# Pre-Lab Information

Purpose To understand rates of absorption by different materials on Earth’s surface and to understand how angle of insolation affects the heating of Earth’s surface

Time Approximately 60 minutes

Question What factors influence the absorption of sunlight at Earth's surface?

**Hypothesis #1**

**Hypothesis #2**

**Variables for H1** *Independent Variable*:

*Dependent Variable*:

**Variables for H2** *Independent Variable*:

*Dependent Variable*:

Summary In this lab, you will measure how quickly different materials (soil, sand, water, and air) heat up. You will also determine how the angle of light affects temperature. Finally, you will construct a simple model to explain how differences in surface temperature create wind.

# Safety

* Behavior in the lab needs to be purposeful.
* Do not touch the light bulb in the lamp. Be sure that it is cool before you put away the lamp.
* Tie back long hair, roll up sleeves, and secure loose articles of clothing.
* Handle thermometers carefully. If one breaks, report it to your teacher immediately.
* Use caution with the open flame on the candle.
* Use oven mitts and hot pads when handling the heated pan of sand.
* Wipe up any spills when it is safe to do so.
* Report all accidents—no matter how big or small—to your teacher.

# Lab Procedure

1. **Gather materials.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Absorption Rate Model**   * 4 ring stands * 4 lamps, each with a 60-watt incandescent bulb * Four containers of the same size * Soil * Sand | * Water * 4 thermometers * Timer or stopwatch * Colored pencils (4 colors per group) * Graph paper | **Wind Model**   * Loaf pan * Ice * Candle * Match or lighter * Oven mitts * Hot plate * Cardboard box (optional) |  |  |

1. **Observe the rate of heat absorption.**
   1. Fill one container with soil. Fill the second container with sand. Fill the third container with water. Use the same amount of material in each container. Leave the fourth container empty. This container represents air.
   2. Place a lamp at a 90-degree angle to each container. A 90-degree angle is when the lamp is directly over the container, pointing down at it.
   3. Insert one thermometer into each container. Make sure the thermometers are at the same depth and are not touching the sides or bottom of the container.
   4. Turn on the lights at the same time.
   5. Record the temperature in each container every 3 minutes for 15 minutes. Record the data in Table A in the **Data** section.
2. **Graph the temperature changes related to absorption.** 
   1. Use the data in Table A to create a graph with Time on the *x*-axis and Temperature on the *y*-axis.
   2. Draw the lines on the graph with four different colored pencils, one for each material.
   3. Create a key showing which color represents each material.
3. **Observe how the angle of insolation affects soil temperature**
   1. Locate your data for the container of soil in Table A. Record these temperatures in Table B in the **Data** section.
   2. Empty the three containers and then refill them with room temperature soil, sand, and water respectively.
   3. Repeat using a 0-degree angle. A 0-degree angle is when the light bulb is placed close to the desk or counter on which the container sits. Make sure the light bulb is pointing at the container filled with soil.
   4. Record the temperatures in the container of soil every 3 minutes for 15 minutes. Record these temperatures in Table B in the **Data** section.
   5. Empty the three containers and then refill them with room temperature soil, sand, and water respectively.
   6. Repeat using a 45-degree angle. A 45-degree angle is when the light bulb is halfway between a 90-degree angle and a 0-degree angle. Make sure the light bulb points toward the container of soil.
   7. Record the temperatures in the container of soil every 3 minutes for 15 minutes. Record these temperatures in Table B in the **Data** section.
4. **Graph the temperature changes related to insolation.** 
   1. Use the data in the table to create a graph for angle of insolation. Label the *x*-axis Angle of Insolation. Label the *y*-axis Time.
   2. Draw the lines with 3 different colored pencils, one for each angle.
   3. Create a key showing which color represents each angle of insolation.
5. **Find an appropriate location.**
   1. You will need to perform this experiment where the air is very still. Stay away from ceiling fans, open windows, and so on.
   2. If necessary, you can cut along one side of a cardboard box to make a windscreen to shield the sides and back of your area.
6. **Observe smoke movement.**
   1. Light your candle using a match or lighter.
   2. Observe the direction in which the smoke from the wick moves.
   3. Record your observations in Table C in the **Data** section.
7. **Create surface “winds.”**
   1. Fill a loaf pan with ice.
   2. Get a pan of heated sand from your teacher. Make sure you use oven mitts when handling the pan.
   3. Set the pan of ice and the pan of sand next to each other. Make sure they are touching.
   4. Place the candle directly above where the pans touch.
   5. Observe the direction in which the smoke from the candle moves.
   6. Record your observations in Table C in the **Data** section.
8. **Clean up your area.** 
   1. Return unused materials and dispose of any trash according to your teacher’s directions.

# Data

Record your data either in your lab notebook or in the space below.

**Table A: Rate of Absorption of Different Materials**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Temperature (°F)** | | | |
| **Material** | **3 minutes** | **6 minutes** | **12 minutes** | **15 minutes** |
| **Air** |  |  |  |  |
| **Water** |  |  |  |  |
| **Soil** |  |  |  |  |
| **Sand** |  |  |  |  |

**Table B: Angle of Insolation and Soil Temperature**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Temperature (°F)** | | | |
| **Angle** | **3 minutes** | **6 minutes** | **12 minutes** | **15 minutes** |
| **90 degrees** |  |  |  |  |
| **0 degrees** |  |  |  |  |
| **45 degrees** |  |  |  |  |

**Table C: Candle Smoke Direction**

|  |  |
| --- | --- |
|  | **Notes on Direction of Smoke** |
| **Candle Lighting #1** |  |
| **Candle Lighting #2** |  |

# Follow-Up Questions

Answer the following questions:

1. Which material had the highest rate of absorption? What can you conclude about the rate of absorption in the natural world? How might this influence climate regions?
2. How did the angle of insolation affect the temperature? What can you conclude about the effect of the position of the Sun, based on this observation? How might this influence climate regions?
3. What does the pan of sand represent? The ice? What happened to the smoke when you lit the candle the first time? The second time? What weather phenomenon does this experiment demonstrate?