



Established Program to
Stimulate Competitive Research

Eighth Grade Experiment Booklet Spring 2018



Funding provided through:
National Science Foundation
EPSCoR RII Track-1 Award
Award # OIA-1355466

Table of Contents

Acknowledgment.....	3
Summary of Intervention Objectives.....	4
Unit One: Weather.....	5
Cloud particles and cloud formation	6
<i>Lesson One: Hot and Cold Water</i>	6
<i>Lesson Two: Cloud in a Bottle</i>	7
<i>Assessment</i>	10
<i>Lesson Three: Watersheds and the Urban/Rural Inference</i>	11
<i>Assessment:</i>	14
Greenhouse Effect	15
<i>Lesson Three: How to understand and use historical weather data</i>	15
<i>Assessment</i>	17
<i>Lesson Four: Forecasting the weather</i>	19
Unit Two: Sustainable Materials	23
Lesson one: Helpful Hydrogels	24
<i>Assessment</i>	29
<i>Helpful Hydrogels-Lab Questions-Teacher Answer Key</i>	30
Lesson Two: Fermentation in a Bag:.....	32
<i>Fermentation in a Bag- Lab Procedure:</i>	34
<i>Fermentation in a Bag-Data Table</i>	35
<i>Fermentation in a Bag-Career Information</i>	36
<i>Assessment</i>	37
<i>Fermentation in a Bag-Lab Questions-Teacher Key</i>	38
Lesson 3: Shampoo Sequence	40
<i>The Heat Is On – Lab Procedures</i>	42
<i>The Heat is On-Career Information</i>	43
<i>The Heat Is On – Student Data Table</i>	44
<i>Assessment 1</i>	45
<i>Assessment 2</i>	46
<i>The Heat Is On – Lab Questions – Teacher Key</i>	47
<i>pH Neutral Information Sheet</i>	51
<i>pH Neutral - Lab Procedures</i>	51
<i>pH Neutral-Career Information</i>	53
<i>pH Neutral Student Data Table</i>	54
<i>Assessment</i>	55
<i>pH Neutral Student Lab Questions – Teacher Key</i>	56
<i>How Does My Shampoo Rate?</i>	61
<i>Shampoozled Part 1: Lab Procedures</i>	62
<i>Shampoozled-Career Information</i>	63
<i>Assessment</i>	64
<i>Shampoozled Part 1 – Lab Questions-Teacher Key</i>	65
<i>Shampoo Options</i>	69
<i>Shampoozled Part 2 – Lab Directions</i>	70
<i>Shampoozled-Career Information</i>	71
<i>Assessment</i>	72
<i>Shampoozled Part 2-Lab Questions-Teacher Key</i>	73

Acknowledgment

The Rural STEM Outreach Program is supported by ND EPSCoR and NSF Award #OIA 1355466. Materials contained in this booklet were created and compiled by multiple individuals. The source for each lesson is included along with citations and copyright information. While many of these materials have been modified, specifically to adhere to North Dakota education standards, these materials are not the sole creation of any faculty or staff affiliated with EPSCoR.

Summary of Intervention Objectives

Students will be able:

1. To interpret the increase of climate temperature over years.
2. To explain the process of weather forecast.
3. To categorize the types of clouds.
4. To discover the process of cloud particles and formation.
5. To apply principles of hydrogels to critically analyze the environmental impact of using hydrogels in farming or gardening.
6. To follow precisely a multistep experiment through accurate completion of activities.
7. To apply scientific principles from activity to identify use of biofuels to minimize human impact on the Earth.
8. To identify chemical reactions between NaOH and H₂O through regular temperature measurements of the combined mixture.
9. To determine relationships among energies transferred during the NaOH and H₂O chemical reaction through temperature changes of the combined mixture.
10. To place proportional data (e.g. time, temperature) on a graph.
11. To label the addition of citric acid to NaOH as a chemical reaction based on changes in pH levels.
12. To place proportional data on accompanying pH lab table.
13. To identify when a chemical reaction has occurred, during an experiment, by assessing change in substance properties.
14. To apply information regarding minimizing human impact on the environment, via their own consumer habits.
15. To discuss how the process of manufacturing shampoo can consume more or less natural resources and the impact this has on Earth's systems.

Unit One: Weather

This unit is designed to help students understand the phenomena of greenhouse effects on the earth. Students will identify the reasons for rising temperature; which the greenhouse effect is considered to be one of the factors contributing to this issue. Also, this unit is designed to help students understand cloud formation.

Cloud particles and cloud formation

Lesson One: Hot and Cold Water

Standards:

- *MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.*
- *NGSS: Developing and using models.*
- *NGSS: Planning and carrying out investigations.*
- *MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.*

Objectives:

Students will be able to provide an explanation on how the water cycle contributes to the process of cloud formation

Students will be able to interpret the impact of air masses on clouds and precipitations

Note:

This is a Requisite Experiment: Hot and Cold Water
Use as a demonstration for the entire class.

Time: 10 minutes

Materials:

- Eight bottles
- hot water
- cold water
- different food coloring

Activity procedure:

Students will do an experiment about the effect of cool or warm water on its condensation and rising, which is similar to what would occur for cold and hot air.

Steps:

Every group will have four bottles. Two bottles will be filled with hot water mixed with yellow food coloring. Two different bottles will be filled with cold water mixed with blue food coloring. Use a notecard to close the top of hot water bottle and place it on the top of cold water bottle. Repeat steps with cold water bottle on top, and hot water bottle on bottom. Discuss observations.

See this video that demonstrates this experiment:

<https://www.youtube.com/watch?v=86ChgK38EIA>

Lesson Two: Cloud in a Bottle

* This lesson is retrieved from <http://betterlesson.com/lesson/631794/cloud-in-a-bottle>

Objectives:

Students will be able to interpret the process of cloud formation

Time: 35 minutes

Materials:

- Erlenmeyer flask
- Hot plate
- Balloons
- Beaker of water (20 ml)
- Ice
- 2-liter plastic soda bottle (one per group)
- Warm tap water
- Safety matches
- Isopropyl alcohol
- Air pumper
- Glasses

Warning: Ask students to wear their safety glasses when they work on this experiment.

Activity procedure:

Notes:

- *There are four parts to this lab.*
- If you are using the temperature strips—like those you find for aquariums—be sure that students can easily read them.
- Using clear, straight walled 2L bottles versus colored bottles will help.

1. Start by reviewing Gay-Lussac's law and the relationship between pressure and temperature at a constant volume and how clouds form.

Gay-Lussac's Law: if the volume of a container is held constant as the temperature of a gas increases, the pressure inside the container will also increase.

2. To begin the demonstration:
 - a. Add 5 ml of tap water to the Erlenmeyer flask, place the balloon over the opening to seal the flask, and then place it on a hot plate.
 - b. Heat the water, but do not let it all boil away.
 - c. Carefully remove the flask from the hot plate and ask students to share what they observe.
 - d. Have students explain to you why the balloon inflates by drawing on their prior learning from previous labs and investigations.

3. With a second Erlenmeyer flask:
 - a. Add 5 ml of tap water to the Erlenmeyer flask and then place it on a hot plate.
 - b. Heat the water, but do not let it all boil away.
 - c. Carefully remove the flask from the hot plate.
 - d. Stretch the balloon over the opening.
 - e. Place the flask into the ice water bath.
 - i. If done correctly the balloon should be inverted into the flask.
 - f. Again, ask students what they think is happening.
 - g. Relate this back to previous lessons on air pressure.

4. Part four can be optional - It involves using a tiny amount of rubbing alcohol in place of the water.
 - The recommendation is to do this as a demonstration, due to rubbing alcohol being flammable.
 - If you have access to a water bottle rocket device and pump or other similar apparatus, you can create a really dense cloud.
 - There's a demonstration and instructions on Steve Spangler Science. (<https://www.stevespanglerscience.com/lab/experiments/cloud-in-a-bottle-experiment/>)

The reason the rubbing alcohol forms a more visible cloud is because alcohol evaporates more quickly than water. Alcohol molecules have weaker bonds than water molecules, so they let go of each other more easily. Since there are more evaporated alcohol molecules in the bottle, there are also more molecules able to condense. This is why you can see the alcohol cloud more clearly than the water cloud.

After you have your students clean up, engage them in the following questions
 (Note: Giving an “answer” is never sufficient – they must explain their thinking):

Assessment or Discussion Questions:

1. *What did you observe inside the bottle when you squeezed and released the bottle?*
2. *What gas law was operating during this experiment? Explain.*
3. *If pressure decreases and volume increases when the bottle is released, what do you think happens to temperature? What evidence do you have?*
4. *What happened when you used a dry bottle?*
5. *What did you observe when you added water to the bottle?*
6. *Low-pressure areas are the result of air rising into the atmosphere from Earth’s surface. Explain how this might result in cloud formation over a low-pressure area.*
7. *High-pressure areas are the result of air falling from high altitudes and expanding. Explain how this might result in clear skies over a high-pressure area.*
8. *What did you learn about cloud formation from today’s activity?*

With regards to the cloud in a bottle:

1. *What variables did you change when you pumped the air out of the bottle?*
2. *What caused the cloud to form?*

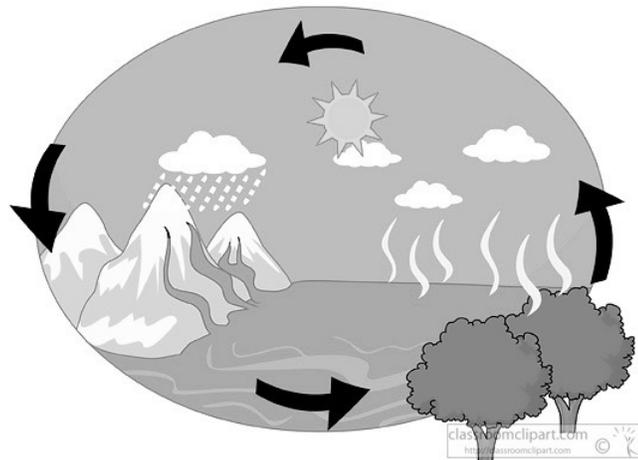
3. *Do you think the water vapor in the air in the room had any effect on the cloud formation?*

With regards to Earth's Atmosphere:

1. *Is the air in our atmosphere in a container? Explain.*
2. *What are the first steps in the formation of clouds? (Evaporation of water, followed by decreases in pressure and temperature.)*
3. *Why does water vapor rise?*
4. *What happens to the temperature and pressure of the water vapor as it rises?*

Assessment

Based on what you have learned, explain the steps of the water cycle below



Lesson Three: Watersheds and the Urban/Rural Inference¹

Standards:

ND 8.1.1. Organize changes (e.g., patterns, cycles) that occur sequentially in systems.

ND 8.2.4. Design and conduct a scientific investigation (e.g., making systematic observations, making accurate measurements, identifying and controlling variables).

ND 8.7.1. Explain the interaction of science and technology with social issues (e.g., mining, natural disasters).

ND 7.8.1. Explain how science is influenced by human qualities (e.g., reasoning, insightfulness, creativity, life-long learning).

Lesson Overview:

Human uses and impacts on water quality and quantity differ in some significant ways in urban and agricultural areas, yet both share the same watershed. Understanding the urban/rural interface is important to understand how human activities from both urban and agricultural areas can have a multiplying effect on the environment. In this activity, students will create a simulated watershed and observe how pollution from urban and agricultural areas mix.

Time Required: Approximately 20 minutes

Concepts and Vocabulary:

- **Point source pollution:** Pollutants that come from a single identifiable source.
- **Non-point source pollution:** Pollutants that come from a widespread area.
- **Urban/rural interface:** Geographical regions where densely populated urban areas and less populated rural areas come into contact. Interactions between these areas affect land use and natural resources.
- **Watershed:** An area of land where ground water and surface runoff drain to the lowest point in that region.

Materials:

- Flip chart paper and writing implements
- One (1) roll of aluminum foil (18-inch width)
- One spray bottle per group
- At least two water-soluble markers per group (watercolor markers work well)

Getting Ready:

- Cut a piece of aluminum foil for each group that measures approximately 18” x 18”.
- Fill the spray bottles with water.
- Divide students into four groups of 3-4 individuals.

¹ This lesson was adapted from 4-H extension services.

- Provide each group with 1-2 sheets of flip chart paper and writing implements.
- Provide each group with two (2) watercolor markers. Make sure each group has two different colors.

Opening Questions/Prompts:

- Ask students to share their answers to these questions either verbally or by recording their responses on the flip chart paper provided.
- Explain what you know about different ways that water is used by humans who live in agricultural areas.
- Explain what you know about different ways that water is used by humans who live in urban areas.
- Discuss ways in which urban water use is similar to agricultural water use. Discuss ways they are different.
- Discuss the types of pollutants you think might be present in urban and agricultural areas. How do you think they might be similar? How do you think they might be different?

Procedure (Experiencing):

1. Explain to students that the foil represents a large piece of land. Each square inch of the aluminum foil represents 10 square kilometers.
2. Instruct the groups to draw a line down the center of the foil using one of their markers.
3. Using **one** of the watercolor markers, draw pictures that depict an urban setting on one side of the piece of foil. Using the **other** watercolor marker, draw pictures that depict an agricultural setting on opposite side.
4. Have each group loosely crumple their piece of aluminum foil and then gently pull out all four corners of the square. This should return the foil to its approximate square shape, but still allow for the foil to have some “peaks and valleys” that represent different landforms.
5. Using a spray bottle to simulate rain, have the students gently spray their foil. Spray water on the foil from a distance of approximately 10-12 inches above the foil. Spray the foil approximately 10 times consecutively to simulate a rainstorm.
6. Instruct students to record their observations in their lab journal and make comparisons with other groups.

Sharing, Processing, and Generalizing:

Follow the lines of thinking developed by students as they share and compare their thoughts, observations, and procedures; if necessary, use more targeted questions or prompts to get to particular points.

Specific questions might include:

1. Ask students to explain what happened when they sprayed their “land” with water.
2. Discuss the significance of the flow of water through their “land” with respect to the “urban” and “agricultural” areas they identified.
3. Discuss ways you think the movement of water across your land might impact the potential mixing of pollutants from urban and agricultural areas.

Concept and Term Discovery/Introduction:

Be sure to introduce the terms [urban/rural interface](#), [watershed](#), [point source pollution](#), and [non-point source pollution](#) within the context of water usage, water quality, and water quantity.

(**Note:** The goal is to have students develop concepts through their own exploration and define terms using their own words.)

Concept Application:

The true test of learners' understanding is when they can apply new knowledge and skills to authentic situations. When engaging students in inquiry-based learning, hands-on activities serve as vehicles for learning new concept knowledge and skills; however, it is the application of new knowledge or skills to independent, real-world situations that is the critical factor in the learning process. Thus, to complete the cycle of experiential learning it is important to provide students specific opportunities for authentic applications.

Suggestions for real-world applications for the activity include:

1. Have students investigate their community or a community in their area. Where is there an interface between urban (or suburban/small town) and rural. What are the potential types and sources of point and non-point pollution?
2. Contact your state or regional water resources control board or water resources agency, offices that regulate water allocation and help ensure water quality protection. Learn strategies that your state or region has in effect or planned to manage issues that arise with respect to the urban/rural interface.

Assessment:

After conducting experiments and contacting local water boards, have students write a reflection paper. What is water quality? Have students include important terms in their paper. Students should include additional research on managing rural and urban water quality.

Greenhouse Effect

Lesson Three: How to understand and use historical weather data

Standards

- *MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.*
- *MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.*
- *Social Studies 1: 8.1.2: Use various primary and secondary resources (e.g., historical maps, diaries, speeches, pictures, charts, graphs, diagrams, time lines specific to North Dakota) to analyze, and interpret information.*
- *Social Studies 1: 8.1.1: Interpret current North Dakota thematic maps (e.g., soils, climate, vegetation, water, climate) to identify where people live and work, and how land is used.*

Objectives:

Students will be able:

- To demonstrate an understanding on how greenhouse phenomenon occurs
- To explore the reasons of temperature rise
- To interpret the data of past climate
- To predict the impact of greenhouse on the earth and agricultural process

Materials

- Glass Container 10in x 10in x 10in
- 2 Small boxes
- 2 Thermometers
- Lab notebook
- Pen/pencil
- Various maps:
 - World map depicting climate change effects:
<https://climate.nasa.gov/interactives/climate-time-machine> or an image available here: https://secure.i.telegraph.co.uk/multimedia/archive/01508/Climate-ChangeNEW_1508747a.jpg
 - US Map depicting climate data: <https://www.climate.gov/maps-data>
 - Figure showing the increase in average temperature over years:
<https://www.climate.gov/maps-data>
- Video describing climate change "Climate Change 101 with Bill Nye":
<https://www.youtube.com/watch?v=EtW2rrLHs08>

Background

Students will be asked “What is climate change and what causes it?” They then will watch the video above describing climate change and look at the world map and figure (see above) showing its effects.

Activity procedure

1. Students will be asked to read about greenhouse effect in a scholarly paper: <http://content.csbs.utah.edu/~mli/Economics%207004/The%20Carbon%20Dioxide%20Greenhouse%20Effect.pdf>. It is also available in HTML here: <https://history.aip.org/history/climate/co2.htm> (They will only need to read the first paragraph of the paper)
2. Students will develop a simultaneous design to interpret greenhouse concept. In this part, students will conduct the experiment, following these directions:
 - a. Place a thermometer into small box that can provide it with a shade and measure the initial temperature. Record this information at the top of your worksheet and label it “test.”
 - b. Cover the thermometer and the box with the glass container 10in * 10in * 10in.
 - c. Place another thermometer into small box outside the glass container make sure to take the initial temperature. Again, record this information at the top of your worksheet and label it “control.”
 - d. After ten minutes, read both temperatures and record them in your worksheet.
3. Students have a chart that represents the temperature variations over 25 years to help students compare and contrast the differences between the weather temperatures across the years, which is known as “hardiness zones”.
4. Students will be asked to:
 - a. Predict the plant hardiness zones for the next ten years based on the information you gathered about the greenhouse effect and the colored map of hardiness zones.
 - b. Predict the impact of growing urban populations (cities, industries, and increase car travel → think about emissions) on greenhouse phenomenon.

Assessment

Name _____

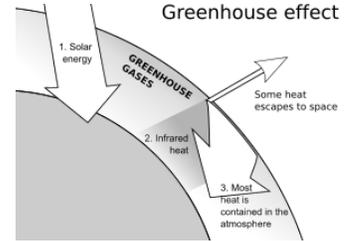
Worksheet 1

Section 1

Initial Temperatures: _____

The temperature of the thermometer inside the glass box:

The temperature of the thermometer outside the glass box:



Explain what greenhouse effect means in your own words based on your observation:

What are 3 implications for greenhouse effect?

1. _____
2. _____
3. _____

Do you think the greenhouse effect will be a threat in the future?

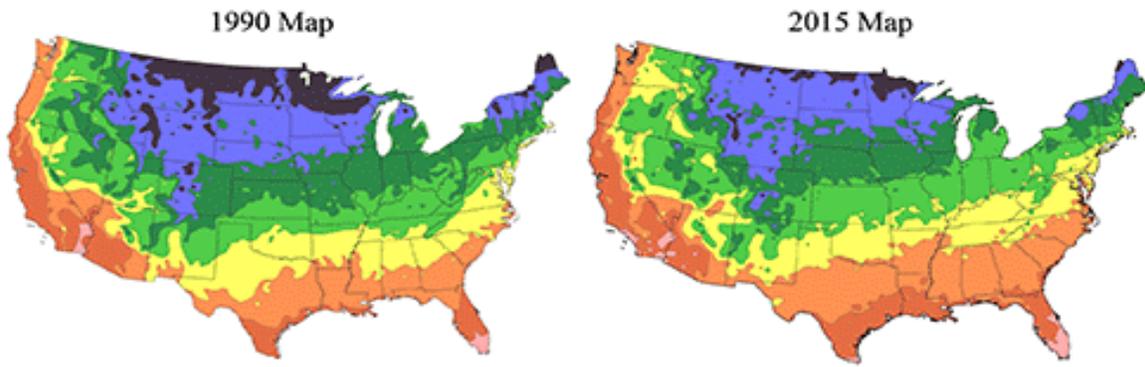
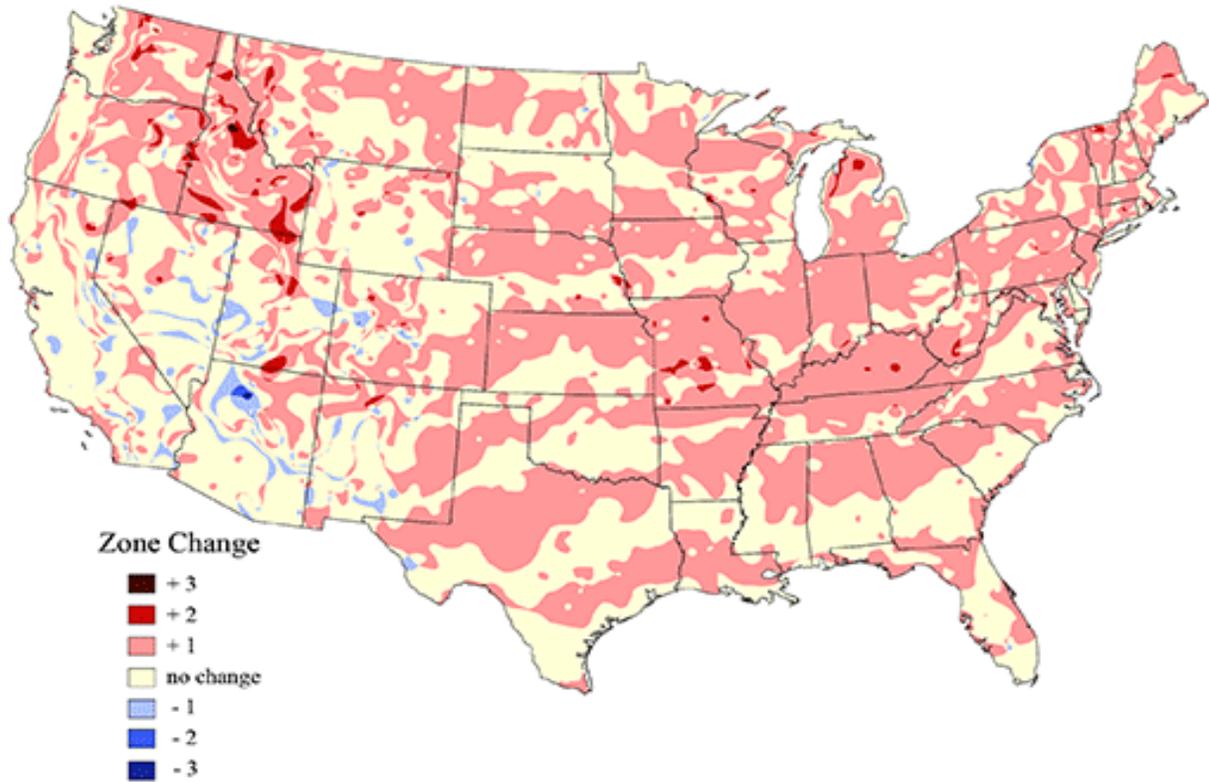
Section 2

By using the maps that show different changes on the climate temperature between 1990 and 2015, several regions and states become warmer such as...

Section 3

What surprised you about this experiment?

Differences Between 1990 USDA Hardiness Zones and 2015 ArborDay.org Hardiness Zones



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990.

Arbor Day Foundation Plant Hardiness Zone Map published in 2015.



© 2015 Arbor Day Foundation®

* This chart retrieved from https://www.arborday.org/media/map_change.cfm

Lesson Four: Forecasting the weather²

Standards

- *MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.*
- *NGSS: Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models.*

Objectives:

Students will be able to predict their weather by developing an understanding on how they can forecast the weather

Time: 45 minutes

Materials:

- Directions sheet
- 1 set of weather maps for three consecutive days per pair of students
- 1 blank map of North America
- Colored pencils (red, blue, purple)
- Highlighter

Activity procedure:

Introduction:

This two-day lesson serves as the final activity in this unit. If you have not completed all of the previous lessons, it is still possible to present this to your students, however you may wish to guide them through the activity leading up to the final prediction.

Note that in the NGSS 6-8 Earth Science MS-ESS2-5 standard, weather station diagrams and weather map symbols are outside of the assessment boundary. This lesson does not address wind barbs and flags or cloud cover, nor have they been included in this unit. If you cover weather station models, you could insert that lesson before teaching this final activity. The decision was made to only address the weather symbols that are common to televised weather maps that are broadcast daily.

It is the end of unit, but if necessary include some review of important terms and definitions. The lab discusses “Hardiness zones”, “occluded fronts”, etc. Make sure students know what they are expected to do.

Engagement:

Show a short video clip of a broadcast weather forecast. Go to the website - <https://www.accuweather.com/en/us/national/weather-radar>, then press "play" to show the national radar. You can also other sites to show other representations or add your location to

² This lesson retrieved from <http://betterlesson.com/lesson/635035/forecasting-the-weather>

show local radar weather (please note that websites are updated regularly and these navigation instructions may no longer work).

After showing the video ask the class what daily information is presented?

Prompts:

What units are given?

Where do they find evidence of fronts, high/low pressure, temperature, precipitation, cloud cover, humidity or wind speeds?

Much of what they have been studying is captured in a few minutes of video and now it's their turn to try their hand at predicting the weather.

Explore:

Give a packet of three weather maps that span three days to each pair of students. For each day, there are four maps to study. One large map that includes fronts, pressure systems and isobars and three small maps showing wind speed, high/low temperature and precipitation. You may choose to select any week you like.

Note: These maps come from the Department of Commerce [Daily Weather Map](http://www.wpc.ncep.noaa.gov/dailywxmap/pdffiles.html) (<http://www.wpc.ncep.noaa.gov/dailywxmap/pdffiles.html>).

From here you can select a week of maps going back several years. If there is a significant weather event you would like to present, say a hurricane, Nor'easter, etc. simply select the week in question to download. You can opt for Black and White or Color images.

Directions:

For each map students will:

1. On the large map, identify/color the following:
 - Warm fronts red.
 - Cold fronts blue
 - Stationary fronts red/blue alternating
 - Occluded fronts purple
 - Center of the high-pressure systems, color the H blue
 - Center of the low-pressure systems, color the L red
2. Highlight the following on the large map:
 - The corresponding air pressure next to each High and next to each Low. NOTE: If using the NOAA maps, these numbers will be underlined and in a smaller font next to the center of each pressure system (i.e. 1023)
3. For the 500-millibar Height Contours map (**wind speed**)

- Circle the locations of the highest and lowest wind speed in the United States only. Recall from earlier lessons that wind speed is faster where the contour lines are closer together and slower where they are farther apart.

4. For the High/Low Temperature Map

- Circle the **highest high** temp and **lowest high** temperature and record their locations on the map. NOTE: On the temperature map there are two values for each location. The top number is the daily high temp and the bottom number is the daily low temp. You can ignore the daily low temp.

68 = **daily high - record this number only**

35 = (daily low - ignore this value)

5. For the 24-hour Precipitation Map

- Circle the region that is the driest. These areas will show a single dot on the map.
- Find and circle the highest rainfall and record its location on the map. Rainfall is measured in inches. A single T indicates a trace of rain.

Predict:

Once they have analyzed three consecutive days of weather, it's time to make predictions for the fourth day. Working with their partner, they are to track the position of the fronts, pressure centers and precipitation then take the blank map of North America and predict the location of the High and Low-pressure systems, all weather fronts, high and low temperatures, driest and wettest locations, and areas of highest and lowest wind speed. They will add these to the blank map using the corresponding colors, symbols and units. When finished they show their work with the teacher.

Reflection:

Once students have made their predictions and checked with you, ask them to reflect on the accuracy of their model. Students are not graded on the exactness of their forecasts, but rather on the completeness and neatness of the maps and the analysis in their reflection.

Students are asked to write a paragraph that compares their prediction to the actual forecast for day 4. *What was similar? What was different? Were you surprised by the outcome? Did it bring up any questions? Talk it over with your partner before drafting the final paragraph.*

Explain:

This lesson will most likely run two class periods. To wrap up this lesson discuss what was challenging about this lesson and connect that to the challenging of forecasting weather.

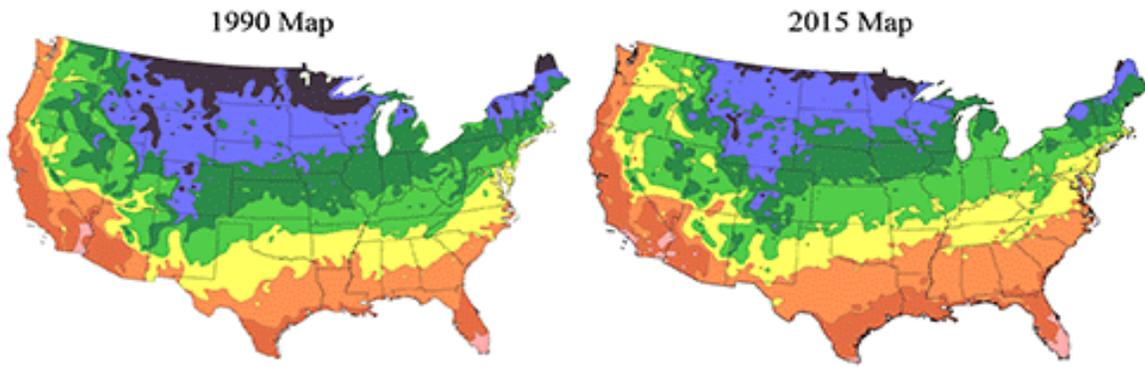
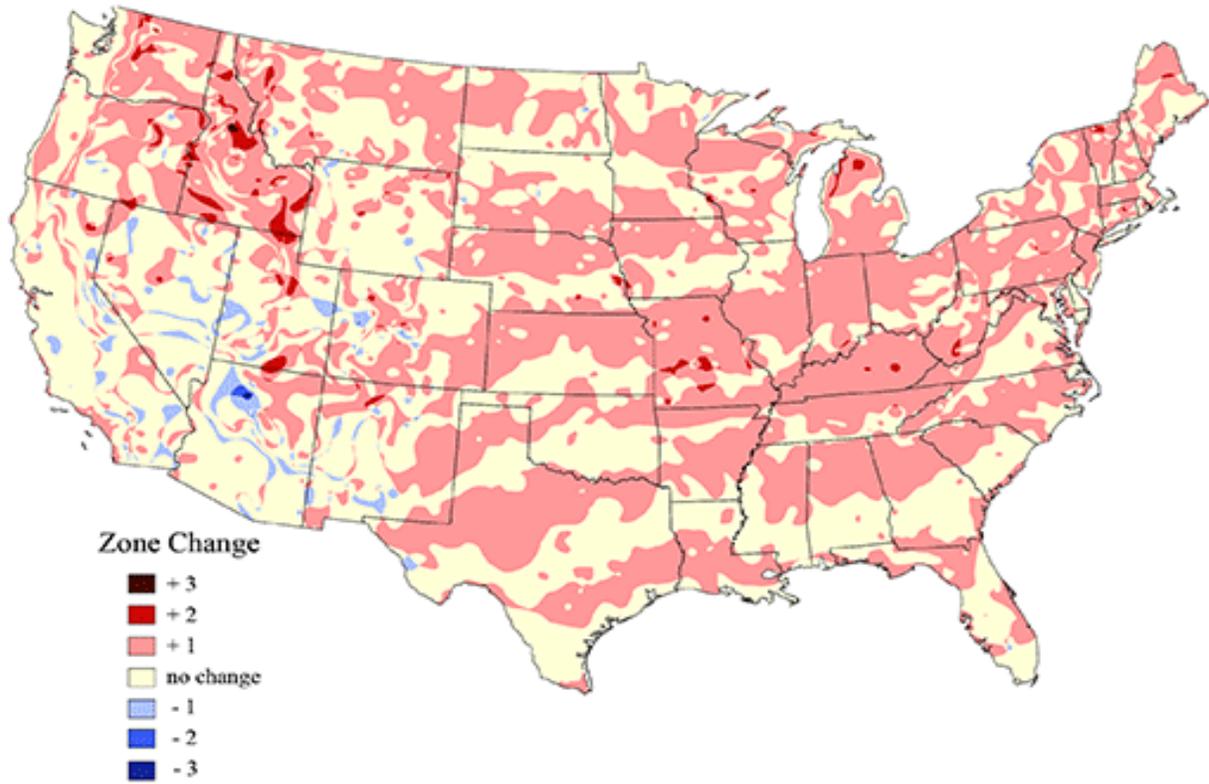
What makes it predictable? What makes it hard to predict? How are all the parts tied together (air pressure, temperature, wind, precipitation, humidity, cloud cover).

Spend the time to hear from the class and help them make sense of any parts of this unit that are still unclear.

Assessments:

The assessments are formative, relying on how students would be able to predict the weather.

Differences Between 1990 USDA Hardiness Zones and 2015 ArborDay.org Hardiness Zones



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990.

Arbor Day Foundation Plant Hardiness Zone Map published in 2015.



© 2015 Arbor Day Foundation®

* This chart retrieved from https://www.arborday.org/media/map_change.cfm

Unit Two: Sustainable Materials

This unit introduces students to the idea of sustainable materials. Students will begin to understand how technology can be created or modified to protect the Earth and its resources. More specifically, students will explore water conservation, biofuels, green manufacturing choices, and consumer purchasing of sustainable materials. We strongly encourage you to invite and collaborate with the 5th grade class during the Shampoo units. In this way, 5th grade students can have experience with this material without handling dangerous substances (i.e., NaOH)

Lesson one: Helpful Hydrogels³

North Dakota Education Standards

- *MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment*
- *RST.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.*

Learning Objectives:

Students will be able to:

- Apply principles of hydrogels to critically analyze the environmental impact of using hydrogels in farming or gardening
- Follow precisely a multistep experiment, through accurate completion of this activity

Goal: Students will observe and measure hydrogels ability to conserve water within soil compared to soil alone. Students will apply this knowledge to real life applications of hydrogels.

Time: Two 45-60-minute class periods. (One day for the diaper portion and one day for soil comparison portion)

Materials Per Lab Group:

- Disposable diaper -1 per group member
- 4 cups red solution (Water and red food dye)
- Scissors-1 per group member
- 1 tsp. measuring spoon
- 1 cup measuring cup
- 1/2 cup measuring cup
- Gallon size zipper-lock bags-1 per group member
- 2 Plastic cups, 266 mL (9 oz)
- 4 cups Potting soil
- 4 Clear plastic pots with drain holes and plastic tray
- 1 tsp. flaked (Bagged) Hydrogel
- 1 tsp. round (Bottled) Hydrogel
- 1 tsp. activated diaper Hydrogel
- 1 Marker
- Graduated Cylinder

Background: Polymers are multiple molecules linked together. This can be compared to monomers, which are composed of one molecule. Polymers (commonly known as plastics) are

³ This lesson was received and modified from Steve Spangler Science on behalf of 4-H National Youth Science Day 2008: <http://www.stevespanglerscience.com/lab/experiments/helpful-hydrogels/>

either naturally occurring (rubber, RNA and DNA, proteins, starch, and cellulose) or synthetic (manufactured).

Hydrogel polymers are long molecule chains made up of repeating units that grab onto water molecules. This characteristic makes them a great solution for soaking up water.

Many environmental applications for hydrogels have been found for agriculture, as well as IN the construction and horticulture industries. Hydrogels help reduce water runoff and soil erosion, thus improving the quality of lakes, streams, and rivers. Hydrogels also help with moisture retention and water conservation by helping soil increase water holding capacity, allowing plants to survive during droughts. Erosion control, soil management, and environmental cleanups are also ways hydrogels can help the environment. Many scientists continue to study the effect of hydrogels on the environment.

In this series of investigations, you will start by looking for a particular polymer at work. Once you discover what this type of polymer can do, you will experiment with other uses for the same polymer. A final step can be taken to consider solutions for water conservation and groundwater contamination.

Procedure:

PREP:

- Mix water and red food dye to create a red solution.

IN CLASS:

- Tell students you will be completing an experiment to understand one-way scientists have created new technology to help conserve water.
- Introduce the concepts of molecules, monomers, and polymers.
- Explain what a hydrogel is and some of their real-life applications
- Hand out student lab procedures, career information, and lab questions. Briefly review lab procedures.
- Have students collect lab materials.
- Students should follow lab procedures and clean up as directed.
- Have students complete lab questions

Assessment:

- Successfully completing experiment
- Following lab procedures (rubric attached)
- Accurate completion of lab questions

Helpful Hydrogels-Lab Procedure

1. Remove all materials from your lab station. Get a pair of safety glasses and gloves for each member of the group. **Put both on.**
2. Have one member of your group collect lab materials:
 - Disposable diapers-1 per group member
 - Scissors-1 per group member
 - Gallon size plastic bag-1 per group member
 - 1 tsp. measuring spoon
 - 1 cup measuring cup
 - 1/2 cup measuring cup
 - 2 plastic cups
 - Graduated cylinder
 - 4 cups red solution
 - 4 cups potting soil
 - 4 clear plastic pots with plastic trays
 - 1 tsp. flaked Hydrogel
 - 1 tsp. round Hydrogel
 - Marker

DAY ONE:

3. Lay the diaper flat on the table. Carefully cut through the inside lining of the diaper on one side. Flip it inside out, inside a gallon size bag. Pull out the cotton and powdered material inside, leaving it on the bottom of the bag. Tear up the cotton part to loosen the powder from it. Discard the outside of the diaper.
4. Blow a little air into the bag to make it puff up like a pillow and then seal the bag.
5. Shake the bag for a few minutes to remove the powdery hydrogel polymer from the stuffing.
6. Carefully remove the stuffing from the bag, leaving as much powder inside as possible.
7. Pour 1/2 cup of water into the bag. Observe the mixture. Save these bags for tomorrow's experiment

DAY TWO:

8. Label one plastic pot "None", one plastic pot "Diaper", one plastic pot "Flaked", and one pot "Round". Set each pot upon its clear tray.
9. Put 1 cup of potting soil into the "None" pot. This is called the **control** in the experiment. It can be compared to the other pots that will have hydrogels in the soil.
10. Collect 1 tsp. of diaper hydrogel from a plastic bag from yesterday's experiment. Combine this with one cup of potting soil. Put the mixture in the "Diaper" pot.

11. Combine 1 tsp. flaked hydrogel with 1 cup potting soil. Put the mixture in the “Flaked” pot.
12. Combine 1 tsp. round hydrogel with 1 cup potting soil. Put the mixture in the “Round” pot.
13. Pour 1/4 cup red solution into EACH of the pots and observe. Does any water drain through the soil onto the tray? Record in the first row of the table in your lab questions handout.
14. After 1 minute, add another 1/4 cup red solution into each pot. Observe the amount of water that seeps through the soil onto the tray
15. After 1 minute, add another 1/4 cup red solution into each pot and observe.
16. After five minutes, observe the color of the water in each tray and write down your observations in the second row of the lab questions table. Use the graduated cylinder to measure the amount of liquid in each tray. Record the amount on the table in the third row of your lab questions handout.

Helpful Hydrogels-Career Information

Did you enjoy using the scientific equipment, the step-by-step accuracy of the experiment, or other parts of this lab? Consider a career where you could include these skills and more!

Some careers that use a similar set of skills as this lab include:

1 Environmental Biologist

Job Duties:

- Collect and analyze data to determine environmental conditions and restoration needs.
- Develop and communicate recommendations for landowners to maintain or restore environmental conditions.
- Plan environmental restoration projects, using biological databases, environmental strategies, and planning software.

Employers (examples):

- Golder Associates - Senior Project Environmental Scientist, Bismarck, North Dakota
- Ackerman-Estvold Engineering and Management Consulting, Inc. - Senior Water Resource Engineer, Minot, North Dakota
- South Dakota Department of Labor and Regulation, Environmental Planner II Wetland Environmental Specialist, Rapid City, South Dakota

2 Ecologist

Job Duties:

- Identify environmental impacts caused by products, systems, or projects.
- Examine local, regional or global use and flow of materials or energy in industrial production processes.
- Analyze changes designed to improve the environmental performance of complex systems to avoid unintended negative consequences.

Employers (examples):

- Environmental Technician – Hazardous Waste - Clean Harbors Environmental Services, Amegard, North Dakota
- Oasis Petroleum - Environmental Representative, Williston, North Dakota
- CACI International - Environmental Protection Specialist, Washington, DC

To explore more career options, visit <https://www.onetonline.org/>

Assessment

Helpful Hydrogels-Lab Questions

Name: _____

1.

	None	Diaper Hydrogel	Flaked Hydrogel	Round Hydrogel
Did water seep onto tray (Yes or No)				
Water Observations:				
Amount of Water in Tray:				

2. Why might scientists need to create different types of hydrogels?

3. List a job that creates or uses hydrogels.

Helpful Hydrogels-Lab Questions-Teacher Answer Key

1. *Answers will vary. Assess for completion*

	None	Diaper Hydrogel	Flaked Hydrogel	Round Hydrogel
Did water seep onto tray (Yes or No)				
Water Observations:				
Amount of Water in Tray:				

2. Why might scientists need to create different types of hydrogels?

Answers may include: needing different levels of absorption, needing different safety standards for humans vs. soil, creating hydrogels that take longer or shorter to decompose based upon what they are being used for.

3. List a job that creates or uses hydrogels.

Answers will vary but may include: Ecologist, Environmental Biologist, Farmer, Agronomist, Day Care Provider (uses diapers with hydrogels in them), Landscaper, or Green House Employee.

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully.			
Accurately followed teacher and lab instructions			
Cleaned up lab area after finishing experiment			

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully.			
Accurately followed teacher and lab instructions			
Cleaned up lab area after finishing experiment			

Lesson Two: Fermentation in a Bag:⁴

North Dakota Education Standards

- *MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*
- *RST.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.*

Learning Objectives: Students will be able to:

- Apply scientific principles from activity to identify use of biofuels to minimize human impact on the Earth.
- Follow precisely a multistep experiment through accurate completion of this activity.

Goal: Students will observe, measure, and record the amount of ethanol produced during the chemical reaction.

Time: 45-60-minute class session

Materials Per Lab Group:

- 3 tsp. Dry active yeast
- Small graduated cylinders (100mL)
- 1 tsp. Measuring spoon
- 1 tsp. Sugar
- 1 tsp. Cornmeal
- 1 tsp. Sawdust
- 3 Re-sealable zipper bags (“snack” size)
- Rulers to measure bag inflation.
- Warm water-about 104°F
- One for the Class: thermos (with spout) for dispensing warm tap water
- One for the Class: Heat Lamp
- Paper towels

Background: All vehicles burn fuel. These fuels, like gasoline and diesel, come from oil, which we pump out of the ground. Oil is made from the ancient, fossil remains of plants that lived millions of years ago. This is why we call oil a **fossil fuel**. Fossil remains of plants, buried, over millions of years turned into oil. Unfortunately, carbon dioxide used by the ancient plants is now stored in the oil in the ground.

When a fuel, like gasoline, burns in a car’s engine, the ancient carbon dioxide that was stored in the oil for millions of years is released back into the air. All of the vehicles burning fuel have

⁴ This lesson received and modified from Great Lakes Bioenergy Research Center:
<https://www.glbrc.org/education/classroom-materials>

added a lot of extra carbon dioxide to the atmosphere, which is trapping heat in our atmosphere and unbalancing world temperatures.

We can make fuels from plants today. Fuels made from recently living plants are called **biofuels**. When biofuels are burned in an engine, carbon dioxide is released just like when gasoline is burned. But unlike gasoline, plants grown within the last year can absorb the carbon dioxide from biofuels. This means that by using biofuels we can recycle carbon dioxide between plants and the atmosphere, rather than releasing extra CO₂ from fossilized oil.

In this simple experiment, students investigate the process of fermentation in re-sealable bags with baker's yeast, warm water and various sources of plant sugar. Students observe, and measure evidence of the chemical changes associated with fermentation: bag inflation (CO₂) and indicators of ethanol production. Students can measure and compare fermentation rates between feedstocks using rulers.

Using table sugar (sucrose) as a feedstock will yield the most rapid results. Some alternate feedstocks include corn meal, ground corn stover, sawdust, finely ground grass clippings, dead leaves, composting materials, etc. Feedstocks with a starchy or fibrous composition will not ferment as well.

Procedure:

PREP:

- Fill warm water into thermos before the experiment.

IN CLASS:

- Tell students they will be examining the process of fermentation.
- Explain the difference between fossil fuels and biofuels, highlighting the usefulness of biofuels to rebalance the cycle of carbon dioxide release.
- Hand out student worksheets.
- Assist students in collecting lab materials and completing the experiment.
- Collect lab questions and grade for safety adherence.

Assessment:

- Precise completion of experiment.
- Following Lab Safety rules (Rubric Attached).
- Accurate completion of data table.

Fermentation in a Bag- Lab Procedure:

1. Remove all materials from your lab station.
2. Get a pair of safety glasses and gloves for each member of the group; **Put both on.**
3. Obtain your lab materials:
 - 3 Re-sealable bags
 - 3 Teaspoons of yeast
 - 1 Teaspoon sugar
 - 1 Teaspoon cornmeal
 - 1 Teaspoon sawdust
 - 1 ruler
 - 150 ml Warm tap water
4. The cornmeal, sugar, and yeast are all considered feed-stovers. A **hypothesis** is an educated guess about what will happen during an experiment. As a group, make a **hypothesis** about what you think will happen when you combine a feed-stover and yeast, and another **hypothesis** about what will happen when you add warm water to the feed-stover and yeast. Write your hypotheses in the lab questions.
5. In each re-sealable zipper bag, add one teaspoon of yeast.
6. In one re-sealable zipper bag, add a teaspoon of sugar. Label the bag Sugar.
7. In one re-sealable zipper bag, add a teaspoon of cornmeal. Label the bag Cornmeal.
8. In one re-sealable zipper bag, add a teaspoon of sawdust. Label the bag Sawdust.
9. Add 1/4 cup of warm tap water (approx. 104° C) to each bag and seal each bag closed, removing as much air as possible.
10. Mix gently. Lay bag flat underneath the heat lamp. Measure changes in bag height every 5 minutes for 25 minutes with a ruler. Write the measurements on the data table.

Fermentation in a Bag-Data Table

Use this table to record bag height in centimeters. Take your first measurement immediately after combining the yeast, sugar, and warm water and sealing the bag. Then, take a measurement every 5 minutes for 25 minutes.

Time (minutes)	Bag Height (CM) Sugar	Bag Height (CM) Cornmeal	Bag Height (CM) Shavings
0			
5			
10			
15			
20			
25			

Fermentation in a Bag-Career Information

Did you enjoy using the scientific equipment, the step-by-step accuracy of the experiment, or other parts of this lab? Consider a career where you could include this skillset and more! Some careers that use a similar set of skills as this lab include:

Chemist

Job Duties:

- Analyze organic or inorganic compounds to determine chemical or physical properties, composition, structure, relationships, or reactions.
- Produce changes in composition of substances by introducing heat, light, energy, or chemical catalysts for analysis.
- Conduct quality control tests.
- Explore uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.

Current Job Examples:

- U.S. Army Research, Development and Engineering Command – Chemist, Aberdeen Proving Ground, Maryland
- Food and Drug Administration – Chemist, Silver Spring, Maryland
- Agricultural Research Service – Chemist, Beltsville, Maryland

Ecologist

Job Duties:

- Identify environmental impacts caused by products, systems, or projects.
- Examine local, regional or global use and flow of materials or energy in industrial production processes.
- Analyze changes designed to improve the environmental performance of complex systems to avoid unintended negative consequences.

Current Job Examples:

- Environmental Technician – Hazardous Waste - Clean Harbors Environmental Services, Amegard, North Dakota
- Oasis Petroleum - Environmental Representative, Williston, North Dakota
- CACI International - Environmental Protection Specialist, Washington, DC

To explore more career options, visit <https://www.onetonline.org/>

Assessment

Fermentation in a Bag-Lab Questions:

1. Hypothesis 1: What will happen when the yeast and feed-stover are combined?

What happened when the yeast and feed-stover combined?

2. Hypothesis 2: What will happen when the warm water is added to the yeast and feed-stover?

What happened when the warm water was added to the yeast and feed-stover?

3. List a job that would investigate chemical reactions.

Fermentation in a Bag-Lab Questions-Teacher Key

1. Hypothesis 1: What will happen when the yeast and sugar are combined?

Answers will vary, but may include:

The sugar and yeast will mix together

The yeast will be on the top and the sugar will be on the bottom

What happened when the yeast and sugar combined?

The yeast and sugar mixed together a little bit

2. Hypothesis 2: What will happen when the warm water is added to the yeast and sugar?

Answers will vary but may include:

It will mix together like soup

It will mix together and turn into paste

The bag will start getting bigger from gas that's created

What happened when the warm water is added to the yeast and sugar?

The yeast and sugar began to dissolve, and little bubbles formed.

3. List a job that would that would investigate chemical reactions

Answers will vary but may include: chemist, ecologist, chemical engineer, fuel scientist

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully (i.e. no horseplay).			
Accurately followed teacher and lab instructions			
Cleaned up lab area after finishing experiment			

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully.			
Accurately followed teacher and lab instructions			
Cleaned up lab area after finishing Experiment			

Lesson 3: Shampoo Sequence⁵

Activity One: The Heat is On

Suggestion: Pair with 5th grade class

North Dakota Education Standards

- *MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.*
- *MS-PS3-4: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.*
- *8.EE.5: Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.*
- *RST.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.*

Learning Objectives:

Students will be able to:

- Identify chemical reactions between NaOH and H₂O by taking the temperature of the combined mixture at regular intervals.
- State the relationships of transferred energy at each temperature change during the chemical reaction of NaOH and H₂O plot proportional data (e.g. time, temperature) on a graph.
- Complete a multistep experiment.

Goal: Students will observe, measure, and record the amount of heat given off in an exothermic* chemical reaction.

*note, at the Middle School level, students may think about this in terms of releasing energy (not exothermic)

Time: 45–60-minute class period

Materials (for a class of 32 working in groups of 4):

- 120 ml Distilled water
- 8 Graduated cylinders
- 40 g Sodium hydroxide
- 8 Erlenmeyer flasks
- 8 Thermometers
- 8 Stopwatches
- 8 Scales or triple beam balances
- 8 Spatulas
- 8 Sheets of weighing paper

⁵ This lesson was received and modified from beyondbenign:
<http://www.beyondbenign.org/K12education/kthru12.html>

Background: An exothermic reaction is a chemical reaction which gives off heat. The reaction produces more (or Extra → Exothermic) energy than it needs, so the extra energy is released as heat. PLEASE NOTE: Students will be using sodium hydroxide (NaOH) which can cause serious chemical burns if directly applied to skin. Before starting experiment, stress the importance of following proper lab procedures when using this material and conducting all experiments.

Procedure:

- Tell students that they are going to test the properties of one of the substances used to make shampoo: sodium hydroxide. (1 min).
- Ask students if they have ever used Drano. (4 min).
 - If yes, have them describe what happens when water is added
 - Do brief demonstration of adding water to Drano, show video for further demonstration of Drano if needed.
 - <https://www.youtube.com/watch?v=wfmzuf-vNIg>
- Explain to students that sodium hydroxide is used in Drano, and it creates an exothermic reaction when the water is added (1 min).
- Quick review on reactions that release heat (1 min).
- Hand out The Heat Is On – Lab Procedures, career information, table, and graph. We suggest printing the procedures and career information back-to-back, while printing the table and graph each one-sided. Walk students through the directions (5 min).
- Ask students if they have questions (1 min).
- Assign students to groups of 2 to 4 (1 min).
- Remind students of safety protocol when working with acids and bases (1 min).
- Allow students time to complete the lab (45 min).
 - If any group is not following safety procedures, intervene quickly to avoid injury.
- When finished with this lab, students should place a stopper on the Erlenmeyer Flask and save the sodium hydroxide solution for the pH neutralization lab.
- Direct students to complete the line graph and lab questions individually.

Assessment:

- Completed data table that accurately depicts the results of an exothermic reaction
- Completed line graph accurately showing data from the Student Data Table
- Completed lab questions
- Adhering to proper lab safety procedures

The Heat Is On – Lab Procedures

1. Remove all materials from your lab station, paying special attention to the removal of any plastic and aluminum materials.
2. Get a pair of safety glasses and gloves for each member of the group.
 - **Put both on**
3. One member of your group should obtain your lab materials:
 - 1 Thermometer
 - 1 Balance
 - 15 ml of Distilled water (H_2O)
 - 1 Stopwatch
 - 1 Erlenmeyer flask
 - 1 Graduated cylinder
 - 2 Sheets of weighing paper
 - 1 Metal spatula
 - 5 g NaOH
4. Use a graduated cylinder to measure 15 ml of distilled H_2O and pour into the Erlenmeyer flask.
5. Take the temperature of the water and record it on your data table.
6. Using the balance and weighing paper, measure 5 grams of NaOH.
7. Slowly transfer the NaOH to the Erlenmeyer flask that contains the H_2O .
8. Carefully swirl the Erlenmeyer flask to mix the two together.
9. Immediately take the temperature of the mixture and record it on your data table.
10. Using the timer, continue to take the temperature at 1-minute intervals. Remember to record your data on the data table! Do this until the temperature of the mixture equals the initial temperature of the distilled water.
11. Put a stopper in the Erlenmeyer Flask to save the sodium hydroxide solution.
12. Keeping your data table out, clean up according to your teacher's instructions.
13. Use the data table to complete your graph and answer the lab questions.



The Heat is On-Career Information

Did you enjoy using the scientific equipment, the step-by-step accuracy of the experiment, or other parts of this lab? Consider a career where you could include these skills and more! Some careers that use a similar set of skills as this lab include:

Chemist

Job Duties:

- Analyze organic or inorganic compounds to determine chemical or physical properties, composition, structure, relationships, or reactions.
- Produce changes in composition of substances by introducing heat, light, energy, or chemical catalysts for analysis.
- Conduct quality control tests.
- Explore uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.

Current Job Examples:

- U.S. Army Research, Development and Engineering Command – Chemist, Aberdeen Proving Ground, Maryland
- Food and Drug Administration – Chemist, Silver Spring, Maryland
- Agricultural Research Service – Chemist, Beltsville, Maryland

Ecologist:

Job Duties:

- Identify environmental impacts caused by products, systems, or projects.
- Examine local, regional or global use and flow of materials or energy in industrial production processes.
- Analyze changes designed to improve the environmental performance of complex systems to avoid unintended negative consequences.

Current Job Examples:

- Environmental Technician – Hazardous Waste - Clean Harbors Environmental Services, Amegard, North Dakota
- Oasis Petroleum - Environmental Representative, Williston, North Dakota
- CACI International - Environmental Protection Specialist, Washington, DC

To explore more career options, visit <https://www.onetonline.org/>

The Heat Is On – Student Data Table

Temperature of Water = _____

Time Lapsed in Minutes	Temperature of Mixture
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

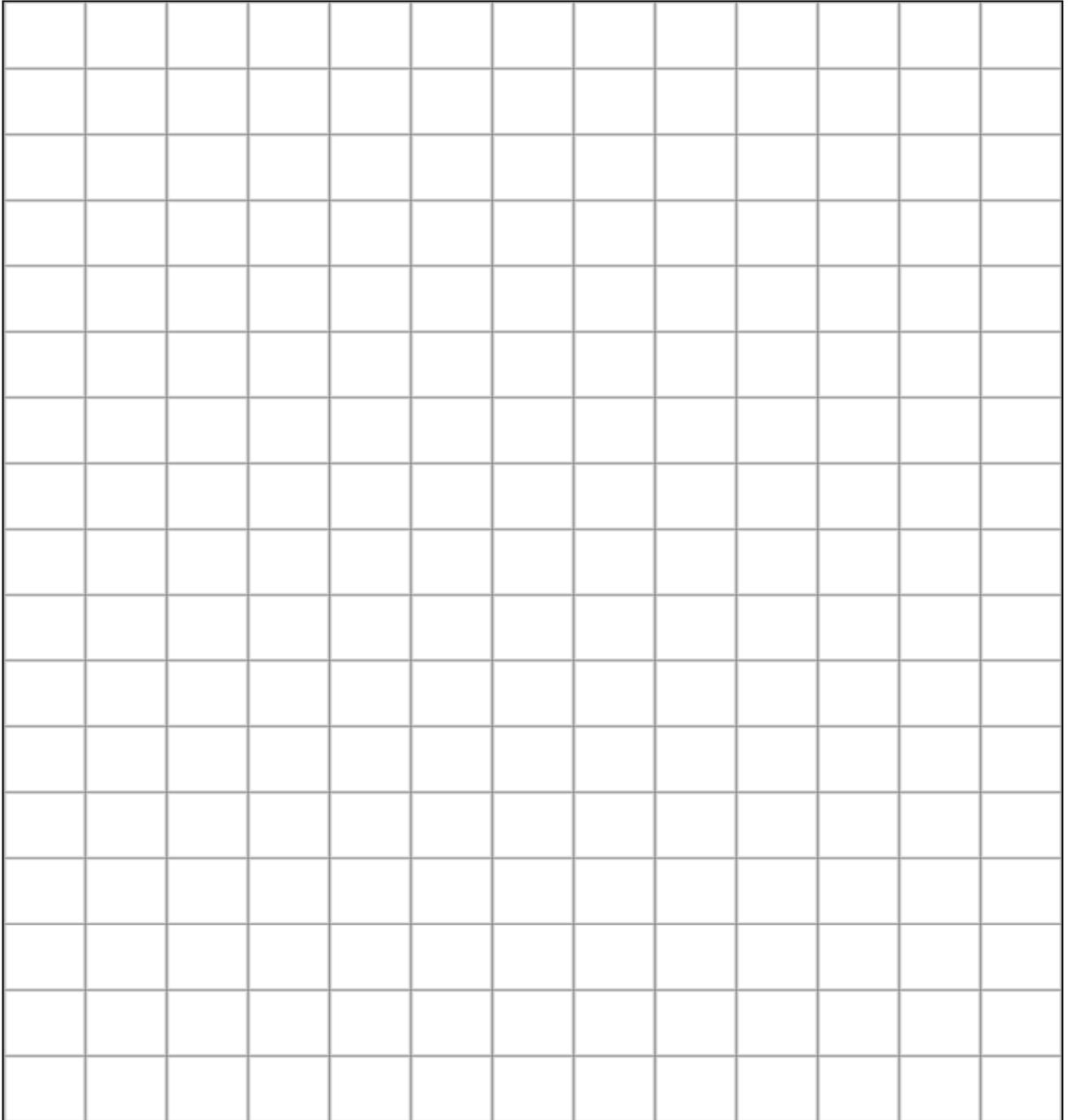
Time Lapsed in Minutes	Temperature of Mixture
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	

Assessment 1

The Heat Is On – Graph

Directions: On the graph paper below, use the data from the Student Data Table to construct a line graph of temperature over time. Your graph must include:

- Title
- Labels
- Temperature on the Y axis, Time on the X axis



Assessment 2

The Heat Is On – Lab Questions

1. How much time did it take for the temperature of the mixture to match the starting temperature of the water? How could you speed up the cooling process?
2. Could an exothermic reaction be dangerous? Why or why not?
3. Shampoo contains sodium hydroxide. Would you want to put this substance on your head regularly? Why or why not?
4. List a job that explores chemical reactions and their impact on the environment and our society.

The Heat Is On – Lab Questions – Teacher Key

1. How much time did it take for the temperature of the mixture to match the starting temperature of the water? List a way to speed up the cooling process.

Answers will vary but will probably be in the 13-19-minute range.

We could add the sodium hydroxide, do the experiment in a giant cooler, or start with colder water.

2. Could an exothermic reaction ever be dangerous? Why or why not?

Students could say yes or no but should understand it can be dangerous at the end of the lesson unit. Supporting reasoning will vary but may include:

Yes. If there was enough heat given off, it could be so hot it could burn someone.

Yes. If there was a lot of really hot heat in an enclosed space, it could lead to a fire.

No. The reaction isn't that big.

3. Shampoo contains sodium hydroxide. Would you want to put this substance on your head regularly? Why or why not?

Answers will vary, but may include:

- *No, the fact that it creates an exothermic reaction with water frightens me. It might burn my head.*
- *Yes, once the reaction ran its course, the sodium hydroxide is not going to burn me.*
- *I don't know. There are still many properties of sodium hydroxide that I am not familiar with. I'd like to do more tests to see if it is safe.*

4. List a job that explores chemical reactions and their impact on the environment and our society.

Answers may vary but include: Chemist, Chemical Engineer, Science Teacher, Chemical Plant Operator

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully (i.e. no horseplay).			
Accurately followed teacher and lab instructions			
Cleaned up lab area after finishing experiment			

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully.			
Accurately followed teacher and lab instructions			
Cleaned up lab area after finishing experiment			

Activity Two: pH Neutral⁶

North Dakota Education Standards:

- *MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.*
- *8.EE.5: Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.*
- *RST.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.*

Learning Objectives:

Students will be able to:

- Identify when the NaOH solution has been neutralized by the addition of citric acid based on the changes of pH levels.
- Complete a pH lab table with correlated data
- Complete a multistep experiment

Goal: Students will observe, measure, and record what happens as different amounts of an acidic solution is added to a basic solution to obtain neutralization.

Time: 45–60-minute class period

Materials (for a class of 32 working in groups of 4):

- Copies of the pH Neutral Information ½ sheets
- Sodium Hydroxide solution from “The Heat Is On”
- 120 ml distilled water
- 8 Graduated cylinders
- 40 g Citric acid
- 8 Erlenmeyer flasks
- 8 100 ml Beaker (or bigger)
- 8 Scales or triple beam balances
- 8 Spatulas
- 8 Sheets of weighing paper
- 8 Reaction plates
- Approx. 25 – 30 pH test strips
- 16 Rye droppers
- forceps
- Stir sticks or toothpicks (12 per group)
- Clear tape
- Paper towels

Background: “Acidic” and “basic” are words used to describe the two extremes of one chemical property. You may sometimes see the word “alkaline” used instead of basic. Mixing acids and

⁶ This lesson was received and modified from beyondbenign:
<http://www.beyondbenign.org/K12education/kthru12.html>

bases can neutralize each other's pH. The pH scale measures how acidic or basic a substance is. It ranges from 0 to 14, with bases having a pH greater than 7 and acids having a pH less than 7. A pH of 7 is neutral, and substances that are neither acidic nor basic are neutral

Procedure:

- Explain to students that you are going to continue to work on shampoo. (1 min)
- Ask them to explain what would happen if they applied sodium hydroxide from The Heat Is On directly onto skin. (2 min)
- Ask if anyone knows or can guess why that happens. (2 min)
- Explain that this is because the pH is not balanced. (1 min)
- Give students the pH Neutral Information Sheet and read it together. (5 min)
 - Ask students why they would want a shampoo formula to be pH balanced
 - On the back of the sheet, have students brainstorm if sodium hydroxide is acidic or basic.
- Tell students that the other substance they will use to reach a balanced solution is citric acid. (2 min)
 - Have students brainstorm if citric acid is acidic or basic.
- Give each student the lab procedures sheet, career information, data table, and lab questions. We suggest printing the lab procedures and career information back-to-back and printing the data table and lab questions back-to-back. (1 min)
- Walk through the materials and steps. (2 min)
- Remind students of best practices when working with acids and bases. (1 min)
- Allow students time to complete the lab and grade safety adherence. (rubric attached) (30 min)
- Have students complete the lab questions. (15 min)
- Direct the students to clean up. (5 min)

Assessment:

Completed data table that accurately depicts pH levels of each mixture well

Accurate completion of Student Lab questions

Adhering to proper lab safety procedures

pH Neutral Information Sheet

“Acidic” and “basic” are words used to describe the two extremes of one chemical property. You may sometimes see the word “alkaline” used instead of basic. Mixing acids and bases can neutralize, or cancel out, their effects. A substance that is neither acidic nor basic is neutral.

The pH scale measures how acidic or basic a substance is. The pH scale ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic. A pH greater than 7 is basic.

Each number below 7 on the pH scale is ten times more acidic than the next higher number. For example, pH 4 is ten times more acidic than pH 5 and 100 times more acidic than pH 6. Acids have a sour taste, react with metals and can burn skin if strong enough. NEVER TASTE ANYTHING IN LAB.

For numbers above 7 each number is ten times more basic than the next lower number. For example, pH 10 is ten times more basic than pH 9 and 100 times more basic than pH 8. Bases have a bitter taste, do not react with metal and can also burn the skin if strong enough. NEVER TASTE ANYTHING IN LAB.

Pure water is neutral. It can become acidic or basic when mixed with acids or bases.



pH Neutral Information Sheet

“Acidic” and “basic” are words used to describe the two extremes of one chemical property. You may sometimes see the word “alkaline” used instead of basic. Mixing acids and bases can neutralize, or cancel out, their effects. A substance that is neither acidic nor basic is neutral.

The pH scale measures how acidic or basic a substance is. The pH scale ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic. A pH greater than 7 is basic.

Each number below 7 on the pH scale is ten times more acidic than the next higher number. For example, pH 4 is ten times more acidic than pH 5 and 100 times more acidic than pH 6. Acids have a sour taste, react with metals and can burn skin if strong enough. NEVER TASTE ANYTHING IN LAB.

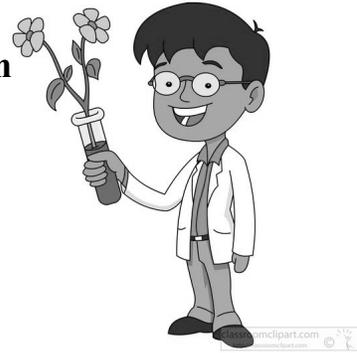
For numbers above 7 each number is ten times more basic than the next lower number. For example, pH 10 is ten times more basic than pH 9 and 100 times more basic than pH 8. Bases have a bitter taste, do not react with metal and can also burn the skin if strong enough. NEVER TASTE ANYTHING IN LAB.

Pure water is neutral. It can become acidic or basic when mixed with acids or bases.

pH Neutral - Lab Procedures

1. Remove all materials from your lab station, paying special attention to the removal of any plastic and aluminum materials.
2. Get a pair of safety glasses and gloves for each member of the group-**Put On Both!**
3. One member of your group should obtain your lab materials:
 - Sodium Hydroxide solution from “The Heat Is On”
 - 15 ml Distilled water
 - graduated cylinder
 - 5 g Citric acid
 - Erlenmeyer flask
 - 100 ml Beaker
 - Balance
 - Spatula
 - Sheet of weighing paper
 - Reaction plate
 - 4 pH Test strips
 - Scissors
 - 2 Eye droppers
 - Forceps
 - 12 Stir sticks or toothpicks
 - Clear tape
 - Paper towel
4. Use scissors to cut each pH strip in sixths. You should have at least 24 small strips when you are finished.
5. Make sure the flask of NaOH is labeled and set aside.
6. Measure 15 ml of distilled water into a 100 ml beaker.
7. Use the balance and weighing paper to measure 5 g of citric acid.
8. Add the citric acid to the water in a 100 ml beaker and swirl to mix.
9. Use an eyedropper and carefully place 5 drops of NaOH in each well of the reaction plate.
10. Using a **clean** eyedropper, add one drop of citric acid to the NaOH in well #one.
11. Add two drops to the NaOH in well #two.
12. Add three drops to well #three and so on.
13. Use a **clean** stir stick or toothpick to mix each of the wells.
14. Use the forceps to carefully drop a segment of pH strip into each well.
15. Remove the segments with the forceps and place on the pH Neutral Student Data Table beside the appropriate well number in the test strip column.
16. Indicate the pH for each well in the appropriate column.
17. Make any observations, considering color, consistency, viscosity, density, etc.
18. Indicate where neutralization occurred and tape the test strips in place.
19. Clean up according to the directions from your teacher.

pH Neutral-Career Information



Did you enjoy using the scientific equipment, the step-by-step accuracy of the experiment, or other parts of this lab? Consider a career where you could include these skills and more!

Some careers that use a similar set of skills, as this lab, include:

Environmental Biologist:

Job Duties:

- Collect and analyze data to determine environmental conditions and restoration needs.
- Develop and communicate recommendations for landowners to maintain or restore environmental conditions.
- Plan environmental restoration projects, using biological databases, environmental strategies, and planning software.

Current Job Examples:

- Golder Associates - Senior Project Environmental Scientist, Bismarck, North Dakota
- Ackerman-Estvold Engineering and Management Consulting, Inc. - Senior Water Resource Engineer, Minot, North Dakota
- South Dakota Department of Labor and Regulation, Environmental Planner II Wetland Environmental Specialist, Rapid City, South Dakota

Ecologist:

Job Duties:

- Identify environmental impacts caused by products, systems, or projects.
- Examine local, regional or global use and flow of materials or energy in industrial production processes.
- Analyze changes designed to improve the environmental performance of complex systems to avoid unintended negative consequences.

Current Job Examples:

- Environmental Technician – Hazardous Waste - Clean Harbors Environmental Services, Amegard, North Dakota
- Oasis Petroleum - Environmental Representative, Williston, North Dakota
- CACI International - Environmental Protection Specialist, Washington, DC

To explore more career options, visit <https://www.onetonline.org/>

pH Neutral Student Data Table

Well #	Drops of NaOH	Drops of citric acid	Test Strip	pH	Observations
A-1	5	0			
A-2	5	1			
A-3	5	2			
A-4	5	3			
A-5	5	4			
A-6	5	5			
B-1	5	6			
B-2	5	7			
B-3	5	8			
B-4	5	9			
B-5	5	10			
B-6	5	11			
C-1	5	12			
C-2	5	13			
C-3	5	14			
C-4	5	15			
C-5	5	16			
C-6	5	17			
D-1	5	18			
D-2	5	19			
D-3	5	20			
D-4	5	21			
D-5	5	22			
D-6	5	23			

Assessment

pH Neutral Student Lab Questions

Name: _____

1. Which substance in this experiment is basic?

2. Which substance in this experiment is acidic?

3. In the well that is pH neutral...
 - a. How many drops of sodium hydroxide are in it? _____

 - b. Write the fraction that represents the amount of sodium hydroxide in the solution

 - c. How many drops of citric acid are in it? _____

 - d. Write the fraction that represents the amount of citric acid in the solution

4. What is the ratio of sodium hydroxide to citric acid in a neutral solution? _____

5. List a job that explores pH levels and their impact on society and the environment.

pH Neutral Student Lab Questions – Teacher Key

1. Which substance is basic?

The sodium hydroxide (NaOH) is basic.

2. Which substance is acidic?

The citric acid is acidic.

3. In the well that is pH neutral...

It will be neutral in well 13 (approximately).

- a. How many drops of sodium hydroxide are in it? 5
 - b. Write the fraction that represents the amount of sodium hydroxide in the solution
5/18
 - c. How many drops of citric acid are in it? 13
 - d. Write the fraction that represents the amount of citric acid in the solution 13/18
4. What is the ratio of sodium hydroxide to citric acid in a neutral solution?
5 NaOH : 13 citric
 5. List a job that explores pH levels and their impact on society and the environment.
Answers may vary but include: Fish and Wildlife Specialist, Biologist, Chemist, Environmental Biologist, Ecologist, Food Production, Manufacturing

Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully.			
Accurately followed teacher and lab instructions			
Cleaned up lab area after finishing experiment			

Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully.			
Accurately followed teacher and lab instructions			
Cleaned up lab area after finishing experiment			

Activity Three: Shampoozled, part 1⁷

North Dakota Education Standards:

- *RST.3 : Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.*
- *MS-PS1-2 : Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.*
- *MS-ESS3-3 : Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.*
- *MS-ESS3-4 : Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.*

Learning Objectives: Students will be able to:

- Follow precisely a multistep experiment through accurate completion of this activity.
- Identify when a chemical reaction has occurred during this experiment by assessing change in substance property.
- Apply information about minimizing human impact on the environment with their own consumer habits.
- Discuss how the process of manufacturing shampoo can consume more or less natural resources and the impact this has on Earth's systems.

Goal: Make a usable shampoo while observing chemical reactions during the process.

Time: 45–60-minute class period

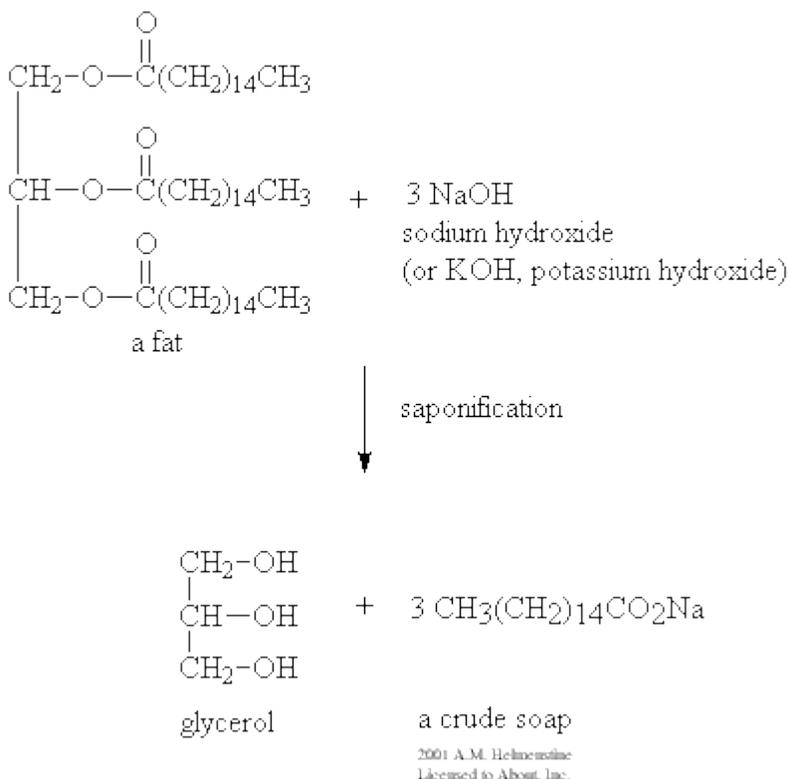
Materials (for a class of 32 working in groups of 4):

- 320g Vegetable oil
- 160g Olive oil
- 80g Sodium Hydroxide
- 960ml H₂O
- Balance
- Weighing paper
- 8 Stir rods
- 8 Erlenmeyer Flask
- 8 Glass jars with lids
- 24 Plastic cups
- 8 Graduated cylinders (50 ml)
- 8 Warm water baths (hot plate with brownie pan)
- 8 Room temperature water baths (cup or glassware with water)
- 16 Thermometers (at least 8 glasses!)

Background: One of the first organic chemical reactions known to ancient man was the preparation of soaps through a reaction called saponification. Natural soaps are sodium or

⁷ This lesson was received and modified from beyondbenign:
<http://www.beyondbenign.org/K12education/kthru12.html>

potassium salts of fatty acids, originally made by boiling lard or other animal fat together with lye or potash (potassium hydroxide). Hydrolysis of the fats and oils occurs, yielding glycerol and crude soap. Hydrolysis is the process of a chemical compound reacting with water, breaking the chemical into smaller units.



In the industrial manufacture of soap, tallow (fat from animals such as cattle and sheep) or vegetable fat is heated with sodium hydroxide. Once the saponification reaction is complete, sodium chloride (salt) is added to solidify the soap. The water layer is drawn off the top of the mixture and the glycerol is recovered using a process called vacuum distillation.

Formula Calculation from: <http://chemistry.about.com/library/weekly/blsapon.htm>

Procedure:

ONE DAY BEFORE EXPERIMENT:

- Assign students to look up the shampoo(s) they use in their house on this website: www.goodguides.com. Have students complete the “How Does My Shampoo Rate?” worksheet at home. Have them keep this worksheet to use for an assignment connected with the “Shampoozled 2” experiment. Participation points can be given as per teacher discretion.

PREP:

Students will be making a large batch of shampoo and storing it in class

- Determine where you’d like students to store their shampoo
- Print the lab procedures and career information back-to-back
- Print the lab questions single sided
- Prepare:
 - Pour distilled water into 8 cups
 - Pour olive oil into 8 cups

- Pour vegetable oil into 8 cups

IN CLASS:

- Ask student to share findings from the “How Does My Shampoo Rate?” worksheet and how this impacted their views towards the shampoo(s) they use.
- Explain to students that they will be creating their first part of their shampoo, the soap.
- Hand out the lab procedures, career information, and lab questions. Review the lab instructions, reminding them of the components of soap (lye and fat).
- Students should follow the directions on the lab sheet and clean up as directed.
- Have students complete lab questions.

Assessment:

- Completion of pre-experiment shampoo activity
- Successful completion of the first part of the shampoo (soap)
- Following lab and safety procedures (rubric attached)
- Accurate completion of lab questions

How Does My Shampoo Rate?

Name: _____

What shampoo(s) does your household use? List them here:

Go to the website www.goodguide.com. At the top of the page is a large search bar. Search for each of your family's shampoo. Each shampoo has multiple ratings. Write ratings for your household's shampoo below.

Shampoo:	Overall Score:	Health Rating:	Environment Rating:	Society Rating:

Shampoozled Part 1: Lab Procedures

1. One member will grab a pair of safety glasses and gloves for each member of the group & put both on.
2. Two members of your group should obtain your lab materials:
 - 1 Glass jar with lid
 - Plastic cups of water, olive oil & vegetable oil
 - Graduated cylinder
 - Erlenmeyer flask
 - Balance
 - Spatula
 - 1 Sheet of weighing paper

 - 2 Thermometers (one glass)
 - 1 Stir stick
 - Paper towels
 - Room temp water bath (cup or glassware with water in it)
 - Warm water bath (hot water from sink)
3. Using the graduated cylinder, measure 22 ml of water. Pour it into the Erlenmeyer Flask.
4. Using the balance, spatula and weighing paper, weigh out 9 g of NaOH.
5. Slowly transfer the NaOH to the Erlenmeyer flask containing the H₂O.
6. Carefully swirl the Erlenmeyer flask to mix the two together.
7. Hold the Erlenmeyer flask in the room temperature water bath.
8. Use a glass thermometer to monitor the temperature of the NaOH solution.
9. Using the graduated cylinder, measure 30 ml of vegetable oil, and pour into glass jar.
10. Using graduated cylinder, measure 14 ml of olive oil, and add to vegetable oil in glass jar.
11. Place both the glass jar and the Erlenmeyer flask into the warm water bath. Monitor constantly until the substances are in the 35-37° C range.
12. When the mixture is in the 35-37° C range, stir the NaOH solution into the oils.
13. Put lid on glass jar. **Make sure the lid is on as tight as possible!**
14. Shake the mixture vigorously for at least 15 minutes.
15. Clean up according to teacher instructions.

Table for quick reference	
<u>Ingredient</u>	<u>Amount</u>
Olive oil	14 ml
Vegetable oil	30 ml
H ₂ O	22 ml
NaOH	9 g

Shampoozled-Career Information

Did you enjoy using the scientific equipment, the step-by-step accuracy of the experiment, or other parts of this lab? Consider a career where you could include these skills and more!

Some careers that use a similar set of skills as this lab include:



Chemist:

Job Duties:

- Analyze organic or inorganic compounds to determine chemical or physical properties, composition, structure, relationships, or reactions.
- Produce changes in composition of substances by introducing heat, light, energy, or chemical catalysts for analysis.
- Conduct quality control tests.
- Explore uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.

Current Job Examples:

- U.S. Army Research, Development and Engineering Command – Chemist, Aberdeen Proving Ground, Maryland
- Food and Drug Administration – Chemist, Silver Spring, Maryland
- Agricultural Research Service – Chemist, Beltsville, Maryland

Ecologist:

Job Duties:

- Identify environmental impacts caused by products, systems, or projects.
- Examine local, regional or global use and flow of materials or energy in industrial production processes.
- Analyze changes designed to improve the environmental performance of complex systems to avoid unintended negative consequences.

Current Job Examples:

- Environmental Technician – Hazardous Waste - Clean Harbors Environmental Services, Amegard, North Dakota
- Oasis Petroleum - Environmental Representative, Williston, North Dakota
- CACI International - Environmental Protection Specialist, Washington, DC

To explore more career options, visit <https://www.onetonline.org/>

Assessment

Shampoozled Part 1 – Lab Questions

1. What was the most difficult part of this experiment for your group? Why?
2. When did an exothermic reaction occur during this experiment?
3. The shampoo isn't ready to be used yet. Based off what you learned in previous experiments in the shampoo unit, what might still need to be done?
4. List a job that combines substances to create consumer goods (i.e. finds scientific formula for shampoo, lotion, or make-up) OR assesses safety of substances for consumer use.

Shampoozled Part 1 – Lab Questions-Teacher Key

1. What was the most difficult part of this experiment for your group? Why?

Answers will vary, but may include transferring materials, maintaining temperature, using the water bath, timing of combining substances etc.

2. When did an exothermic reaction occur during this experiment? (this question tests student knowledge from “The Heat is On experiment”)

When the NaOH was combined with the H₂O.

3. The shampoo isn't ready to be used yet. Based off what you learned in previous experiments in the shampoo unit, what might still need to be done?

The shampoo's pH level needs to be tested to make sure it's safe.

OR

Add more substances to the shampoo to get the pH level neutral.

Approve other answers based on your discretion.

4. List a job that combines substances to create consumer goods (i.e. finds scientific formula for shampoo, lotion, or make-up) OR assesses safety of substances for consumer use.

Answers will vary but may include: chemist, quality control, scientist, ecologist

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully (i.e. no horseplay).			
Accurately followed teacher and lab instructions.			
Cleaned up lab area after finishing experiment.			

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully.			
Accurately followed teacher and lab instructions.			
Cleaned up lab area after finishing experiment.			

Activity Four: Shampoozled 2⁸

North Dakota Education Standards

- *RST.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.*
- *MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.*
- *MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*
- *MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.*

Learning Objectives:

Students will be able to:

- Follow precisely a multistep experiment through accurate completion of this activity.
- Identify when a chemical reaction has occurred during this experiment by assessing change in substance property.
- Apply information about minimizing human impact on the environment with their own consumer habits.
- Discuss how the process of manufacturing shampoo can consume more of or less of natural resources and the impact this has on the Earth.

Goal: Make a usable shampoo while observing chemical reactions during the process.

Time: 45–60-minute class period

Materials (for a class of 32 working in groups of 4):

- 100ml H₂O
- 150g Citric acid
- 100g Glycerol monostearate
- Balance
- Weighing paper
- 8 Beakers (50 ml)
- 16 Stir rods
- 24 Plastic cups
- 8 Re-sealable baggies
- Jars containing their soap

Procedure:

⁸ This lesson was received and modified from beyondbenign:
<http://www.beyondbenign.org/K12education/kthru12.html>

ONE DAY BEFORE EXPERIMENT:

- Assign students “Shampoo Options” worksheet to be used in conjunction with the “How Does My Shampoo Rate?” worksheet from the previous experiment. Participation points can be given as per teacher discretion.

PREP:

- Determine where you would like students to store their shampoo.
- Pour a small amount of distilled water into plastic cups (1 plastic cup per lab group-students will measure 12ml of water from this cup).
- Put 13g of citric acid in separate cups (13g per lab group).
- Put 10g of “glycerol monostearate” in separate cups (10g per lab group).
- Print the lab direction and career information back-to-back.

IN CLASS:

- Explain to students that they will be making their shampoo pH balanced.
- Hand out the lab directions, career information, and lab assessments.
- Review the lab instructions, reminding them of the pH neutral lab.
- Students should follow the directions on the lab sheet and clean up as directed.
- Optional: you may want to allow students to check the pH level of the shampoo before and after they add citric acid.

Assessment:

- Completion of pre-lab assignment
- Successful completion of shampoo
- Following lab and safety procedures (rubric attached)
- Accurate completion of lab assessment

Shampoo Options

Name: _____

Using your “How Does My Shampoo Rate?” worksheet, write the name of a shampoo your household currently uses and put the appropriate information for that shampoo in the table below. Next, go to www.goodguide.com. Find a shampoo option your family could buy instead. Look for a shampoo that has better ratings, can be easily bought by your family, and is a similar price to your current shampoo. Write the name of the comparable shampoo option in the top box of the table and put the appropriate information for that shampoo below.

	Current Shampoo:	Shampoo Option:
Overall Score:		
Health Rating:		
Environment Rating:		
Society Rating:		
Nearby store selling it:		
Price of Shampoo:		

Shampooed Part 2 – Lab Directions

1. Get a pair of safety glasses and gloves for each member of the group to put both on.
 - Two members of your group should obtain your lab materials: Plastic cup of distilled water
 - 13g Citric acid (in plastic cup)
 - 10g Glycerol monostearate (in plastic cup)
 - Graduated cylinder
 - 50 ml Beaker
 - Balance
 - Spatula
 - Stir sticks
 - Jar with soap made in previous lab
 - Paper towel
 - Small pH strips
 - Warm water bath

3. Using the graduated cylinder, measure 12 ml distilled water, pour it into the cup of citric acid and stir.

4. Pour both the glycerol monostearate and the citric acid solution into the 50 ml beaker.

5. Place beaker in warm water bath. Monitor constantly until substance is melted and dissolved. Use a stir stick to agitate.

6. Once the solution has melted, pour it into the glass jar containing the shampoo.

7. Put lid on glass jar. **Make sure the lid is on as tight as possible!**

<u>Ingredients</u>	<u>Amount</u>
glycerol monostearate	10 g
water	12 ml
Citric acid	13 g

8. Shake the mixture vigorously for at least 5 minutes.

9. Using a small pH strip, test the pH of the shampoo and record the pH here: _____

10. Clean up according to teacher instructions.

Shampoozled-Career Information

Did you enjoy using the scientific equipment, the step-by-step accuracy of the experiment, or other parts of this lab? Consider a career where you could include these skills and more!
Some careers that use a similar set of skills as this lab include:



Chemist:

Job Duties:

- Analyze organic or inorganic compounds to determine chemical or physical properties, composition, structure, relationships, or reactions.
- Produce changes in composition of substances by introducing heat, light, energy, or chemical catalysts for analysis.
- Conduct quality control tests.
- Explore uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.

Current Job Examples:

- U.S. Army Research, Development and Engineering Command – Chemist, Aberdeen Proving Ground, Maryland
- Food and Drug Administration – Chemist, Silver Spring, Maryland
- Agricultural Research Service – Chemist, Beltsville, Maryland

Ecologist:

Job Duties:

- Identify environmental impacts caused by products, systems, or projects.
- Examine local, regional or global use and flow of materials or energy in industrial production processes.
- Analyze changes designed to improve the environmental performance of complex systems to avoid unintended negative consequences.

Current Job Examples:

- Environmental Technician – Hazardous Waste - Clean Harbors Environmental Services, Amegard, North Dakota
- Oasis Petroleum - Environmental Representative, Williston, North Dakota
- CACI International - Environmental Protection Specialist, Washington, DC

To explore more career options, visit <https://www.onetonline.org/>

Assessment

Shampoozled Part 2-Lab Questions

1. How might the information you found before this lab on the Shampoo Options worksheet be useful for your family?
2. If lots of people decided to stop buying their current shampoo and started buying shampoos with the highest ratings, how would that impact shampoo manufacturers or the world?
3. Looking back on all four shampoo experiments (The Heat is On, pH Neutral, Shampoozled, Shampoozled 2) which experiment was your favorite? Why?

Shampoozled Part 2-Lab Questions-Teacher Key

1. How might the information you found before this lab on the Shampoo Options worksheet be useful for your family?

Assess for critical thinking when assigning points. Answers will vary but may include:

“Our family could buy a safer shampoo”

“Our family would stop spending money on a shampoo that has really bad ratings”

“Our family could help the environment by buying shampoo that is made with the environment in mind”

2. If lots of people decided to stop buying shampoo with low ratings and started buying shampoos with the highest ratings, how would that impact shampoo manufacturers or the world?

Assess for critical thinking when assigning points. Answers will vary but may include:

“People who make shampoo with low ratings would stop making money and go out of business”

“People who make shampoo with low ratings would change their business to get higher ratings, so people would buy their shampoo”

“The world would have a better environment, because businesses who hurt the environment with their shampoo manufacturing would go out of business”

3. Looking back on all four shampoo experiments (The Heat is On, pH Neutral, Shampoozled, Shampoozled 2) which experiment was your favorite? Why?

Answers will vary. Assign points based on listing their favorite and giving a thought response to why it was their favorite

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully (i.e. no horseplay).			
Accurately followed teacher and lab instructions.			
Cleaned up lab area after finishing experiment.			

Lab Safety Rubric

Names: _____

The Lab Group:	Always (3 pts)	Sometimes (2 pts)	Needs Work (1 pt)
Wore safety goggles and gloves during experiment.			
Handled materials carefully.			
Accurately followed teacher and lab instructions.			
Cleaned up lab area after finishing experiment.			