Can you keep your cool?

Subject Area(s) **Earth and Space, Physical Science, Science and Technology**

Lesson Title **Can you keep your cool?**

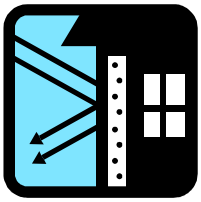
Header 

Image 1
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Grade Level 5

Time Required **45 minutes**

Summary

Students learn how engineers use insulation in building construction and why. They attempt to keep an ice cube from melting when its house is subjected to a direct heat source. Students investigate the insulating capacities of test materials based on how well they conduct heat. They learn about how light energy from the sun is transferred into heat energy. They relate concepts learned about reflection, absorption and thermal energy storage capacities to a new application which is different from collecting the sun's energy for some purpose.

Engineering Connection

Architectural engineers design heating ventilation and cooling systems to make buildings comfortable to inhabit. When engineers design buildings they want to provide insulation to keep the temperature of the building comfortable and to use energy efficiently (saving energy by using it wisely or not wasting it.) Heaters and air conditioners heat or cool the space but in order to keep the cold in and the hot out in the summer, or keep the hot air in and the cold air out in the winter, we need insulation.

Engineering Category

Relates science concept to engineering.

Keywords

Solar energy, insulation, building design, heating, cooling, heat transfer, reflection, absorption

Educational Standards

Science: PA Standards

3.2.7.B p. 30
3.2.7.A p. 28
3.4.7.B p. 46
3.2.7.C p. 32

Pre-Requisite Knowledge

Students should understand that light energy is transferred to heat energy through a process called energy transfer. Students should also be aware that different materials have different thermal properties and absorb or reflect different amounts of light energy.

Learning Objectives

After this lesson, students should be able to:

- Explain how heat is transferred from one place to another.
- Relate energy sources and transfers to heat and temperature.
- Describe how we use a scientific principle to solve a practical problem.

Materials List

Each group needs:

- Ice cubes (about the same size)
- Plastic Cup
- Styrofoam bowl
- Insulating materials: newspaper, styrofoam, bubble wrap, paper towel, aluminum foil, paper, cloth
- Tape

For the entire class to share:

- Heat lamps
- Infrared heat bulbs

Introduction / Motivation

When the suns energy hits the earth, it is in the form of light energy and infrared light (heat energy). When an object absorbs light it becomes warmer. This process is called energy transfer and it changes the temperature of the material. Different materials absorb different amounts of energy including earth materials and man-made materials. Different color materials absorb different amounts of light energy. The light energy that is not absorbed is reflected.

We can use solar energy to heat a space like the inside of a home. But once the heat is captured the trick is to hold on to it. To do this we can use insulation. Insulation is a material that slows the transfer of heat energy. Using insulation helps us to conserve energy no matter how our home is heated.

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Today you are going to build your own insulator to protect an ice cube from melting. You can choose from a variety of materials. At the end of the class we will measure how much water has melted from your ice cube to determine which design and materials are best.

Vocabulary / Definitions

Word	Definition
Insulation	The act of protecting something by surrounding it with material that reduces or prevents the transmission of sound or heat or electricity
Conductivity	The ability or power to conduct or transmit heat, electricity, or sound.
Thermal	Of, relating to, using, producing, or caused by heat.

Procedure

Background for Teacher:

The term **thermal insulation** can refer to materials used to reduce the rate of heat transfer, or the methods and processes used to reduce heat transfer.

Thermal radiation is composed of all wavelengths of light, however most of the energy of the thermal radiation of objects at room temperature is in the infrared part of the spectrum according to Wien's displacement law. As with all electromagnetic radiation, it requires no medium in which to travel. The amount of energy radiated by an object is proportional to its surface temperature and its emissivity.

Thermal radiant barriers possess the characteristics of low emissivity, low absorptivity and high reflectivity in the infra-red spectrum. They may also exhibit this for other wavelengths including visible light but this is not necessary to function as thermal barrier. Only a small fraction of radiant energy is absorbed by such a material (most being reflected back away) and therefore only a small fraction is re-emitted. Highly polished metals are one example. Conversely, dark materials with low reflectivity will absorb a large fraction of energy, and similarly emit a large fraction.

Maintaining acceptable temperatures in buildings (by heating and cooling) uses a large proportion of total energy consumption worldwide. When well insulated, a building:

- is energy-efficient, thus saving the owner money.
- provides more uniform temperatures throughout the space. There is less temperature gradient both vertically (between ankle height and head height) and horizontally from exterior walls, ceilings and windows to the interior walls, thus producing a more comfortable occupant environment when outside temperatures are extremely cold or hot.
- has minimal recurring expense. Unlike heating and cooling equipment, insulation is permanent and does not require maintenance, upkeep, or adjustment.

(Wikipedia, 2009)

Before the activity:

- Set up the lamps in a location where all students have access to them.
- Spread out materials in a distribution area for students to collect what they want to use for the investigation.

With the students:

1. Divide the class into sets of partners.
2. Give each group a plastic cup and a Styrofoam bowl. Explain that this is the ice cube's house. The bowl is the bottom and the cup sits upside down inside the bowl.
3. Explain the objective of the activity, defining new terms for the students.
4. Tell the students that the houses will be placed under the heat lamps for 5 minutes each and the amount of water that melts will be measured to determine which group insulated the best.
5. Allow the students a few minutes to decide which materials they want to use. Remind them of how different colors and finishes reflect or absorb light (if necessary.)
6. Give the student their ice cubes and allow them to start designing their insulation schemes.
7. Allow about 15 minutes for them to complete the design.
8. Have each group place their houses under a heat lamp. Place them as evenly as possible. If there isn't enough room to place them all under at once then do them in shifts. Leave the bowls under the lamp for at least 5 minutes.
9. Pour the water into graduated cylinders to measure how much water melted.
10. Have each group record their number.
11. Review the activity and determine a winner if appropriate.

Assessment

Activity Embedded Assessment: Have the students answer the following questions in their science journals.

1. What materials did you use to insulate your ice cube?

2. How did you use the materials?

3. How much water did you have in your container at the end of the designated time?

4. What could you have done to improve your design to reduce the amount of water that melted from your ice cube?

References

Thermal insulation. (2009, March 18). In *Wikipedia, The Free Encyclopedia*. Retrieved 15:02, April 8, 2009, from http://en.wikipedia.org/w/index.php?title=Thermal_insulation&oldid=278113278

Owner

Drexel University GK-12 Program, Engineering as a Contextual Vehicle for Science and Mathematics Education, supported in part by National Science Foundation Award No. DGE-0538476

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Version: January 2009