PINNIPED BEACH RESORT *(MODIFIED FOR ADEED)*

Science Concept:

Energy can change forms and be transferred. Students should have some background knowledge of energy transfers and transformations.

Objectives:

The student will:

- identify energy transfer and transformation;
- design and conduct an investigation; and
- identify the line of best fit.

GLEs Addressed:

Science

[10] SB2.1 The student demonstrates an understanding of how energy can be transformed, transferred, and conserved by examining energy (i.e., nuclear, electromagnetic, chemical, mechanical, thermal) transfers, transformations, and efficiencies by comparing useful energy to total energy.

[10] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.

Math

[10] S&P-4 The student demonstrates an ability to analyze data (comparing, explaining, interpreting evaluating, making predictions, describing trends; drawing, formulating or justifying conclusions) by using a best-fit line to describe trends and make predictions about data.

Vocabulary:

albedo – the proportion of the incident light or radiation that is reflected by a surface, typically that of a planet or moon

control group – in experimental design, the control group provides a baseline assessment of any change which might happen without the treatment under investigation

electrical energy – a form of energy related to the position of an electric charge in an electric field

electromagnetic radiation (energy) – energy resulting from the acceleration of electric charge and the associated electric fields and magnetic fields

energy transfer - the transfer of energy of a given form among different scales of motion (such as kinetic energy)

energy transformation - the process of changing one form of energy into another

pinnipedia – an order of carnivorous aquatic mammals which comprises the seals, sea lions, and walrus

thermal radiation (energy) – Electromagnetic radiation that arises from the thermal energy of an object

Materials:

- Pinwheel
- LED flashlight
- Candle
- Match or lighter
- Radiometer
- Box with lid
- Stopwatch
- Pint-sized paint cans (six per group)
- Flat white paint
- Flat black paint
- Lamps (one per group)
- 100 watt light bulbs (one per group)

- Thermometers (six per group)
- Styrofoam lids for paint cans with holes in the centers for thermometers

Activity Preparation:

Paint the outside of the pint-sized paint cans in various shades to produce various albedo measures so that each group has a set of six cans: paint the outside of one can flat white for an albedo of 1 and another flat black for an albedo of 0. To create intermediate albedo values, paint a can with black and white stripes. First, paint the can white, allow it to dry, then add strips of tape and paint the can again with black. Remove the tape after the paint has dried. A can with equal areas of white and black has an albedo of .5; a can with white stripes covering twice the area of the black stripes will have an albedo of .33. A number of intermediate albedo values can be created in this manner.

Activity Procedure:

Please refer to the assessment task and scoring rubric located at the end of these instructions. Discuss the assessment descriptors with the class before teaching this lesson.

Gear Up

Process Skills: observing and inferring

1. Without any explanation, display the following items on a table where all students can see: a pinwheel, a LED flashlight, a candle and match or light, and a mystery item (radiometer) hidden in a box.
2. Explore each item, providing a visual or verbal reaction of surprise or interest for the students to observe: Pick up the pinwheel, and blow on it a couple of times. Pick up the flashlight, turn it on, and shine it around the room. Strike the match, light the candle, and let it burn a few seconds before blowing it out. Now lift the box off of the radiometer and let it start to spin up to speed.
3. Ask students what is occurring. Explain they have just observed a variety of things powered by energy. Review the definitions of the terms "energy transfer" and "energy transformation" with students. Ask them the following questions and discuss:
    a. What is the name of each item in the demonstration? (pinwheel, flashlight, burning candle, radiometer)
    b. What types of energy do the items use?
    c. Which of these demonstrations represent energy transfers? (pinwheel)
    d. Which of these demonstrations represent energy transformations? (flashlight, burning candle, radiometer)
    e. Do any of the demonstrations represent both an energy transfer and transformation?

Explore

Process Skills: observing and predicting

4. Divide students into groups and distribute the following materials to each group: thermometers, stopwatch, Styrofoam lids, lamps with bulbs, and a set of paint cans (as prepared during the Activity Procedure).
5. Ask students to make a prediction about what will happen to the temperature of the cans when they shine the light on them. Start the exploration of the materials. Students should write at least two qualitative observations and two quantitative observations during the activity. Circulate during this activity to ask questions and elicit student thinking about new things to test.
6. Ask students to do an Internet search to find the definition of albedo.

Generalize

Process Skills: communicating and predicting

7. Ask students the following questions and discuss as a class:
    a. What did you observe happening to the temperature in the cans? (the darker the can, the greater the temperature should increase)

   b. How did your prediction compare to your results?
   c. Did the cans with different albedo values behave the same?
   d. What energy transformations did you observe?
   e. What energy transfers did you observe?
   f. What was the initial form of energy? What was the final form of energy?
   g. Did albedo affect the amount of energy transferred and/or transformed in your exploration? Explain. (yes, greater albedo results in a smaller amount of light energy being transformed into heat energy)
8. Ask students to write at least two questions related to the Exploration that can be tested quantitatively.

Experiment

Process Skills: observing, measuring, controlling variables, making graphs, experimenting, and collecting data

9. Ask students to work with their groups to form at least two testable hypotheses to account for their observations of what happened to the temperature in the cans. These hypotheses may answer the quantitative questions students developed previously or may be based on a new question.
10. Make sure students understand the term "testable" means one can design an experiment to validate the hypothesis. Remind students the parameter measured is the dependent variable, the item changed between measurements is the independent variable, and an item measured, but left unchanged, is the control. (NOTE: The control may also be a measurement against which all other measurements are compared.) Explain a good experimental design will test just one variable at a time.
11. Instruct groups to design a simple experiment that will test at least one of their hypotheses and allow them to construct a line plot from their quantitative data values. The experiment should have an experimental group and an identified control that is labeled. Ask students to list the materials that they will need. Review student-designed experiments before groups start, to check for safety concerns. Discuss safety rules before any experimentation takes place.
12. Instruct students to collect, record, and graph all data.

Interpret

Process Skills: communicating and interpreting data

13. Ask a spokesperson from each group to state the group's hypothesis and describe the variable they chose to test. Ask groups with similar hypotheses to meet, share, and discuss their data. Groups should discuss the following questions:
   a. What trends were observed between albedo and temperature?
   b. What might account for these trends?
   c. Is the trend linear or curved?
   d. Based on the graph, is the transfer/transformation energy the same for all albedo values?

Apply

Process Skills: communicating

14. Ask students to imagine they have been asked by a friend to be a partner in building an Alaskan coastal resort. Explain this is a chance to get in on the ground floor of a potential fortune-making endeavor, but there is a lot of financial risk. The plan is to build a resort where tourists can go to view pinnipeds without interfering with their natural activities. Ask students to write a paragraph in which they explain (based on the information learned in this lesson) what the beach must look like, and why, before they invest. If students need a hint, tell them the color of sand on the beach could be changed.

PINNIPED BEACH RESORT

RUBRIC

Assessment Task

In your science journal, identify the initial form of energy and describe one or more energy transformations and/or transfers that have taken place during the investigations in this lesson. Quantitatively describe the relationship between albedo and temperature using a graph and best fit line.

Rubric

Objective	GLE	Below Proficient	Proficient	Above Proficient
The student identifies energy transfers and transformations.	[10] SB2.1	The student does not identify any energy transfers or transformations.	The student identifies one energy transfer or transformation.	The student identifies two or more energy transfers and/or transformations.
The student designs and conducts an investigation.	[10] SA1.1	The student does not design and/or implement an investigation to test the relationship between albedo and the energy transfer from radiant energy to thermal energy.	The student designs and/or implements an investigation to test the relationship between albedo and the energy transfer from radiant energy to thermal energy.	The student designs and/or implements an investigation to quantitatively test the relationship between albedo and the energy transfer from radiant energy to thermal energy.
The student identifies the line of best fit in a graph and uses the information to make a prediction.	[10] S&P-7	The student identifies the line of best fit that relates albedo to temperature for less than three albedo values.	The student identifies the line of best fit that relates albedo to temperature for three or four albedo values.	The student identifies the line of best fit that relates albedo to temperature for five or more albedo values.