Solar Winds and Solar Engines

Overview:

Students develop a hypothesis, perform an experiment to test the hypothesis, and collect data. They observe the loss of heat from a lamp over various distances.

Objectives:

The student will:

- differentiate between qualitative and quantitative data;
- discover the role distance plays in the dissipation of energy from a heat or light source; and
- conclude that solar wind dissipates as it travels away from the sun.

Materials:

- Radiometer (one per group)
- Heat lamp (one per group)
- Meter stick (one per group)
- Masking tape
- STUDENT WORKSHEET: "Solar Winds and Solar Engines"

Activity Procedure:

1. Distribute the STUDENT WORKSHEET: "Solar Winds and Solar Engines."
2. Explain this experiment determines if energy from a heat lamp dissipates as it travels away from the source.
3. Ask students to check off the hypothesis they think will be most accurate on the bottom of STUDENT WORKSHEET: "Solar Winds and Solar Engines."
4. Divide students into groups. Provide each group with the items from the materials list.
5. Groups will need enough room so that one group's heat lamp does not interfere with another group's experiment. The best method for setting up this experiment depends on the type and design of heat lamp used. Direct students to place heat lamps so that the light is aimed toward their work space. This experiment should be conducted on the floor, if possible, to prevent the fragile radiometers from being knocked off of a desk or table.
6. Ask each group to perform the tests described in the *Procedure* section of the STUDENT WORKSHEET: "Solar Winds and Solar Engines" and record their data in the data table.

Answers to Student Worksheet:

Data: *Answers will vary based upon the materials you supply. However, students should observe some spinning of the radiometer vanes at 25 centimeters without the heat lamp. Once the heat lamp is turned on, the radiometer should spin very rapidly when it is placed closest to the heat lamp, and get slower as it is moved further away.*

Analysis of Data: *1. A. 25 centimeters (no lamp) 2. A. 25 centimeters 3. E. 200 centimeters*

Conclusion: *Heat from a heat lamp dissipates with distance. Other answers will vary.*

Further Questions:

1. *Solar wind is a stream of energy that travels away from the sun into space at a rate of about 400 kilometers/second.*
2. *No. It dissipates over distance because it is spread out. Students should use experimental results to support answer.*

Name:_____ **Student Worksheet (1 of 3)**

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Testable Question/Problem:

Does the energy from a heat lamp dissipate over distance?

Background Information:

In 1875, William Crookes created the first **radiometer**, also known as a light mill or solar engine. Within a radiometer is a set of vanes mounted on a spindle. One side of each vane is black, while the other side is white. There is very little air within a radiometer, but it is not a perfect vacuum. In fact, a radiometer will not work if there is a vacuum inside the bulb. When a radiometer is exposed to light (or even the heat of your hand) it will begin to spin, with the light sides of the vanes leading. The more light or heat applied to the radiometer, the faster it will spin. If the radiometer is cooled, it will spin in the opposite direction. How does a radiometer work? That is a good question. There are numerous theories about this, but none have been accepted.

A radiometer does not actually take measurements, but by closely observing its behavior, most importantly how quickly it spins, we can gather **qualitative data**. Scientists use two kinds of observations, those which are qualitative and those which are **quantitative**. In a quantitative experiment, the data gathered is based upon direct objective measurements; for example, using a thermometer to measure the temperature of two water samples. Qualitative data is based upon a subjective assessment; for example, placing a hand in two water samples to observe that one sample is warmer than the other.

The **solar wind** streams away from the sun in all directions at an average rate of about 400 kilometers/second. As it passes Earth, it interacts with our magnetosphere to create the aurora. The solar wind continues traveling toward the outermost planets in our solar system and beyond for an unknown distance. Over these great distances, the energy of the solar wind dissipates. The total amount of energy is the same, but the amount of energy in a square mile close to the sun is greater than the amount of energy in a square mile far from the sun. Imagine measuring the thickness of the balloon material in a balloon that is not inflated. Now imagine inflating the balloon and measuring the thickness of the material again. The inflated balloon is thinner than the deflated balloon. The same amount of material makes up the balloon in both cases, but it is spread out over a greater area when the balloon is inflated.

Hypothesis:

Use the background information provided by your teacher or on this worksheet to make a hypothesis (Check one):

_____ Heat from a heat lamp will not dissipate with distance.

_____ Heat from a heat lamp will dissipate with distance.

Name:_____ **Student Worksheet (2 of 3)**

Solar Winds and Solar Engines

Experiment:

Materials:

- Radiometer
- Meter stick
- Heat lamp
- Masking tape

Procedure:

1. Set up the heat lamp as directed by your teacher, but do not turn it on until instructed to do so in the procedure.
2. Using a meter stick, place small pieces of masking tape on the floor at the following distances from the heat lamp: 25 centimeters, 50 centimeters, 100 centimeters, 150 centimeters, 200 centimeters.
3. Place a radiometer at the 25 centimeter mark. Step away from the radiometer so your body heat does not interfere with the experiment. Without turning on the heat lamp, observe any motion within the radiometer. Describe this motion on the data table. Be sure to observe the rate at which the vanes in the radiometer are spinning.
4. Leave the radiometer at the 25 centimeter mark and turn on the heat lamp. Give the heat lamp about 30 seconds to warm up, then observe the motion within the radiometer. Describe the motion on the data table.
5. Once you have thoroughly observed the motion of the radiometer at 25 centimeters, carefully move the radiometer to the next measured location (50 centimeters) and make observations. Record these observations in the data table.
6. Repeat this at the 100 centimeter, 150 centimeter, and 200 centimeter locations, making sure to record observations at each station.

Data:

In the table below, record the observations you made while performing the experiment.

Distance	Observation of Radiometer
25 centimeters (no lamp)	
25 centimeters	
50 centimeters	
100 centimeters	
150 centimeters	
200 centimeters	

Name:_____ **Student Worksheet (3 of 3)**

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Analysis of Data:

1. Which experimental location would be considered the control experiment? Circle the correct answer.

   A. 25 centimeters (no lamp)
   B. 25 centimeters
   C. 50 centimeters
   D. 100 centimeters
   E. 150 centimeters
   F. 200 centimeters

2. At which experimental location (when the heat lamp was on) did the radiometer spin the fastest? Circle the correct answer.

   A. 25 centimeters
   B. 50 centimeters
   C. 100 centimeters
   D. 150 centimeters
   E. 200 centimeters

3. At which experimental location (when the heat lamp was on) did the radiometer spin the slowest? Circle the correct answer.

   A. 25 centimeters
   B. 50 centimeters
   C. 100 centimeters
   D. 150 centimeters
   E. 200 centimeters

Conclusion:

Place a check next to your conclusion:

_____ Heat from a heat lamp does not dissipate with distance.

_____ Heat from a heat lamp dissipates with distance.

Was your hypothesis proved or disproved?

_____

Explain what evidence supports your conclusion. Use complete sentences.

_____

_____

Further Questions:

1. What is solar wind? _____

2. Does the solar wind travel throughout the solar system without dissipating? Use your experimental results to support your answer.

_____

_____

