Lesson Name: Let it go, let it go, Albedo of ice and snow!
(sung to the tune of ‘Let it go’ from the movie Frozen)

Grade Level: ___5____
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Standards Connection(s):

CA Science Standards: Grade 5 Earth Sciences
NGSS: 5-ESS2 Earth’s Systems

*Note to teachers: Detailed standards connections can be found at the end of this lesson plan.

Teaser/Overview

Why should we be concerned about the earth’s ice caps melting? Why do asphalt-covered areas of the city feel so hot? Why are you cooler wearing white on a sunny summer day? The answer to all these questions involves albedo, the amount of incoming radiation, like light, that a surface reflects. In this lesson, students will learn about how the color of an object affects its temperature due to albedo.

Lesson Objectives

- Students will discover what albedo is and how albedo affects temperature
- Students will use the scientific method to test how the color affects the temperature of an object when exposed to light radiation
- Students will discuss how changing their albedo (by wearing different colored clothes) or the earth’s albedo (by melting ice and snow) will affect how warm they are.

Vocabulary Words

Albedo-the proportion of light radiation that is reflected from a surface
Light Radiation-the energy of light waves

Materials
Scientist Volunteers will bring:
Painted posterboard squares
Thermometer(s)
Lamp(s)
Cardboard
Crayons
Timers

Materials teachers should provide:
Pencils, white 8’x11’ paper

**Classroom Set-Up**

Students will work in three groups.
Two of the three groups will need desk space for writing and coloring.
If it is sunny, students will go outside for about 10 minutes during the lesson.

**Classroom Visit**

1. **Introduction** ( _10_ minutes)

   **Role Model Introduction:**
   We are scientists from Lawrence Berkeley National Laboratory. It is a laboratory that the government runs and we study all kinds of things related to the earth and climate. (We will each introduce ourselves and summarize our research in one sentence.)

   **Topic Introduction:**
   Today we are going to learn about how different colors absorb and reflect heat. This is important because the sun heats up our whole planet, but colors can make a difference in the amount of heat that stays on the surface of the Earth.

   We’re going to do one experiment, and two other activities to learn for ourselves how the sun might heat up different things on the Earth’s surface. But first....

   [we’ll perform a skit – each of us will be wearing different colors and will be hot or cold depending on our albedo – see Teacher’s Guide for script]
Afterwards we will spend a few minutes asking students what they think is the coolest color and why. We expect to get a lot of “red” vs “blue” and will have them write down their hypothesis while one of us explains the experiment and activities that will help us find out.

We will hold off on using albedo the vocab word until later.

Vocabulary: albedo, radiation, energy, temperature

2. Learning Experience (_30_minutes)_

Students will rotate in groups through 3 activities [see Heat and Color handout]:
Activity 1 is an experiment where they will measure the temperature of different-colored cardboard tiles under an infrared light and record the temperature.
Before class, we will set up a variety of colored pieces of cardboard under a warming lamp. Each student in each group will get the chance to choose one color and record the temperature using a thermometer that we will provide. One student in each group will use the timer to time 30 seconds to hold the thermometer in place. During measurement periods, we will ask students why we are using a standardized measurement time, why we put each cardboard piece in the same position to measure its temperature, and explain the concept of experimental controls.
Activity 2 is a discussion centered around a map of albedo on Earth and what might happen if light-colored snow and ice melts.
There are a series of questions (outlined in the handout) that we will talk students through in order to get them to think about what might happen to the temperature at the surface of the Earth if the ice and snow melted from the poles. We will define albedo during discussion and show students other examples of albedo in nature (e.g., white polar bears and arctic foxes vs. darker temperate mammals).
Activity 3 is a drawing activity where students will imagine and draw what they think is underneath a sheet of ice.
We will provide some examples of land surfaces that were once covered by ice to give students some inspiration. Inevitably, whatever they draw will be darker than white, and we will discuss whether or not their new surface is warmer, and why.

At least one volunteer will be at each station to guide students through the activity.

3. Wrap Up: Review and Discuss the Learning Experience (_10_minutes)_

We will tally up the hottest and coolest colors as well as their temperatures, make a simple bar graph as a class, and discuss why some colors were warmer than others. If a projector is available, we will demonstrate how to make a bar graph using Excel.

Discussion questions: Why are the hot colors hot? What color should you wear on a hot day?
1. **Connections to the real world around students**: Discussion about the implications of changing the color of the Earth.
   
a. What happens when ice melts? What you drew was surely darker in color than the white paper – so will it be warmer or colder than the ice? Can warming the Earth enough to melt the ice make it darker and warm it even more (positive feedback loop)?
   
b. Why is it better to figure things out for yourself? Science can help you make up your own mind.

**Close:**

What questions do you have about being a scientist?

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**Follow Up: After the Presentation**

We will provide and email address to the kids for future questions.

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**Standards Connections**

**CA Science Standards: Earth Sciences, Grade 5**

- Students know that the amount of fresh water located in rivers, lakes, underground sources, and glaciers is limited
- Students know the influence that the ocean has on the weather

**NGSS:**

- Connections by topic:
  - 5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact
  - 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment

- Connections by scientific and engineering practices:
  - Asking questions and defining problems
  - Planning and carrying out investigation
  - Analyzing and interpreting data

- Connections by cross-cutting concepts:
  - Patterns
  - Cause and effect: Mechanism and explanation
  - Systems and system models
  - Energy and matter
  - Stability and change