SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

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National Science Education Standard—Earth and Space

Energy in the Earth System

Global climate is determined by energy transfer from the sun at and near the the Earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the Earth's rotation, and static conditions such as the position of mountain ranges and oceans.

Teacher Materials

Learning Sequence Item:

927

Atmospheric Pressure

March 1996
Adapted by: Brett Pyle

Global Climate: Sun's Energy and Influence of Dynamic and Static Forces. Grade nine students should understand basic kinematics, velocity, and acceleration, and their relationships in the context of atmospheric air masses (that contain water vapor). In this same context, they should examine pressure, temperature, the ideal gas law qualitatively, and the relationship between density of an air mass and its buoyancy. The basic concepts of heat and temperature and phase changes for water are essential.. (*Earth and Space Sciences, A Framework for High School Science Education, p. 141.)*

Contents

This micro-unit was adapted by **Brett Pyle** (Grady Middle School, Houston, Texas)

927

Learning Sequence

Global Climate: Sun's Energy and Influence of Dynamic and Static Forces. Grade nine studetns should understand basic kinematics, velocity, and acceleration, and their relationships in the context of atmospheric air masses (that contain water vapor). In this same context, they should examine pressure, temperature, the ideal gas law qualitatively, and the relationship between density of an air mass and its buoyancy. The basic concepts of heat and temperature and phase changes for water are essential (*Earth and Space Sciences, A Framework for High School Science Education, p. 141).*

Science as Inquiry	Science and Technology	Science in Personal and Social Perspectives	History and Nature of Science
I Don't Feel Any Pressure **Activity 1** Bottles of Air **Activity 2** Buford, 1 **Activity 3** Buford, 2 **Activity 4** Gas Laws **Assessment 4** Gas Laws, Shampoo Bottle **Assessment 5** Pop, There Goes the Note **Assessment 6** The Ascending Balloon, Pressure **Assessment 7** The Ascending Balloon **Assessment 9**	Car Tire Pressusre **Assessment 3**	Gas Laws, Shampoo Bottle **Assessment 5**	

Suggested Sequence of Events

Event #1

Lab Activity

1. I Don't Feel Any Pressure (1 hour total over several days)

Alternative or additional activity

2. Bottles of Air (45 minutes)

Event #2

Readings from Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives, and History and Nature of Science

Suggested readings:

Lambert, D. and R. Hardy, "Monsoon Climates." *Weather and Its Work*. New York: Facts on File Publications, 1984.

Greiman, Chana, "Transatlantic Teen." *Science World*, Vol. 51, No. 3., Oct. 7, 1994, pp. 17–19.

Malusa, J. and W. Faidley, "The Weatherman." *Destination Discover: The Magazine of the Discovery Channel*, Vol. 8, No. 9, 1992, pp. 28–33.

Assessment items are at the back of this volume.

Assessment Recommendations

This teacher materials packet contains a few items suggested for classroom assessment. Often, three types of items are included. Some have been tested and reviewed, but not all.

1. Multiple choice questions accompanied by short essays, called justification, that allow teachers to find out if students really understand their selections on the multiple choice.

2. Open-ended questions asking for essay responses.

3. Suggestions for performance tasks, usually including laboratory work, questions to be answered, data to be graphed and processed, and inferences to be made. Some tasks include proposals for student design of such tasks. These may sometimes closely resemble a good laboratory task, since the best types of laboratories are assessing student skills and performance at all times. Special assessment tasks will not be needed if measures such as questions, tabulations, graphs, calculations, etc., are incorporated into regular lab activities.

Teachers are encouraged to make changes in these items to suit their own classroom situations and to develop further items of their own, hopefully finding inspiration in the models we have provided. We hope you may consider adding your best items to our pool. We also will be very pleased to hear of proposed revisions to our items when you think they are needed.

Science as Inquiry

I Don't Feel Any Pressure

What are the effects of atmospheric pressure?
Demonstration and Lab Activity

Overview:

All of us at one time or another have seen or performed this classic activity. A discussion session with appropriate questions is essential for this demonstration to be effective. Remember you are trying to demonstrate that atmospheric pressure does exist. The readings really provide the earth science context and should be used as much as possible and not left to the last event.

Materials:

Demonstration:

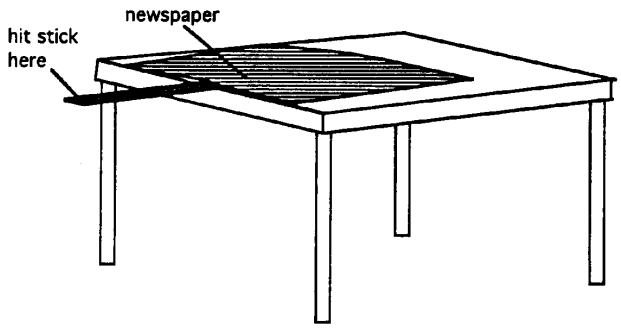
newspaper
stick (about 3 feet long, 1–2 inches wide, 1/4 inch thick)
hammer

Per lab group:

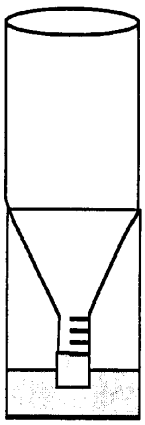
beaker
clear bottle to fit inside beaker (not airtight)
marker
food coloring
water

Procedure:

Demonstration. Show students the stick and tell them you will break it using the newspaper. Place the stick on a table so that it overhangs the edge about a foot. Cover the remaining two feet of the stick



Set up for demonstration.



Construction of simple barometer.

with a single sheet of newspaper. Make sure to press the newspaper as flat as possible. Ask the students what will happen when you strike the end of the stick with the hammer. After taking student responses, hit the stick with the hammer striking it hard. The stick will break leaving the newspaper intact. This should lead into a discussion of the whether the weight of air changes or is constant and how it is measured (air pressure). The discussion can also be related to the subject of gas density, which was studied in an earlier activity. Have students record their observations of the demonstration.

Lab Activity. Students will now construct a simple barometer. The construction of the barometer must be done on a day when the air pressure is low (during a storm). Students place a small amount of water in a beaker and add food coloring. They invert the bottle and place it into the beaker so that the opening is underwater. Some of the water should rise into the neck of the bottle. Students let it sit for 15 minutes, then place a mark at the water level in the bottle's neck. Next, they place three more marks on the neck of the bottle at 1-cm intervals. Students create a data table and record any changes in the water level over several days. You may have them take measurements 2–3 times per day.

Background:

This is designed to be a more qualitative investigation of air pressure and weight. The students will get into more detailed examination of the atmosphere in grade 10. At this stage the primary goals are for the students to recognize that air has mass (and therefore weight) and that air pressure is a measurement of the weight of the column of air above them. The weight of this air depends on its density. In high pressure areas the gas molecules are packed closer together. This "heavier" air tends to sink toward the surface. This generally produces clear skies. The air in low pressure areas is less dense causing it to rise. This rising air usually brings moisture from the surface with it which condenses when it cools at higher altitudes. This produces clouds and eventually precipitation.

Another phenomenon you may discuss with the students is the problem of breathing at high altitudes. Because air at high altitudes compresses the air beneath it, about half of the total weight of the atmosphere is in the 5 km layer closest to the ground. As you climb, there is less and less air above you. The air is "thinner" and so because there is less oxygen it becomes more difficult to breath.

Variations:

There are several ways to make a simple barometer. Any version will work. You may also wish to have the students make general weather observations along with the water level measurements to begin to correlate weather changes to changes in barometric pressure.

Adapted from:
S. V. Bosak, D. A. Bosak and B. A. Puppa, *Science Is...*, 2nd ed., Richmond Hill, On: Scholastic Canada, Ltd., 1991.

Science as Inquiry

Bottles of Air

How does the density of warm air differ from the density of cool air?

Overview:

When discussing weather, air is often described as warm or cold air masses. What does this mean? This demonstration shows how air is affected by heat.

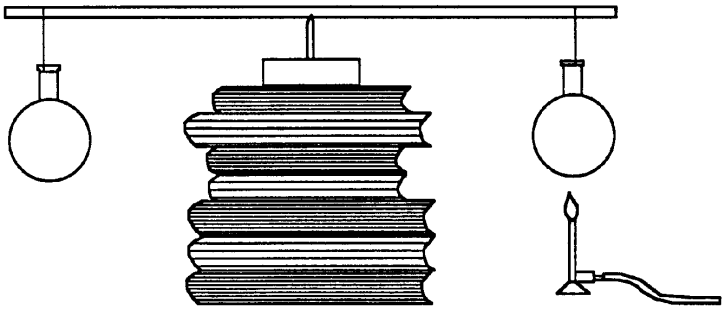
Materials:

Per lab group:

2 flasks
simple balance (see teacher background)
bunsen burner (or candle)

Procedure:

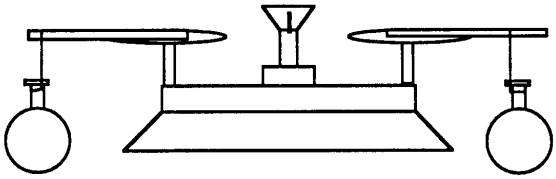
Have students set up the balance rod and adjust it so that it is balanced. A small piece of clay can be added on the balance until the dowel rod is hanging in perfect balance. Next have the students suspend a flask from each end of the balance (these should be hung from a string tied around the neck of the flask and secured with tape on the flask). Students then use the flame source to heat one of the flasks, observe the results and record their observations.



Laboratory setup.

Background:

This is an exercise to demonstrate that warm air is less dense and therefore more buoyant than cold air. As the students heat one of the flasks it will rise. After the students do this have them remove the flame and let the flask cool until it balances again. Then have them heat the other flask to see that the result is the same.



Using a pan balance. Place on the corner of a lab table so that flasks do not hit the table.

The balance to be constructed consists of a board (1×4) placed on a fulcrum. Eyescrews can be placed on the underside of each end of the board in which to tie the string which supports the flasks. It would also be possible to tape a stick to each pan of a double pan balance.

Variations:

The source for this activity also has a similar setup using paper grocery bags in place of the flasks. This setup would require extra care to prevent the bags from catching on fire.

Adapted from:
UNESCO, *700 Science Experiments for Everyone,* New York: Doubleday, 1962.

Science as Inquiry

Buford, 1

Item:

Buford received a balloon for his birthday. When he let go of the balloon, it floated to the ceiling. Using what you know about buoyancy and density of gases, explain why this might have happened.

Answer:

Science as Inquiry

Buford, 2

Item:

Buford received a balloon for his birthday. When he let go of the balloon, it floated to the ceiling. The next morning the house was cold and Buford found that the balloon looked about the same size as on the day before, but it is now on the floor. When Buford returned from school he noticed that the balloon was again floating close to the ceiling. What could explain Buford's observations?

Answer:

Science and Technology

Car Tire Pressure

Item:

John measured the pressure of the air in his automobile tires early in the morning and found it to be 32 psi. After driving around town most of the day, he stopped at a gas station and measured the pressure and found that it now read 34 psi. Which of the following statements correctly explains why the pressure might build up in a tire on a hot day?

A. As the temperature increases, more molecules are produced.
B. The volume of the tire decreases as the temperature increases.
C. As the temperature increases, the molecules expand and occupy more space.
D. As the temperature increases, the molecules move faster.

Justification:

Explain in terms of kinetic energy.

Answer.

D. The average kinetic energy is proportional to the temperature. As the temperature increases the average kinetic energy increases. Therefore, the molecules are moving faster and hitting the sides of the tire faster and more often. This will cause an increase in pressure.

Science as Inquiry

Gas Laws

Item:

When a scuba diver fills his or her air tanks with compressed air, they often will cool the tanks first by immersing them in the coldest water they can find. In terms of your knowledge of the behavior of gases, explain the advantage of cooling the tank before and during filling.

Answer:

At a lower temperature, a given mass of gas (moles) will have a lower pressure. Thus the tank can be filled with more air if cooler. It is to be used in cold water, so that is desired.

Science as Inquiry/Science in Personal and Social Perspectives

Gas Laws, Shampoo Bottle

Item:

Juan buys a bottle of shampoo while on vacation in the mountains. The shampoo bottle is made of soft, pliable plastic. The next day, Juan accidently spills most of the shampoo out of the bottle. To be safe, he securely fastens the cap on the shampoo bottle before he drives home to San Francisco, which is on the coast of the Pacific Ocean. When he gets home, he notices that the shampoo bottle looks crunched, as if it were being squeezed. The change in the appearance of the bottle is due to:

A. A change from a high pressure to a low pressure.
B. A change from a low pressure to a high pressure.
C. Less air molecules hitting on the outside of the bottle.
D. Has nothing to do with air pressure.

Justification:

Explain your answer.

Answer:

B. Atmospheric pressure increases when travelling from a position of high altitude to an area of low altitude. The increase in atmospheric pressure could cause the bottle to appear slightly squeezed.

Science as Inquiry

Pop, There Goes the Note

Item:

Sometimes at fairs and festivals, people attache notes to helium-filled balloons and release them with a message attached. Often a prize is given later to the person whose message is returned from the farthest distance from the release site. Usually, the balloon eventually pops and releases the note to fall to the ground. What factors can cause the balloon to pop?

Answer:

Usually the balloon will rise because of helium buoyancy. As it does so, it enters regions of lower atmospheric pressure and expands until the rubber can no longer hold the helium pressure and pops. For this reason, weather balloons designed to go to high altitudes are released when they are only partly filled with helium. There is more room for gas expansion as higher altitudes are reached.

Science as Inquiry

The Ascending Balloon Series, Pressure

Item:

Lionel performed a weather experiment using a large balloon and helium gas. He attached a recording device to measure pressure, temperature and wind speed/direction. The balloon was let go on a foggy, February day and results were obtained. One of his findings was that the air temperature on this day increased slightly as the balloon went higher. His data allowed him to predict certain things about the weather and the helium in the balloon. If the balloon is made of mylar, such that its volume cannot change, what would happen to the gauge pressure inside of the balloon?

A. Go up as the balloon goes up.
B. Go down as the balloon goes up.
C. Remain constant as the balloon goes up.
D. Increase slightly, then level off as the balloon goes up.

Justification:

In this scenario, what factors are present which could influence the balloon's pressure?

Answer:

A. The primary factor which influences the gas inside the balloon is atmospheric pressure. As the balloon ascends, the atmospheric pressure decreases. As the atmospheric pressure decreases, the gauge pressure of the gas inside the balloon increases. Another factor would be the atmospheric temperature. The lower the temperature, the lower the pressure of the gas inside the balloon.

Science as Inquiry

The Ascending Balloon Series, Temperature

Item:

Lionel performed a weather experiment using a large balloon and helium gas. He attached a recording device to measure pressure, temperature and wind speed/direction. The balloon was let go on a foggy, February day and results were obtained. One of his findings was that the air temperature on this day increased slightly as the balloon went higher. His data allowed him to predict certain things about the weather and the helium in the balloon. If the balloon is made of mylar, such that its volume cannot change, what would happen to the internal temperature of the balloon?

A. Go up as the balloon goes up.
B. Go down as the balloon goes up.
C. Remain constant as the balloon goes up.
D. Rise slightly, then level off as the balloon goes up.

Justification:

What are the forces involved in the balloon's temperature change?

Answer:

A. As the balloon goes up, the atmospheric pressure decreases. This causes the pressure of the gas inside the balloon to go up. At a constant volume, the pressure of a gas is directly related to the temperature of the gas.

Science as Inquiry

The Ascending Balloon Series, Volume

Item:

Lionel performed a weather experiment using a large balloon and helium gas. He attached a recording device to measure pressure, temperature and wind speed/direction. The balloon was let and results were obtained. His data allowed him to predict certain things about the weather and the helium in the balloon. As the balloon ascends:

A. The volume of the balloon decreases.
B. The volume and pressure of the balloon increases.
C. The volume of the balloon increases.
D. The volume of the balloon remains constant.

Justification:

In this scenario, what factors are present which could affect the volume of the balloon?

Answer:

C. The primary factor which influences the volume of the balloon is atmospheric pressure. As the balloon ascends, the atmospheric pressure decreases. As the pressure decreases, the volume of the balloon increases. Another factor would be the atmospheric temperature. The higher the temperature, the greater volume of the gas inside the balloon. Increased pressure inside the balloon could cause an increase in the volume of the balloon.