Build Your Own Planet  
Lesson 3: Albedo

Group: _____________________________

Does the surface of a planet affect how warm or cold it is? If so, how? This lesson will explore these questions.

Not all the energy that arrives at a planet actually warms the planet. Some of it is reflected back into space. The measure of the amount of energy reflected back into space is called the “ALBEDO” of the planet. (Albedo can be measured different ways. For this unit we will be using a particular type of measurement called “BOND ALBEDO.”)

Rocky surfaces can vary in color, but are usually dark. Icy surfaces can be very light or very dark depending on how much dust is mixed in with the ice—the more dust mixed in, the darker the ice. Liquid surfaces tend to be less dark than rocky surfaces.

Before we do the experiment, discuss the following question with your group and make a prediction: Will a dark-colored surface reflect more or less heat away from a planet than a light-colored surface?

Prediction: A dark colored surface will reflect ____________ heat. (more or less)

Experiment: Testing the Effect of Albedo on Temperature

You will need:  
This worksheet  
2 plastic two liter pop bottles  
2 small thermometers  
Flat black paint  
Flat white paint

Step 1: Cut off the top of the two plastic pop bottles at the top of the label. Remove the labels.
Step 2: Paint the outside of one of the bottles black and the other bottle white. You should also paint the inside of the bottles if you have enough paint.

On a sunny day:
Step 3: Place both thermometers in a refrigerator for at least 5 minutes (longer is fine).

Step 4: Remove the thermometers from the refrigerators. Bring this worksheet, both thermometers and the two painted bottles outside into the Sun.

Step 5: Place the thermometers on the ground. Cover one with the white bottle and the other with the black bottle. (If the thermometer is longer than the diameter of the bottle you will need to stand the thermometer up inside the bottle.) Wait at least three minutes.

Step 6: Lift up the white bottle and check the temperature on the thermometer. Record the temperature here: _________ ° F / C (circle).

Note: Circle “F” if you recorded the temperature in degrees Fahrenheit. Circle “C” if you recorded it in degrees Celsius. Make sure to use the same temperature scale throughout this experiment.

Step 7: Lift up the black bottle and check the temperature on the thermometer. Record the temperature here: _________ ° F / C (circle).

Because there might be small differences in the thermometers, we need to swap the thermometers between the two bottles and repeat the experiment, so continue on to Steps 8 - 10.

Step 8: Take the thermometer that was under the white bottle and place it under the black bottle. Put the thermometer that was under black bottle under the white bottle. Wait at least three minutes.

Step 9: Lift up the white bottle and check the temperature on the thermometer. Record the temperature here: _________ ° F / C (circle).

Step 10: Lift up the black bottle and check the temperature on the thermometer. Record the temperature here: _________ ° F / C (circle).
Step 11: Add together the two temperature readings under the white bottle recorded in Steps 6 & 9.
Total temperature under the white bottle: _______________ °F / °C (circle).

Add together the two temperature readings under the black bottle recorded in Steps 7 & 10.
Total temperature under the black bottle: _______________ °F / °C (circle).

Questions:
1) Which color bottle had the higher total temperature?

______________.

2) Which color bottle had the lower total temperature?

______________.

3) Which color bottle reflected away more heat?

______________.

4) Since albedo is the measure of how much energy is reflected away, which color bottle had the higher albedo?

______________.

5) Was the difference in total temperature between the two bottles great or small?

______________.

6) Do you think albedo has a great effect or a small effect on a planet’s surface temperature?

______________.

Based on what you just discovered about the black and white bottles, circle the correct answers to the next three questions.
7) If all other conditions were the same, you would expect a planet with a high albedo to have a **higher** average surface temperature than a planet with a low albedo.

8) If all other conditions were the same, a planet with a dark-colored surface would have a **lower** average surface temperature than a planet with a light-colored surface.

9) Much of the Earth’s north and south Polar Regions are covered by ice caps. This ice is very light-colored, almost white. This means that the ice caps have a **higher** albedo than the rest of Earth’s surface. As the ice caps melt and become smaller the Earth’s albedo **increases** and the Earth becomes **cooler**. If the ice caps start increasing the Earth’s albedo would **increase** and the Earth would become **warmer**.

10) In your own words, explain how the average surface temperature of a planet changes as its BOND ALBEDO changes: ________________

________________________________________________________________________

11) Now think about the average surface temperature of the planet you are exploring. Based on what you have discovered with the Planet Temperature Calculator, is the average surface temperature of your planet too hot, too cold or about right? ______________________________. Do you want your planet to have a high or a low albedo? ____________

Look at question 5 of the Planet Preference Survey to find the type of surface you selected for your planet. The surface you chose will restrict the range of numbers that you may enter for BOND ALBEDO in the planet temperature program.

  - If you chose “Liquid” choose a number between 15 and 25.
  - If you chose “Solid” choose a number between 1 and 15 for a rocky surface, 50 and 80 for a fresh ice covered surface, or 10 and 50 for an old, dirty ice covered surface.
  - If you chose “Mixture” decide whether your planet is mostly rock, mostly liquid or mostly ice. You should choose a number close to the allowable range for that surface (check the ranges listed above) but it can be a little higher or lower, depending on what else is on your planet’s surface.

  Our planet has a BOND ALBEDO of ____________.