Looking for some new ideas to get your students excited about math and science?

Many Federal agencies provide resources to help inspire and engage your students.

And we've made those resources easy to find...

The Democratic Caucus of the House Committee on Science Presents

Math and Science Lesson Plans: A Resource for Educators

www.house.gov/science_democrats/LessonPlans.htm

Prepared at the direction of Representative Mark Udall,
Member, House Committee on Science

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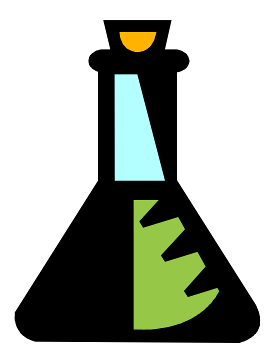
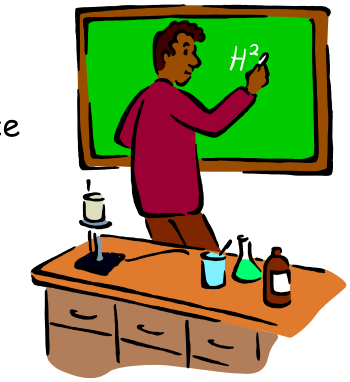


Environmental Protection Agency (EPA) Lesson Plans



What is the EPA?

The mission of the Environmental Protection Agency (EPA) is to protect human health and the environment. Since 1970, the EPA has been working for a cleaner, healthier environment for the American people.

The EPA works to develop and enforce regulations that implement environmental laws enacted by Congress. The Agency is responsible for researching and setting national standards for a variety of environmental programs, and delegates to states and tribes the responsibility for issuing permits and for monitoring and enforcing compliance. Where national standards are not met, the EPA can issue sanctions and take other steps to assist the states and tribes in reaching the desired levels of environmental quality.

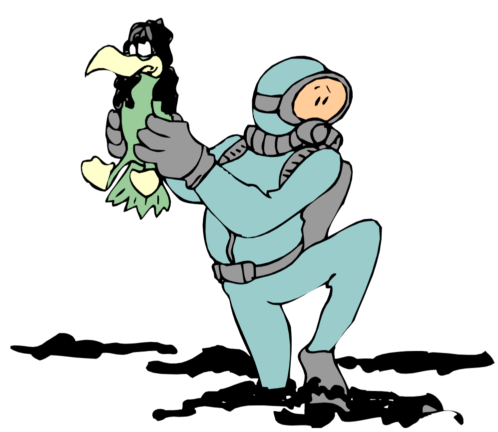
At laboratories located throughout the nation, EPA scientists work to assess environmental conditions and to identify, understand, and solve current and future environmental problems; integrate the work of scientific partners such as nations, private sector organizations, academia and other agencies; and provide leadership in addressing emerging environmental issues and in advancing the science and technology of risk assessment and risk management.

EPA Educational Resources

The EPA lesson plans deal with a wide variety of topics and subject material, including toxic waste and superfund sites, water biology, and human health research. Additional student activities, professional development opportunities, and other resources for all grade levels are available online at the EPA's educational outreach website. Links to all of this information can be found at our website, http://sciencedems.house.gov/resources/LessonPlans.htm.

Example

Critter Clues (3-6) Pages 5-8



Critter Clues (3-6)

Objective: Students will learn how aquatic organisms can be indicators of water quality.

Materials: Pictures of different bodies of water, Biotic Index of Water Quality (see page 9), plastic sandwich bags with a selection of macroinvertebrate pictures cut and duplicated form the Biotic Index, water critter costume or mask (option, see step #2)

Time Allotment: 20 minutes

Directions:

1. Show the students pictures of different bodies of fresh water: lakes, rivers, streams, ponds, puddles. Include some pictures that show pollution. Ask for their impressions of the quality of the water. Would they like to visit there? Would they like to go swimming or boating? Does any of the water look clean enough to drink? What do they think they would find living in these different bodies of water? Record their list of organisms. Would they expect to find the same things living in each of the bodies of water? Why or why not?

2. Explain that good indicators of water quality are the small plants and animals who live there. The organisms scientists look for are **benthic macroinvertebrates**. You may make a costume or mask depicting one of the critters by enlarging their picture from the *Biotic Index of Water Quality* (page 33) onto poster board. Use this critter to introduce the class to the world of macroinvertebrates and to introduce how and why they are important indicators of water quality. (See *Listen to Lydia* on page 34). Use an aquatic field guide to help with the critter's introduction.

3. Divide the children into small groups. Pass out a *Biotic Index of Water Quality* to each group. Ask them to find the organism they were just introduced to. In what quality of water are they typically found? Explain that one organism is not enough to classify the water quality of a body of water. Scientists need to look at many organisms and consider the types and amounts of each. Tell the students they will now get a chance to use the *Biotic Index* to analyze some fictional bodies of water.

4. Give each group a plastic sandwich bag containing a selection of pictures of benthic macroinvertebrates (see *Guidelines for Creating Sample Bags* on the next page). This water sample bag represents the diversity of organisms that were collected from a body of water. Have the students sort these organisms by type and record the amounts of each. Then have the students analyze this information using the *Biotic Index* to determine the water quality.

From: http://www.epa.gov/superfund/students/clas_act/spring/critter.htm#Biotic%20Index

5. When all groups have rated their body of water, have the groups with similar ratings compare their findings. Have the students discuss variations and similarities. As a class, share the results from all the groups.

Extensions: **a.** *Have your students use field guides to write descriptions of other benthic macroinvertebrates. Have them create costumes and introduce their critter to the class.*

b. *Have the class analyze a local body of water. Visit the area and record general impressions of the water and surrounding area. Sample the water using wire mesh kitchen strainers as dip nets. Look for organisms living in aquatic vegetation and samples of mud. Bring at least two buckets for collecting. Use one for sorting critters from the water and mud, then transfer them to a second bucket filled with clear water. Have the students count and record the number of each type of critter. Using the* ***Biotic Index****, determine the quality of the water. How could they maintain or improve the water quality?*

GUIDELINES *for* CREATING SAMPLE BAGS

Enlarge the pictures of the various benthic macroinvertebrates from the Biotic Index. Make 10- 15 copies of each critter and mount these on index cards and label them. Make up sample bags by adding these cards to plastic sample bags based on the following general guidelines.

BODY OF WATER	GROUP 1	GROUP 2	GROUP 3
Good quality	Majority	Several	A few
Wide Ranging Quality	A few	Majority	A few
Poor Quality	None to a few	A few	Majority

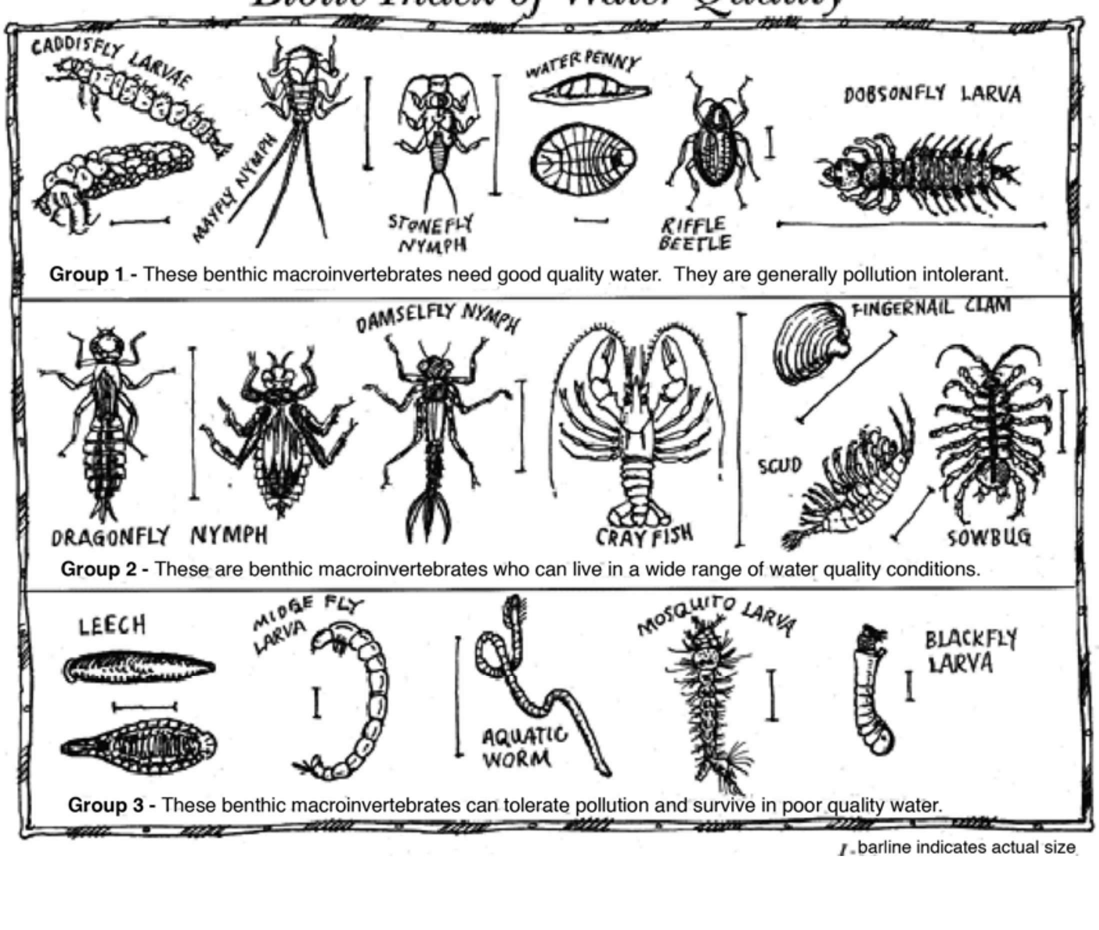
Good quality water has a high diversity of critters living in it. A sample bag would contain several different types of critters, possibly from all three groups with the majority in Group 1. There is usually a low diversity of critters in poor quality water. A sample bag would contain only a few different critters.

FITNESS TEST *for* WATER

Who lives in a body of water depends on the physical features of the water. Several of these features are easy to measure and give important clues to water quality.

Temperature	*Most aquatic creatures are cold-blooded, so surrounding water temperature determines and limits their growth and metabolism. Colder water has more oxygen in it, and likewise, warmer water has less oxygen in it. Using aquarium thermometers, have students take water temperatures in different areas of a body of water.*
pH	*Most aquatic animals thrive in water whose pH is in the neutral range (6.5-8.5). Acid rain is the main contributor to aquatic pH changes. Using pH paper, have students test a body of water in several locations, collect and test rain water, and compare readings.*
Turbidity	*Turbid water is cloudy water. Loose soil, sediments, and pollutants from erosion, runoff and waste water contribute to turbidity, as well as algal growth caused by excess nutrients such as phosphorus and nitrogen. The effect of turbid water on water quality is complex. Less light can enter, inhibiting plant growth, which in turn limits food supply and reduces oxygen levels. Suspended sediments also absorb heat, causing temperatures to rise, further reducing oxygen levels and diverse life forms. Create a Secchi Disk by painting a black "X" on an 8-inch diameter jar lid. Punch a hole in the center and suspend it from a long rope. Have students lower the disk into standing water until it is no longer visible, then direct them to slowly raise it until they can just barely distinguish the "X" mark. Have them grasp the string at the surface and measure the distance between the water surface and the disk. Compare readings in several places.*

Biotic Index of Water Quality



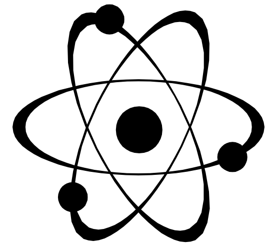
I barline indicates actual size

LISTEN *to* LYDIA

*Meet Lydia. Her real name is <u>Plathemis lydia</u>. That's Latin for White-tailed Dragonfly. She is one of the many **benthic macroinvertebrates** who live in water. **Benthic** means bottom dwelling. Look in the sediment and debris at the bottom of a pond to find Lydia or her close relatives. **Macro** means she's big enough to be seen without a microscope, and **invertebrates** describes a whole group of critters without internal backbones unlike you and me. Most benthic macroinvertebrates are insects in one or another stage of their life cycles. Lydia is just a young nymph, but through gradual metamorphosis, she'll become a dragonfly in a few years. Benthic macroinvertebrates are good storytellers, especially when it comes to water quality. Consider Lydia. She's been living in the same neighborhood for a few years, calling the muck at the bottom of Shelbourne Pond home sweet home. She can tell you about the history of the pond during her lifetime because she and other benthic macroinvertebrates are sensitive to both physical and chemical changes in the water. Although fast enough to escape predators, even Lydia, with her own special form of jet propulsion, can't swim away from pollution. She tolerates it, but only to a certain point when she gets sick and dies. Some critters are more tolerant and even flourish as the water quality declines, while others die or disappear with the slightest change. The saying "the more the merrier" applies to benthic macroinvertebrates as well. The greater the variety that lives in any body of water, the healthier it is. So next time you scoop up some water critters, listen to their story.*

A dragonfly nymph
http://www.epa.state.oh.us/dsw/nps/NPSMP/SI/asiswausjumppage.html

Department of Energy (DOE) Lesson Plans



What is DOE?

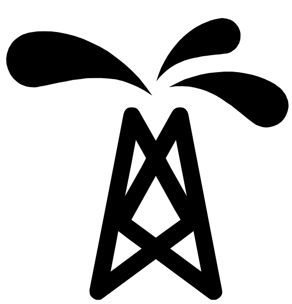
The Department of Energy's (DOE) overarching mission is to advance the national, economic and energy security in the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex.

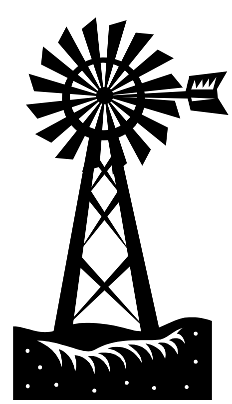
DOE has a very rich and diverse history, traced back to the Manhattan Project and the race to develop the atomic bomb during World War II. Today, DOE contributes to the future of the nation by ensuring our energy security, maintaining the safety and reliability of our nuclear stockpile, cleaning up the environment from the legacy of the Cold War, and developing innovations in science and technology. DOE has won more research and development awards than any private sector organization, and twice as many as all other federal agencies combined.

DOE Educational Resources

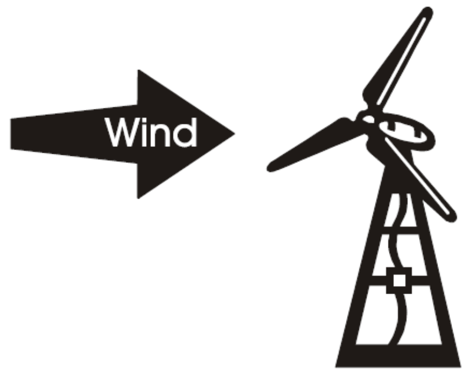
DOE has a wide variety of lesson plans available on the Internet for all grade levels that deal with how energy is created, stored, and used, as well as information on regional museums and offices that provide exciting educational opportunities. For additional information, please visit our website at http://sciencedems.house.gov/resources/LessonPlans.htm.

Examples





Spin the Saltine! (K-3)



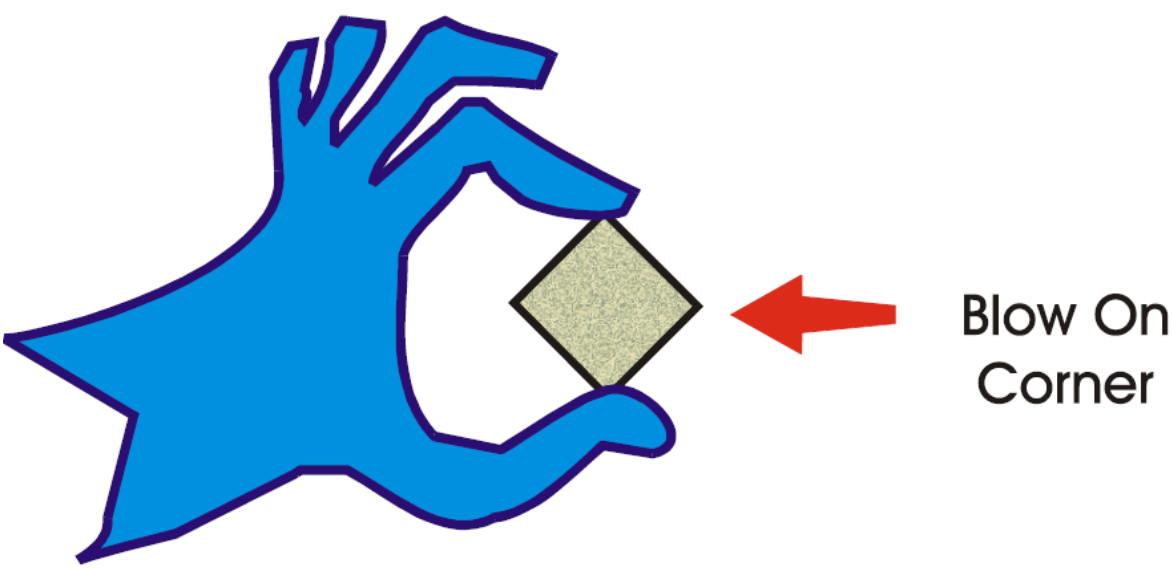
Concepts: The chemical energy in food can be converted into motion. The linear (straight) motion of air can be changed into a rotational (spinning) motion. Windmills convert wind - the motion of air - into electricity.

Materials: Box of saltine crackers (enough for each student)

Directions: Provide each student with an unbroken saltine cracker. Make sure the corners of the crackers are sharp. Demonstrate how to hold diagonal corners of a cracker gently between your thumb and index finger, as shown in the picture below. Blow on the outside corner and the saltine will spin like a turbine.

Direct the students to hold their crackers very gently and blow on the outside corner. It might take the students a few attempts to master the technique.
Explain to the students that they are converting the energy in the food they have eaten into motion energy - the movement of air. The energy in the moving air is spinning the cracker. Direct the students to blow very lightly, then harder and harder to see what happens.

Explain that windmills work on the same principle. The blades of a windmill convert moving air, called wind, into a spinning motion that spins a turbine. The turbine spins a magnet inside a coil of wire to produce electricity.



From: http://www.eia.doe.gov/kids/classactivities/SaltinePrimary.pdf

Making Clouds (5-8)

Objective
The objective of this activity is to investigate the conditions that must be present for clouds to form.

Materials
Each student or group of students will need the following:

- 1 liter (or larger) clear glass jar with lid (large mouth jars work best)
- Ice cubes or crushed ice
- Hot water—**Caution:** Even very warm water will do. Do not use water that is hot enough to burn your skin
- Matches
- Can of aerosol spray (air freshener is suggested)
- Black construction paper
- Safety goggles
- Flashlight (optional)

Important Points to Understand

- Three things are necessary for cloud formation: cooling of air, water vapor, and condensation nuclei.
- Water vapor must have something to condense on in order to form the droplets that compose clouds.
- Many things can serve as condensation nuclei. Some of the most common include dust, pollen, salt from ocean spray, and smoke.

Preparation
Before the lesson begins, discuss cloud formation with the class to determine the students' ideas on how clouds form. Ask students what they think a cloud is made of, then ask them how it forms.

Be sure that all materials are either centrally located or already distributed to the groups of students. Perhaps the students could bring clear glass jars, such as mayonnaise jars, pickle jars, canning jars, etc., from home. The jars do not have to be the same shape, but clear glass works the best. The larger the mouth of the jar, the better the experiment.

Depending on the students, the teacher may choose to light all matches for them to reduce the risk of accidents and the temptation for horseplay. Be careful: Flames and aerosol cans are an explosive combination. Holding a lighted match in front of an aerosol can makes a very effective flame thrower. Students must never have access to both the matches and the aerosol at the same time. If in the teacher's opinion, this represents too great a risk for his or her students, it is strongly recommended that the aerosol not be used at all. The important points of the activity can still be made using only smoke.

Procedure

1. Fill the jar with hot water. Do not use water that is hot enough to burn your skin.
2. Pour out most of the hot water, but leave about 2 centimeters of water in the bottom of the jar. Hold the black paper upright or prop it up against some books behind the jar.
3. Turn the lid of the jar upside down and fill it with ice. Now place the lid on the jar. Observe the jar for 3 minutes. If you have a flashlight, darken the room, and shine the flashlight on the jar while you observe it. Record your observations in the table, under "Control."
4. Pour the water out of the jar and repeat steps (1) and (2).
5. Prepare the lid so that you can immediately cover the mouth of the jar during the next step.
6. Move all loose papers away from the jar, put on your safety goggles then strike a match and drop the burning match into the jar. Cover the mouth of the jar immediately (with the ice-filled lid). Record your observations in the table, in the box marked "Match." Be extremely careful with the matches.
7. Pour out the water in the jar and repeat steps (1) and (2).
8. Spray a very small amount of the aerosol in the jar and immediately cover the mouth of the jar with the ice-filled lid.
9. Observe what happens in the jar for three minutes and record your observations in the table in the box marked "Aerosol."

Trial	Observations
Control	
Match	
Aerosol	

Questions

1. In all the trials of this experiment, the jar contained water vapor and cooled air. Where did each come from?
2. Did a cloud form the first time you put the lid over the mouth of the jar? How about the second and third times?
3. Define *aerosol*.
4. Based on the definition of aerosol, would you classify smoke as an aerosol?
5. Based on your observations and your answers, what is the other condition besides moisture and cool air necessary for cloud formation?

<u>Nuclear Marble Lab (9-12)</u>

(Adapted from Conceptual Physics Lab Manual by Paul Robinson)

Subject: particle physics

Instructional Objectives:

1. To determine a marble's diameter, without taking direct measurements.
2. To discover how scientists can use particle scattering experiments to determine information about atoms.

Materials needed per group:

10 marbles
3 metersticks

Advance Preparation Needed: none

This lab may be used as an introduction to Rutherford's experiment, or as a closure to the unit. No knowledge of Rutherford's Gold Foil Experiment is needed prior to performing this lab.

Background:

In this lab, students will determine the diameter of a marble by rolling other marbles at the target & from the percentage of rolls that lead to collisions, determine the size of the marble.

To determine the probability that a rolling marble (rm) will collide with a nuclear marble (nm), you need to find the ratio of the path width required for a hit to the width of the target area (w).

Probability = path width / target area

Probability = 2R + 2r / w = 2 (R + r) / w

where R = radius of the nuclear marble
r = radius of rolling marble
w = width of target area

If we increase the number of nuclear marbles to N, then the probability that a rolling marble will hit one of the nuclear marble is:

Probability = 2N (R+r) / w

Probability can also be expressed as the ratio of the number of collisions to the number of trials.

Probability = hits / trials
P = H/T

Now, since we have 2 equations for probability, we can equate them to each other to find the diameter of the marble.

$$H/T = 2N (R + r) / w$$

If the diameter of the rolling marble and the nuclear marble is the same, then $R=r$ & so $R + r$ = diameter.

Thus, $H/T = 2 N d/ w$

where:
- H = # hits
- T = # trials
- N = number of nuclear marbles
- d = diameter of marble
- w = width of target area

so the diameter of the marble is:

$$\mathbf{d = wH / 2NT}$$

Procedure:

1. Place three metersticks together to form a shape of a U, and section off an area 60 cm wide. Place 6 marbles in this area. These are the nuclear marbles. Roll additional marbles, randomly, one at a time, toward the whole target area. If a marble collides with a nuclear marble, record it as a hit. If a marble hits more than one marble, still record it as only one hit. If the marble rolls outside the sectioned off area, then do not count that trial. Record the total number of hits and the total number of trials.
2. Use the formula above to determine the diameter of the marble.
3. Measure the diameter of the marble using a vernier caliper & compare with your calculated results.

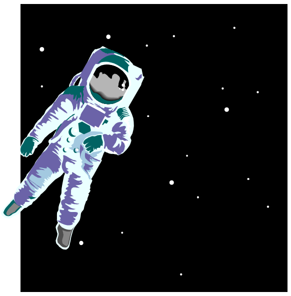
Questions:

1. How do the calculated and measured values compare? What are some sources of error in this experiment? What could you do to minimize this error?

2. How does this lab relate to real life? Physicists often use particle scattering experiments to give them information about matter. Do you think scientists use particle scattering experiments to give them information about very large objects, or very small objects? What sort of information do you think scientists can gain from such experiments?

National Aeronautics and Space Agency (NASA) Lesson Plans

What is NASA?



NASA's mission is to understand and protect our home planet, to explore the Universe and search for life, and to inspire the next generation of explorers…as only NASA can. NASA works to improve understanding of the Earth's system and its response to natural and human-induced changes, enabling a safe, secure, efficient, and environmentally friendly air transportation system, and investing in technologies and collaborating with others to improve our quality of life and to create a more secure world. To better understand the Universe around Earth, NASA actively explores the Universe and the life within it, first with robotic trailblazers, and eventually humans, as driven by these compelling scientific questions: How did we get here? Where are we going? Are we alone? Finally, NASA educates the public, particularly students, about its mission and research.

Since its inception in 1958, NASA has accomplished many great scientific and technological feats in air and space. NASA technology also has been adapted for many non-aerospace uses by the private sector, such as the cochlear implant for the hearing impaired and a new type of insulation that can be painted on. NASA remains a leading force in scientific research and in stimulating public interest in aerospace exploration, as well as science and technology in general. Perhaps more importantly, our exploration of space has taught us to view Earth, ourselves, and the universe in a new way.

NASA Educational Resources

Educating students about NASA's programs is one of the core components of its mission and the agency has devoted many resources to educational programs. NASA has a great variety of online resources for all ages, from lesson plans, to games and activities for students, to opportunities for teachers and other educators. It also has many regional centers and museums that can provide hands-on opportunities. Our webpage has neatly organized links to NASA's lesson plans at http://sciencedems.house.gov/resources/LessonPlans.htm and all of NASA's other resources at http://sciencedems.house.gov/resources/NASAResources.htm.

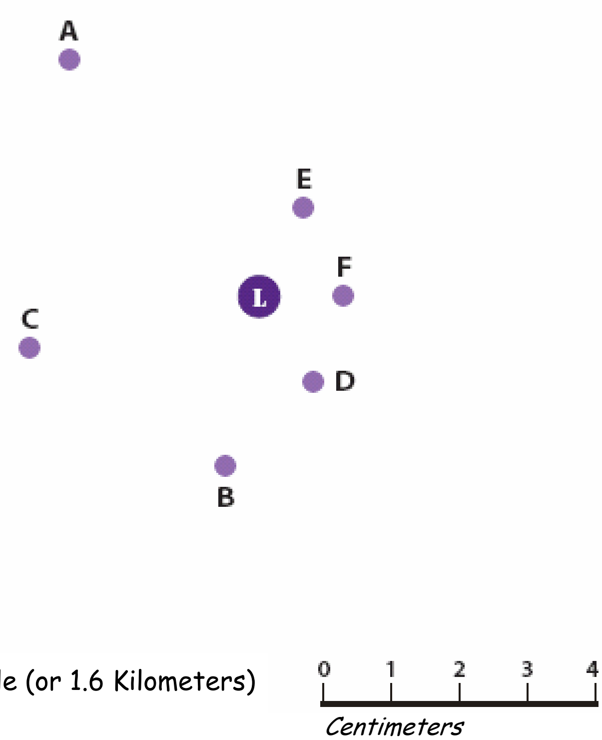
NASA Lesson Plan Examples

Extreme Weather: Thunder Math Extension Activity (5-8)

You probably already know that you see lightning before you hear its thunder because light travels faster than sound. You may also know that you can tell how far away you are from the lightning by using a simple "rule of thumb": If you count how many seconds it takes to hear thunder after you see a lightning stroke, every five seconds equals a distance of approximately one mile (or 1.6 kilometers). So, for example, if you see lightning and then count ten seconds before you hear the thunder, then the lightning was two miles (3.2 kilometers) away (ten divided by five.) Here's a simple math activity to understand more about this:

During a storm, six students at locations A, B, C, D, E, and F saw the lightning stroke at point L at the same moment. The scale on this map is: one centimeter equals one mile. As mentioned above, every five-sec-ond difference between when you see lightning and when you hear thunder means a distance of one mile (or 1.6 kilometers) between you and the storm. Use this information to answer the following questions.

1. Which student heard the thunder first? _______
   How long after seeing the lightning? ____________ seconds.
2. Which student heard the thunder last? _______
   How long after seeing the lightning? ____________ seconds.
3. Which two students heard the thunder at the same time? _______ and _______ .
4. How far away from the storm was student B? ____________ miles.
5. If the storm moved to directly above where student E is and another lightning stroke occurred, how long would it take before student C heard it? ____________ seconds.



Scale: 1 centimeter = 1 mile (or 1.6 Kilometers)

From: http://trmm.gsfc.nasa.gov/education_dir/Weather_04.pdf

Fold It And Fly It!* (5-8)

Teacher Sheet(s)

Objective: To determine the effectiveness of assembly line production
Level: 5-8 **Subject(s):** Technology
Prep Time: Less than 10 minutes **Duration:** One Class Period
Materials Category: General Classroom
National Education Standards: Technology (ITEA): 1c, 2a, 2d, 6a, 7b, 19b
Materials: Plain paper (8.5 x 11 inch); tape **Related Links:** None
Supporting NASA Article(s): Small Jets, Big Future
(www.nasaexplores.com/show2_articlea.php?id=02-035)

Pre-Lesson Instructions:
This activity will require the class being split into two groups. You will need groups of four for the assembly line groups. Other students can work individually to represent nonassembly line work.

Background Information:
Production of the Model T automobile began a new trend in manufacturing. The assembly line has revolutionized industry and made production more effective. By dividing the task of building an entire piece of machinery into many smaller tasks that can be done quickly, an entire car or airplane can be built in a fraction of the time it would take one person to build that same car from start to finish.

Guidelines:

1. Read the 5-8 NASAexplores article, "Small Jets, Big Future."
2. Discuss manufacturing with the class and how the assembly line has changed the way factories make things. Be sure to include how the assembly line improves efficiency and reduces costs.
3. Distribute the Student Sheets.
4. Groups that are assembly line workers will divide the work up among the four group members. Read over the directions as a class.
5. Students working in nonassembly line groups will perform all steps from start to finish. Only after they have completely finished making a paper airplane can they begin on another one.
6. When all groups are ready and understand the activity, have the students begin building paper airplanes. Time them for 3 minutes for their practice round.
7. Have the groups prepare for the actual production session. Time the groups for 5 minutes. When the time is up, have everyone stop. Only completed airplanes can count toward the group's finished goal. Remind the class any excess inventory will be subtracted from their total.
8. Have each group count the number of paper airplanes it has completed. Compare the groups' productivity on the board, and have them answer the questions on their Student Sheets.

Discussion/Wrap-up:

- Go over the questions on the Student Sheets with the class.
- Discuss ways to improve productivity even more. Did using the Just In Time theory change how you set up your assembly line? Explain.
- How does mass production of products affect our buying power?

Extensions:

- Have the class research the history of the assembly line and the impact on our society.
- Try the activity again, and incorporate the students' ideas for improving efficiency.
- Test the quality of the work done by each group. Which method creates better quality of work? Test the airplanes by flying them. Any difference between the two assembly methods?

*This exercise has been modified slightly for inclusion in the Lesson Plans for Teachers booklet. View the original NASA version at http://nasaexplores.nasa.gov/show_58_teacher_st.php?

Fold It And Fly It! Student Sheet(s)

Procedure

<u>Assembly Line Groups</u>

1. Each member of the group will have steps to perform in the process of building the paper airplane. Your group will divide the steps between the members.
2. Each group will have 3 minutes to practice building the model and assigning steps.
3. Once you have completed your step(s), you will pass the airplane to the next worker for the next step to be completed and start another airplane. You will use the production theory called, "Just In Time," which was developed by the Japanese for automotive assembly lines. It attempts to minimize waste in all areas. You pass the product to the next operator. If they are not ready, you must wait to begin work on another plane until they are ready to take the item from you. Do not pile up inventory at your station.
4. Your group will have 5 minutes to build as many paper airplanes as possible. Remember, quality is just as important as quantity! Would you want to fly in a poorly built airplane?

<u>Nonassembly Line Groups</u>

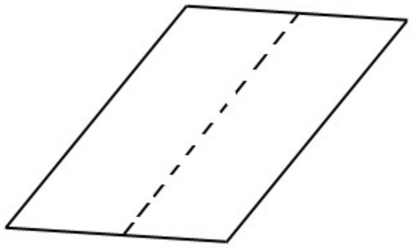
1. Each member of the group will complete all steps for building the paper airplane. Once you have completely finished a paper airplane, you can begin another one. Each member will be working independently.
2. Your group will have 5 minutes to build as many paper airplanes as possible. Remember, quality is just as important as quantity! Would you want to fly in a poorly built airplane?

<u>All Groups</u>

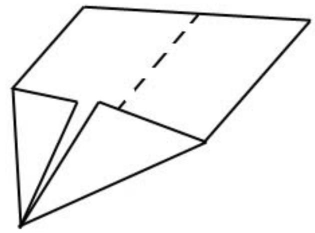
1. Once the 5 minutes is up, you must stop building. Only fully assembled airplanes will be counted toward your group total. Any excess inventory or unfinished planes will count against your group total.
2. After the activity is complete, work as a group to answer the questions below.
   a. Which method do you think is better, assembly line or nonassembly line? Why?
   b. How could the assembly of the paper airplanes have been improved?
   c. Do you think quality was better or worse using the assembly line method? What do you think caused this difference?
   d. Divide the total number of airplanes made by the number of people in your group. Compare this average between the two methods. Is there a difference? Does this surprise you?

Super Jet Paper Airplane Assembly Instructions

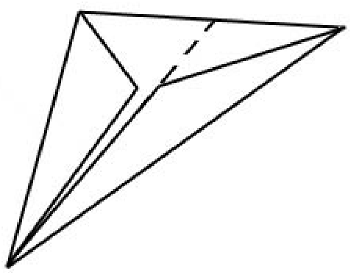
1. Fold a piece of paper down the center lengthwise.



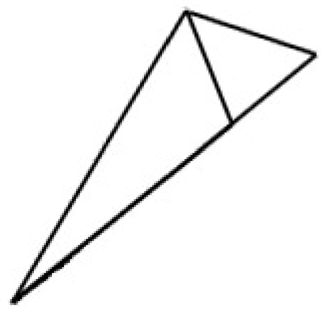
2. Fold the two upper corners down to the centerline.



3. Fold the two folded corners down to the centerline.

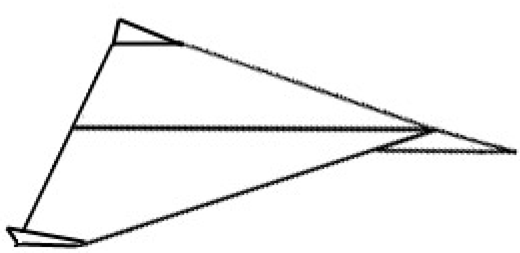


4. Fold the plane in half.



5. Fold one wing down, flip the plane over, and fold the other wing down.

6. Open the plane, fold the wing tips up, and tape the center together.



Your airplane is complete! Start again!

Educator's Guide to Kitchen Comets (5-12)

Make a Comet Nucleus

Comets are made up of some of the original material from which the solar system formed. Orbiting far from the Sun, this primordial material has survived in an unaltered state for billions of years.

When a comet nucleus is gravitationally drawn into the inner solar system it begins to heat up. The volatile materials from which it is made boil off to form the head and tail(s) that have amazed, baffled, and frightened people throughout history. This tremendous light show is produced from just the small solid nucleus measuring only 15 or 20 kilometers long. Think of it as a very dirty iceberg! This view was confirmed by the spacecraft flybys of Halley's Comet by Japanese, Soviet and European spacecraft in 1986.

You can make an accurate model of a comet nucleus easily and inexpensively. Unfortunately, it is difficult to do it neatly. Here is what you need:

- Dry Ice (5 lbs) available from ice companies or ice cream parlors; CAUTION: Dry ice is -79 degrees C (-110 degrees F). Any more than brief exposure will cause burns. Be careful when handling it.
- Water (around half a gallon) in pitcher
- Ammonia (a few drops or sprays of window cleaner)
- Dirt (fine grained, one handful);
- Corn Starch, or Worcester Sauce (a couple of pinches or drops)
- Trash Bags (2)
- Large Bowl or Small Pot
- Water Proof Gloves (the better insulated the warmer your hands will remain)
- Cloth Towel
- Paper or Cloth Towels
- Hammer
- Mixing Spoon or Stick

These ingredients are either actual components or handy analogous ones. The dry ice is frozen carbon dioxide. Water, ammonia, organic (carbon based) molecules, and silicates are all present on comet nuclei. They have been identified through spectral measurements of comet tails and the collection of tiny ice particles by very high flying research aircraft.

Here is the recipe:
Line the bowl with a trash bag. Place the other trash bag on the floor. Pour about a pint of water into the bowl. Add the corn starch or Worcester sauce, ammonia, and some of the dirt; mix a bit.

- Use the gloves to wrap the dry ice in a cloth towel and place it over the trash bag on the floor
- Use the hammer to crush the dry ice into a powder
- Gradually pour the dry ice powder into the water, mixing as you pour (lots of vapor will form). The dry ice, water and other ingredients should form a thickening slush. Keep stirring for a few seconds as it thickens.
- Now, using the trash bag to lift the slush away from the sides of the bowl, use your gloved hands to pack the slush into a ball. Keep packing and forming until the ball solidifies as a big lump.
- Peel back the trash bag and scatter more dirt over the lump.
- Pour some of the remaining water over the lump, turning it as you do so that a layer of water ice forms over the entire lump.

Observe the behavior of your miniature comet nucleus. It can be handled without gloves if the water ice coating is intact. If a spot feels sticky, pour water on the spot. It hisses and pops as carbon dioxide sublimes (goes from the solid state directly into a gas) and forces its way through weak spots in the water ice crust. On real comet nuclei this results in slight jetting forces that can cause the nucleus to spin, slightly alter its orbit, or split apart ("calve").

Note: Get three or four pounds of dry ice for each nucleus you plan to make. You can purchase it the afternoon or evening prior to the demonstration and store it in a freezer or ice chest. Place an inch or so of newspaper below the dry ice to prevent cracking of the surface on which the dry ice rests. Try the demonstration first to get an idea of the correct amount of water to use.

It's fun, it's a mess, and it's one of the most memorable and scientifically accurate demonstrations in astronomy!


Telescopic photo of comet C/2001 Q4, which passed close to Earth in May 2005.

From: Astronomy Picture of the Day
Credit & Copyright: Loke Kun Tan (StarryScapes)

National Oceanographic and Atmospheric Administration (NOAA) Lesson Plans

What is NOAA?

NOAA works to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our nation's economic, social, and environmental needs. NOAA envisions an informed society that uses a comprehensive understanding of the role of the oceans, coasts, and atmosphere in the global ecosystem to make the best social and economic decisions.

NOAA is an intrinsic part of the history of the United States and the development of its science and commercial infrastructure. The ancestor agencies of NOAA included the first physical science agency in the United States, the first agency formed specifically for observation and study of the atmosphere, and the first agency formed to study and conserve natural resources. Under these agencies and their descendants, the United States has become recognized as a world leader in the sciences of geodesy, geophysics, metrology, oceanography, meteorology, climatology, marine biology, and marine ecology.

Photo of Hurricane Frances from the International Space Station on Aug. 27, 2004.
Photo courtesy of NASA

NOAA Educational Resources

NOAA has several lesson plans in addition to teaching tools on topics such as weather, climate change, oceans, satellites, and space. The activities are for all grade levels. Visit our webpage, http://sciencedems.house.gov/resources/LessonPlans.htm, to learn more about the educational resources that NOAA offers.

NOAA Lesson Plan Examples

Greenhouse Effect: Too much, too little, or just right? (5-8) Pages 23-27

Greenhouse Effect: Too much, too little or just right? (5-8)

Problem: What is the seasonal variation in the amount of atmospheric carbon dioxide at two different locations on Earth's surface? What is the annual increase in the amount of global atmospheric carbon dioxide and methane?

Materials: Ruler, colored pencils

Background Information

Venus and Earth are about the same size and are so close that they are frequently called the "twin planets" of our solar system. Yet, Venus is so hot that lead will melt on its surface! This extreme heat is the result of a runaway greenhouse effect.

The greenhouse effect occurs when the atmosphere of a planet acts much like the glass in a greenhouse. Like the greenhouse glass, the atmosphere allows visible solar energy to pass through, but it also prevents some energy from radiating back out into space. The greenhouse effect insures that the surface of a planet is much warmer than interplanetary space because the atmosphere traps heat in the same way a greenhouse traps heat. Certain gases in our atmosphere, called greenhouse gases, tend to reflect radiant energy from the Earth's atmosphere back to the Earth's surface, improving the atmosphere's ability to trap heat.

All greenhouse gases are trace gases existing in small amounts in our atmosphere. Greenhouse gases include:

- **carbon dioxide;**
- **methane;**
- **nitrous oxide;**
- **some chlorofluorocarbons; and**
- **water vapor**.

We know that the greenhouse effect is necessary for survival. Without it, the Earth would be cold, so cold that life as we know it could not exist. However, scientists still have questions that must be answered. What kinds and amounts of greenhouse gases are necessary for survival? Are the amounts of greenhouse gases increasing, decreasing, or remaining the same? To answer these questions, scientists monitor the amounts of greenhouse gases in the Earth's atmosphere.

The atmospheric gas most responsible for the warming effect on both Venus and Earth is carbon dioxide (CO_2). On both planets, primary sources of CO_2 are volcanic eruptions. The difference between these two planets is that on Venus, 97%

From: http://www.fsl.noaa.gov/visitors/education/sam1/Activity5.html

of the atmosphere is CO_2, whereas on Earth, much less than one percent of the atmosphere is CO_2. Why is there so much less CO_2 on Earth? The carbon cycle holds the answer.

In the natural cycle of carbon, plants take in CO_2 and give off oxygen, whereas animals take in oxygen and emit CO_2. Further, CO_2 dissolved in seawater is used by plants during photosynthesis and by other seawater organisms such as clams and coral to produce calcium carbonate ($CaCO_3$) shells. These processes help control the amount of CO_2 in our atmosphere.

Human beings complicate the natural carbon cycle because they increase the amount of CO_2 in the Earth's atmosphere by burning fossil fuels. Driving automobiles, heating buildings, and producing consumer goods all add to the concentration of CO_2 in the Earth's atmosphere.

Methane (CH_4) is another greenhouse gas. It is produced in swamps, bogs, and rice paddies, as well as in the intestinal tracts of most animals, including cattle, sheep, and humans. Coal, oil, and gas exploration also contribute to the accumulation of methane in the atmosphere. However, methane concentrations are much less than CO_2 concentrations.

Nitrous oxide (N_2O), or"laughing gas," is another greenhouse gas accumulating in the atmosphere, although not as fast as methane. Fertilizer decomposition, industrial processes that use nitric acid, and small amounts from automobile emissions all contribute to increasing atmospheric N_2O.

In the procedures for this activity, you will plot curves for the CO_2 (ppm) and methane (ppb) concentrations found in the atmosphere over a period of time. In much the same way a scientist would monitor concentrations of gases in the atmosphere, you will look for changes and trends, as well a maximum and minimum concentrations during that same time period.

Answer Key for the following questions

1. Northern Hemisphere winter
2. Southern Hemisphere winter
3. Less vegetation in the Southern Hemisphere, further from sources and sinks.
4. To avoid local contamination and to find an air average over large areas.

Procedure

1. Using the data from Table 5.1, plot the points corresponding to the monthly mean CO_2 concentration at Pt. Barrow, Alaska on Figure 5.1. Use a colored pencil to connect the points.

2. Using the data from Table 5.2, plot the points corresponding to the monthly mean CO_2 concentration at Amundsen - Scott South Pole Station, Antarctica on Figure 5.1. Use a different colored pencil to connect the points.

3. Print a title at the top of your graph.

4. Place a color-coded legend on your graph in the space provided.

Questions

1. During what season is the monthly mean CO_2 concentration greatest in Pt. Barrow, Alaska?

   ____
   ____

2. If you were in the Southern Hemisphere, during what season would the monthly mean CO_2 concentration be greatest at the Amundsen - Scott South Pole Station, Antarctica?

   ____
   ____

3. Why do CO_2 concentrations vary less at the South Pole location than at Pt. Barrow?

   ____
   ____
   ____
   ____

4. Why do scientists collect CO_2 data at remote isolated locations, such as Alaska and Antarctica?

   ____
   ____
   ____
   ____

A second part to this lesson plan is available at http://www.fsl.noaa.gov/visitors/education/sam1/Activity5.html.

The data in Tables 5.1, and5.2 were provided by National Oceanic and Atmospheric Administration (NOAA), Office of Oceans and Atmospheric Research (OAR), and Climate Monitoring and Diagnostics Laboratory (CMDL).

Month	1989	1990	1991	1992
Jan	360.88	359.81	360.82	361.62
Feb	358.16	359.85	362.09	362.21
Mar	359.15	361.24	361.16	362.48
Apr	359.27	361.04	361.73	362.55
May	358.74	360.48	361.52	362.77
Jun	357.04	356.77	359.80	360.42
Jul	349.34	349.49	353.69	353.58
Aug	344.48	345.74	347.44	347.09
Sep	346.18	346.37	348.28	347.69
Oct	351.19	353.87	356.21	353.66
Nov	355.81	356.63	358.34	357.24
Dec	358.29	359.21	360.87	361.05

Table 5.1 Monthly Mean CO2 concentrations at Point Barrow, Alaska.

Month	1989	1990	1991	1992
Jan	349.62	350.76	351.97	353.05
Feb	349.68	350.57	351.66	352.80
Mar	349.60	350.64	351.50	352.68
Apr	349.68	350.91	351.77	352.90
May	349.92	351.25	352.03	353.25
Jun	350.22	358.58	352.38	353.65
Jul	350.58	352.06	352.81	354.09
Aug	351.00	352.40	353.22	354.47
Sep	351.08	352.70	353.37	354.66
Oct	351.24	352.74	353.32	354.67
Nov	351.29	352.74	353.46	354.49
Dec	350.87	352.30	353.33	354.22

Table 5.2 Monthly Mean CO2 concentrations at Amundsen—Scott South Pole Station.

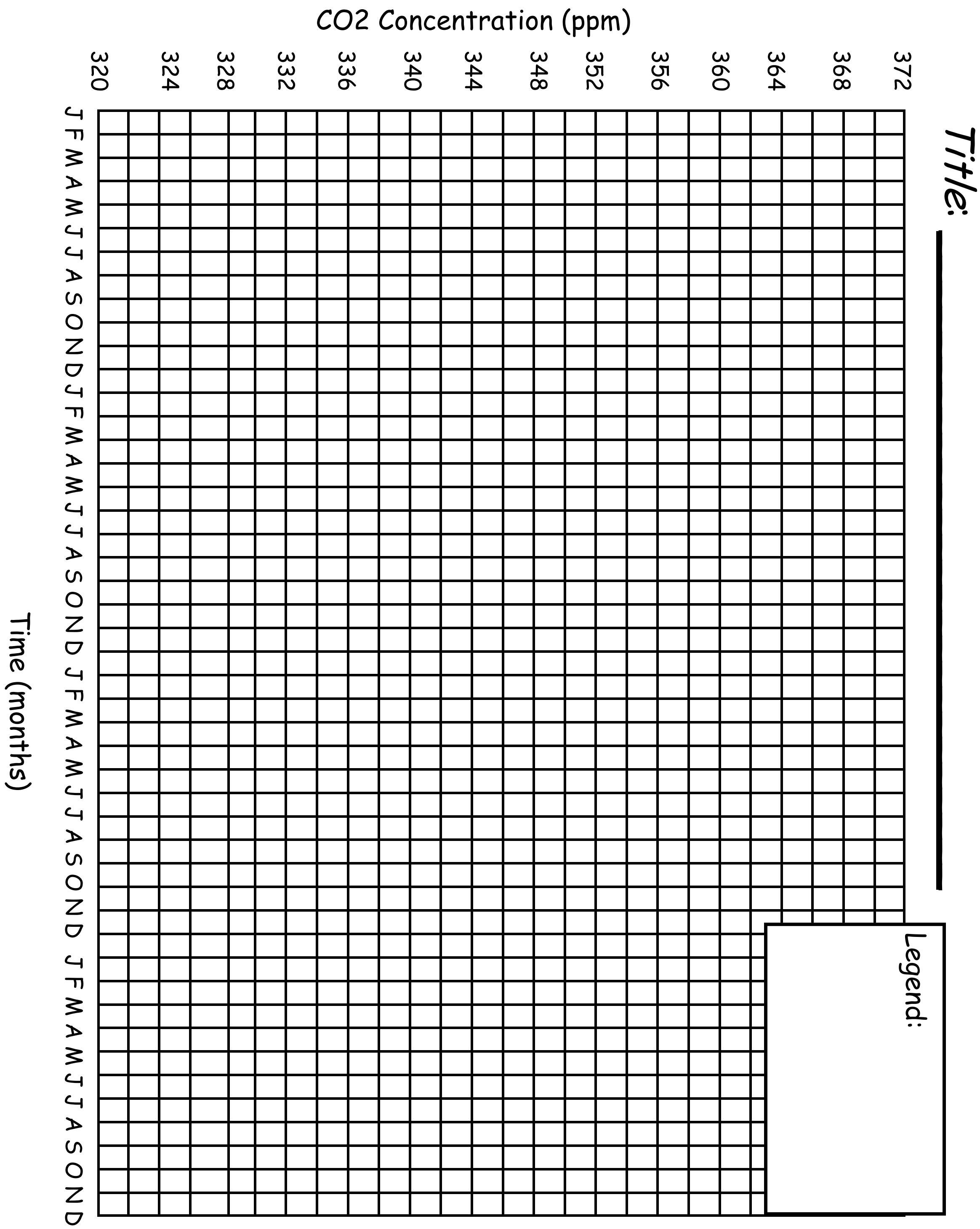

CO2 Concentration (ppm)
320 324 328 332 336 340 344 348 352 356 360 364 368 372
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
Time (months)
Title:
Legend:

Figure 5.1.

National Science Foundation (NSF) Lesson Plans

What is NSF?

The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" With an annual budget of about $5.5 billion, it is the funding source for approximately 20 percent of all federally supported basic research conducted by America's colleges and universities. In many fields such as mathematics, computer science and the social sciences, NSF is the major source of federal support.

NSF is the only federal agency whose mission includes support for all fields of fundamental science and engineering, except for medical sciences. It is tasked with keeping the United States at the leading edge of discovery in areas from astronomy to geology to zoology. In every case, it ensures that research is fully integrated with education so that today's work will also be training tomorrow's top scientists and engineers.

NSF Educational Resources

NSF helps fund several online programs that contain lesson plans, online videos, and interactive websites for educational purposes, among other activities. Its lesson plan database has an eclectic assortment of subjects, including life sciences, physics, and biology to name just a few, and has resources available for teachers of all grade levels. To see the variety of topics that are available, go to http://sciencedems.house.gov/resources/LessonPlans.htm.

Example

Specific Gravity (5-12) Page 29

Specific Gravity (5-12)

Target Audience: General Science or Chemistry

Introduction: Students will observe what happens when they put unopened cans of Diet Coke and Regular Coke in water. They will predict and record the results and relate them to the specific gravity of each fluid.

Materials: Unopened cans of different soft drinks (diet and sugar sweetened). We use diet and regular Coke.
Large bucket of water.

Hands-on Activity:

In this activity students write, in journals or lab books, what they expect will happen when Coke is placed in the water. They then test their predictions by placing the Coke in the water. Repeat with the Diet Coke. (The outcome, which you as the teacher already know, will be that the Coke will sink and the Diet Coke floats because real sugar is heavier than substitute sugar.) It is likely that your students have predicted the same fate, whether that is floating or sinking, for both cans. The fact that one floats and one sinks is called a discrepant event. Discrepant events are very good attention hooks.

Ask the students to answer whether the observed results matched their predicted results. Why are they different? Discuss their expectations and their observations with them as a group.

Using this activity as a starting point one can weigh objects, compare their masses to the unit mass of water and demonstrate how specific gravity is calculated. Empty the coke and weigh just the liquid. Weigh different objects and equal volumes of water, then ask the students, "Will this float or sink?"

Writing Activity:

Ask students to write in their journals and explain what would happen and why if we filled the pop can with sand? filled it with air and sealed it? Have students calculate the specific gravity of different objects as well.

Other Considerations:

- Be sure to test cans of pop before doing the experiment; some cans are not full of liquid, and the air will cause them to float.
- A 12 - ounce can of regular Coke has roughly nine teaspoons of sugar in it. That puts the specific gravity of the fluid well over 1 and normally more than compensates for the CO and air in the can.

From: http://www.rit.edu/%7Ecomets/pages/lessonplans/specgrav.html

The Smithsonian Lesson Plans

What is the Smithsonian?

In 1826, James Smithson, a British scientist, drew up his last will and testament, naming his nephew as beneficiary. Smithson stipulated that, should the nephew die without heirs (as he would in 1835), the estate should go "to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men."

Smithson died in 1829, and six years later, President Andrew Jackson announced the bequest to Congress. On July 1, 1836, Congress accepted the legacy and pledged the faith of the United States to the charitable trust. In September 1838, Smithson's legacy, which amounted to more than 100,000 gold sovereigns, was delivered to the mint at Philadelphia. Recoined in U.S. currency, the gift amounted to more than $500,000.

According to the Secretary of the Smithsonian, Lawrence M. Summers, "The Smithsonian is committed to enlarging our shared understanding of the mosaic that is our national identity by providing authoritative experiences that connect us to our history and our heritage as Americans and to promoting innovation, research and discovery in science. These commitments have been central to the Smithsonian since its founding more than 155 years ago."

Smithsonian Educational Resources

The Smithsonian's wide range of museums deal with a variety of topics. Education is part of its core mission. Smithsonian offers online lessons plans, field trip ideas, professional development courses, and other resources. The wide variety of science and technology lesson plans are primarily for grades 3 to 8, but other educational resources are targeted for a wider age range. To see the variety of resources available, check out our website at http://sciencedems.house.gov/resources/LessonPlans.htm.

Examples

Why Use Money? Getting What We Need (3-8)

Objectives

- Understand the difference between purchase, barter, and payment for service.
- Learn how the Akan and the North African people used a barter system to exchange gold and salt.
- Identify the most efficient ways of procuring your everyday needs.

Materials: Paper; Pencil; Map

Subjects: Social studies, economics

Procedure

1. Ask students to discuss the respective values of gold and salt. Discuss the reasons that the Akan wanted salt and the North Africans wanted gold. Use a map to show where each group lived. Explain that trade routes linked the desert and the Gold Coast.

2. Make a needs chart.
   ⇒ In the first column, have students list their most critical needs in the hour or two between the time they wake up and the time they arrive at school. Their list might include food, clothing, utilities (electricity, water, heat), soap, containers (book bag, lunch box), radio, transportation (bicycle, car, bus, gasoline), books, lunch, calculator.
   ⇒ In the second column, have students write down how they obtain these items or services. Discuss which items or services require multiple transactions before they reach the students. For example, their morning orange juice was purchased at a store. The store managers purchased the juice from a corporation that transforms oranges into orange juice and packages it for sale. The food corporation bought the oranges from orange growers.
   ⇒ In the third column, students should note *all possible ways* of obtaining each of the goods and services on their needs chart. Possible ways might be (a) purchase with money or a credit card (b) barter (offer another object in trade) (c) offer service instead of money (d) make it yourself. Discuss the potential problems inherent in each type of transaction. Which seems to be the most efficient method?

3. Study these classified ads written by three different people needing housing. Which house hunter is offering money? Who wants a barter agreement? Who is offering service in exchange for a place to live?
   Out-of-town grand-mother wishes to house sit during winter. Please call Mary, ___/___-_____.
   Single male visiting area seeks simple room. October 3-13 for $10-$30 per night. Call ___/___-_____.
   Wanna Swap? Washington, D.C., commuter looking for a furnished place to stay during the week in exchange for a beautifully furnished two-bedroom condo on the beach. Call ___/___-_____.

4. Have each student write a comical classified ad for something he or she wants or needs. The ad should reveal what cash, barter, or service arrangement the student will offer as payment.

From: http://www.smithsonianeducation.org/educators/lesson_plans/currency/lesson1.html

Minerals, Crystals, and Gems: Stepping-Stones to Inquiry

Mineral Scavenger Hunt (3-8)

Stibnite Crystals

Objectives

- Recognize minerals in commonly used objects and products.
- Recognize the ways in which minerals enhance our daily lives.

Materials: Mineral Scavenger Hunt chart (see the following page) reproduced for each student pencils and paper for additional notes

Subjects: science; geology; technology

Procedure

This lesson resembles an old-fashioned scavenger hunt. The focus of the hunt isn't the objects themselves, however, but rather on recognizing the minerals and mineral products contained within them. Give the Mineral Scavenger Hunt chart to students as a checklist for the objects they've found and where they have found them. Or, have them research what minerals are in different everyday objects, and then use the chart for comparison.

1. Ask the students to look around the classroom for objects that contain minerals or mineral products. Have them compile a list of all the objects they find and the name of minerals or mineral products they contain. They will find some answers listed in the product content label. In other cases they will have to make educated guesses. Typical examples are coins, cosmetics, lightbulbs, and computers. Almost anything that is not from a plant or an animal is a mineral or derived from a mineral. Everything that is metal, for example, is a mineral product.

2. Have students continue the search at home, a hardware store, or a pharmacy. Smithsonian staff readily found most of the items on the chart. In addition to checking labels, students can ask their parents or store employees for information. The goal is not to find an example of every single mineral, but rather for students to understand how widespread is the use of minerals and mineral products.

3. Throughout the project, class discussions can include the following questions:

- What are some actual minerals, as opposed to mineral products, that people use frequently?

  salt, talc in baby powder, gravel.

- What are some things the students used that day before coming to school that involved minerals or mineral products?

  drinking from a glass, eating cereal from a bowl with a spoon, showering with soap, using deodorant, putting on makeup, wearing jewelry, turning on a light, listening to a portable radio, using a computer, cleaning the cat litter, riding a bicycle or schoolbus to school, using coins

- How would our lives be affected if we did not use minerals?

From: http://www.smithsonianeducation.org/educators/lesson_plans/minerals/lesson3_main.html

Mineral Scavenger Hunt Chart

Mineral or Mineral Product	Uses	Object Location
aluminum	aluminum foil, cosmetics, beverage cans, deodorant, hand lotion, antacids, cooking pots	
beryllium	fluorescent lamps	
chromium	chrome fixtures (cars, bicycles, lamps, kitchens, etc.), stainless steel	
copper	wires, pipes, cooking pots, old gutters and roofs, brass, pennies	
fluorite (fluoride)	toothpaste, drinking water	
gold	dentistry, jewelry, computers, electronics	
gypsum	wallboard, plaster	
halite (salt)	table salt, food preservatives, de-icers	
iron	cosmetics, hair dye, steel, wrought iron	
lead	car batteries, computers, fuel tanks, TV tubes, leaded glass, x-ray shields, fishing sinkers	
mica	sheetrock, paints, hair dye, cosmetics, soap, electronics	
molybdenum	fertilizer, filament supports in light bulbs, steel	
nickel	nickel coins, stainless steel, alnico magnets, sheetrock	
perlite	gardening	
phosphate	fertilizer, dishwashing detergent,laundry detergent	
potassium (potash)	fertilizer, toothpaste	
silica	computer chips, glass, cosmetics, antacids, paint, laundry detergent, drain cleaner, quartz watches	
silver	photography developer, jewelry, electronics, silverware, dentistry	
sulfur	fertilizers, matches, car tires	
talc	baby powder, cosmetics, antacids, sheetrock, primer	
titanium	cosmetics, hand lotion, soap, toothpaste, hair dye, bug spray, primer, paint	
tungsten	filament in light bulbs, drill bits (tool steel)	
zinc	sunblock, fertilizer, cosmetics, dandruff shampoo, pennies, galvanized metal, brass, dry-cell batteries	
zirconium	deodorant, jewelry	

From: http://www.smithsonianeducation.org/educators/lesson_plans/minerals/lesson3_a.html

Reviled and Revered: Toads, Turtles, Snakes, Salamanders and Other Creepers and Crawlers
Examine Your Attitudes (3-8)

One of the best ways to help students dispel misconceptions about herps, which are reptiles and amphibians, is to have them examine their own feelings about the animals. In this lesson, your group can do just that by completing a survey. Afterward, they can help educate others about herps by creating posters and displays.

Objectives: Discuss some of the misconceptions people have about herps.
Describe ways to improve the image of herps.

Materials: Survey Examine Your Attitudes (following page), poster board, markers, and other art supplies.

Subjects: Social studies, science, math

Procedure:

1. Before the activity, make copies of the survey Examine Your Attitudes. Make at least two copies per student – the students will be having parents or friends complete the survey after they've completed it themselves.
2. Start the activity by defining the word "herp" and leading a discussion about the different kinds of herps. (See the background information under Who's a Herp? Webpage: www.smithsonianeducation.org/educators/lesson_plans/herps/essay2.html)
3. Have the students complete the survey, then collect them.
4. Assign the students into small groups. Give the surveys to each group, in turn. Have the groups tally the responses to each question.
5. Discuss the students' answers, using the information under Survey Discussion Points below.
6. Have the groups use the numbers they tallied earlier to create bar graphs of responses for questions 1-4. For questions 5-7, they can calculate percentages.
7. Pass out the extra copies of the survey and have each person ask a parent, neighbor, or friend to complete it.
8. The next day, have the students again work in groups to create bar graphs and calculate percentages based on the new survey responses.
9. Tell the students that they'll be participating in an "education campaign" to help improve the image of herps. To do this, each group should examine their calculations and graphs to decide on what area or areas to focus. Then they can create posters, buttons, and other materials to help dispel myths and negative opinions about herps.
10. Get permission to display the students' creations in a nature center, library, or other public facility.

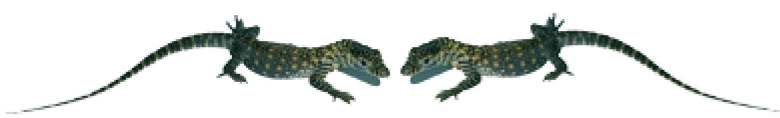
From: http://www.smithsonianeducation.org/educators/lesson_plans/herps/lesson1.html

Examine Your Attitudes Survey*

Circle the answer that best describes your feelings. Be honest! (Don't worry – you won't be graded. And remember: There's no right or wrong answer for many of these questions.)

Key: somewhat agree=1, agree=2, disagree=3

1. Snakes are mean.	1	2	3
2. Most herps are ugly and gross.	1	2	3
3. Endangered species that are cute or intelligent, such as pandas and whales, should be saved before en-	1	2	3
4. It's O.K. to use the skins of alligators, snakes, and other herps to make shoes, handbags, belts, and other	1	2	3
5. Touching a toad can give you warts.	True	False	
6. Most snakes are poisonous.	True	False	
7. Reptiles are slimy.	True	False	



* A Spanish version of the survey, Examina Tus Actitudes, is available at www.smithsonianeducation.org/educators/lesson_plans/herps/survey-s.html.

From: http://www.smithsonianeducation.org/educators/lesson_plans/herps/survey.html

Survey Discussion Points

1. *Snakes are mean.*
   It's important for students to understand that snakes, like other animals, exhibit a wide range of behavior. Some species of snakes are quite docile, whereas others are more aggressive. Behavior that students may label as "mean," such as eating other animals or biting people, is merely a snake's way of surviving.
2. *Most herps are ugly and gross.*
   It is true that some people think herps are ugly. But, as with other animals, the way a herp looks has been honed by evolution into a "design" that helps the animal survive. For example, a snake's lean, streamlined body can slip into tunnels where mice and other prey animals live.
3. *Endangered species that are cute or intelligent, such as pandas and whales, should be saved before endangered snakes, frogs, turtles, and other herps.*
   People very often favor cute, cuddly, or intelligent animals, but it's important to realize that all species have a role to play in their natural habitats. For example, snakes eat rodents – animals that can sometimes do a lot of damage to crops and spread disease.
4. *It's O.K. to use the skins of alligators, snakes, and other herps to make shoes, handbags, belts, and other products.*
   This is a matter of personal opinion, but it's worth pointing out that, in some cases, harvesting lizards, snakes, and other herps for leather products can cause their populations to plummet. For example, American alligators once bordered on extinction because of overharvesting, but when hunting was halted the animals made a comeback. They are being harvested once again, but the collection is now carefully regulated.
5. *Touching a toad can give you warts.*
   False.
6. *Most snakes are poisonous.*
   False. Fewer than 10 percent of snakes have venom that can hurt humans.
7. *Reptiles are slimy.*
   False. Reptiles have smooth, dry skin.

United States Geological Survey (USGS) Lesson Plans

What is USGS?

The United States Geological Survey (USGS) was established on March 3, 1879. It serves the nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. USGS is a world leader in the natural sciences thanks to its scientific excellence and responsiveness to society's needs.

The USGS is proud of its outstanding history of public service and scientific advances. USGS scientists pioneered hydrologic techniques for gaging the discharge in rivers and streams and modeling the flow of complex ground-water systems. The astronauts who landed on the Moon in 1969 were trained in geology by the USGS. More recently, innovative ventures with the private sector have given the world access to digital images of neighborhoods and communities in one of the largest data sets ever made available online. Modern-day understanding of the formation and location of energy and mineral resource deposits is rooted in fundamental scientific breakthroughs by USGS scientists.

As the nation's largest water, earth, and biological science and civilian mapping agency, the USGS collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. The diversity of their scientific expertise enables their to carry out large-scale, multi-disciplinary investigations and provide impartial scientific information to resource managers, planners, and other customers.

USGS Lesson Plans

USGS has a variety of lesson plans for a range of grade levels covering subjects including life science, Earth science, and geography. These resources guide teachers and students on how to explore fossils and climate change, learn to understand and use maps, or discuss why we have volcanoes. For more information, please go to our website, http://sciencedems.house.gov/resources/LessonPlans.htm.

Example

Volcanoes!: Lesson 2: Creators and Destroyers (4-8) Page 38-42

Volcanoes! Creators and Destroyers (4-8)

On May 18, 1980, Mount St. Helens erupted violently. At 8:32 a.m. Pacific Daylight Time, a magnitude 5.1 earthquake occurred about a mile beneath the volcano, triggering a catastrophic series of events that transformed Mount St. Helens' picturesque mountain landscape into a gray wasteland.

The Catastrophic Eruption

The earthquake shook the walls of the volcano's summit crater and triggered many small rock avalanches.Within seconds, a huge slab of the volcano's north flank began to slide, and small dark clouds billowed out of the base of the slide. Plumes of steam and ash also rose from the volcano's crater. As the avalanche of rock and ice raced down the mountain's north flank at more than 250 kilometers per hour (155 miles per hour), a massive explosion blasted out of the north side of the volcano. This lateral blast became a fearsome torrent of ash and rock that outraced the avalanche. Probably no more than 20 to 30 seconds had elapsed since the triggering earthquake!

The Eruption Was No Surprise

The eruption of Mount St. Helens was not a surprise. For nearly 2 months, scientists had been monitoring changes at Mount St. Helens. For a volcano to erupt, magma must move to the Earth's surface. Increased earthquake activity, eruptions of steam and ash, and changes in the shape of the surface of the volcano all signal that magma is on the move toward the surface.

Inside the volcano, the solid rock that surrounds the molten rock often cracks from the increased pressure and causes earthquakes. Between March 20 and May 18, more than 10,000 earthquakes were recorded beneath Mount St. Helens. The largest of these were felt by people living near the volcano. In addition to recording the discrete jolts characteristic of earthquakes, seismographs also detected continuous rhythmic vibrations called harmonic tremors. These numerous small earthquakes were further evidence that magma was moving within the volcano.

As magma made room for itself inside the volcano's cone, the surface of the volcano swelled, or inflated. By early April, Mount St. Helens' north flank began to visibly bulge and crack. The bulge grew 2 to 3 meters (7 to 9 feet) a day and it moved outwards about 150 meters (450 feet) in 2 months.

When the 5.1 magnitude earthquake shook Mount St. Helens on May 18, 1980, the bulge collapsed. The resulting avalanche was the largest volcanic avalanche recorded in historical times. In turn, the sudden removal of masses of rock and ice by the avalanches triggered an explosive eruption of steam trapped in cracks and voids in the volcano and of gases dissolved in the magma. Unleashed by the abrupt release of pressure, magma, rock, ash, aerosols, and gases exploded from within the volcano's north flank.

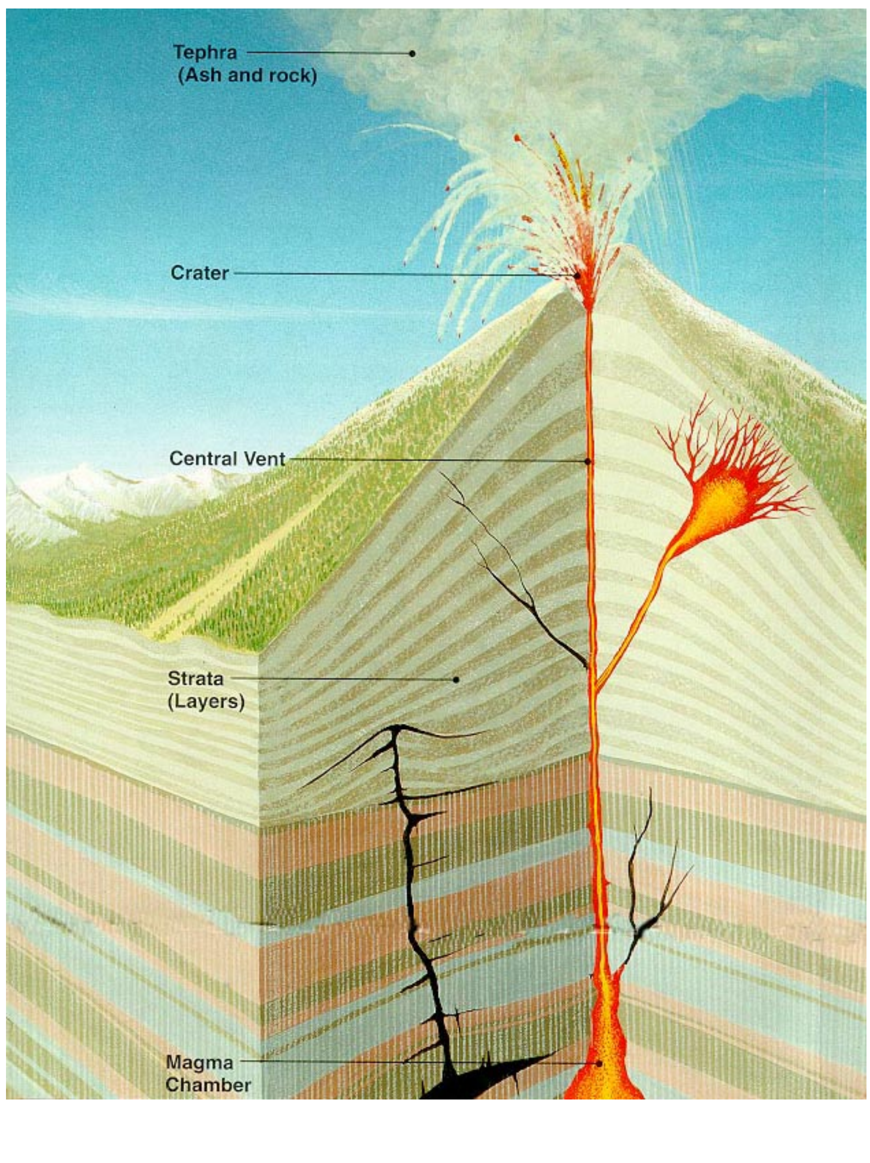
From: http://interactive2.usgs.gov/learningweb/teachers/volcanoes.htm

The Mountain is Transformed

In a few minutes, Mount St. Helens' symmetrical cone was transformed. It was 400 meters (1,312 feet) shorter and a gaping crater was gouged into its north side. An avalanche of rock, ash, ice, water, and fallen trees flowed as far as 9 kilometers (15 miles) down the valley of the North Fork Toutle River. Debris dumped into Spirit Lake raised the lakebed by more than 940 meters (295 feet). The lake's cool, crystal-clear waters became a black stew of rocks, mud, and floating trees. Gone were 70 percent of the glaciers that had crowned the volcano, melted by the heat of the eruption or carried away by the fast-moving avalanche. Towering forests with trees up to 45 meters (150 feet) were flattened and strewn like match sticks in the wake of the lateral blast and debris-laden avalanche.

Eruptions Continue

Between May 18, 1980, and October 1995, Mount St. Helens has had at least 21 eruptions of magma and dozens of smaller gas explosions. All of the volcanic activity has taken place in the bottom of the crater created by the May 18, 1980, eruption. There Mount St. Helens is rebuilding itself. During each eruption, new lava squeezes up and pushes aside old material from the surface of the dome. The volcanic activity that began in 1980 is not yet over.



Activity: The Mountain Blows its Top

Time: 45 minutes

By observing two demonstrations, students will understand (1) why a bulge developed on the north flank of Mount St. Helens and (2) why the avalanche triggered an explosive eruption.

Key teaching points

- The bulge that developed on the north flank of Mount St. Helens was evidence of changes occurring inside the volcano. Magma was moving closer to the surface and inflating, or deforming, the side of the volcano.
- Scientists had been closely monitoring the growth of the bulge for nearly a month to help them try to forecast an eruption.
- The 5.1 magnitude earthquake on May 18, 1980, shook the volcano, including the bulge area. In turn, the shaking of the bulge area caused a sudden collapse of the volcano's north flank and triggered a large avalanche.

The removal of this large mass of rock by the avalanche caused a sudden release of pressure inside the volcano and a violent eruption occurred.

Materials

- 1,500 ml beaker (Pyrex™)
- Damp sand
- Several small balloons
- Rubber bands
- Bunsen burner or hot plate
- Straight pin
- A bottle of soda water
- Basin or bowl to catch the "explosion"
- Master Sheet 2.1 (page 25)

Procedures

Preparation

Before class begins, put about ½ inch of sand in the bottom of the beaker and level the surface of the sand. Partially inflate a balloon, secure it with a rubber band, and place the balloon on top of the sand in the beaker. Cover the balloon with sand to a depth of about 1 ½ inches. Level the surface of the sand.

Introduction

In class begin the lesson by reviewing the series of events that occurred on May 18, 1980. Use Master Sheet 2.1 (page 42) to discuss the following events: the bulge that had been growing on the north side of the volcano for a month, the 5.1 magnitude earthquake that triggered an avalanche, and the avalanche that unleashed an explosive eruption, a lateral blast.

Demonstrations

Demonstration 1: Why the bulge grew

1. Partially inflate a balloon. Ask students what would happen to the balloon if you were to heat the air in the balloon? (The balloon would expand because the air expanded.) Explain that inflation caused a bulge to develop on the north flank (side) of Mount St. Helens.
2. Tell the students that the inflated balloon represents the magma rising within Mount St. Helens and that the sand represents the surface of Mount St. Helens. (fig. 1)
3. Show the beaker to the students and tell them you have a partially inflated balloon in the beaker. Place the beaker on the Bunsen burner or the hot plate. Heat the beaker until the balloon begins to expand. (The surface of the sand should begin to "bulge".) (fig. 2)
4. Observe the changes in the shape of the surface of the sand. What happens to the "land" as the "magma chamber" expands?

fig. 1

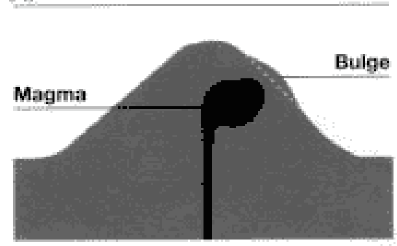
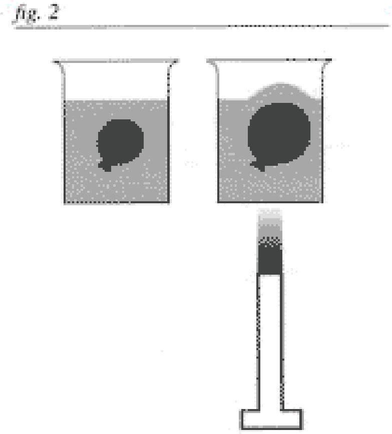


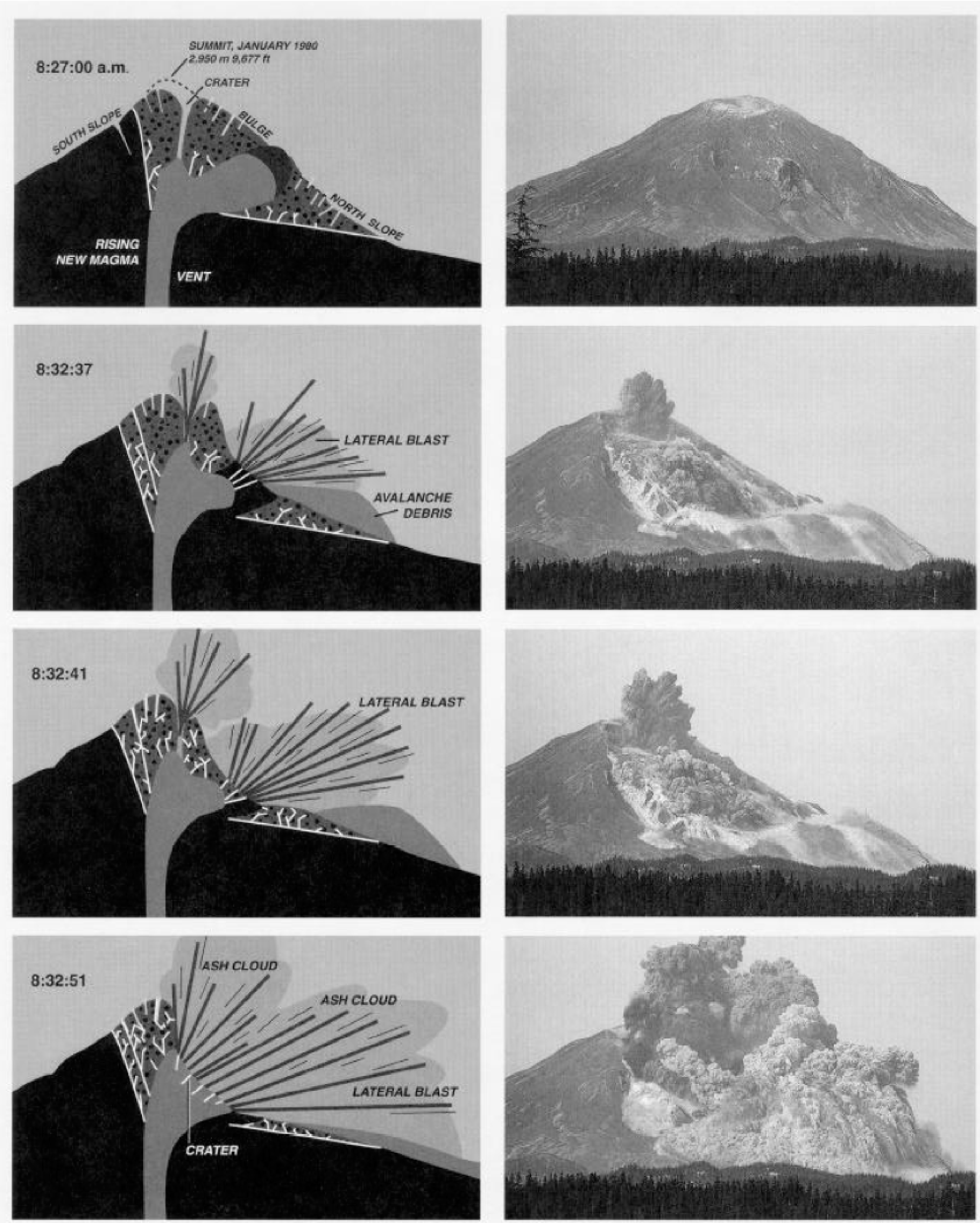
fig. 2



Demonstration 2: Why the avalanche triggered the explosive eruption

1. Ask students what would happen if you were to stick a pin into the balloon. (It would pop or explode.) Why does it explode? Burst the balloon. (The balloon bursts because the pressure inside the balloon is suddenly released and the gases can escape rapidly.)
2. Ask students what happens when they open a bottle of soda. (It goes "fizz" because the gas, CO_2, in the soda escapes.) Demonstrate this by shaking a bottle of soda water and releasing the cap. (The soda water "erupts" out of the bottle.)
3. Look at the figure on page 22. Compare the soda bottle to a magma chamber. As long as the top is on the bottle, there is no eruption. Compare the rock and ice that was unloaded by the avalanche to the soda cap. When the "cap" was suddenly removed, the pressure inside the volcano was suddenly released, and the volcano erupted.

Master Sheet 2.1



From: http://interactive2.usgs.gov/learningweb/pdf/volcanoes/ms2-1.pdf