I. Objectives

1. Determine the relationships among and object's surface characteristics and its temperature.

II. Introduction

The surface characteristics of a planet play a significant role in determining how much energy from the Sun will be reflected or absorbed. Although we can't take a field trip to any of the other planets and return in time for your next class, we can obtain the temperatures of many items outside and determine how surface features, including color, reflectivity, degree of roughness affect their surface temperatures and relate this to the surface characteristics of the other planets.

III. Materials

Infrared thermometer, white, silver and black radiation cans, 500 mL beakers, stop watch

IV. Theory

Objects emit and absorb electromagnetic energy. When an object has the same constant temperature as its surroundings, the amount of energy absorbed must balance the amount emitted. If absorption exceeds emission, then the energy of the object would increase; if emission exceeds absorption, then the energy of the object would decrease, and its temperature would change.

V. Prelab Definitions

1. temperature

2. albedo

VI. Prelab Questions

1. How does foliage affect temperature and albedo?

2. How does soil color affect temperature and albedo?

3. How does human construction and urban activity affect temperature and albedo?

4. What is Earth's average albedo?

5. What is the relationship between color and albedo?

VII. Lab Procedure

1. Using the infrared thermometer, record the temperature of 25 different objects taken at right angles to the objects under different lighting conditions and situations. Be sure to select a variety of metallic, non-metallic, highly reflective, non-reflective, dark, light, rough, and smooth objects.

Temperatures and Characteristics of Campus Objects

A	B	C	D	E	F	G	H
Object	Location	Temper-ature	Color	Lighting conditions: sunlight, shade	Reflectivity: high, medium, low	Surface: rough, smooth	Metallic or non-metallic

2. Fill a black, silver, and white radiation can each with 325 *mL* of tap water and allow the water to sit in the uncorked cans for approximately 10 minutes.

3. After 10 minutes, record the initial water temperature for each can in the first row of the table below.

4. Place all three cans outside in the same lighting conditions, preferably in direct sunlight.

5. Record the water temperature in each can every 3 minutes, until you have 10 data points for each can or until the temperature in all three can remains the same for three consecutive temperature readings.

Radiation Can Water Temperatures

A	B	C	D
Time *t* in minutes	Black can water temperature in ^{0}C	Silver can water temperature in ^{0}C	White can water temperature in ^{0}C
0			
3			
6			
9			
12			
15			
18			
21			
24			
27			
30			

6. Plot the temperature *T* versus time *t*, using *t* in column A as the x-coordinate and temperature *T* in column B, as the y-coordinate. Connect the points with a line and label the line as black can water temperature.

7. Plot the temperature *T* versus time *t*, using *t* in column A as the x-coordinate and temperature *T* in column C, as the y-coordinate. Connect the points with a line and label the line as silver can water temperature.

8. Plot the temperature *T* versus time *t*, using *t* in column A as the x-coordinate and temperature *T* in column D, as the y-coordinate. Connect the points with a line and label the line as white can water temperature.

VIII. Lab Discussion

1. How do lighting conditions affect temperature?

2. How does reflectivity affect temperature?

3. How does surface roughness affect temperature and albedo?

4. How does reflectivity and color affect the rate at which the water in the cans changes temperature?