



4-H Grab and Go: *What Causes the Wind?*

Concept:

Heat transfer is a cause of wind

Age Level:

Middle School: Grades 5-8

Education Standard:

NSES – Science as Inquiry,
Physical Science, Earth and
Space Science

SET Ability:

Demonstrate, observe, measure,
record, compare

Life Skill:

Problem solving, Critical thinking

Success Indicator:

Youth will be able to design and
conduct a scientific investigation
to show whether air moves
because land and water heat at
different rates.

National 4-H Curriculum:

The Power of the Wind (www.4-H.org/curriculum/wind)

PREPARATION

Time: 10 minutes

Space:

Tables, access to electricity for
light bulbs

Materials for each group:

- Water
- Soil
- Tubs for water and soil
- Thermometers or temperature probes
- Light bulb to produce heat
- Streamer to detect air movement

Background Information:

Heat is transferred in three different ways: conduction, convection and radiation.

Conduction is the transfer of heat through matter by molecular activity. Heat moves by direct contact. If you put one half of a spoon in boiling water you will notice that the end of the spoon that is not in the water is also hot.

The second way that heat transfers is through **convection**. This is the transfer of heat by mass movement or circulation within a substance. This occurs often in gases and liquids. Consider boiling water on a stove top. At first heat moves by conduction from the stove top through the pan to the water. Warmer water rises as the molecules move apart and it becomes less dense. The hot water at the bottom of the pan moves to the top and the cooler water at the top moves to the bottom. When the cooler water is heated it moves back to the top, circulating the heat throughout the liquid. The same thing happens in air. Warmer air rises and cooler air sinks to take its place.

The third way heat is transferred is by **radiation**. Radiation energy travels through the vacuum of space. Our planet receives heat from the sun in this way.

Changes in temperature cause changes in air pressure. Warm air has less pressure than cool air. When air is heated the molecules spread apart and it rises. When air is cooled, molecules move together and it sinks. This is one way that wind is created.

As the sun comes up, heat reaches the planet through radiation. Land surfaces heat and cool more quickly than the surfaces of water. Since the land near the ocean heats more quickly than the nearby water surface, the air above the land heats faster than the air over the ocean.

Convection causes the warmer air over land to expand and rise, which in turn causes low air pressure over the land. The cooler air over the ocean rushes in to replace the warm air that just rose over land. This causes a sea breeze.

As the sun begins to set, the land cools faster than the ocean. At some point the temperature of the land air and the ocean air are the same. This causes the breeze to stop for a short period. Gradually, convection and radiation cause the air over the ocean to expand and rise because it is warmer than the air over land. The cooler air over the land rushes in to fill the gap caused by the rising, warmer ocean air. This causes a land breeze. This transfer of heat through convection and radiation happens each day.

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What Causes the Wind?

YOUTH DEVELOPMENT TIP

When asking questions, recognize all possible solutions and answers. Respond with additional questions to probe for deeper learning and stimulate dialogue.

QUESTIONS

- Look at the U.S. Wind Resource Maps at the National Renewable Energy Laboratory (NREL). What do you notice about the coastal areas?
- Which other areas of the U.S. have good or fair wind resources?
- How might convection and radiation explain wind in non-coastal areas?

LEARN MORE

The Weather World 2010 Project (WW2010) has been developed by the Department of Atmospheric Sciences at the University of Illinois at Urbana-Champaign.

Learn more about forces and winds including sea and land breezes at: [http://ww2010.atmos.uiuc.edu/\(Gh\)/guides/mtr/fw/home.rxml](http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/fw/home.rxml)

The National Weather Service Forecast Office in Honolulu, HI sponsors wind activities for young people at: <http://www.prh.noaa.gov/hnl/kids/activities.php>

View an animation showing land and sea breezes during a 24-hour period at: <http://serc.carleton.edu/resources/39039.html>

Instructions

Conduct an experiment to examine the absorption rate of heat in light and dark colored material.

1. Ask if a dark shirt absorbs more heat on a sunny day than a light or white colored shirt.
2. Place one thermometer under a piece of black material.
3. Place a second thermometer under a piece of white material.
4. Set both pieces in the sun for ten minutes.
5. Record the temperature on a chart every two minutes.

What are your results? Did the black or white material heat faster?

Extend

1. Conduct a second experiment to determine how water and land heat at different rates.

Consider these questions when you design your experiment:

- How will you record and display your results?
 - Will it make a difference if the container for the soil and the water are different sizes?
 - Will it make a difference if you use different amounts of soil and water?
 - Would the containers with the soil and the water have to be placed next to each other?
 - Will it matter if you place the thermometer at different depths in the water and the soil?
 - Will a lamp work as the source of heat instead of the sun?
 - Does it matter if sand is used instead of soil?
 - What if the soil is sod with grass growing on the top?
 - Does salt water make a difference?
2. How could you change your experiment to show whether or not land and water cool at the same rate?
 3. How could you use streamers in your experiment to see if a slight breeze occurred as you heated the soil and the water?

