Sparking Discovery in the Classroom

TRAVELING
SCIENCE
WORKSHOPS

DISCOVERY MUSEUM

Green Engineering

Teacher Resource Guide

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Green Engineering Traveling Science Workshop
Follow-up Activities and Teacher Guide

Thank you. We enjoyed sharing the Discovery Museum's Traveling Science Workshop with your students. We hope that everyone returns to class full of wonder and curiosity, confident about their abilities to do science, and eager to make further discoveries. There are countless ways to continue your exploration in the classroom. This packet includes suggestions, activities, and resources that you might find useful.

You can encourage your students to reflect on their museum experience through group discussion, journal entries, or artwork. Some prompts might be:

What did you like best about the museum visit?
What surprised you?
Did you notice familiar objects used in new ways?
What do you want to know more about?

Help them to recognize that they were "doing science" and developing skills.

I noticed (observed)……..
I tried (tested/experimented)…….
I thought that (predicted/hypothesized)……
Our group had different ideas (teamwork/communication) and we…….
We discovered that when we did……,then…….happened.

If you did a pre-visit activity with the students such as observations, brainstorming, or creating a web of ideas around the topic of green energy, try doing it again. What new ideas and connections have your students discovered?

During the Green Energy experience students explore and are intrigued by different things. What interests them? What do they want to find out more about? There are so many possible ways to explore green energy; please share with us your own ideas and successful classroom projects.

Exploring Green Energy:

The energy used in the average home accounts for more than twice the greenhouse gas emissions of the average car. Much of this energy comes from heating and cooling our homes. Luckily, there are simple and effective ways to reduce the amount of energy needed to heat, cool, and power our homes. Less energy consumed equals less pollution created.

Your trip to The Discovery Museums exhibit *Dream Green* gave your students a chance to explore how insulation works. Heat energy flows naturally from a warmer to cooler space. Insulation provides resistance to this heat flow. In a home, insulation helps to keep homes cozy and warm in the winter and cool in the summer. There is a lot that can be done in the classroom and at home to continue student exploration of how insulation works. Students may also be inspired to investigate other "green" habits that decrease overall energy use at home. This guide offers suggestions for pursuing both.

Introduction
You might begin a conversation with your students in the following way…
Have you heard the phrase "going green?" "Going Green" is another way of saying you are practicing habits that help keep our planet healthy. I bet you already practice recycling and reusing materials at home and school. These are excellent ways to reduce the amount of trash we create and the amount of energy needed to make new materials or break down the old.

There are some other "green" habits that can make a BIG, BIG difference in keeping the planet healthy. We are going to conduct some experiments that will help us better understand what those "green" habits are, and why they work.

Activity 1: Feathers, Fur, Fat, or Fleece
(A variation of this activity is presented in our Traveling Science Green Energy Workshop)

Many animals have physical adaptations or behaviors that help them to regulate their body temperatures—staying warm in colder climates and cool in hotter climates. One of the ways they accomplish this is with insulation. Insulation slows down the energy transfer between an object and its environment. The following activity explores the effectiveness of different materials used as insulators.

You already have some experience working with insulators. How do you insulate your own body on a cold winter's day? What materials keep you nice and warm? Think about what kinds of materials animals use to insulate their bodies, nests, and homes. What natural materials do you think might make good insulation for an animal's home?

The following activity will help you make and use some special "gloves" to test the insulating properties of various natural and man-made materials.

You will need:
Gallon-size heavy-duty re-sealable plastic bags
Variety of materials that you think might make good insulation: packing peanuts, dirt, leaves, fake fur, various types of fabric, craft feathers, strips of newspaper
Duct tape
Large tub of ice water

Making the Gloves:
Make the "gloves:" Place one re-sealable plastic bag inside another. Fill the space between the two bags with one type of insulating material. Using strips of duct tape create a watertight seal between the two bags so that the stuffed insulating material will not get wet when the glove is submerged in the bucket of ice water. Repeat with other bags and insulation materials. Be sure to create one "glove" that contains no insulation. This will be your control in the experiment.

Time to Explore:
You may want to begin by thinking about each insulated glove you have created and making a guess as to which will be the best at keeping your hand warm.

Slide your hand into a "glove" and ease your hand under the water. Leave it for thirty seconds or so and note the temperature you feel? Try other gloves in the same way.

Think about it:
What do you notice? Can you feel a difference between insulated "gloves"? Does one seem to insulate your hand better than the others? Were you surprised by any of the insulators? Which materials seem to be the best at insulating your hand from the cold? Can you think of other materials you might like to test? Try them out!

Activity 2: Ice Cube Challenge
Just as insulation in a lunch box helps to keep a sandwich cold, or a thermos keeps soup hot, insulation in a house can keep the house warm and cozy in the winter and cool in the summer.

The following activity challenges you to use your prior knowledge about insulation to design a "house" for an ice cube. How long can you keep your ice cube "alive" by insulating its paper cup "house?" Think about what you learned about insulation in the preceding insulated glove activity.

What you need:
• An ice cube
• A 3oz paper cup (or similar size) and a 5oz paper cup (or similar size). It is important that the two cups are different sizes and that one cup will nest inside the other cup, leaving a small space between the two cups.
• A variety of materials that you think might be good insulators. For example, craft feathers, shredded newspaper, packing peanuts, sand, fabric
Directions:
1) Nest the two cups together.
2) Stuff the insulating material of your choice between the two cups.
3) Place the ice cube in the small cup and place in a warm spot to observe.
4) How long does your ice cube last before it melts?
5) Try the experiment again, this time using a different insulating material.
6) What do you notice? Do all materials make good insulators?

Think About It:
Think about how you decided which insulation material to use for your cup. Did you try just one material or lots of different materials? Did you have previous experience with some of the materials that suggested to you which might be better at insulating?

Which material did you find was most effective at keeping the inside of your cup cold? Check with your classmates; did they reach the same conclusion? If not, why do you think that might be?

Do you think that how the insulation is arranged or installed in your cup makes a difference to how well it works as an insulator? Could you design an experiment to test your idea? What other questions arose as you experimented? Is there something else you would like to test as a result of those questions or new ideas? Go ahead, test your ideas!

Activity 3: Build and Insulate a Model House

The following activity helps you to apply your knowledge of insulation and how it works to a real-life challenge. What are some of the materials we use to insulate actual houses? How do those different materials

compare in the quality of insulation they provide? How does the installation of those materials impact the effectiveness of the insulation?

What you need:

- Small cardboard box (Small cubed gift boxes work well or students can construct their own five sided box out or 5”x5” sheets of foam core and duct tape)
- Scissors and Utility knives
- 2 -3 clamp-on lamps with high watt bulbs (sold at hardware or home improvement stores)
- 2-3 infrared thermometers (available through Educational Innovations, http://www.teachersource.com/category/s?keyword=infrared+thermometer)
- Choice of insulating materials:
  Bubble wrap, cotton balls, foam sheets, trash bags, a variety of paper including: newspaper, tissue, construction
- Samples of insulating materials used to insulate real buildings (cellulose, fiber glass, foam, cotton)

Set-up:

Position a heat lamp or set of heat lamps about 16 inches above a flat work surface such as a desk or table. Arrange the choice of insulating materials on a table

Opening Discussion:

Review the students understanding about the importance of insulation: what it does, how it works and why we use it, etc.

Introduce some different types of insulation, such as cellulose which is made from recycled paper, cotton from recycled denim, fiberglass made of silica and recycled glass and foam. Have them discuss some of the pros and cons of the various insulating materials, such as effectiveness, cost, environmental impact.

Time to Explore:

Each of you is going to be given a model house to insulate. To begin with, test some of the insulating properties of materials similar to those used in real houses by securing the insulation to the walls with tape. As you experiment you might notice different types of materials insulate differently and you might discover that different approaches to installing the insulation make a difference in how the effective the insulation is.

Directions:

1) Distribute the houses.
2) Choose a material to insulate one wall of the house.
3) Install the insulation in one wall.
4) Place your house under the heat lamp and let the house heat up for about 30 seconds.
5) Take a temperature reading of the outside walls of the house using the infrared thermometer.
6) Record the temperature reading of the insulated wall vs. a non-insulated wall.
7) Continue testing different insulation materials. Note any differences in installation techniques you are using and if this makes a difference in the temperature reading
8) Insulate the whole house using any insulation, combination of insulation, and insulating technique that you think will prevent the most heat from escaping your house.
9) Test your house and record your findings.
10) Share your findings with other students. Discuss what you have noticed about both insulating properties of different materials and installation techniques. What works, what doesn’t work? Do

certain insulating materials work better in certain parts of the house—fitting into tight corners, ceiling vs. walls, etc.

11) Ask the teacher for help cutting doors and windows in your house and test how that impacts heat loss
12) Devise window and door treatments that might slow or prevent the loss of heat out these openings. Test these treatments.

Think About It:

- Share what you noticed with other members of your class. Did they have similar experiences? Did they reach the same conclusions?
- What might you do differently if you were to reinsulate your house another time? Are there other materials you would like to try?
- Ask your parents if your home has insulation, and if so, what kind?
- Based on your experience, what would you recommend for insulating a home and why?
- What materials would you recommend scientists test further for possible use as house insulation?

Further Exploration

Bring your insulated model house to The Discovery Museums and use our infrared camera to take a heat picture of your model house. The heat image, displayed on a large flat screen, is a highly effective way to see where the insulation is working really well and where heat is leaking out from different parts of the house.

Talk with your parents about having an energy audit done of your own home. An infrared camera is often used during an energy audit and provides a thermogram (heat pictures) of the house. The thermogram is then studied to identify the effectiveness of any existing insulation and to uncover any problems or leaks in the insulation.

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Suggested Reading

Friend; Robyn C. and Cohen; Judith Love. *A Clean City: The Green Construction Story.* California: Cascade Pass, Inc., 2008

Friend; Robyn C. and Cohen; Judith Love. *A Clean Planet: The Solar Energy Story.* California: Cascade Pass, Inc., 2008

Friend; Robyn C. and Cohen; Judith Love. *A Clean Sky: The Global Warming Story.* California: Cascade Pass, Inc., 2008

Owen, Ruth. *Building Green Places: Careers in Planning, Designing, and Building (Green-Collar Careers)*. New York: Crabtree Publishing Company, 2010

Smith, Molly. *Simple Steps Towards a Healthier Earth*. California: Chronicle Books LLC, 2010

Related Websites

- Visit the Discovery Museums' Dream Green Exhibit resources online – http://discoverymuseums.org/hands-exhibits/dream-green
- put your family on The Low Carbon Diet - www.fightglobalwarming.com
- Renewable energy sources - http://www.eia.doe.gov/kids/energy.cfm?page=renewable_home-basics
- IGLO International Action on Global Warming - http://astc.org/iglo/
- Hands-on activities for families - http://atmospheres.gsfc.nasa.gov/iglo/view_cat.php?cid=1
- WGBH Meet the Greens - http://www.meetthegreens.org/info/, http://www.meetthegreens.org/games/
- Carbon Footprint calculator - http://atmospheres.gsfc.nasa.gov/iglo/view_cat.php?cid=8

Curriculum Connections:

- Identify the basic forms of energy: light, sound, heat, electrical, & magnetic. (PS, Grades 3-5, 4)
- Recognize that energy is the ability to cause motion or create change. (PS, Grades 3-5, 4)
- Give examples of how energy is transferred from one form to another. (PS, Grades 3-5, 5)
- Recognize that light travels in a straight line until it strikes an object or travels from one medium to another, and that light can be reflected, refracted, and absorbed. (PS, Grades 3-5, 12)
- Identify materials used to accomplish a design task based on a specific property. (T/E, Grades 3-5, 1.3)
- Identify a problem reflecting the need for shelter. (T/E, Grades 3-5, 2.2)
- Identify relevant design features for building a prototype of a solution to a given problem. (T/E, Grades 3-5, 2.4)
- Compare natural systems with mechanical systems that are designed to serve similar purposes. (T/E, Grades 3-5, 2.5)
- Recognize that heat is a form of energy, and that temperature change results from adding or taking away heat from a system. (PS, Grades 6-8, 14)
- Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium. (PS, Grades 6-8, 15)
- Given a design task, identify appropriate materials based on specific properties and characteristics. (T/E, Grades 6-8, 1.1)
- Identify and explain the steps of the engineering design process, i.e., identify the need or problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign. (T/E, Grades 6-8, 2.1)
- Describe and explain the purpose of a given prototype. (T/E, Grades 6-8, 2.3)
- Explain how such design features as size, shape, weight, function, and cost limitations would affect the construction of a given prototype. (T/E, Grades 6-8, 2.5)

Student At-Home Activity

Beyond Insulation

You have just explored the properties and benefits of good insulation as a means to save energy at home, but there are other habits that will also help you "green-up" and save energy. The following activities are designed for you to try on your own or with a friend or family member. Give them a try!

It is easy and fun to invent and build simple devices that will reduce energy needed to light, heat, and cool a room. Before you start building, first conduct an energy audit of your bedroom. An energy audit is just a set of simple tests that help you identify where energy may be wasted in your room. Read on to learn more and check out some of the additional ideas at http://nstar.apogee.net/kids/

Check for Cold Drafts

In the winter, check your bedroom for cold-air leaks around all windows and doors that lead outside.

You can make a simple *Draft Sensor* for detecting air leaks by taping a downy feather or a few very fine hairs to the end of a pencil or small stick. Hold the *Draft Detector* up to the edges of windows where the frame meets the window trim or sill. Allow the detector to hang freely. Do you notice any movement of the feather/hair? This might suggest air is moving through the spaces/cracks around the outside edge of the window or door.

Check for Heat Gain

In warmer months, check for sunlight "heat gain" coming through any windows that are not fully shaded. You can usually feel any heat gain by moving your open hand back and forth into a sunlit space from an adjacent shaded area. If you can feel heat from sunlight streaming through a window with no shade, make a note. You will want to suggest adding a window shade.

Make a list of your findings for suggested repairs of winter air leaks from windows and doors and summer heat gain from windows. Share your list of recommendations with your parents and see if you can help them fix the problems.

Reduce the energy consumed by lighting, heating, and cooling your bedroom.

Plan the most energy efficient layout of your bedroom space. How would you arrange your bed, chair, and desk each summer and winter for the best use of sunlight for heating and lighting?

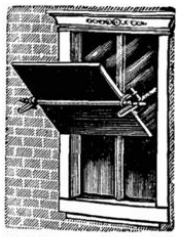
If possible, reduce your bedroom heat by two degrees in the winter and turn the air conditioning up by two degrees warmer in the summer.

Invention Challenge

Can you figure out how to build simple structures that will reflect more sunlight into your bedroom or maybe direct breezes towards your bed?

Here is a clue for finding ideas: architects use *Window Light Reflecting Shelves* for expanding window light to fill more areas of the room. Check out http://en.wikipedia.org/wiki/Architectural_light_shelf

Here are a few clues about building materials: Think about inexpensive materials and discards that reflect light. What kind of stiff paperboard scraps might make good light deflectors?



Reflektor von W. Hanifch & Co., Berlin.

More to Do and Think About

Family Choices Add Up!

Work together to save energy, resources, and money! Your choices, and those of your neighbors, community, and country, add up to a greener world.

8 Easy Ways to Go Green:

- Close shades & curtains to reduce drafts and heat loss
- Wear a sweater; lower the heat
- Use flannel sheets & blankets
- Turn lights off when you leave a room
- Turn off electronics when not using them
- Turn off computers at night
- Take short showers to conserve water and save energy
- Recycle paper, plastic, and glass

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