Absorption and Radiation of Heat Energy

Grade Level : 7-12
Subject : Earth Science, Algebra I
SOL's : A.5, A.6, ES.2, ES.4

Objectives:

1. To compare the rate which shiny and dark materials absorb and radiate heat energy

2. To compare the rate at which soil and water absorb and radiate heat energy

Background:
Have you ever noticed how you feel cooler in light colored clothing than in dark clothing when you are outside on a sunny day in the summertime? Have you ever noticed how cool a jump in the lake is on a hot summer day? Why does the land get so hot, yet the lake remains cool? In this investigation you will compare the rate at which different materials absorb and radiate heat energy.

Part A: Light and Dark Materials

Materials:
- two empty soup cans (one painted dull black, one shiny silver), each with a hole punched in the unopened end to insert temperature probe
- desk or clip-on lamp, with 100W light bulb
- EA-100 data analyzer
- Casio CFX - 9850G calculator with link cable
- Two temperature probes
- timer (optional)

Procedure:
1. Place the cans with the open ends down. Insert the temperature probes so that the tip of the probes are about 2 inches from the top of the cans.

2. Set the lamp 12cm from the top of the cans. Make sure that the cans are an equal distance from the lamp.

3. Plug the probe from the shiny can into Channel 1 on the EA-100. Plug the probe from the black can into Channel 2. Turn the EA-100 on.

4. If you see "done" on the data analyzer you are in the communication mode.

This is where you want to be. If you see the word "multimeter" in the lower left corner, push the MODE button one time. You are now in the communications mode.

5. Press SHIFT, then MODE to enter SET UP

6. The first setting is the number of seconds you want between samples. Use the dataLOG key to scroll forward through your choices. For this investigation choose 60 sec. Press TRIGGER to make your choice.

7. The next setting is the total number of samples you want to take. Use the dataLOG key to scroll through your choices. Press the TRIGGER key when you reach 20.

8. The final setting is the time recording mode. Use the dataLOG key to choose 1 so the actual time will be recorded. **DO NOT** push the TRIGGER button until you are ready to turn the light on.

9. Turn the light on (record the time the light is turned on) and push **TRIGGER** (It may be necessary to push TRIGGER twice. Make sure that the screen on the data analyzer says "**sampling**") **After 10 minutes turn the light off.**

10. "Done" will appear on the screen of the data analyzer when the sampling is complete. Link the data analyzer and the calculator with the link cable. Be sure the ends of the cable are pushed in securely. Turn the calculator on.

11. Press CHN VIEW on the data analyzer until the REC TIME indicator in the left top corner is blinking (not the CH1 or CH2)

12. Select PRGM from the main menu on the calculator. Press EXE.

13. Use the arrow key to locate the RECEIVE program. Press EXE. The box in the upper right hand corner means the calculator is thinking.

14. When the screen says DONE, you are ready to disconnect the link cable and view the graphs. First you must set up the graph.

Go back to the main menu by pushing the MENU key
Choose STAT
EXE
F1 (Graph)
F6 (set)
Highlight Graph Type
F2 (xy)
Go down to XLIST
F1 (List 1)

Go down to YLIST
F2 (List 2)
Go down to Frequency
F1 (1)
Go town to Mark Type
F3 (**.**)
Go down to graph Color
F3 (green)
EXE

15. You have just set up the graph for the shiny can. Now you must set up the graph for the black can.
F6 (set)
F2 (GPH 2)
Change the Ylist to List 3 by pressing F3
Change the Mark Type to x by pressing F2
Change the graph color to blue by pressing F1
EXE

16. To view both graphs together, press F4 (SEL). Highlight StatGraph1. Press F1. Highlight StatGraph2. Press F1. StatGraph3 should be off. EXE.

17. The graphs will appear on the screen. The time will be on the X axis, and the temperature will be on the Y axis. The shiny can will be graphed in green ....., the black can will be blue xxxx.

Analysis:

Press Shift, then F1 to trace Statgraph1(shiny). Using the right and left arrow keys make x (time) as close as possible to the times in the chart and record the temperature(y) for that time. Fill in the chart, rounding temperature (y) to the nearest tenth.

time (x) in sec.	**temperature (y)**	**change from previous temp.**	**rate of change (change/5)**
0		**XXXXXXXXXX**	**XXXXXXXXX**
300			
600			
900			
1200			

Use the down arrow to trace Statgraph2 (black). Follow the same procedure

used for Statgraph1 and fill in the chart .

time (x) in sec.	Temperature (y)	change from previous temp.	rate of change (change/5)
0		**XXXXXXXXXX**	**XXXXXXXXXX**
300			
600			
900			
1200			

1. Did the two cans warm at the same rate? _____ If not, which one warmed faster? _____ Did the two cans cool at the same rate? ____ Which can cooled the fastest? _____

2. On the basis of your results , what can you conclude about the relationship between the color of an object and the rate at which it absorbs heat energy?

_____

_____

Part B: Soil and Water

Materials:
- two large glass beakers (one filled with water, one filled with sand)
- desk or clip-on lamp, with 100W light bulb
- EA-100 data analyzer
- Casio CFX - 9850G calculator with link cable
- two temperature probes
- ring stand with two clamps
- timer (optional)

Procedure:
1. Place one temperature probe in the sand and one in the water so the tips of the probes are 2 inches below the surface. You will need to use a ring stand and two clamps.

2. Follow steps 2-16 from Part A - Light and Dark Materials

3. The graphs will appear on the screen. The time will be on the X axis, and the temperature will be on the Y axis. The sand will be graphed in green ....., the water will be blue xxxx.

Analysis:

Press Shift, then F1 to trace Statgraph1(sand). Using the right and left arrow keys make x (time) as close as possible to the times in the chart and record the temperature(y) for that time. Fill in the chart, rounding temperature (y) to the nearest tenth.

time (x) in sec.	temperature (y)	change from previous temp.	rate of change (change/5)
0		XXXXXXXXXX	XXXXXXXXXX
300			
600			
900			
1200			

Use the down arrow to trace Statgraph2 (water). Follow the same procedure used for Statgraph1 and fill in the chart .

time (x) in sec.	Temperature (y)	change from previous temp.	rate of change (change/5)
0		XXXXXXXXXX	XXXXXXXXXX
300			
600			
900			
1200			

1. Which material absorbed more heat in the first 10 minutes? _____

2. Which materials lost more heat in the second 10 minutes? _____

3. Which will absorb more heat, dark, rough materials or smooth shiny materials? _____

4. On a hot summer day the sun shines on the ocean and the sand. Which will heat up more during the day? _____ Why? _____

_____

5. Which area will cool off faster at night? _____ Why? _____

_____

6. Birmingham, Alabama and Charleston, South Carolina are located at about

the same degree of latitude. Which city is warmer on the during the summer? Explain why? _____

_____

7. Which city would have the milder winter? Explain why? _____