Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN
Mail Code C9000, Austin, TX 78712
(512) 471-5847• fax (512) 232-1913
www.esi.utexas.edu

Black or White – Solar Energy

Adapted by Duc Tran, Environmental Science Institute, November 2010
Sources:
- "Solar Energy Experiment" by Beatrice Ortiz from Ann Parish Elementary, NM (http://www.col-ed.org/cur/sci/sci106.txt)
- "Solar Matters I" by Florida Solar energy Center (http://www.fsec.ucf.edu/en/education/k-12/curricula/sm1/documents/SM1_solar-energy-and-color.pdf)

Grade Level: 2 – 6; can be modified for all grades

Length: 1 class period

Sample TEKS
§112.13. Science, Grade 2: 2A, 2D, 2E, 2F, 3B, 5B, 6A
§112.14. Science, Grade 3: 1B, 2A – F, 3A, 5C, 6A
§112.15. Science, Grade 4: 1B, 2A – F, 3A, 6A
§112.16. Science, Grade 5: 1B, 2A –G, 3A, 6A
§112.18. Science, Grade 6: 1B, 2A, 2B, 2D, 2E, 3A, 7A – B

Objectives
Students will be able to:
1. Discuss the effect of colors on the amount of solar thermal energy absorbed.
2. Describe which colors absorb more/less solar energy.
3. Investigate the effect that colors have on solar thermal energy.

Materials (per group of 2-3 students)
- 1 clear plastic bottle
- 1 plastic bottle painted white
- 1 plastic bottle painted black
- 3 balloons of the same color

Background
The visible light spectrum is composed of different wavelengths, ranging from violet to red. Violet light has the shortest wavelength but the highest energy and is closest to ultraviolet light. Red light has the longest wavelength but the least energy and is closest to infrared light. All the other colors of the visible light spectrum increase in wavelength and decrease in energy as they draw near to red and infrared light.

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An object appears to be the color of the light it reflects when white light or sunlight is shone upon it. White reflects all colors of the visible spectrum, while black reflects none and absorbs all. Lighter colors reflect more light while darker colors absorb more light. Light is energy, so absorption of light will increase a material's temperature.

Naturally, there is a gradient of colors; therefore, there must be a gradient of absorption. The degree of energy absorption does not solely depend on colors but also the type of material.

Activity

The experiment should be done outside on a sunny day. Students should formulate a hypothesis before working on the experiment.
Divide the class into groups of 2 -3 students. Each group will be provided with a set of bottles and balloons. Each group is responsible for capping each of their bottles with a balloon. Then they will place those bottles in the sun (the clear bottle serves as the control).

Students should observe and record (drawings, descriptions, quantitative data) what happens to the balloons over a period of time. Students should touch the bottles and note how they feel. [After a few minutes, the balloon attached to the black bottle should begin to inflate while the balloon attached to the white bottle will remain limp. The black bottle will be warmest.]

The black bottle will absorb more solar energy in comparison to the white bottle which reflects most of the sun's energy. The increase absorption of energy will warm up and expand the air inside the bottle, causing the balloon to inflate.

Sample Assessment Questions

1. Which color, black or white, absorbs more heat? Why is that?
2. What is the purpose for including the clear bottle in the experiment? Why is it necessary?
3. What color would be the best for a solar collector that heats water such as a solar pool heater or water heater?
4. What color roof would be the best for a house in Texas that is trying to keep cool?
5. What would be a good color to paint your car if you wanted to stay cool in the summer?
6. Why do you think the balloon of the black bottle expanded? Does heat make air expand?