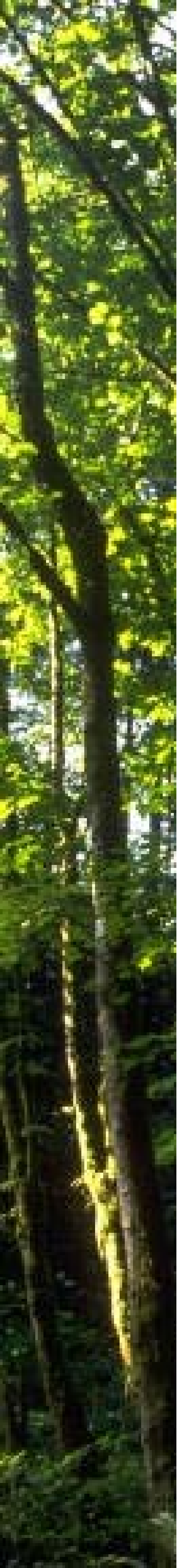


RAIN FOREST TEACHING CURRICULUM

Table of Contents

Welcome to Rain Bird's Rain Forest Teaching Curriculum!

The Rain Bird Rain Forest Teaching Curriculum features "I can relate to that" science learning tools for teachers, students, and parents. The following is a list of answers to some frequently asked questions about the Rain Bird Rain Forest Teaching Curriculum:

What is it?

Rain Bird's Rain Forest Teaching Curriculum is an online educational tool for teachers to use and find specific lesson plans and related course work for kindergarteners through high school seniors. This content is also available online at www.rainbird.com.

What is its purpose?

To teach natural history, ecology, biology, physics, and chemistry through demonstrations, experiments, and classroom activities. Rain Bird and California State Polytechnic University, Pomona (Cal Poly Pomona) designed the program content, which focuses on endangered tropical rain forests in Latin America, South America, Africa, and Southeast Asia as the basis for teaching science through fun, hands-on things children already do and like—art projects, outdoor activities, and classroom demonstrations. The curriculum motivates kids to think about the part each of them plays—or the actions they can take—in preserving and protecting the environment.

Who should use it?

Teachers and parents. Teachers who are seeking a new, fun and engaging resource to teach children about science. Parents who are looking for friendly, but educational how-to's on "bringing science home." But most of all, it offers something for just about anyone and it's just plain fun for kids, no matter what their age.

Is the information easy to use?

Yes! The information is well organized and self-explanatory. The curriculum is arranged with grade-appropriate material (K-1, 1-2, 2-3, 3-4, 4-5, 6, 7, 8, and 9-12). As appropriate, each grade level contains projects that integrate science with art; data gathering, observation, and inference; analysis of physical matter; in-class demonstrations to be performed by teachers for students; and at-home projects that illustrate scientific principles in a manner both understandable and meaningful to school-age children.

Why the focus on rain forests?

Rain Bird has always supported and educated its consumers on the importance of the "Intelligent Use of Water." The curriculum ties into this philosophy because rain forests provide oxygen and consume carbon dioxide, playing a pivotal role in the climate control of our planet. This affects wind, rainfall, humidity, and temperature worldwide. Rain Bird is deeply concerned about the environment and has always promoted stewardship of Earth's resources, or which water is among the most precious. Some 30 million species of plants and animals—a majority of all things living on Earth—exist interdependently in tropical rain forests. In addition, rain forests are rich with plants vital in creating modern medicines.

What has the response to the curriculum been?

Thousands of online visitors each month learn about the important role tropical rain forests play in the world. And, because the information is being so well received, Rain Bird has expanded its commitment to university-level education through its partnership with California State Polytechnic University, Pomona. Jointly, they will unveil in 2002 three Rain Bird Learning Centers at Cal Poly Pomona's BioTrek Project, located on the Cal Poly campus.

About Rain Bird

Rain Bird Corporation, based in Glendora, California, USA, is the world's largest manufacturer of sprinkler and drip irrigation equipment. Founded in 1933, Rain Bird offers the industry's broadest range of irrigation products to golf courses, sports arenas, amusement parks, farms, and commercial and residential developers in more than 130 countries. For more information, visit Rain Bird's web site at www.rainbird.com.

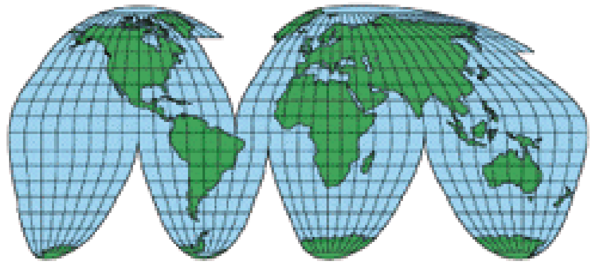
This workbook is brought to you through a partnership between:

Rain Bird, Azusa, California

Science IMPACT, College of Science,
California State Polytechnic University, Pomona

The Rain Forest: An Introduction

What is a tropical rain forest?



A tropical rain forest is a forest that receives 4 to 8 meters of rain each year.

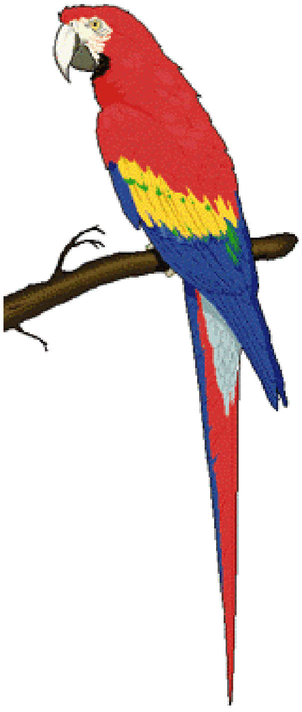
Where are tropical rain forests located?

Rain forests are located within a narrow region near the equator in Africa, South and Central America, and Asia.

Why are tropical rain forests important to our earth?

Rain forests play an important role in the climate control of our planet by having an affect on the wind, rainfall, humidity, and temperature. Within the rain forest, water, oxygen, and carbon are recycled. This natural recycling helps to reduce flooding, soil erosion, and air pollution.

The rain forests support over one half of the plant and animal life on Earth, even though they cover only 2% of the Earth's surface.



Approximately one fourth of the pharmaceuticals (medicines) we use come from plants of the tropical rain forests. According to the National Cancer Institute, 70% of the plants from which we make medicines and that are effective in the treatment of cancer can only be found in the rain forests.

What is happening to our rain forests?

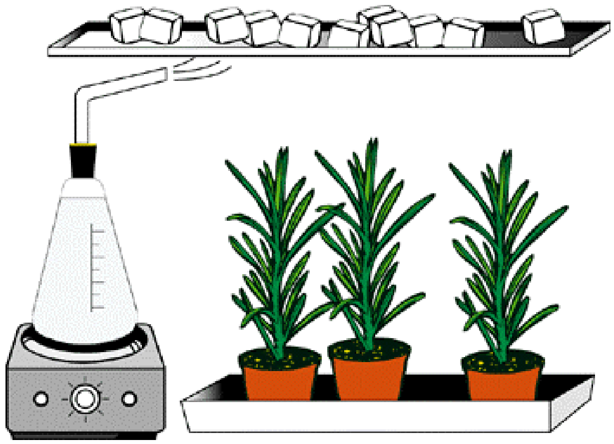
27 million acres of the Earth's rain forests are destroyed each year due to man. The activities which threaten the rain forests are: agriculture, clearing and developing of land, beef cattle ranching, logging, and the building of dams and hydroelectric plants. This results in a loss of 100 acres of rain forest per minute and 80% of the rain forests in the world are now gone. The destruction of the world's rain forests at this rate causes 10,000 plant and animal species to become extinct each year.

Grades 6-8 Activities Overview

The tropical rain forest is a wonderful environment to learn not only about natural history, ecology, and biology, but also physics and chemistry. So much goes on in the rain forest and so many plants and animals live there (approximately 50% of the plant and animal life on the planet) that exclusive existence on the ground is impossible for the abundance of species. That is why the rain forest exhibits a layering of habitats, or canopy. There are many plants and animals, including insects, which never spend any part of their lives on the ground. These plants and animals have developed very specialized adaptations that allow them to compete successfully for all of the resources they require to thrive.

As we look at our planet, we can observe that the closer we move to the equator, the greater the abundance of life. The tropical rain forests, which exist in the narrow band around our Earth called the equator, are environments that require all plant and animal species to become very specialized in their strategies for acquiring food, water, reproduction opportunities, and all aspects of survival, because the competition for these resources is so great. This is very different from other areas of our planet, farther north and south from the equator, where the concentration of life is less dense. In those areas, it is more advantages to have very general adaptations and to be able to utilize many different strategies and resources. In other words, survival depends on being a generalist. Indeed, the rain forest can be a study in economics—supply and demand.

It is interesting to note that many of the species living in the tropical rain forest have yet to be discovered. In this portion of the Rain Bird Rain Forest Curriculum, we will be making our own discoveries, as we explore the sciences in the context of the highly specialized adaptations that all life forms exhibit in this fascinating environment. At each grade level, there are three activities for students and one in-class demonstration to be presented by the teacher.



Grade 6 Activities At a Glance

- Activity: Using Plants as a Natural Source of Dyes
- Activity: Making Rain
- Activity: The Impact of a Raindrop on Soil
- Demonstration: Energy in the Rain Forest

Grade 6 Activity: Using Plants as a Natural Source of Dyes

As we learn about the varied species in the rain forest, it is essential to remember that native peoples have inhabited this environment for hundreds of thousands of years. They too have developed survival adaptations and, in addition, have made fascinating discoveries and developed countless methods for making the most of the resources available to them.

An area where they have excelled is the use of native plants for food, medicine, shelter, clothing, and the making of artifacts. Native, rural peoples in many regions around the globe are actually excellent scientists. They have finely honed abilities in observation, analysis, and drawing conclusions. In the use of plants, they have proven to be good chemists, as they developed highly effective methods for dying fibers.

In this section we will experiment with some formulas for dyes made from plants. We will also employ an energy saving alternative to boiling the dye over a flame—we will construct a solar reflector to accomplish the same job! This is an excellent activity for the integration of the social sciences and art.

Materials:

Variety of plant materials collected from the wild, home garden, school campus or purchased, large glass jars with lids, wax paper or plastic wrap, water, cardboard box (such as a sturdy photocopy paper box), aluminum foil, mirror, alum, clean, carded wool or commercial skeins of white wool yarn.

Procedure:

We will employ the most simplified "one pot" method here. Usually, there are at least 2 steps involved. The first step is the mordant process. This is where a chemical is used to break down the fiber to be dyed so that the pigment bonds more effectively with the wool (or cotton) fiber. The word mordant comes from the Latin word mordere—to bite. This process is generally done first and you may wish to take the extra step first. It can, however, be incorporated right into the dying process.

Not using a mordant will result in color that fades. The type of mordant used also influences the color obtained from the plant pigment. The most common mordants used are naturally occurring water-soluble metal salts, all of which are poisonous to varying degrees. THE SAFEST MORDANT TO USE IS ALUM—THE SAME ALUM (ammonium alum) FOUND IN THE DRUGSTORE AND USED AS AN ASTRINGENT. Other mordants include chrome, tin, copper, and iron. Native peoples found these elements in the soil. In early pioneer days in the United States, rusty nails and old horseshoes were added as the source of iron in a mordant. Also, using a copper or iron pot was useful (though it was impossible to determine how much of the metal was being added to the fiber).

The mordant process is as follows:

1. Tease the wool material apart a little.

2. Obtain a nonreactive pot with a lid. The size depends on the amount of material you will be placing in the pot (water must cover the wool). Here's a guide: a pound of wool requires 2 gallons of water to cover it . You will probably not be using that much wool. If so, you can divide it up and place it in smaller vessels.

3. Place the wool in a vessel of warm water to loosen it up a bit. Let it stay there for at least 10 minutes.

4. In the nonreactive pot, add 4 tablespoons (64 grams) of alum to 2 gallons of water—always add the chemical to the water, not the water to the chemical. Bring the mordant bath to a simmer (180-190°F or 64-70°C). Simmer for 15 minutes or until the alum is dissolved.

5. Add the soaked wool and simmer, covered, for an hour.

6. Remove the mordant bath from the heat and let it cool. Remove the wool for dying. The damp yarn can be retained for at least 3 weeks in a plastic bag in the refrigerator if you are not ready to dye it just yet.

The "one pot", energy saving method for dying the wool is described below:

1. For each student or lab group of 2, 3, or 4, obtain a glass jar with a lid.

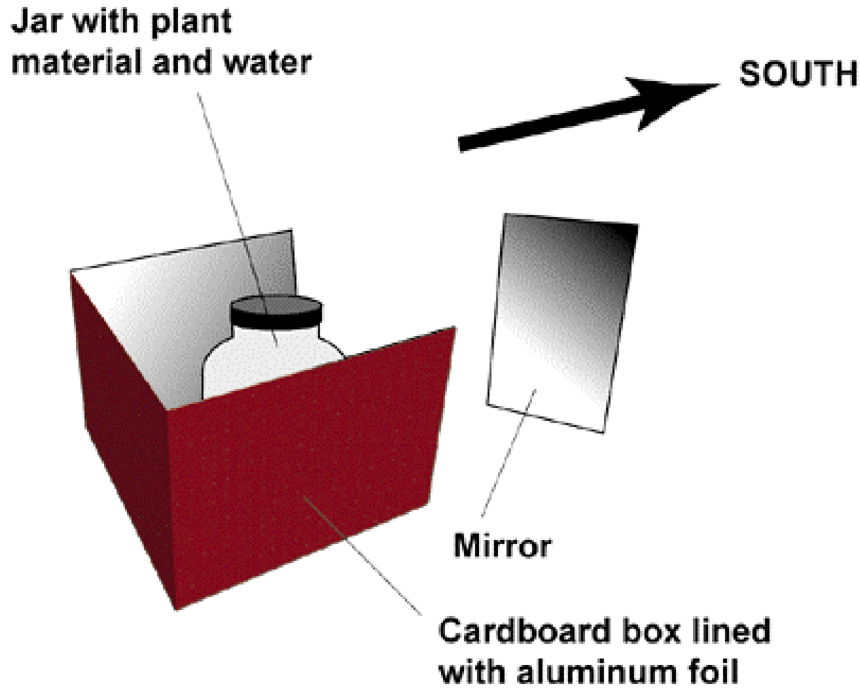
2. Place plant material (weeds are great—don't overlook them!) in the jar. Each student or group of students should try a different type of plant. Sunflower seeds, with hulls on, are also a good source of dye. Use flowers, leaves, stems, roots—experiment! Cover the plant material with water and place a piece of wax paper or plastic wrap over the mouth of the jar and secure the lid over that. This will create a lining for the metal lid and prevent a metal contamination of the dying process. Remember, the more plant material, the stronger the dye!

3. Construct a solar reflector by cutting the top and one side out of a cardboard box. Line the box with aluminum foil (shiny side of foil up). Place the box and the jar in the sun, with the open side of the box facing south. For extra energy, add a mirror to reflect light escaping from the open side back into the box. Surprisingly, the water will boil, producing an excellent dye bath.

4. Allow the plant material to simmer for an hour. (If you do not wish to use solar energy, this can also be done over a burner—but we're trying to save energy!) After an hour, allow the plant material solution to cool, then strain out the plant material. You now have a natural dye!

5. Place some wool yarn in the dye jar and add a level teaspoon of alum (unless you already put the yarn through the mordant process), replace the lining and lid, swirl the jar to mix in the alum in the solution and simmer for an hour in the solar reflector.

   An alternative is to simply chop up plant material, add the yarn (pre-mordanted), cover with water and allow the jar to sit out in the sun for 30 to 40 hours. This is how many Native American groups did their dying.



Questions for Students:

1. Which plants produced which colors of dyes?

2. Which plants produced the deepest colors? What could you do to ensure deep, rich colors?

3. Did you try more than one process for making the dyes (i.e. the regular boiling over a flame, the solar reflector, and 30-40 hours left out in the sun) and did the results vary or were they the same?

4. Did you try to dye yarn that was not mordanted? If so, compare to the yarn that went through the mordant process. Are the colors as deep? Did they fade?

5. If plants are not used, how do commercial companies make dyes? Check on the package of a commercial box of dye at the market.

Notes to the Teacher:

Be cautious not to use poisonous plants in this activity. If you are not sure about the safety of a plant, do not use it. Be very careful and direct students to be careful in handling hot liquids. You can also experiment with making dyes from asparagus and other vegetables and fruits. The amounts of plant material, water, mordant, and material to be died will vary depending on your needs. The rule of thumb is one pound of wool to 2 gallons of water to 4 tablespoons of alum (for the separate mordant process). For the dying, be certain that there is enough dye to cover the wool or yarn. You just need to experiment like the native, rural people of the rain forests did!

Grade 6 Activity: Making Rain

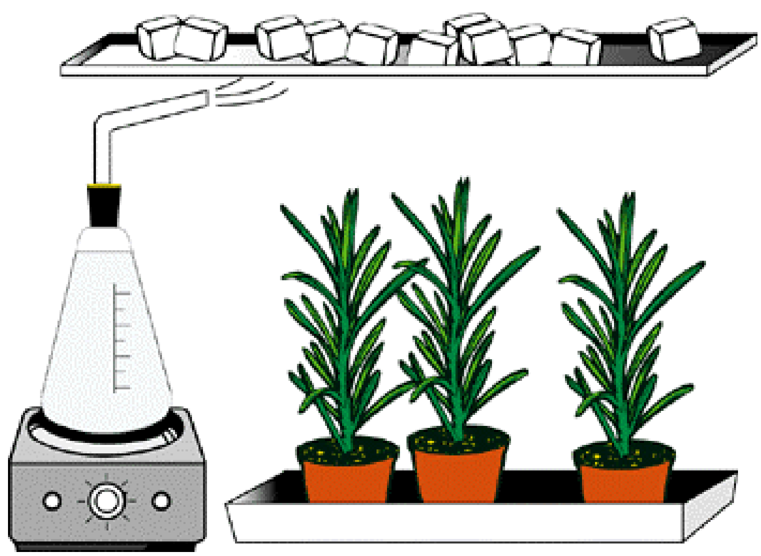
A rain forest by its very name indicates that much rainfall occurs there—up to 8 meters per year! This important process remains very overlooked and under-appreciated by many students. Often the depth of their investigation consists of merely copying a diagram of the water cycle. While this activity can be done as a teacher demonstration, it is much more engaging for the students to do it in lab groups or pairs.

Materials (per group):

Ice, baking sheet, ring stand, hot plate, tea kettle (or lab glassware for boiling water and creating a stream of steam), a tray with a few potted small live plants.

Procedure:

1. About 40 cm from the tabletop, attach a baking sheet horizontally to a ring stand and cover the sheet with a layer of ice cubes.
2. Place water to boil on the hot plate adjacent to the baking sheet. A tea kettle works well, or use a flask with a one hole rubber stopper and a piece of glass tubing (a sturdy plastic flexible drinking straw can be used in place of the glass tubing). Direct the output of the kettle or tubing onto the bottom of the baking sheet.
3. In a tray, place a few small, potted plants and place this tray directly under the baking sheet (see diagram).



4. Wait for rain!

Questions for Students:

1. Describe the process you just observed. Make a list of what occurred in the order in which it occurred.

2. Where is the cool air in this set-up and what does it represent? Where is the hot air in this set-up and what does it represent? How does the warm air and the cool air come together?

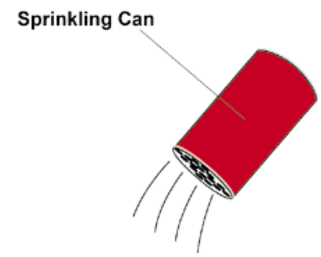
3. Why did it rain?

Notes to Teacher:

The tea kettle or the flask represents the source of water on Earth. As this evaporates and rises up to the ice-filled tray (the upper layers of Earth's atmosphere cooled by expansion), moisture condenses on the bottom of the tray and precipitation occurs. Rain falls on the small plants, which are used to model plant life on Earth.

Grade 6 Activity: The Impact of a Raindrop on Soil

When rain forest land is cleared and completely void of plant life a series of devastating events occur. One is the impact that clear cutting can have on the soil. This applies not only to the rain forest, but anywhere soil is left exposed.



Materials (per group):

Soil, 3 small flowerpots or food cans (e.g., tuna cans), one can (like a soup can) with holes punched in the bottom (this will act as a sprinkling can), 12 coins or bottle caps.

Procedure:

1. Fill 3 pots or cans with loose soil and press the soil so that it is even with the top on the container.
2. Place 4 coins or bottle caps on the soil of each container.
3. Place the cans or pots on several sheets of newspaper (or in a basin).
4. Use the "sprinkling can" to rain down on 2 of the 3 containers. Allow no water to fall on one container, moderate water to fall on the second container, and a heavy "rain" to fall on the soil of the third container.

Questions for Students:

1. What do the coins or the bottle caps represent in this activity?
2. What happed to the unprotected soil? Compare the results between your moderate and heavy rain to address this question.
3. Briefly describe the environmental impact of clearing land and exposing soil.

Notes to the Teacher:

Unprotected soil is splashed out and soil remains under the coins or bottle caps. You might want to make the "sprinkling cans" ahead of time for each group. This can be done simply by poking holes in the bottom of a soup can with a hammer and nail.

Grade 6 Demonstration: Energy in the Rain Forest

One of the most important concepts in biological, chemical, and physical processes is energy. In any natural process, energy is transferred or transformed. There are three types of energy that can be possessed by a system:

Kinetic Energy—the energy associated with the translational or rotational motion of the system

Potential Energy—the energy associated with interactions among members of the system (e.g., gravitational, electrical, tension in a spring, etc.)
Internal Energy—when considering a macroscopic system, this is the energy associated with the microscopic components of the system. It includes vibrational energy of atoms and molecules, bond energy between molecules, and nuclear energy in the nuclei of atoms.
There are several ways of transferring energy across the boundary of a system. The three most important energy transfer methods for studying the rain forest are the following:
Electromagnetic Radiation—the most familiar example of this is light, which is used in the process of photosynthesis. Other examples include radio transmissions and microwave cooking.

Heat—Energy will flow into or out of a system by heat if there is a temperature difference between the system and its surroundings. This process involves the collisions of molecules. If the temperature of the system is higher than the surroundings, molecules in the system will be moving randomly with a higher average kinetic energy than those in the surroundings. The higher energy molecules will collide with the lower energy molecules, transferring energy to them. As a result, there is a net energy flow from the system to the surroundings. There is significant energy flow by heat in the rain forest. For example, if the ground is warmer than the air, there will be a flow of energy by heat from the ground to the air.

Mass transfer—energy can be transferred by moving matter containing the energy from one location to another. A simple example of this is bowling—the energy you put into the bowling ball travels along with the mass of the ball (as kinetic energy of the ball) and is delivered to the pins. Another everyday example is filling your car with gasoline. The energy in the gasoline is transferred by moving matter—the gasoline—from the gas station holding tanks into your car. In the rain forest, the primary mass transfer mechanism is convection, in which energy in air is moved from one location to another. For example, the air that is warmed by heat from the ground, as discussed above, will rise upward and deliver the energy to higher regions of the canopy of the rain forest.

Part 1—Electromagnetic Radiation

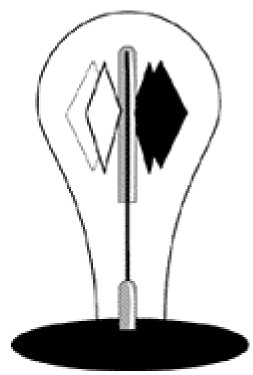
Materials:

Crooke's Radiometer, flashlight.

Procedure:

Shine a flashlight on a Crooke's radiometer. (Crooke's radiometers are available from scientific supply houses as well as many novelty gift stores.) The vanes should begin to turn, with the white sides leading.

Questions for Students:



1. How is energy entering the glass envelope of the Crooke's radiometer?
2. In what form does the energy appear inside the Crooke's radiometer?
3. How is energy carried from the Sun to the Earth?
4. What happens to the energy from the Sun when it is absorbed by a leaf in a rain forest plant?

Notes to the Teacher:

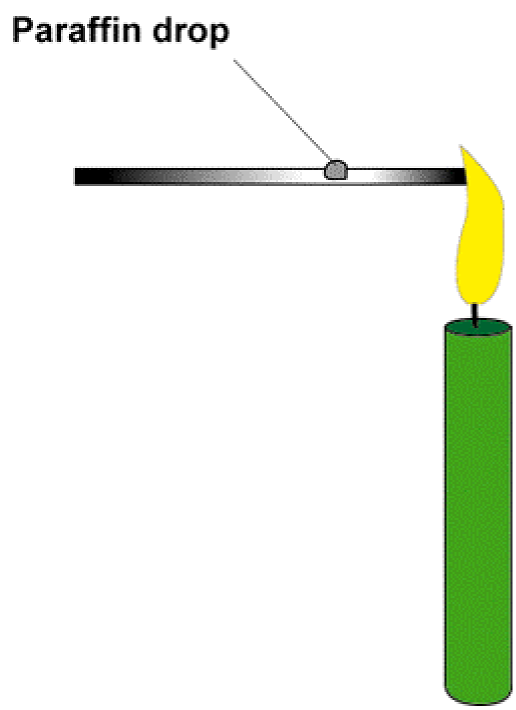
In the Crooke's radiometer, energy is transferred into the system by electromagnetic radiation, and appears in the system as kinetic energy—the rotation of the vanes. In a plant leaf, energy is transferred into the system by electromagnetic radiation, and is used in the process of photosynthesis. Be sure to point out this analogy for the students.

Part 2—Heat

Materials:

Metal rod, candle.

Procedure:



1. Light the candle and allow some wax to drip onto the metal rod and harden.
2. Secure the candle in an upright position and let it burn.
3. Place the metal rod in the flame so that the wax is two centimeters from the flame. After a few moments, the wax on the metal rod will melt.

Questions for Students:

1. What is happening inside the metal rod to allow the energy to move through the rod?
2. How would the demonstration be different if a glass rod were used?
3. At night in the rain forest, the water in a lake might be cooler than the air above the water. In which direction will energy be moving by heat?

Part 3—Mass Transfer

Materials:

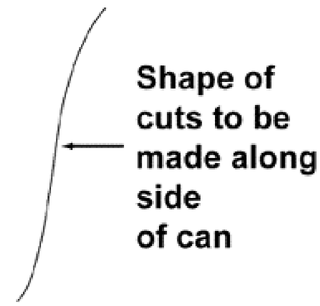
Soda can, tin snips or scissors, candle, thumb tack, pen, cork with hole, modeling clay.

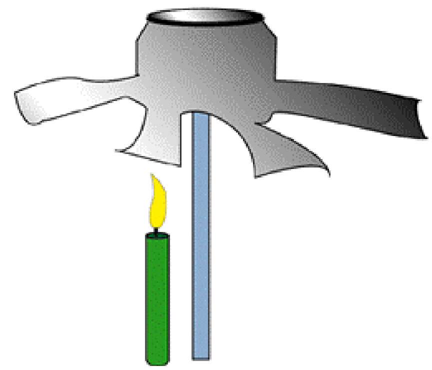
Procedure:

1. Cut the top from a soda can and discard the top.
2. Along the length of the can, make several cuts of the shape shown in the diagram, stopping about two centimeters from the bottom of the can.
3. Bend the resulting strips of metal upward, and you will have a fan-shaped object.
4. Insert a thumbtack through the center of the bottom, from the inside of the can.
5. Rest the head of the thumbtack on the flat end of a vertical rod such as a pen, so as to provide a relatively low-friction support.

6. Secure the rod to the tabletop by inserting the end of the pen into the hole in a cork and fastening the cork to the table with modeling clay.

7. Place a candle under the fan, and watch the fan rotate.





Questions for Students:

1. What causes the fan to rotate?

   If the fan is moved to a new position under the blades, will the direction of rotation change?

   How would the rotation change if three or four candles were under the fan?

2. In the rain forest, are there different temperatures at different heights? Will this cause energy transfer by convection?

Notes to the Teacher:

The word "heat" is one of the most misused words in our language. Be sure to use this word correctly in your teaching. Heat is a process by which energy moves from one location to another. It is also the amount of energy that is transferred by this process. It is not, however, a form of energy and it is not energy in motion, two concepts that are often presented as heat. Thus, the following phrases represent incorrect uses of the word:

"The water has a lot of heat in it..."

"The heat moved from one object to another..."

"Heat transfer occurred..."

As a test, substitute the word "transfer" for "heat" in a phrase. If it sounds awkward, the word heat is likely being used incorrectly. For example, the phrases above become,

"The water has a lot of transfer in it..."

"The transfer moved from one object to another..."

"Transfer occurred..."

These clearly sound awkward, so the word "heat" has been used incorrectly.