PSI: PHYSICAL SCIENCE INVESTIGATION

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GREAT LAKES Science Center

Teacher's Lesson Description

Title	**It's in the Bag**
Brief Description of Videos	In these videos, students will watch as Danté demonstrates the relationship between temperature and air as he creates a hot air balloon in a bag.
Time Needed	2 class periods
Ohio Science Benchmarks Addressed	Earth and Space Sciences Benchmark C, and E Physical Science Benchmark A and D Science Inquiry Benchmark A Science Ways of Knowing Benchmark A and C
Ohio Grade Level Indicators Addressed	Earth and Space Sciences Benchmark C • 7th Grade Weather Indicators 1, 3, 5, 7, 8, and 9 Earth and Space Science Benchmark E • 8th Grade E Earth Systems Indicators 9, 10, 12 and 13 Physical Science Benchmark A • 7th Grade Nature of Matter Indicator 1 Physical Science Benchmark D • 7th Grade Nature of Energy Indicators 2, 3, and 4 Science Inquiry Benchmark A • 7th Grade Doing Scientific Inquiry Indicators 1, 2, and 3 Science Inquiry Benchmark B • 6th Grade Doing Scientific Inquiry Indicators 3 and 4 Science Ways of Knowing Benchmark A • 8th Grade Nature of Science Indicator 1 Science Ways of Knowing Benchmark C

	• 6^{th} Grade Science and Society Indicators 3, 4 and 5 • 7^{th} Grade Science and Society Indicator 3
Concepts Developed	Students will be able to explain that: • Air has mass and volume. • Temperature affects the volume of air. • Increased temperature increases the space that a gas takes up or its volume. • Density of a substance is mass (g) divided by volume (mL or cm^3). • When the volume of a given mass changes, its density changes. • Increased volume = decreased density • Decreased volume = increased density
Lesson Rationale	Most students are familiar with hot air balloons and helium balloons. They know that both "float" in air. To dispel the myth that these objects are lighter than air and therefore float, students had the opportunity to observe the way in which warm air and cold air interact to produce convection currents. This is done through the concepts of changed density and buoyant forces. In the last activity "Red, Wet and Blue" students were able to hold the mass constant on a water balloon, change its temperature and change the ability of the balloon to sink or float. Now, students will be able to see the way that this changing of density and the buoyant forces come together to make convection currents. Convection currents are of major importance as students discover the science behind weather, climate and the transfer of heat energy.
Background Knowledge for Teachers	Review the "teacher video" segment and student video segments. • Air has mass. • Air has volume. • The volume of air is affected by temperature. Increasing temperature increases volume. Decreasing temperature decreases volume.

	• Density is the relationship between mass and volume. It is calculated by dividing the mass by the volume and is recorded as g/cm^3. • When the density of the object is greater than the density of the substance into which it is placed, the object sinks. • When the density of the object is less than the density of the substance into which it is placed, the object floats. • When the density of the object is equal to the density of the substance into which it is placed, the object subsurface floats • An object immersed in a fluid (Gases and liquids are both considered fluids.) experiences an upward force called buoyant force. • Buoyant force opposes the gravitational force • Buoyant forces of air cause it to move in a circular motion known as a convection current. • Convection currents are involved in small-scale weather like thunderstorms and large-scale weather like desert areas and tropical region formations. An object immersed in a fluid (Gases and liquids are both considered fluids.) experiences an upward force called buoyant force. • Buoyant force opposes the gravitational force. • Buoyant forces of air cause it to move in a circular motion known as a convection current. • Convection currents are involved in small-scale weather like thunderstorms and large-scale weather like desert areas and tropical region formations.
Classroom Procedures	Students will watch the videos and record all observations and predictions as requested in the stopped segments. To reinforce these concepts, complete the "Convection Cell in a Bottle" laboratory either as a teacher demonstration or as independent laboratory.

Convection Cell in a Bottle

Problem: Does the heating of air cause it to move in different patterns?

Background Knowledge:

- Heated air is less dense than cooler air. The cooler air sinks beneath it causing it to rise.
- After it rises, hot air cools, becomes more dense and eventually sinks.
- As colder, denser air sinks, it pushes the hotter air up.
- A pattern of circulation of air like this is known as a convection cell.
- Convection cells are involved in both small-scale and large-scale weather.

Hypothesis:

Students should predict the smoke pattern that they expect. Since this is a difficult process, use the following hinge point question to assess the prior knowledge students have about the movement of warm and cold air.
When a candle is placed inside a 2-liter bottle and lit, it will heat up the air molecules inside the bottle. As these molecules heat, they expand and move further and further apart. The heated air will flow out the open cap of the bottle. It a smoking stick is placed outside the bottle, what will the smoke do?

A. Rise outside the bottle and keep rising.
B. Be pushed away from the bottle as the heated air moves out of the bottom of the bottle.
C. Be pulled into the bottle and go out the top.
D. Be pulled into the bottle, go out the top, fall and create a circle of smoke movement.

Procedure:

1. Cut the bottom off the 2-liter bottle.
2. Cut a rectangular 2” high by 3” long opening in the side cutting up from the bottom

	of the bottle. 3. Remove the cap. 4. Place the bottle over the votive candle. 5. Light the candle. 6. Hold the smoking object near the opening. 7. Observe the smoke. **Observations:** Students should notice that the smoke moved from outside the bottle, through the opening, up inside the bottle and then back down the outside of the bottle. In other words, the path of the smoke looks like an oval, moving in a circular clockwise movement. **Conclusions:** Students should be able to relate the movement of the smoke to the way that air moves in the atmosphere. They then should relate this to the movement of air in thunderstorms. Finally, this convection movement of air accounts for the fact that we have major desert areas and tropical regions.
Materials Needed	Convection Cell in a Bottle • 2-liter plastic bottle • Small votive candle • Something that gives off smoke like incense •
Science Connections	Weather Geographic regions (climate zones) like desert areas and tropical regions. Convection is also related to the transfer of heat energy and the movement of tectonic plates.
Additional Web Resources	How Stuff Works: http://science.howstuffworks.com/hot-air-balloon5.htm Dragonfly TV: http://pbskids.org/dragonflytv/show/balloonfiesta.html NOVA: http://www.pbs.org/wgbh/nova/balloon/ NASA Glenn Research Center Density of Gases http://www.grc.nasa.gov/WWW/K-12/WindTunnel/Activities/buoy_Archimedes.html

	Search for more Web pages related to this topic at the Ohio Resource Center http://www.ohiorc.org/for/science/Default.aspx Classroom Safety: http://membership.acs.org/c/ccs/pubs/chemical_safety_manual.pdf Search the National Science Digital Library: http://nsdl.org/ Find more science teaching lessons at Teacher's Domain: http://www.teachersdomain.org/

Ohio Science Standards Abbreviations:

ES – Earth/Space Science
LS – Life Sciences
PS – Physical Sciences
SI – Scientific Inquiry
ST – Science and Technology
SW – Scientific Ways of Knowing