Weather in the Garden 3: Do Land and Water Absorb/Lose Heat At Equal or Unequal Rates?

Grade: 6

GPS: S6E4: Students will understand how the distribution of land and oceans affects climate and weather.

- Demonstrate that land and water absorb and lose heat at different rates and explain the resulting effects on weather patterns.

Essential Question: How does the rate at which land and water absorb/lose heat affect the weather?

Teacher Note: This lesson demonstrates 1) that land and water absorb and lose heat at different rates 2) hot air is less dense than cold air 3) less dense substances (liquids and gases) rise above more dense substances. It also defines high and low pressure systems and convection currents, through hands on learning and experimentation. This lesson is best taught over at least two days.

Garden Relevance: This lesson also contains a mini-lesson on how to use a soil thermometer in the garden. This is an excellent way to start seeds using 6th grade curriculum.

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Mini Lesson

*The mini-lesson should be completed before experiment 1, below. Ideally, the mini-lesson will be completed the day before.

Part 1: How and Why to Use a Soil Thermometer

Scientists that study the weather also measure the temperature of the soil. This is usually tested for gardeners, farmers, and climatologists. Soil temperature is measured in the garden to determine when to plant seeds. Seeds germinate at different temperatures; for example, pepper seeds need temperatures of 80-85 degrees Fahrenheit, while carrots can germinate with soil temperatures of 40 degrees Fahrenheit. Soil thermometers can also be used to measure the temperature of compost. Compost temperatures indicate what phase of decomposition compost is in, if it needs to be turned, or other elements should be adjusted.

To test soil temperature for seed germination, insert soil thermometer into the top three to four inches of soil. Wait a moment for reading to finalize, then record the temperature. Measure temperature several days for consistency before planting. If soil is not loose enough to insert probe, use a screwdriver to create a hole to insert the thermometer. For measuring compost temperature, insert soil thermometer as deep as possible for an accurate reading

Discuss with students why soil thermometers are used, and use a student volunteer to demonstrate use of a soil thermometer. If a soil thermometer is not available, an outdoor temperature

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thermometer may be used to test for seed germination, though it may not go high enough in temperature to evaluate compost. Meat thermometers may also be used to test soil temperatures. Distribute thermometers amongst small student groups, and assign each group an area to practice testing. Each student should use the thermometer to test the soil, and should record their findings. After determining the soil temperature, students should use the germination table below to make a list of seeds they could plant in the garden at this temperature. The table is also included in the student handout packet.

http://www.aces.edu/pubs/docs/A/ANR-1061/ANR-1061.pdf

Part 2: Planting Seeds According to Soil Temperature

Part 2 is not necessary to complete before the weather lesson. This is an optional activity that builds upon the soil temperature measuring skill, and applies it to seed starting. Although soil temperature can be measured at any time, only complete this portion of the activity if you are ready to start seeds for the garden.

1. Measure and record soil temperature 5-6 times over 1-2 weeks.
2. Graph the soil temperatures to identify trends. Is the soil consistently becoming warmer? Colder? Fluctuating? What weather patterns are affecting these changes? Discuss as a class.
3. Decide what temperature to use as baseline for making planting decisions. If temperatures are relatively steady, the baseline could be the average. If the temperatures are steadily

increasing, maybe the class wants to only consider the last couple of data points. After the class has decided what temperature recording is the most relevant for starting seeds, allow them to consult the germination temperature chart.

4. Students will make a list of what seeds it would be appropriate to plant with current soil conditions. Before continuing make sure to discuss other relevant concerns for planting such as days to maturity or frost tolerance that make take certain plants off the list.
5. Discuss as a class what seeds you will be planting in the garden, review how to plant seeds as well as garden expectations, then plant away!

Interest Approach

Ask students why they think we have different weather conditions. They can do this as a journal entry, with partners, or as a class discussion; whichever works best for your classroom. After discussing and recording possibilities, explain to students that today they will do a series of experiments that will help them discover one of the primary reasons we have different weather patterns.

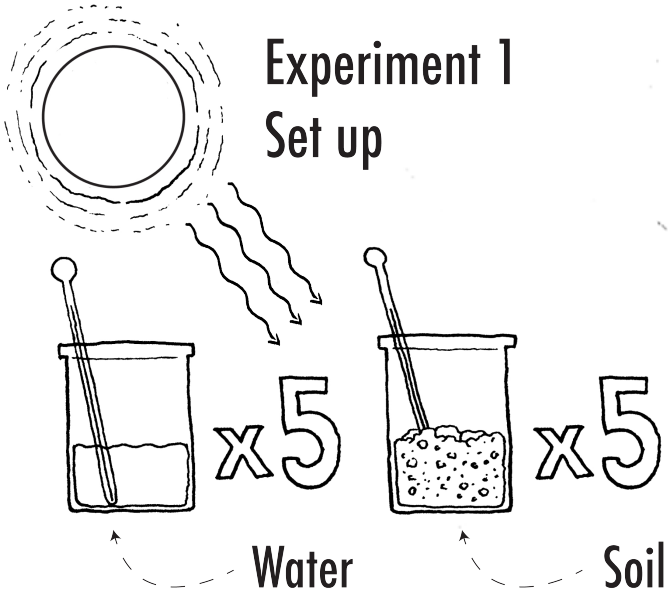
Lesson/Learning Activity

<u>Experiment 1: Land and Water Absorb and Lose Heat at Different Rates</u>

1. Set up five containers of water and soil in the garden; set them out the afternoon before the activity, so they have a chance to

reach outside temperature conditions.

2. Begin each group of students at a different station. Students will record the temperature of both the water and the soil on their worksheets; make sure students take turns taking temperature and reading the thermometers.
3. After recording the temperature of water and soil at each station return to the classroom.
4. In the classroom have students continue to answer questions on the worksheet.
5. After they are finished, review results and discussion questions. Keep a chart on the board throughout the day tracking the averages in temperature; this will help students to see the change.



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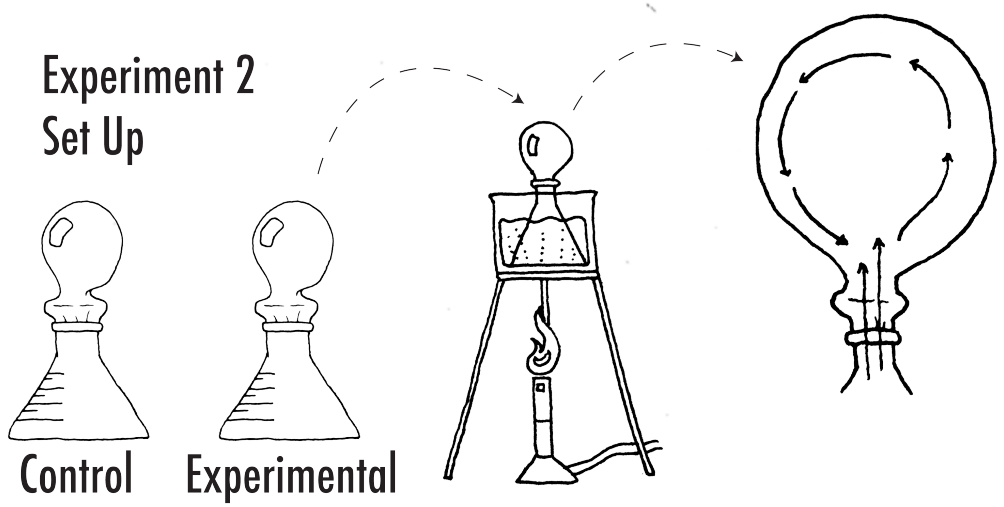
Experiment 2: Hot Air Is Less Dense Than Cold Air

Balloon Demonstration

1. Get two glass bottles and place a balloon over the top of each. (two bottles are not necessary for this demonstration, but it is nice to have a second bottle as a control)
2. Put one bottle in a small pot of hot water situated over a Bunsen burner. The water doesn't have to be boiling, but it needs to be hot enough to warm the air inside the bottle. Leave the other bottle on the counter.
3. As the water heats the air in side the bottle, the air will expand and fill the balloon. The demonstration can stop here, or continue to the next step.
4. To show that the hot air will become more dense as it cools, carefully remove and tie off the balloon. Place the balloon in a container of ice water; the balloon will shrink back to a small size.
5. Allow students to answer discussion questions



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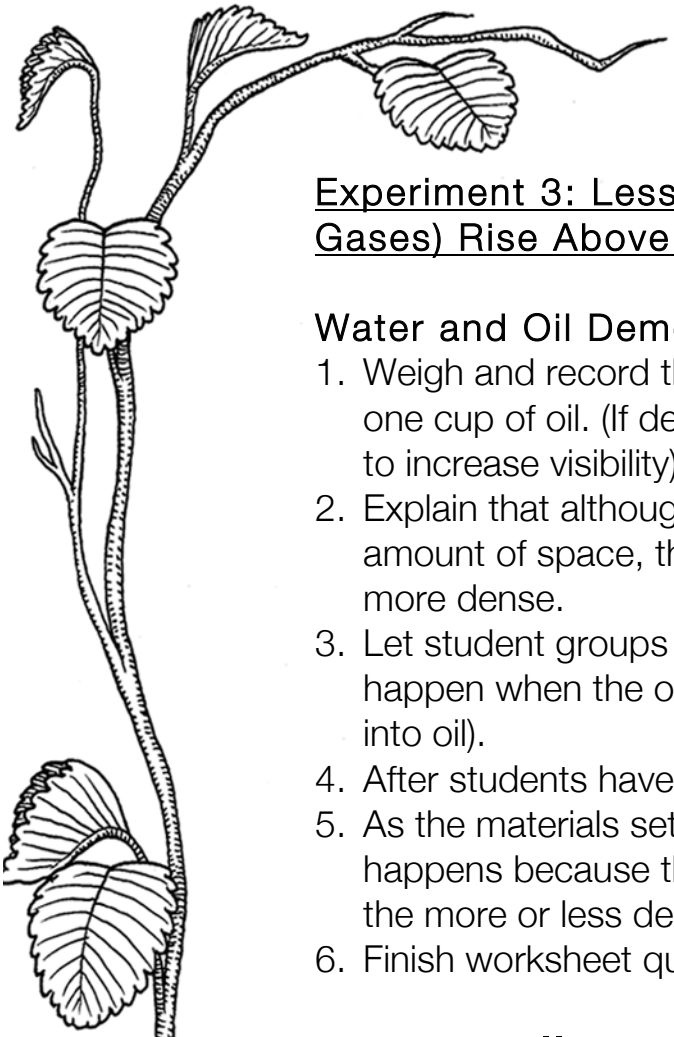


Experiment 3: Less Dense Substances (Liquids & Gases) Rise Above More Dense Substances

Water and Oil Demonstration

1. Weigh and record the measurement for one cup of water, and one cup of oil. (If desired, put food coloring in the cup of water to increase visibility)
2. Explain that although both liquids are taking up the same amount of space, the water is heavier because it is more dense.
3. Let student groups write down their hypothesis for what will happen when the oil is poured into the water (or water poured into oil).
4. After students have shared, pour the oil into the water.
5. As the materials settle, they will separate. Explain that this happens because they have different densities. Ask students if the more or less dense liquid was on top.
6. Finish worksheet questions for experiment three.

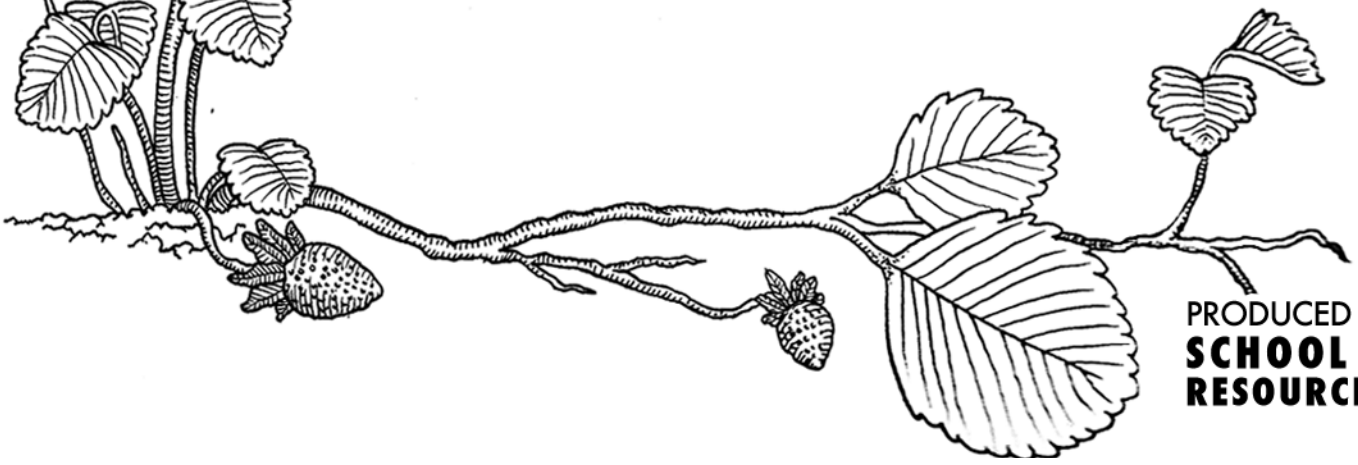
Putting It All Together

After finishing experiment three, review the concepts learned and how they relate to weather to answer the essential question…How does the rate at which land and water absorb/lose heat affect the weather? For example…

- Make sure to ask students questions during this process, and stop to teach the concepts.

Check for Understanding

Students will complete the “Putting It Together” worksheet.



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Horticulture Notes

Soil Temperature Conditions for Vegetable Seed Germination

Vegetable	Min (°F)	Optimum Range (°F)	Optimum (°F)	Max (°F)
Asparagus	50	60-85	75	95
Bean	60	60-85	80	95
Bean, Lima	60	65-85	85	85
Beet	40	50-85	85	85
Cabbage	40	45-95	85	100
Carrot	40	45-85	80	95
Cauliflower	40	45-85	80	100
Celery	40	60-70	70	85
Chard, Swiss	40	50-85	85	95
Corn	50	60-95	95	105
Cucumber	60	60-95	95	105
Eggplant	60	75-90	85	95
Lettuce	35	40-80	75	85
Muskmelon	60	75-95	90	100
Okra	60	70-95	95	105
Onion	35	50-95	75	95
Parsley	40	50-85	75	90
Parsnip	35	50-70	65	85
Pea	40	40-75	75	85
Pepper	60	65-95	85	95
Pumpkin	60	70-90	90	100
Radish	40	45-90	85	95
Spinach	35	45-75	70	85
Squash	60	70-95	95	100
Tomato	50	70-95	85	95
Turnip	40	60-105	85	105
Watermelon	60	70-95	95	105

Soil temperatures should be taken by inserting a soil thermometer 3 to 4 inches deep into the soil surface and noting temperature. Soil thermometers are available from garden centers, feed and seed stores, and from many garden supply catalogs. Soil temperatures should be consistent for several days before seeds are sown to ensure that the seeds are being exposed to optimal temperatures for germination.

www.aces.edu

How does the rate at which land and water absorb/lose heat affect the weather?

Experiment Procedures and Questions

Experiment 1: Do Land and Water Absorb and Lose Heat at Different Rates?

Measure the temperature of the soil and the water at each station. Record below.

	Water Temperature (F ˚)	Soil Temperature (F ˚)
Station 1		
Station 2		
Station 3		
Station 4		
Station 5		
Average Temperature		

1. Average the water and soil temperatures for all stations and enter into the graph.
2. Based on the data gathered, which absorbs heat faster, water or soil? Temperature should be rising throughout the day, so unless otherwise instructed due to inclement weather, assume both the soil and water are absorbing (gaining) heat from the sun.

   _____

   _____

3. What effect do you think this has on weather as continents and oceans absorb / lose heat? Why?

   _____

   _____

   _____

   _____

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Experiment 2: How Does Temperature Affect the Density of Air?

Density: mass per unit volume

1. Describe the bottle and balloon before it is put into the hot water.

   _____

   _____

   _____

2. What do you think will happen when the bottle is placed in the water?

   _____

   _____

   _____

3. What actually happened when the bottle and balloon were placed in the water? What does this tell you about the air in the bottle before and after it is heated?

   _____

   _____

   _____

   _____

4. What happened when the balloon was placed in ice water?

   _____

   _____

   _____

5. Did the amount of air in the bottle/balloon apparatus change during the experiment?

   _____

   _____

6. Based on the evidence from this experiment, which is more dense, hot or cold air?

   _____

   _____

Experiment 3: How Does Density Affect the Position of Gases and Liquids?

1. Which is more dense, the oil or water?

   _____

2. What do you think will happen when they are poured together? Why?

   _____

   _____

   _____

3. What actually happened?

   _____

   _____

   _____

4. Based on this demonstration, which will rise and which will sink: hot or cold air?

   _____

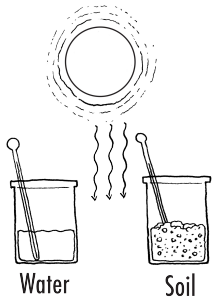
   _____

   _____

Putting It Together

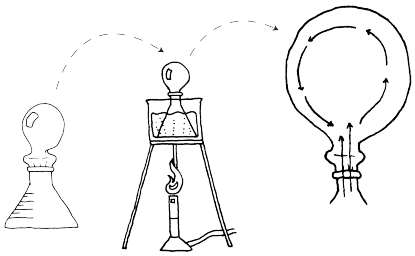
Draw a picture showing what each experiment represents in our weather system.

Experiment 1: Land and Water Absorb and Lose Heat at Different Rates

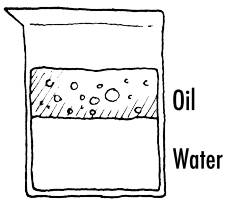


"Water and land absorb and lose heat at different rates, which affects the temperature of air above those surfaces."

Experiment 2: Hot Air Is Less Dense Than Cold Air



Experiment 3: More Dense Substances Sink Below Less Dense Substances



"As warm air rises, cool, dense, air moves in to fill the void."