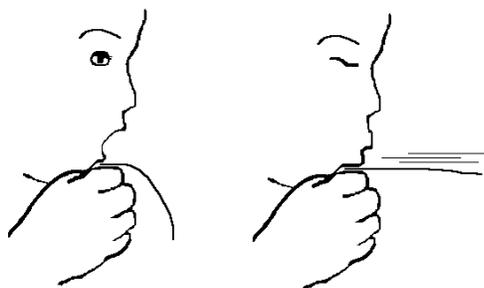


# Zero Gravity Demonstrations

## Demonstration 1:

Aim the Zero Gravity vertically upward, and place the ball on the platform above the fan. When you pull the trigger to activate the fan, the air stream will support the ball. “Look ma, no hands!” Next, with the air stream still supporting the ball, slowly tilt Zero Gravity until the air stream is about 30 degrees from vertical. Notice that the ball remains in the stream!

## Demonstration 2:



With your thumbs and fingers, hold a sheet of paper in front of your mouth, so that the paper droops downward away from you, with leading edge close to your mouth. (See diagram at left.) When you blow across its top surface, the paper rises. Viscous drag on the air between your breath stream and the paper “pumps away” nearby air, dropping the pressure there. This allows the higher room air pressure below the paper to lift the paper. This experiment demonstrates the Coandă effect.

## Demonstration 3:

You can amaze your friends by suspending a small 15 mm diameter spherical gumball with your breath by blowing straight upward through a drinking straw. The breath stream supports the gumball, just as with Zero Gravity device. This experiment demonstrates all three of the forces above.

## Demonstration 4:

*This fantastic idea comes from one of our customers, Rusty Davis of Watertown, CT.*

“For me, the best use of this device is something that many people may not even notice. The red tray only floats *when it is oriented flat side down*. In the other orientation it always just flips out of the flow and is not stable. This is a great example of the concept of center of pressure, a distinct point that is different from center of mass. For a body to be stable in a flow, the center of pressure must be above the center of mass. In this case, a small displacement will cause the object to return to its previous position in the flow. If the center of pressure is below the center of mass, the opposite happens and the body flips over. The tray will be unstable. This device demonstrates this idea beautifully.”

# The Science behind Zero Gravity

## Does the device actually demonstrate zero gravity?

Einstein himself could not eliminate gravity, and neither does the Zero Gravity device (despite its name). In this activity, we are actually balancing gravity with the forces from the air stream.

## Does Zero Gravity demonstrate the Bernoulli principle?

The Bernoulli principle states that increased speed is accompanied by lower pressure, for a single non-sticky fluid. But the principle is often misapplied to two different interacting fluids (here, the air stream and still air), giving the wrong prediction that (stream pressure) < (room air pressure). It is then claimed that the ball is pushed inward toward this low-pressure stream. But if the stream were at less than room pressure, it would collapse. The stream pressure is EQUAL to room pressure. The Zero Gravity device demonstrates a sticky fluid (air stream) acting on another sticky fluid (still air). Without air's stickiness (viscosity), the world would be a very different place. For one thing, airplanes could not fly without air's viscosity!

## Watch the Zero Gravity demo in action:



<https://youtu.be/rrIpDi5Oy8w>

# Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons. For us, “*Teachers Serving Teachers*” isn’t just a slogan—it’s our promise to you!

Please visit our website  
for more lesson ideas:

[TeacherSource.com/lessons](http://TeacherSource.com/lessons)

Check our blog for classroom-tested  
teaching plans on dozens of topics:

<http://blog.TeacherSource.com>

To extend your lesson, consider these Educational Innovations products:

## **Atmospheric Mat** (AIR-280)

There's nothing like a discrepant event demonstration to bring an abstract concept to life. Our Atmospheric Mat offers a dramatic introduction to the concept of air pressure. Invite your students to pick up the mat. No matter how hard they pull on its sturdy metal hook, this mat will not budge! Is it some kind of suction trick? Nope! It's just air pressure. The room's air pressure is so much greater than the pressure under the mat that—in effect—the air itself is holding the mat in place. Works on almost any smooth surface.



## **Air Zooka** (AIR-200)

This amazing device launches a powerful vortex of air up to 20 feet. Powerful enough to blow out a candle from across the room! Safe for classroom use because it launches no projectile, only a strong puff of air. Easy to assemble and use and requires no batteries.

## **Bernoulli's Principle Class Kit** (AIR-500)

Is it Bernoulli's Principle or the Coandă Effect? Using high energy activities, your students will learn about air pressure and common but counter-intuitive phenomena. Our kit provides everything you need to demonstrate the relationship of air speed and air pressure for students in grades 4 to 8. The lessons can easily be adapted for younger or older students. Materials for 25 students. Includes: 25 funnels, 28 ping pong balls, 50 flex straws, roll of kite string, 100 cards, 50 toothpicks, and detailed instructions.



## **Hovercraft Class Kit** (AIR-520)



This kit includes everything you need to make a dozen balloon Hovercrafts. The principle behind the Hovercraft's levitation is that when the air is released from the balloon, it hits the ground and rushes outward in all directions. The air flowing from the balloon through the holes forms a layer of air between the Hovercraft and the table. This reduces the friction (the resistance that occurs when two objects rub against each other) that would have existed if the Hovercraft rested directly on the table. With less friction, your Hovercraft scoots across the table.