

Demonstrating That Air Has Mass

Students are presented with the problem of designing an experiment to demonstrate that air has mass. To solve this problem, students will apply concepts they have learned about the properties of air.

◆ Expected Outcome

Students should devise a plan that allows them to show that an inflated balloon has greater mass than a balloon that is not inflated. The most likely setup would include a meter stick suspended horizontally by a string tied around the middle and two equally inflated balloons attached with additional pieces of string to the opposite ends of the meter stick. If students adjust the middle string so that the two inflated balloons are balanced and then puncture one of the balloons, the side of the meter stick with the punctured balloon will rise as the air rushes from the balloon. This will demonstrate that the air-filled balloon has greater mass than the balloon that has been deflated, and thus that air has mass.

◆ Content Assessed

This activity assesses students' understanding of the properties of air.

◆ Skills Assessed

developing hypotheses, designing experiments, observing, inferring

◆ Materials

- ◆ Provide each student with a meter stick, a long piece of string, and two identical balloons. If you do not have enough meter sticks for each student, you may substitute other materials, such as dowels or long cardboard tubes.
- ◆ Have available in a central location several pairs of scissors for cutting string and tacks or pins for puncturing balloons.

- ◆ You will need to provide a coat rack, shelf, or other fixture suitable for suspending students' meter-stick balances.

◆ Advance Preparation

- ◆ Before students do the activity, you may want to show them how to construct a meter-stick balance. You can demonstrate how the balance works by tying two items with the same mass, such as two pencils or two chalkboard erasers, to opposite ends of the meter stick and then removing one of the items by cutting the string. Students will observe that end of the meter stick rise.

◆ Time

20 minutes

◆ Safety

Warn students to be careful when using scissors and tacks or pins.

◆ Monitoring the Task

- ◆ Review students' hypotheses and drawings before they try their plans.
- ◆ Advise students to only partially inflate the balloons so they will not explode when they are punctured.
- ◆ After students have attached two inflated balloons to opposite ends of the meter stick, make sure they balance the meter stick by adjusting the string that suspends it. The meter stick should be resting horizontally when students puncture one of the two balloons.
- ◆ Tell students that the less they disturb their balance when they puncture one of the inflated balloons, the more likely their setup will show effectively that air has mass.



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In assessing students' performance, use the following rubric.

	4	3	2	1
Designing the Experiment	The student's hypothesis and drawing represent an experimental design that would demonstrate effectively that air has mass.	The student's hypothesis and drawing represent an experimental design that has a minor error but is easily corrected so that it would demonstrate that air has mass.	The student's hypothesis and drawing represent a flawed experimental design that would not demonstrate that air has mass.	The student tries but fails to develop a hypothesis or drawing for an experimental design that demonstrates that air has mass.
Concept Understanding	The student demonstrates a mastery of the concepts that underlie the experiment, including the concept that air has mass, density, and pressure.	The student demonstrates an adequate understanding of the concepts that underlie the experiment, including the concept that air has mass, density, and pressure.	The student demonstrates a partial understanding of the concepts that underlie the experiment, including the concept that air has mass, density, and pressure.	The student demonstrates very little understanding of the concepts that underlie the experiment, including the concept that air has mass, density, and pressure.



PERFORMANCE ASSESSMENT

Demonstrating That Air Has Mass

◆ Problem

How can you design an experiment to demonstrate that air has mass?

◆ Suggested Materials

meter stick
string
two balloons of the same size
scissors
tack or pin

◆ Devise a Plan

1. Examine the materials your teacher provides and think of a way you could use them to demonstrate that air has mass. (*Hint:* Think of a way you could make a balance with a piece of string and a meter stick and then use your balance to compare the mass of two balloons.) State your ideas in the form of an “If . . . then. . .” statement. Write your hypothesis on a separate sheet of paper.
2. Make a drawing to show how you would use the materials to set up your demonstration.
3. Try out your plan using the materials. Modify your plan if you need to until you can show that air has mass.

◆ Analyze and Conclude

Respond to the items that follow on a separate sheet of paper.

1. Make two drawings showing how your setup looked before and after you used it. Use labels and arrows to show the changes that occurred.
2. Explain how your experiment demonstrates that air has mass.
3. If you punctured one of your balloons, the air inside rushed out quickly and forcefully. What property of air does this demonstrate?
4. In addition to mass, air has density. Which do you think has greater density, the air inside a fully inflated balloon or the air surrounding the balloon? Explain your answer.

