Climate Discovery: Climate Future

Some Like It Hot!

Teacher's Guide *http://eo.ucar.edu*

Subject Focus:

Physical Science
Earth Science
Environmental Science

Time: Two 40-50 minute class periods -- one period to prepare for the lesson and collect the data; one period to analyze it.

Preparation:

Arrange for 10 cars to be available in the parking lot or a designated safe area for the activity. If lab notebooks are not being used, prepare or have students prepare a table to record his/her data. Purchase materials and ensure that all materials are in working order.

Materials:

- hand-held infrared heat detector*
- stopwatch
- regular room thermometer
- calculators
- graph paper
- a sunny day

Do not aim infrared camera at eyes.

*Infrared hand-held heat detectors can be purchased at Radio Shack for approximately $50 (catalog No. 22-325). Each thermometer requires one 12-volt battery (about $2.50). More expensive infrared thermometers can be found on line that do a better job of measuring reflective, shiny surfaces more accurately than the Radio Shack units.

National Science Content Standards Addressed:

Underlying Concepts and Processes standard; Inquiry standard; National Science Concept standard B and D

Objective:

Students will use hand-held infrared heat detectors to investigate color and its connection to surface temperature. Through an analysis of their data, students will understand that the physical characteristics of a surface have a powerful effect on the way that the surface absorbs and releases heat from the Sun.

Procedures:

1. Discuss how to use the infrared thermometer safely before beginning the activity.
2. Using the infrared heat detector, collect the room air temperature and outside air temperature.
3. Proceed to specified parking lot and cars. Take surface measurements with an infrared heat detector of each car's roof, hood, trunk, windshield, dash board, and tire. Lastly take a measurement of the asphalt surface, parking lot line markings, and the nearest sidewalk.
4. Analyze data using the questions given.

Background:

What do trees, snow, cars, horses, rocks, centipedes, oceans, the atmosphere, and you have in common? Each of you are a source of radiation to some degree. Most of this radiation is invisible to humans but that does not make it any less real.

Radiation is the transfer of heat energy by electromagnetic wave motion. The transfer of energy from the Sun across nearly empty space is accomplished primarily by radiation. Radiation occurs without the involvement of a physical substance as the medium**.** The Sun emits many forms of electromagnetic radiation in varying quantities.

About 43% of the total radiant energy emitted from the Sun is in the visible parts of the electromagnetic spectrum. The bulk of the remainder lies in the near-infrared (49%) and ultraviolet section (7%). Less than 1% of solar radiation is emitted as x-rays, gamma waves, and radio waves.

The amount of energy absorbed by an object depends upon the intensity of the radiation striking the object.

Darker-colored objects absorb more visible radiation, whereas lighter-colored objects reflect more visible radiation. That's why we usually choose light-colored clothing on really hot days.

Each surface on earth absorbs and reflects energy at varying degrees, based on its color and texture.

Questions and Observations for Discussion

1. Which part of the car absorbed the most heat?

2. Which IR reading was greatest: the asphalt, sidewalk, parking lines, tires, or windows?

3. Imagine that it is a sunny day and the Sun is shinning on the ocean and on a stretch of land. Which will heat up more during the day? Which will cool more slowly at night? Explain.

4. The Earth's surface tends to lose heat in winter. Why do you think this is so?

5. Since the sun is approximately 93 million miles from the Earth, and space has no temperature, how do we get heat from the Sun?

6. How would the uneven energy absorption by different surfaces on Earth (water, soil, snow, trees, sand, etc.) affect the atmosphere?

Assessment:

Discuss and review each student's data table to ensure understanding. Utilize their answers to the above questions to ascertain level of mastery of the concept of albedo, IR radiation, energy and the electromagnetic spectrum.

Extensions:

There are many activities that are possible using an infrared thermometer. Detailed activities can be found via the Digital Library for Earth System Education at www.dlese.org.

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car color	roof temp.	hood temp.	trunk temp.	wind-shield temp.	tire tempera-ture	asphalt temp.	sidewalk temp.	parking lot lines temp.	Outside current temp.
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									

Analysis

1. Compare and contrast color results with your lab group. How do they compare?
2. How do your results compare to those of other lab groups?
3. Rank the colors by temperature from highest to lowest.
4. Can you infer why there are differences in color temperatures?
5. Predict the loss of heat rates for the colors.
6. On a piece of graph paper, graph the results of the colors for two parameters of interest.
7. Find the mean and standard deviation in degrees Celsius for both of the parameters graphed.