

# Solar Houses

Time: 4-6 hours (Broken down into 4-6 one hour classes)

## 4<sup>th</sup> Grade CA Science Content Standards

PS1. Electricity and magnetism are related effects that have many useful applications in everyday life.

PS1a. Students know how to design and build simple series and parallel circuits by using components such as wires, batteries, and bulbs.

PS1c. Students know electric currents produce magnetic fields and know how to build a simple electromagnet.

PS1d. Students know the role of electromagnets in the construction of electric motors, electric generators, and simple devices, such as doorbells and earphones.

PS1e. Students know electrically charged objects attract or repel each other.

PS1f. Students know that magnets have two poles (north and south) and that like poles repel each other while unlike poles attract each other.

PS1g. Students know electrical energy can be converted to heat, light, and motion.

I&E6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

I&E6a. Differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations.

I&E6c. Formulate and justify predictions based on cause-and-effect relationships.

I&E6d. Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.

I&E6f. Follow a set of written instructions for a scientific investigation.

## **5<sup>th</sup> Grade CA Science Content Standards**

PS1. Elements and their combinations account for all the varied types of matter in the world.

PS1b. Students know all matter is made of atoms, which may combine to form molecules.

PS1c. Students know metals have properties in common, such as high electrical and thermal conductivity. Some metals, such as aluminum (Al), iron (Fe), nickel (Ni), copper (Cu), silver (Ag), and gold (Au), are pure elements; others, such as steel and brass, are composed of a combination of elemental metals.

I&E6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

I&E6c. Plan and conduct a simple investigation based on a student-developed question and write instructions others can follow to carry out the procedure.

I&E6f. Select appropriate tools (e.g., thermometers, meter sticks, balances, and graduated cylinders) and make quantitative observations.

I&E6g. Record data by using appropriate graphic representations (including charts, graphs, and labeled diagrams) and make inferences based on those data.

I&E6h. Draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.

Topical Objectives:

- Students will understand that heat is the transfer of thermal energy from a hotter to a colder object.
- Students will understand that radiation is the transfer of energy through space in the form of rays.
- Students will know that solar energy is one example of a renewable energy resource.
- Students will understand that some materials act more as an insulator and some materials act more as a conductor for heat.
- Students will understand how electrons flow in a simple and complex circuit.
- Students will design and build a simple circuit.
- Students will understand how motors work.
- Students will understand how electricity works in homes.

Safety Precautions:

- Students should be aware that bare copper wires may get hot. Do not touch the bare wires while it is connected to a battery.

## **Day 1: Exploring Radiation**

### Materials:

- Infrared thermometers
- Boxes containing misc. testing materials (white cloth, black cloth, aluminum foil, white plastic, black plastic, sand paper, etc.)
- Trays
- Alcohol thermometers
- Clear jars
- Rubber bands
- Plastic wrap
- Clipboards
- Testing materials datasheets
- Stopwatches

### Preparation:

The instructor will need to set-up the trays with the materials on them. (Infrared thermometers, fabrics, glass jars with rubber bands around the lids.)

### Procedure:

1. Show the students how to use the infrared thermometers. They should hold the thermometers approximately 12 inches away from the surface they are trying to measure.
2. Take students outside and have each group take the temperature of ten different surfaces in the sun and shade.
3. They should record their results on their datasheets.
4. Ask the students which surfaces were the hottest? Which were the coolest? Ask the students why they think some surfaces were hotter or cooler than others?
5. Students will now test the temperature of the materials. Have each group of students choose three different materials they would like to test.
6. Each group should place their three materials on a tray.
7. Each group should also get two alcohol thermometers and a glass jar. They should place one of the thermometers in the jar and seal the top of the jar with plastic wrap and a rubber band.
8. Take them outside and have them place their trays in the sun.
9. The students will use the infrared thermometers to take the temperatures of their materials every 5 minutes. They should record their results on their datasheets. They should also record the starting and ending temperatures of the two alcohol thermometers.

10. Take the students inside and record their results on the board. Discuss which materials heated up quickly.
11. Explain that, in general, dark colored surfaces absorb more solar radiation than light colored surfaces. Another factor that affects heating and cooling rates is texture. Rough or bumpy surfaces usually absorb more radiation than smooth surfaces.
12. Discuss why the temperature in the jar was much hotter than the ambient air temperature.

### Background Information:

As heat energy reaches an object, it can be absorbed, in a similar manner to the way sponges absorb water. Heat enters an object, warming it. The longer the object is exposed to the heat source, the more heat that it absorbs. Different objects absorb heat at different rates. Some objects are excellent absorbers, while others are very poor absorbers. Generally, dark colored objects absorb better than do lighter colors. Why do dark colors absorb better than light colors? Why do dark colors look dark in the first place? Dark colors look dark, because they absorb more light, making them harder to see.

### Day 2: Protect the Ice Cube

#### Materials:

- Ice cubes
- Thermometers
- Plates
- Different types of fabric (black fabric, white fabric, sand paper, aluminum foil, white plastic, felt, etc.)
- Feathers
- Construction Paper
- Packing peanuts
- Shoeboxes
- Cardboard boxes
- Styrofoam boxes
- Plastic containers
- Tape
- Scissors
- Glue
- Markers

Preparation: For this challenge, students will design an environment that will keep an ice cube from melting for as long as possible. The main idea is to protect an ice cube from the temperature of its surroundings, in such a way that it will take the longest possible time to melt. Along the way, the students will learn some ideas about how buildings might be designed in order to minimize the energy needed for heating and cooling.

## Procedure:

1. Students will place an ice cube on a plate out in the open air. Measure how much time it takes for the ice cube to melt. The students will record their information on their datasheets. This will serve as a baseline for later comparisons.
2. Students will now design an environment for the ice cube that will increase the time needed for the ice cube to melt.
3. Students will use the materials provided and build a structure for their ice cube and try to protect the ice cube from the outside elements.
4. Make sure the outside environment is the same.
5. Student will record how long it takes for their ice cube to melt in its new environment. Students will write down the type of insulating materials they used in this experiment.
6. Students will choose different insulating materials and retest. Students will record their information on their datasheets.
7. What insulation materials worked best to minimize heat loss to the structure? What would you suggest to someone building a home who wanted to keep their home cool in the summertime?

## Background Information:

What melts an ice cube? The answer is heat of course, but what is heat? What is cold? Heat is a form of *thermal energy* and results from the motion of atoms and molecules. Warm objects have a greater amount of thermal energy than cooler objects. Cold can be described as the absence of heat (less thermal energy). Heat will flow from areas of high thermal energy towards areas of low thermal energy. An ice cube melts as heat flows towards the ice from its surroundings. Swimming in cold water results in a similar process as your body begins to lose its heat to the cooler water. On a cold winter day one can actually feel the thermal energy (heat) leaving the body towards the cold surrounding air.

Insulation materials are designed to interfere with thermal energy transfer. A jacket can keep you warm in winter by minimizing the movement of cold air currents over your body surface and reducing convective heat loss. Additionally, heat loss can be reduced by adding layers of materials that are poor conductors of thermal energy to your clothing such as plastic fibers (fleece) or wool. The space suits worn by astronauts also include a silver foil lining designed to reduce energy transfer by radiation. Insulation materials are used in homes and buildings to help minimize thermal energy loss and reduce the owner's energy bills. Home insulation not only reduces the loss of heat in winter but will also help keep a home cooler in summer.