ADVENTURE 10

Active Wear

Time:
2 class periods

Suggested grade levels: 6-8

Math Objectives:

Create, interpret and analyze graphs of data, Relate slope to rate of change

Science Objectives:

Understand which surfaces make the best solar collectors, Understand the difference between absorption and reflection

Materials:

TI-73 Explorer™, Calculator-Based Laboratory™ (CBL 2™), DataMate™, Temperature sensor, Three soda cans, spray painted black, white, and silver, Putty, clay, or sticky tack, Heat source (heat lamp or sun)

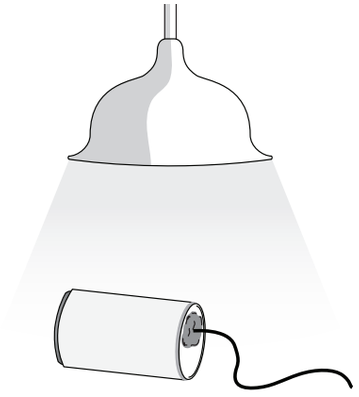
OVERVIEW

Anyone adventuring under the hot sun is potentially at risk for suffering from heat stroke or other heat related illness. One safety precaution they should take is to wear loose fitting, light colored clothing. Why is light colored clothing best when under the sun? In this adventure, students will test which solar collector—black, white, or silver— absorbs the most heat.

NOTE Demo the activity using the overhead calculator so the entire class can see the process. If you have only one CBL 2, have each group individually perform this activity. If you have enough CBL 2 units, have students work in small groups.

SET UP

1. Collect the three soda cans and spray paint one black, one glossy white, and one metallic silver.
2. Heat lamps with clamps designed for labs are optimal; however, student desk lamps with flexible necks and 60-/100-watt bulbs work fine. Keep the distance from the heat



source constant for all trials by measuring the distance from the heat lamp to the can. If working outside, place the cans in the sun for the same amount of time.

3. Connect the CBL 2 to the calculator using the I/O unit-to-unit cable.
4. Plug the TI temperature sensor into Channel 1 (CH 1) on the CBL 2.
5. To launch the DATAMATE program, press the [APPS] key, select **DataMate** and then press [ENTER] to view the DataMate screen. **See Figure 1.**

Figure 1

NOTE: DataMate may be listed under Programs (Press [PRGM]).

NOTE: For help with transferring DataMate to the CBL 2, see Appendix D.

NOTE: DATAMATE moves slowly between screens. As you make selections, be patient as the program executes the command.

6. The DataMate screen changes to the Main Screen. Select **1:SETUP.** Then, select **CH1.** Select **1:TEMPERATURE** and **4:STAINLESS TEMP(C).** If you are using a different temperature sensor, select the appropriate item from the menu. **See Figures 2a-b.**

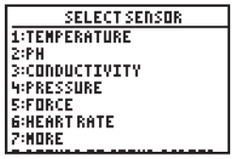


Figure 2a

Figure 2b

NOTE: The calculator may identify the temperature probe for you.

NOTE: The flexible TI temperature sensor is the same as the stainless steel.

7. Press [▼] to select MODE. Press [ENTER] and then select **2:TIME GRAPH.** Press **2:CHANGE TIME SETTINGS.** For **ENTER TIME BETWEEN SAMPLES IN SECONDS,** enter **30**. Press [ENTER]. For **ENTER NUMBER OF SAMPLES,** enter **20**. Press [ENTER]. The **TIME GRAPH SETTINGS** screen reappears, showing the new settings. The value for **EXPERIMENT LENGTH** automatically changes to **600** for these trials. Select **1:OK** twice to return to the Main Screen.

DATA COLLECTION

1. Place the temperature sensor into the black can and seal the opening with putty.
2. Place the can (on its side) under the heat source. If using a heat lamp, place the can as close as possible to the lamp. If outside, place the can in full sunlight.
3. When you are ready to begin, select **2:START.** The CBL 2 beeps twice and displays a graph with the temperature in °C in the upper right corner. At the end of each 30 second interval, a data point is plotted.
4. Continue to hold the sensor in the can. After 20 data samples are collected from the sensor and plotted, the CBL 2 beeps twice and the line graph is displayed. It will take 10 minutes.
5. Use the arrow keys ([▶] and [◀]) to move the cursor to each data point and record the values on your worksheet. Then sketch the graph.
6. Repeat steps 1–5 for the other two cans. Sketch all three graphs onto the same set of axes on your worksheet.
7. To exit from the DATAMATE program, press [ENTER] to return to the Main Screen. Select **6:QUIT** and press [ENTER].

NOTE: If you have three temperature sensors, data can be collected in one trial using CH1, CH2, and CH3. Note which sensor is in which color of can.

EXTENSION ACTIVITY

Predict which color emits heat best. Design a lab to collect temperature data with the CBL 2 for 10 minutes after turning off the heat lamp. If you do this on another day, you will need to warm up the cans again. Compare actual results to your predictions.

DISCUSSION NOTES

Heat is either absorbed or reflected into, or off of, an object. Objects that absorb a lot of heat do not reflect much heat. Objects that reflect a lot of heat do not absorb much heat. Objects made of lighter colors reflect more heat than they absorb, whereas darker objects absorb more heat than they reflect.

Show how these ideas can be seen in the scatterplot. Each point represents the temperature of the inside of the can at a certain time. The line for the black can increased the most; therefore the temperature inside the black can increased the most.

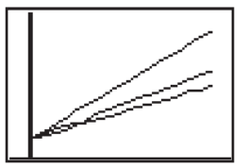
In active wear, color is just one factor to consider. If choosing between two cotton T-shirts, one white and one black, you will be cooler in the white one. However, much active wear these days is often made of "breathable" material that is cool and dry regardless of color.

WORKSHEET ANSWERS

NOTE: The data in these tables is simulated. Actual data will be slightly different.

1. Answers will vary. Sample data: Black 47.72, Silver 23.86, White 30.06
2. Black
3. Silver
4. Black, white, silver. Possible answer: Black isn't shiny so it doesn't reflect much heat, so it must absorb it. Silver is very shiny, so a lot of heat is reflected, rather than absorbed.
5. Black; silver or white

Time (in sec)	Temp. (°C) Black	Temp. (°C) Silver	Temp. (°C) White
0	22	22	22
30	24.37	23.19	23.44
60	26.09	24.38	25.01
90	29.12	25.61	26.78
120	31.65	26.76	28.60
150	34.01	28.04	29.12
180	36.33	29.15	29.73
210	38.77	30.34	32.54
240	41.08	31.54	34.23
270	43.46	32.86	35.63
300	45.92	33.91	37.12
330	47.96	35.13	38.91
360	50.62	36.29	40.52
390	53.32	37.44	41.34
420	55.76	38.67	43.01
450	57.78	39.88	44.52
480	60.17	41.06	46.22
510	62.55	42.28	47.63
540	64.98	43.44	49.06
570	67.32	44.25	50.51
600	69.72	45.86	52.06



Extension Answer

Black is the best emitter of heat. Good absorbers are also good emitters.

TI-NAVIGATOR™ EXTENSION ACTIVITY

Have groups compare results by using **Quick Poll (**with Open Response) and have one member from each group submit the following:

- the change in temperature in the black can, rounded to the nearest whole degree
- the change in temperature in the silver can, rounded to the nearest whole degree
- the difference between the changes in temperatures in the black and silver cans
- the order of the colors, from greatest to least temperature increase (have students write just the first letter of each color, without commas, to aggregate the data)

Name _____

ADVENTURE 10

Active Wear Worksheet

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In this adventure, you will test which solar collector—black, white, or silver— absorbs the most heat.

1. Subtract the initial temperature from the final temperature to find the change in temperature of each color.

2. Which can color made the best solar collector?
3. Which color reflected the best?
4. Rank the solar collectors from the greatest temperature increase to the least. Give reasons why these results seem reasonable/unreasonable.

5. If the can's or solar collector's surface is painted _____, more heat will be absorbed and the interior temperatures will increase more than if the color were _____ or _____.

DATA COLLECTION

Time (in sec)	Temp. (°C) Black	Temp. (°C) Silver	Temp. (°C) White
0			
30			
60			
90			
120			
150			
180			
210			
240			
270			
300			
330			
360			
390			
420			
450			
480			
510			
540			
570			
600