SCHOLASTIC

Greenhouse Gases

» **Essential Question:** Where do greenhouse gases come from and how do they affect the atmosphere?
» **Materials:** graph paper, pencils, colored pencils, rulers, Internet access
» **Activity Sheet:** It's Getting Hot in Here » **Time Required:** 40 minutes, plus homework
» **Background Resource:** **Learn the Basics** epa.gov/climatestudents/basics/index.html

LEARNING OUTCOMES

Students will be able to:

1. Name the type of energy provided to Earth by the sun.
2. Describe the processes by which Earth receives energy from the sun and by which greenhouse gases trap this energy to keep our planet warm.
3. Plot a graph tracking data over time.
4. List three reasons why children are vulnerable to the health effects of climate change.

INTRODUCE THE CONCEPT

Ask students to describe what happens in a closed car on a sunny day. How does the temperature differ inside and outside the car? (If circumstances allow, consider going out to the parking lot to measure the air temperature inside and outside a car.) Explain that the car's closed windows prevent heat energy from escaping the car. This illustrates the *greenhouse effect*. While the air in our atmosphere goes through much more complex processes than air trapped in a car, the intense heat in the closed car demonstrates the concept of heat becoming more extreme when trapped by greenhouse gases.

EXPLORE THE SCIENCE

Have a class discussion about energy, the atmosphere, and the role of greenhouse gases:

» Earth receives energy from the sun in the form of sunlight. The energy that is not reflected back into space is absorbed by land and water. After being absorbed, some energy is released back into the atmosphere in the form of *infrared radiation*, or heat energy.

» Gases in Earth's atmosphere help Earth maintain balanced temperatures by trapping some of that heat close to Earth. Those gases—called greenhouse gases—hold in the heat needed for plants and animals to survive.

» Greenhouse gases are created both as part of natural environmental cycles and as a result of human activity. Carbon dioxide (CO_2) is one of the main greenhouse gases in our atmosphere. Watch this carbon cycle video with your class to learn how carbon is balanced in our atmosphere and how it is becoming imbalanced: epa.gov/climatechange/students/basics/today/carbon-dioxide.html.

COMPLETE THE ACTIVITY

Distribute Activity Sheet A: "It's Getting Hot in Here." Explain that scientists use monitoring stations like Mauna Loa Observatory in Hawaii to collect data about the amount of CO_2 in the atmosphere. This data demonstrates how the levels of CO_2 are changing over time. Review the introductory information with students, then have them select a month to graph the rise in CO_2 levels over time. Ask students to describe the results and discuss their conclusions.

APPLY THE KNOWLEDGE

Ask students to discuss why climate change has a large impact on children. For background, have students consider how plants, animals, and people rely on the environment for survival.

» Print out or project "How could climate change affect children's health?" at epa.gov/climateforaction/pdf/Section_3.pdf.

» Using page 7 of the PDF, have students explain how children are particularly affected by climate change. Make sure they factor in the impact of extreme changes in temperature, air and water quality, and weather due to climate change. *Note, you will review these impacts in greater depth in Lesson 4.*

» Separate students into groups to do brief research on one of the following topics to explain the impact of climate-related air quality on children's health: smog, airborne allergens (aeroallergens), longer allergy seasons, and increased asthma attacks.

Family Connection: Direct students to investigate their county's top industrial contributors to greenhouse gases with their families. Instruct them to visit ghgdata.epa.gov/ghgp/main.do and select their state under "View Facilities in Your State." After selecting their county on the state map or from the menu, they should click on one of the building icons. Ask them to research what type of facility it is and to work with their families to identify what products the facility produces or what process the facility manages. After the family discussion, have students use their findings to write a profile of three facilities that contribute to their state's greenhouse gas emissions. In their profiles, students should include additional research about how greenhouse gases are released from the facilities.

ADDITIONAL RESOURCES

- Global Climate Change: climate.nasa.gov
- Ice Cores: britannica.com/EBchecked/topic/281089/ice-core
- PPM: climatekids.nasa.gov/health-report-air
- Carbon Concentration: carbonvisuals.com/blog/400-ppm
- 400 ppm: scripps.ucsd.edu/programs/keelingcurve
- Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations, and Nature: journals.plos.org/plosone/article?id=10.1371/journal.pone.0081648
- Mauna Loa Observatory: esrl.noaa.gov/gmd/obop/mlo
- Effects of Climate Change on Children's Health: niehs.nih.gov/news/video/scivid/children/index.cfm

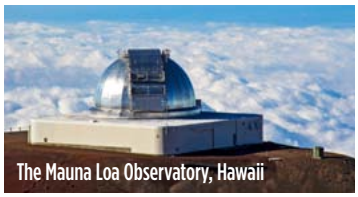
It's Getting Hot in Here

Greenhouse gases exist naturally in Earth's atmosphere.

Without the greenhouse effect, our planet would be so deadly cold that all water on Earth would freeze and life, as we know it, would not exist. But greenhouse gases function in a delicate balance. Add too many to the atmosphere and the planet's temperature rises higher and higher. When we burn fossil fuels for energy, we release large amounts of carbon dioxide and other greenhouse gases into the atmosphere, endangering our planet's delicate temperature balance.

The Path to 400 ppm

By measuring the levels of carbon dioxide in ice cores recovered from Antarctic and mountain glaciers, scientists have determined that the natural CO_2 range in the past 800,000 years was 170 to 300 ppm (parts per million, which measures how many parts of CO_2 are in one million parts of air). Many scientists believe 350 ppm or less should be the maximum level of CO_2 in the atmosphere. Data from the Mauna Loa Observatory monitoring station in Hawaii demonstrated that in April 2014, CO_2 reached an average monthly concentration of 400 ppm for the first time in recorded history! Check out the historical data below to see just how much the CO_2 levels in the atmosphere have increased over time.



The Mauna Loa Observatory, Hawaii

Average Monthly Concentrations of CO_2 from January 1960 to June 2015 (ppm)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1960	316.43	316.97	317.58	319.02	320.03	319.59	318.18	315.91	314.16	313.83	315.00	316.19
1965	319.44	320.44	320.89	322.13	322.16	321.87	321.39	318.81	317.81	317.30	318.87	319.42
1970	325.03	325.99	326.87	328.13	328.07	327.66	326.35	324.69	323.10	323.16	323.98	325.13
1975	330.68	331.41	331.85	333.29	333.91	333.40	331.74	329.88	328.57	328.36	329.33	330.59
1980	337.80	338.28	340.04	340.86	341.47	341.26	339.34	337.45	336.10	336.05	337.21	338.29
1985	345.25	346.06	347.66	348.20	348.92	348.40	346.66	344.85	343.20	343.08	344.40	345.82
1990	353.79	354.88	355.65	356.27	357.29	356.32	354.89	352.89	351.28	351.59	353.05	354.27
1995	359.87	360.79	361.77	363.23	363.77	363.22	361.70	359.11	358.11	357.97	359.40	360.61
2000	369.25	369.50	370.56	371.82	371.51	371.71	369.85	368.20	366.91	366.99	368.33	369.67
2005	378.47	379.76	381.14	382.20	382.47	382.20	380.78	378.73	376.66	376.98	378.29	379.92
2010	388.45	389.82	391.08	392.46	392.95	392.03	390.13	388.15	386.80	387.18	388.59	389.68
2015	399.96	400.26	401.52	403.26	403.94	402.80						

Graph It! Choose one month between January and June and graph the changes in CO_2 levels from 1960 to 2015.

Grade: 4-8

Objectives: Students will examine the role of product packaging and resource waste

Time Needed to Complete: 50 minutes

Materials Needed:

- 6-7 different brands of gum, each with unique packaging
- Scale
- calculators

Background:

According to the EPA, in 2006, Americans produced 251 million tons of trash. 80 million tons, or 32% of the trash came from packing and containers. Of the total trash, only 32% of the volume was recycled. All of this trash adds up and presents many problems. One of those issues is where to put the trash. Landfill space is running out and landfills present ecological problems to the community surrounding them.

The Model T Ford provides an example of rethinking trash and packaging. The box that the car was shipped in was to later be used as the floorboards inside the car. This activity will look at the amount of packaging used relative to the product it's used for, and will encourage students to consider packaging as part of product purchases.

Procedures:

1. Record the different brands of gum and their prices in the appropriate columns of the handout.
2. Find the total mass of your group's package (gum + packaging). This may be printed on the package; if not, use a balance or scale.
3. Record the printed gum mass. This may not be present; use balance if necessary.
4. Calculate the mass of the packaging:
   Total mass – gum mass = packaging mass
5. Unwrap all of the gum in your package. Measure the mass of gum. Record actual gum mass.
6. Measure the packaging mass. Record actual packaging mass.
7. Calculate and record the packaging percentage of the total mass:
   $\frac{\text{Actual gum mass}}{\text{Total packaging mass}} \times 100$
8. Calculate and record the cost per gram of gum:
   $\frac{\text{Price}}{\text{actual gum mass}} \times 100$
9. Graph the percentage of packaging on the bar graph on the handout. Get the information from the other groups and complete your bar graph.

Possible Interactive Questions:

- What types of materials are used in the packaging of the gum?
- Are any of the materials recyclable? If not, are the materials waste or can they be reused?
- Did higher cost relate to more packaging?
- Why do we need packaging?
- Does the packaging affect which gum you buy?

Wrap It Up!

Record your pack's brand name and packaging in the table below:

Brand Name of Package	Price of Package

Pick one pack of gum and complete the following directions.

Find out the total mass of your group's package (gum + packaging). This may be printed on the package; if not, use a balace or scale.

Mass of Package = _____

Record the printed gum mass. This may not be present; use balance if necessary.

Mass of Gum = _____

Calculate the mass of packaging: Total mass – gum mass = packaging mass

_____ - _____ = _____

Unwrap all of the gum in your package. Measure the gum mass.

Actual Gum Mass = _____

Measure the packaging mass. Record.

Actual Packaging Mass = _____

Calculate and record the packaging percentage of the total mass:

$$\frac{\text{Actual gum mass}}{\text{Total packaging mass}} \times 100$$

Percentage of Total Mass = _____

Calculate and record the coast per gram of gum:

$$\frac{\text{Price}}{\text{Actual gum mass}} \times 100$$

Cost of Gram of Gum = _____

5GYRES

Identifying Plastics

Background: In our everyday life, we encounter many polymeric materials (plastics), many of which are in the form of disposable containers used for many household products. As our natural resources are diminished and our landfills become filled, we are finding that it is better to recycle much of our waste materials than to dispose of them or burn them.

Most of the polymers we encounter in our daily lives are the six polymers listed in Table 1. To make recycling of these polymers easier, the plastics industry has adopted the codes shown. Since compliance in labeling is voluntary, not all plastics are labeled for identification. Identification, simply by appearance, is difficult; however, there are a few types that are readily identifiable. Clear, colorless containers that are used for soft drinks are most often polyethylene terephthlate (PETE). Opaque, translucent (and often white in color) plastics used for containers such as milk cartons are usually high- density polyethylene (HDPE). Bottles used for shampoos or cleaning materials are usually made from polyvinyl chloride (V or PVC). Plastic bags and some plastic wrap are often made from low-density polyethylene (LPDE).

In this experiment, we will examine some common plastics and perform several tests to identify them. A flow chart for the tests is given below:

Grade: 7th and up

Objectives: Students learn that plastics are made of different chemical structures and learn how to identify each type by subjecting it to a variety of tests.

Time Needed to Complete: 60 minutes

Materials Needed:

1. Samples of plastic pieces labeled 1 through 6
2. 2 Unknown samples of plastics (These are in vials labeled 7 through 12)
3. Isopropyl alcohol solution, $CH_3CHOHCH_3$, 45.5% by volume. This solution is made bydiluting 45.5 mL isopropyl alcohol to 100 mL with water. (Also, by diluting 65 mL 70% isopropyl rubbing alcohol to 100 mL with water.)
4. Mazola corn oil
5. Copper wire
6. Corks to fit 18 mm test tubes
7. Acetone
8. Test tubes, 18 x 150 mm Stirring rod, glass Bunsen burner
9. Beaker, 50 mL Beaker , 250 mL
10. Tongs or forceps
11. Ring stand and ring with wire gauze

STEM IN THE LAB

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BUILD A BIRD FEEDER

Did you know that there are about 10,000 different types of birds in the world? You don't have to go far to see some of them. Birds live outside in backyards and parks and can even be found in a busy city! Do you know what kinds of birds live in your neighborhood? Have you ever taken a close look at the birds you see in your backyard to identify them and observe their behavior? In this activity, you will build a bird feeder to attract birds, so you can study them.

GRADE LEVELS: K-8

VOCABULARY

Ornithology- *The scientific study of birds.*

Ecology- *the branch of biology that deals with the relations of organisms to one another and to their physical surroundings.*

Oxygen- *a colorless, odorless reactive gas, the chemical element of atomic number 8 and the life-supporting component of the air.*

MATERIALS

- *Plastic milk/juice container with cap*
- *Scissors or craft knife*
- *Wooden dowel, twig, or wooden coffee stirrer*
- *Bird seeds*
- *Mini cup(s)*
- *Water*
- *Tape*
- *Optional: paper plate*
- *Possible decorations: tree bark, shells, stones, stickers, etc.*
- *Note: Make sure that any materials you use to decorate the bird feeders are safe for the birds. If possible, stick to as many natural materials as possible.*
- *Optional: paintbrushes, when using paint*
- *Glue or glue gun*
- *Twine, yarn, or thin rope*
- *Pen or pencil*
- *Binoculars (optional)*
- *Bird field guide (optional)*
- *Lab notebook*

Idaho National Laboratory

PROCEDURE

PREP WORK

1. *Clean out the milk or juice container with warm water and soap. Let the container dry completely.*

INSTRUCTIONS

1. *Ask an adult to help you cut an opening into the flat side of the container. The opening should be at least one inch above the bottom of the container and at least three inches in diameter.*
2. *Use tape to cover the sharp edges of the opening so the birds don't get harmed when coming into your bird feeder.*
3. *Cut a small hole below the opening and insert a wooden dowel or stick to build a perch for the birds. Secure the stick in place with glue.*
4. *Glue one or more mini cups onto the floor of your bird feeder or onto the inside walls.*
5. *Prepare a place for your bird food. You can either put a paper plate into your bird feeder or plan to put the seeds directly in the container.*
6. *With the help of an adult, poke two holes on opposite sides next to the opening/cap of the container. Then thread the twine, yarn, or rope through the holes and tie the ends in a knot to create a handle.*
7. *Once you are done, start decorating or coloring your bird feeder. Make sure all the materials are safe for birds. Good choices are natural materials such as pebbles, shells, tree bark, etc.*

   What type of decoration would be best to attract the most birds?

8. *Fill the bird feeder with bird seeds and add some water to the mini cup.*
9. *Set the bird feeder up outside. You can, for example, hang it in a tree or let it sit on a table. Observe the birds that come to your bird feeder.*

   What do the birds look like that visit your bird feeder? Which birds can you identify? Can you differentiate them by their appearance or their songs?

WHAT HAPPENED?

Once you set up your bird feeder, it may have taken a while before you saw birds visiting. This is because the birds first have to get used to the bird feeder that they haven't seen before, so they know it is safe. After a couple of days, you should have started seeing birds come to your bird feeder. They will come for the bird seeds and the water that you have provided for them. If you have binoculars and a field guide for birds, you might have been able to identify some of the birds you saw. Which birds live in your backyard depends on the area you live in. Different places on Earth have different birds living there.

If you tested different bird seeds in your bird feeder, you might have noticed that different birds prefer different seeds. This is because every animal has their own special diet and can only eat certain things. Some seeds that birds like to eat are millet or sunflower seeds. Depending on where you have set up your bird feeder, you may have also seen other animals besides birds come to your bird feeder, such as squirrels, mice, or rats. These animals also need to hunt for food and must find water in order to survive in the wild.

THE SCIENCE BEHIND IT

Every animal on our planet, including birds and humans, needs food, water, air, and shelter to survive. Animals need to eat regularly to get energy for their bodies to function. What kinds of foods an animal eats depends on the type of animal; some animals hunt or prey on other animals (carnivores), whereas others will search for foods like plants or fruits (herbivores) or eat both plants and fruits and other animals (omnivores). A wild bird's diet consists of plants such as grains or seeds and animals like insects, worms, or fish. Each animal chooses to live where they can find the food they need to survive.

Water is also important. An animal's body can consist of as much as 90% water. Most animals lose water when they sweat or exhale. In order to replenish their water supply, they have to drink on a regular basis. Some animals that live in the desert where there is not a lot of water get most of their water from the food they eat.

Almost every animal needs air, or a special gas called oxygen that is part of the air. Even fish that live under water need to take up oxygen with their gills. The oxygen is important to keep the processes in the body going. For example, oxygen is needed to make energy from the food an animal eats. Because birds need lots of energy and oxygen for flying, they have special air sacs in addition to their lungs for breathing.

Shelter, or a protected place to live, is important for all animals. Each animal can only live within a certain temperature range. When the temperature gets too high or too low, an animal will die. A shelter can help protect them from temperatures that are too high or too low. In addition, a shelter is a place where animals can raise their young and helps protect them from dangers such as predators. The type of shelter, or home, an animal builds or chooses can vary. Some animals build underground borrows, some build nests in trees, and others prefer to live in caves. In the wild, birds build nests made of twigs and other materials as their shelter. This is where they lay their eggs and raise their young. Some birds also live in hollow trees.

Building a place that provides birds with some of the things they need to survive, such as a ***bird feeder****, is a great way to learn more about the birds in your area. A bird feeder will attract birds, allowing you to get a closer look without disturbing the birds. When bird watching, features such as the bird's size, plumage color, or beak shape help to identify a specific bird species.*

People who study birds are called ***ornithologists****. They try to learn as much as they can about each of the different types of birds. They study what each bird looks like, what they eat, where they fly, how they sound, and much more.*

EXTENSIONS

- *In addition to using your bird feeder to find out what kinds of birds live in your neighborhood, you can also find out what kind of food these birds like best. Instead of a bird seed mix, put just one kind of bird seed into your bird feeder. Some seeds to try are sunflower seeds, millet, or corn. Then observe the bird feeder for about one week to see which birds visit the feeder. The next week, change the type of bird seed in the feeder and again observe the birds that are coming to your bird feeder. Test several different seeds this way. Which seeds are most popular? Do some types of birds prefer a specific seed?*
- *Build several bird feeders and decorate them each with different colors. Hang them up in a tree and observe how many birds come to each bird feeder. Is there a certain color that the birds are more attracted to compared to the others?*
- *Compare the types of birds that come to your feeder. Observe their size, shape, or behavior. How are they different or similar to each other?*
- *Find out more about the types of birds that come to your feeder. Where else in the world do they live? What do they usually eat? Where do they build their nests? Are they common birds or endangered? Create a report about one specific type of bird with all the information that you can find.*

RESOURCES

https://www.sciencebuddies.org/stem-activities/build-bird-feeder#summary

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For information on grants, training and student opportunities; curriculum ideas and resources, please visit us at: ***stem.inl.gov****.*

Test #5: The Acetone Test

1. There should be a beaker of acetone located under the hood. If not, place about 10 mL of acetone in a 50 mL beaker. Work under a fume hood to minimize vapors in the room.
2. For this test, use samples of plastics that did not give a green colored flame.
3. Using tongs, place a pellet of the plastic in the acetone for 20 seconds. Remove the pellet and press firmly between your fingers. A positive reaction has occurred if the polymer sample is soft and sticky. Scrape the sample with your fingernail to see if the outer layer has softened.
4. If the sample has a positive reaction, discard it in the trash as the conclusion of this test.
5. Repeat this test for each of the remaining plastic samples that did not give a green colored flame.

Test #6: The Heat Test

1. Place approximately 100 mL of water in a 250-mL beaker and heat to boiling.
2. For this test, use the samples of plastics that did not have a positive acetone test.
3. Using tongs, place a pellet of the plastic in the boiling water for 30 seconds. Remove the pellet and press it between your fingers to see if it has softened. A positive reaction has occurred if the polymer sample is softened.
4. If the sample has a positive reaction, discard it in the trash as the conclusion of this test.
5. Repeat this test for each of the remaining plastic samples that did not have a positive acetone test.

Clean Up

Recycle all plastic resins in their appropriate containers.
Return all liquid solvents for reuse of dispose them according to local regulations. (Your instructor will advise you on this.)

Procedure:

1. Students have either been previously taught or are reviewing the terms condensation, evaporation, precipitation, and collection.
2. Cut out the water cycle wheel and the water cycle illustration papers.
3. Have students place the wheel behind the illustration paper so they understand how the finished diagram will work.
4. Tell students that they must produce a diagram that will demonstrate their knowledge of the four main phases of the water cycle: collection, evaporation, condensation, and precipitation. Scenes involving oceans, lakes, or rivers will probably be easiest for students to conceptualize and illustrate. Remind students that the sun should be in their picture as its heat is necessary to the water cycle.
5. Students create their own illustrations, correctly label each stage, and fasten with brass tacks once they are done.
6. Water cycle illustration. Cut off along the lines. Cut out the two windows. Create your own illustration to show collection, evaporation, condensation, and precipitation. Label each stage correctly. Use a brass fastener to complete your diagram.
7. Water cycle wheel. Color it or run off on blue paper. Students may be asked to brainstorm other forms of precipitation to illustrate. Remember the droplets are only a symbol of the water cycling; water may precipitate in other forms such as sleet or snow, and it evaporates as a vapor or gas.
8. Have students explain the four phases of the water cycle shown in the diagram in a paragraph.

Assessment Rubric:

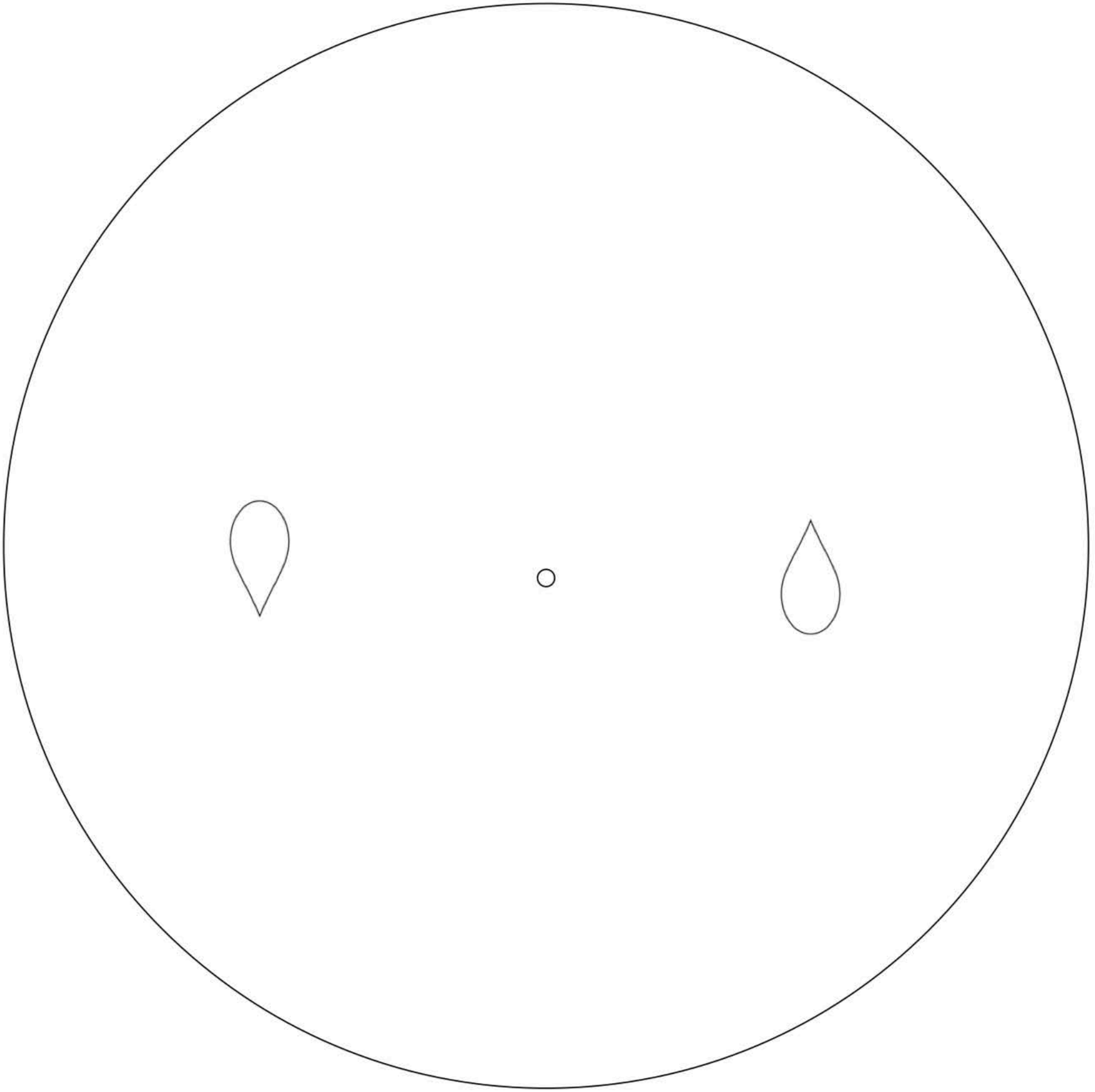
4 The diagram is correctly illustrated, labeled, and spelled to demonstrate student's understanding of the four main phases of the water cycle.

3 The diagram is correctly illustrated and labeled, but has spelling errors or one phase mislabeled.

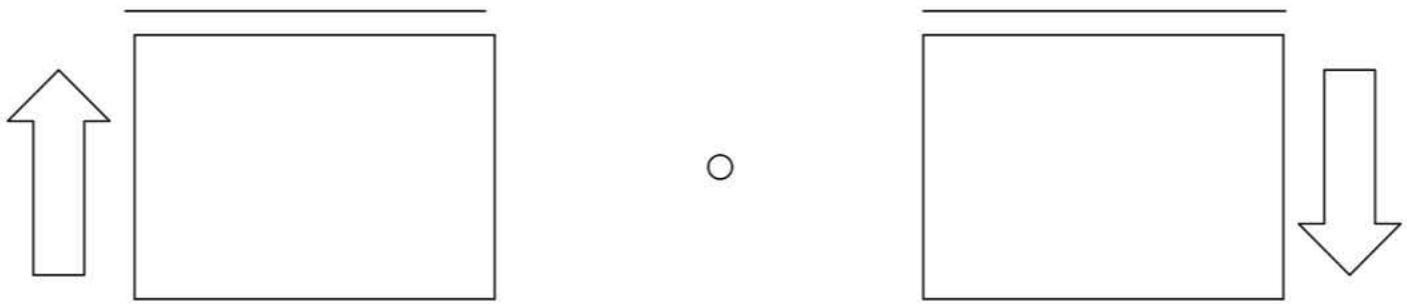
2 The diagram is correctly illustrated but only two phases of the cycle are correct.

1 The diagram is incorrect and/or only one phase of the cycle is correct.

0 No response is given or all four phases are incorrect.



The Water Cycle



Water Cycle Journey Game

Framework Focus:

Earth and Space Science Learning Standard 10: Describe how water on earth cycles in different forms and in different locations, including underground and in the atmosphere.

Physical Sciences (Chemistry and Physics) Learning Standard 3: Describe how water can be changed from one state to another by adding or taking away heat.

Objectives:

1. Students will learn about other places water cycles on the earth.
2. Students will understand that water remains in some locations longer than others.
3. Students will practice vocabulary associated with the water cycle and use reading comprehension skills.

Introduction:

In this lesson, students will expand their knowledge of the water cycle beyond just the four basic stages. They will understand that water is present in many other places such as plant and animal life, underground, frozen in glaciers, etc. Students will also use more advanced vocabulary associated with the water cycle.

Time: About two 45 minute periods.

Materials:

Water Cycle Signs

Water Cycle Dice: A template is given which may be run off on cardstock and folded. Place two to three dice at each station, depending on the size of your class.

Water Cycle Record paper

Paper to illustrate journey after the game. Long, thin strips of paper tend to work best.

Water Cycle Vocabulary paper (to use when students are illustrating their journey)

Procedures:

1. Before introducing the lesson, make up the dice for each station by running off on oak tag. Students or the teacher may label the dice. You could extend this part of the lesson by having a math discussion around the number of faces on a cube, the probability of traveling to a different station versus collecting, etc.
2. Ask students to brainstorm where water is found on the earth. As they identify each of the nine stations used in this game, place the sign up in an area of the room, along with the dice.
3. Explain that in this game students will pretend they are a molecule of water cycling through the earth and its atmosphere. Their path will be determined by rolling a single die at each station and recording their results.
4. Assign students to begin at each of the nine stations in small groups. They should begin the game by writing down the first station on their record sheet. Clipboards are useful, but not necessary.
5. Have students record which stations they visit and how many times they stay or collect at that station.
6. Students should rotate through stations and record their journey for about twenty minutes.
7. Summary: At the conclusion of the game, discuss the different paths taken by students. At which stations did water seem to collect for a long period of time? (glaciers, oceans, ground water) Through which stations did water pass quickly? (clouds, soil, animal)
8. In the second class period, have students use the long strips of paper to illustrate their journeys using their record sheets. Their illustrations should include: numbered steps, the name of the location of the water (ocean, cloud, animal, etc.) and the appropriate vocabulary to describe the change that took place (evaporation, precipitation, condensation, etc.)

Assessment Rubric:

4 Completed record sheet and accurately labeled illustration with title. Illustration must be clear and demonstrate correct usage of the vocabulary words.

3 Completed record sheet, illustration may lack some vocabulary or have some errors.

2 Not completed or illustration is unclear, unlabeled, or incorrectly labeled.

1 Very minimal response or completely incorrect response.

0 No response.

A fun summary to this part of the lesson is to ask students to put their smaller parts of the water cycle together by matching up endings and beginnings to create a larger water cycle journey. For example, a student whose last phase was cloud can link to a student whose first phase was cloud, and so on.

Water Cycle Journey Record Sheet

Number of station	Location of water (ocean, glacier, animal, etc.) (make a tally each time you roll "stay/collect")	Movement of water to get to next location (evaporation, precipitation, condensation, etc.)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

PennState College of Agricultural Sciences

Department of Ecosystem Science and Management

Youth

The Water Cycle

- **Keywords:** water cycle, clouds, precipitation
- **Grade Level:** seventh and eighth grade
- **Total Time for Lesson:** two to three 40-minute class periods
- **Setting:** classroom

Concepts and Goals

- By taking notes on a guide sheet and in their notebooks and by performing experiments and analyzing their results, students will explore the different components of the water cycle.
- Students will develop a better understanding of the need to conserve this valuable renewable resource.

State Standards Addressed: Effect of Consumer Desires on a Natural Resource (4.2); Dependency of Living Components in an Ecosystem on the Nonliving Components, Identification, and Explanation of a Cycle (4.6)

Procedure

- Students will use their notebooks and complete the attached guide sheet illustrating the water cycle as they are presented with the following information. This will be done prior to the lab activities.

Introduction

Like all matter, water is constantly cycled through ecosystems. This compound comprises nearly 70 percent of our bodies and is used in many of our chemical reactions. The oceans contain about 97 percent of the world's water. The remainder is fresh water that is in the form of gas (vapor), liquid, or

ice. Seventy five percent of this water is frozen in glaciers and in ice in the polar regions. Only about 1 percent of the earth's water is available as fresh, liquid water.

Much of this fresh, liquid water is found in the ground in rock and soil layers. The zone in the earth that contains water saturated soil and/or rocks is known as an aquifer. The upper surface of an aquifer is known as the water table. The remainder of our fresh water is found in the surface water of lakes, rivers, and ponds, and in the bodies of organisms.

The Components of the Water Cycle

1. The movement of water into the atmosphere--molecules of water, like molecules of all liquids, are in constant motion.
2. Because of this, what happens to these molecules? They collide with each other, causing them to move to a less crowded area.
3. What is the movement of particles from a crowded to a less crowded area called? Diffusion. When water diffuses from the soil or from a body of water, it changes from a liquid to a gas form.
4. What is this diffusion of water called? Evaporation. Water is also released from the bodies of organisms and evaporates into the atmosphere.
5. In what ways do animals release water? Excretion, exhaling, and perspiration
6. Where is water released from plants? Mostly from microscopic pores in their leaves
7. What is transpiration? The evaporation of water from pores of plants

The Formation of Clouds

9. As water diffuses into the atmosphere, it will become cooler. Also, the air molecules and tiny dirt particles it mixes with will become increasingly farther apart. (The air pressure decreases.) The presence of

    - water molecules
    - dirt particles, also known as condensation particles
    - a decrease in air pressure
    - a decrease in air temperature result in condensation

10. What is condensation? Process whereby water changes from a gas to a liquid. As they condense, the water molecules attach themselves to nearby condensation (dirt) particles. The result is a cloud droplet. Many, many of these droplets form a cloud.

Precipitation

11. Eventually the clouds become heavy with water.
12. What is precipitation? Water in clouds falling to the earth as rain, snow, sleet, or hail.
13. Explain what becomes of the precipitation? It may seep into the soil and become part of the ground water (aquifer). Much of the water enters the roots of plants. Some enters into the cells of microscopic organisms, and some enters the bodies of animals when they drink water or when they eat other animals. Some of the water moves along the surface in rivers and streams.
14. What is this water flow along the surface called? Runoff
15. What becomes of this water? It enters various bodies of water.
16. If water is constantly cycled, why do we need to conserve water? The water we fail to conserve will over time pass through the cycle and return to the earth in some form of precipitation, but it may return many miles away. Also, water pollution is still a problem: therefore, it is wise to conserve water that is safe to drink. This completes the water cycle.

Exploring the Components of the Water Cycle

If there is enough equipment and class time, any of the activities below can be performed by the students working in pairs.

Transpiration

Materials

- small potted plant
- clear plastic bag
- twist tie

1. Put a plastic bag over a small potted plant or over one of its branches and secure the base of it with a twist tie around the stem. For quicker results, put the plant in a warm, preferably sunny location and observe throughout the period.
2. Explain what you observed on the inside of the plastic bag. Water from the plant diffused into the air and collected on the inside of the bag.
3. What is the process of water diffusion from plants called? Transpiration

Cloud Formation Part 1

Materials

- flask
- stopper (one holed) for top of flask into which the syringe fits

- water
- matches
- large plastic syringe

1. Place enough slightly lukewarm water in the bottom of a flask to cover the bottom. Fit the top with a one holed stopper into which a large plastic syringe has been inserted vertically. Remove the stopper/syringe assembly. Light a match. Hold it over the mouth of the flask and blow it out so that some of the smoke if forced down into the flask. Quickly replace the stopper/syringe assembly and while holding it down, pull up on the plunger in the syringe. Observe the inside of the flask.
2. Explain the change that you observed inside the flask. Pulling up on the plunger decreased the air pressure inside the flask causing the water molecules to condense onto the smoke particles (condensation particles). A cloud formed. (Note: Pushing the plunger back down increases the air pressure. The water molecules move away from the smoke particles. The cloud "disappears.")
3. What three conditions were present in this experiment that enabled a cloud to form? Condensation particles, water, and a drop in air pressure
4. What condition that is often involved in cloud formation is not involved in this experiment? A decrease in temperature

Cloud Formation Part 2

Materials

- 400-500 ml beaker or jar
- plastic wrap
- water
- rubber band
- matches
- ice cubes

1. Fill a 400-500ml. beaker fill with lukewarm water. Light a match and hold it over the beaker. Then blow it out forcing some of the smoke down into the beaker. Quickly put a piece of plastic wrap over the beaker and secure it if necessary to keep in the smoke. Observe the beaker for any change in the air above the water. After 30 seconds, place 2-3 ice cubes on top of the plastic. Observe again.
2. Why was there very little, if any, change in the air before the ice cubes were placed over the top? Not enough conditions were present for cloud formation to occur.
3. What conditions for cloud formation were present before the ice was added? Water and smoke particles
4. Explain the change you observed after the ice was added. The temperature of the air dropped enabling the water to condense onto the smoke particles forming cloud droplets and therefore, a

cloud.

5. What condition that is often involved in cloud formation was not present in this experiment? A drop in air pressure.
6. When you see fog, what are you actually seeing and what caused it to form? It is a cloud over the earth's surface due to a sufficient amount of water molecules and dirt particles in the air. along with a drop in air pressure and/or a drop in temperature.

Evaluation

During the discussion of the water cycle ask the students questions about the various components of the cycle: what they anticipate will happen at each phase and how and why it happens. Answers to the questions that pertain to each of the lab activities can also be discussed and graded.

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Author

Becky Rudesill, Shenango High School

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EPA ENVIRONMENTAL EDUCATION

WATER PURIFICATION BY EVAPORATION AND CONDENSATION

GRADE LEVEL: 4 – 7

BACKGROUND: The following demonstration illustrates how the water cycle helps to purify water. The key terms are evaporation and condensation. Evaporation is defined as the process through which a liquid becomes a vapor. Condensation is the process through which a vapor becomes a liquid, and is the opposite of evaporation. In the case of water, the main mechanisms for evaporation and condensation are heating and cooling, respectively.

MATERIALS NEEDED:
4 cups of dirt or sand
a dozen stones
2 quarts of water
a large glass bowl with tall sides (mixing bowl)
a short glass
clear plastic wrap
a sunny day.

PROCEDURE: Mix the dirt (or sand) and water in a large bowl. Stand a clean and empty short glass in the center of the bowl. Place the bowl outside in the sun. Cover the bowl with the plastic wrap and weigh down the edges with the remaining rocks. Place one rock on the plastic wrap directly over the cup. Allow the bowl to remain in the sun for several hours. Look in the cup (it should contain some relatively clean water free of mud). Look in the bowl (it should contain the dried dirt).

FOLLOW-UP QUESTIONS:

1. What are the two processes responsible for purifying the water? (Evaporation and Condensation)

2. Where else do you see condensation? (Cold drink outside on a hot day)

3. How does this process work on Earth?

4. What is the plastic wrap? (Our atmosphere)

5. What is the condensation? (Clouds and rain)

6. What would happen if the plastic wrap was dirty? (Air pollution)

VARIATIONS: Add food coloring to water to demonstrate that this process does not remove all pollutants. This may be done simultaneously with the procedure above.

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Introduction to the Water Cycle

Framework Focus:

Earth and Space Science Learning Standard 10: Describe how water on earth cycles in different forms and in different locations, including underground and in the atmosphere.

Physical Sciences (Chemistry and Physics) Learning Standard 3: Describe how water can be changed from one state to another by adding or taking away heat.

Objectives:

1. Students will be able to correctly define and use basic vocabulary terms associated with the water cycle (collection, evaporation, condensation, precipitation, etc.)
2. Students will be able to illustrate a labeled diagram of the water cycle.

Introduction:

This is a water cycle wheel intended to be made after students have learned basic vocabulary terms collection, evaporation, condensation, and precipitation and have viewed multiple visual models of the water cycle. This may be done through the science text or any other technique of the teacher's choice. There is also a link to a template for a water wheel with a pre-made picture in the web resources section for students who may need an illustration to label. The objective in giving students a blank wheel is to allow them to illustrate a scene from their own experience.

Time: 45 minute period (lesson assumes prior knowledge of water cycle)

Materials:

Visual representations of the water cycle (posters, books, etc.)
Water cycle wheel and illustration blank diagrams
Markers, colored pencils, or other art materials
Water cycle vocabulary sheet (optional for this lesson)
Scissors, brass fasteners