Feeling the Heat

A Lesson on Heat Energy

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Lesson #19

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Note: *The activities that follow are DRAFT activities and have not yet been peer reviewed for content accuracy or pedagogy. The lesson plans and opinions in this report are those of the authors and do not necessarily reflect the opinions of any of the supporting institutions or the editors.*

The American Physiological Society
2011 Works in Progress

ABOUT THE AMERICAN PHYSIOLOGICAL SOCIETY

The American Physiological Society (APS) is a nonprofit organization devoted to fostering education, scientific research, and dissemination of information in the physiological sciences. The Society was founded in 1887 with 27 members. APS now has over 10,500 members. Most members have doctoral degrees in physiology and/or medicine (or other health professions).

The APS supports a variety of educational activities, including programs and fellowships to encourage the development of young scientists at the undergraduate and graduate levels, with a particular focus on women and underrepresented minorities.

ABOUT APS EDUCATION PROGRAMS

The American Physiological Society (APS) has activities addressing educational and career issues at the K-12, undergraduate, and graduate/professional levels as well as continuing education for physiologists. At the K-12 level, the APS programs focus on providing resources and professional development for excellence in science education. At the undergraduate level, APS programs and fellowships encourage excellence in physiology education and the development of young scientists. Programs and activities are available for students and faculty and resources for undergraduate education and career exploration are provided. At the graduate level, APS programs and fellowships provide opportunities for student study, travel, and interaction with experienced physiologists. Educational materials offer tools to improve teaching and learning at both the graduate and professional levels. APS also provides awards, refresher courses, mentoring resources, and educational materials to promote continuing professional development for its members and excellence in physiology education for their students.

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References

National Research Council (NRC). (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

Alignment and references to state science education standards as of 2010 are cited by the authors.

PURPOSE

The purpose of the unit is to introduce students to the concept of heat. In particular, students should grasp an understanding of the following terms: conduction, convection, radiation, insulation, specific heat and build comfort using the heat energy formula (delta Q=mc delta t). This is the fourth lesson in the first unit of the freshmen physics curriculum.

This lesson asks students to build a "model home" out of paper to investigate heat transfer during a simulated day and night. The purpose of creating a "model home" is to investigate the concepts of heat transfer and insulation through a topic that is relevant to ever day life. Though the ultimate goal is not to learn how to build an ideal home, this project provides a means of increasing the relevance of the materials in the students' mind. This lesson will help students think about the final project for the unit, designing a universal home, and the use of passive solar designs for light and heat in the home. This lab is one of 8 activities in the unit based on heat.

OBJECTIVES

Upon completion of this activity, students will be able to:

- explain how radiation affected the internal temperature of their home structure.
- describe how insulation affects internal temperature of their home structures.
- contrast temperature results of their home structures with and without insulation.

GRADE LEVEL

This lesson is designed for freshmen or students within an introductory physics course.

PRIOR KNOWLEDGE

This lesson is used early within the course. Students do not need much prior knowledge to start this lesson. It will help students think about their final project for the unit, designing a universal home. This lab is one of 8 activities in the unit based on heat. Conclusions and connections made to physics concepts in this lesson will influence the design of their universal home. Following this lesson, students will investigate the affect of windows on their "model home". Students will also be involved in activities that introduce them to the concepts of convection and conduction.

TIME REQUIRED

The maximum amount of time would be two 60-minute class periods.

INCLUDING ALL STUDENTS

A tactile leaner can engaged in building the "model home." Creating a blueprint of home, drawing a graph of data collected and participating in the webquest can engage a visual learner. An auditory can engage in the preparation and delivery of the presentation of results and graph. Students will have an opportunity to write a reflection describing the key concepts they learned from the lesson. Using a "model home" makes the lesson accessible for all students as most have experience and familiarity associated the work "home."

QUESTIONS TO ASK ALONG THE WAY

- What do you think: Buildings that heat quickly cool slowly; or do buildings heat quickly also cool quickly?
- On a warm summer day, how do you stay cool at home?
- On a cold winter day, how do you stay warm at home?
- How do you think it is possible for these methods to work in your home without any affect from the external conditions?
- Does climate play a factor in heating and cooling of a home?

NATIONAL SCIENCE EDUCATION STANDARDS

K-12 Unifying Concepts and Processes

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Physical Science
- Conservation of energy and increase in disorder
- Interactions of energy and matter

Science and Technology
- Abilities of technological design

Science in Personal and Social Perspectives:
- Science and technology in local, national, and global challenges

MASSACHUSETTS STATE SCIENCE EDUCATION STANDARDS

Scientific Inquiry Skills Standards:
- Make observations, raise questions, and formulate hypotheses
- Design and conduct scientific investigations
- Analyze and interpret results of scientific investigations
- Communicate and apply the results of scientific investigations

Content:
- Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.

MATERIALS

Lab materials need to support 4 student groups with up to five members
- heat lamps with bulbs (4)
- digital Thermometer (4)
- tape (4 dispensers)
- package of cardstock
- computers with Internet access (1 computer per 2 students)

SAFETY

Students should be careful handling the heat lamp and light bulb. These items can become very hot and may require cloth gloves to protect hands from burns.

PREPARATION AND PROCEDURE

A. Preparation: Have a set of supplies available for student use: cardstock, tape, thermometers, light sources.

B. Warm Up: Describe the relationship between heating and cooling.

C. Lab session Day 1

1. Students work in groups of 5 students max.
2. Students design an experiment that would help answer the warm up question: What is the relationship between heating and cooling? Teacher must approve procedures. Here are the components of an approvable experiment:

PREPARATION AND PROCEDURE

- Needs to have a cooling and heating phase
- Needs to identify a variable to be tested and what else should be controlled.
- Needs to identify an interval of when and how many measurements will be taken

3. Students will draw a sketch of their "model home".
4. Students will collect supplies needed to build "model home".
5. Students will conduct the experiment they designed.
6. Students must construct a table to record their data.

D. Analysis

1. Students must create a graph of their choice that represents their data.
2. Students will revisit the warm up question and see how their data has answered the question.

E. Lab Session Day 2

1. Students work in groups of 5 students max.
2. Students design an experiment investigating the addition of insulation to the "model home" from the previous day.
3. Reflection: Based on your data, what is the relationship of heating and cooling of a home? What factors may affect this relationship?
4. Students will show off their "model home" and graphs in a gallery walk.

F. Teacher Notes

1. Students can vary their experimental design to test many variables. These variables could include:
   a. time intervals for measurements.
   b. the dimensions of the "model home".
   c. proximity of the light source.
   d. angle of light source.
   e. amount of insulation.
   f. placement of insulation.
2. **PLEASE NOTE:** The temperature of the room does affect the cooling phase. Warmer rooms cause less cooling.

G. Extension

Webquest: Students will research types of homes throughout the world. Students will make a list of 5 countries with each country being on a different continent. They will then research online how homes in that area are constructed. They will relate heating and cooling concepts learned in class to these homes.

Suggested websites:
Shelter Online
http://www.shelterpub.com/_wonderful_houses/wh-toc.html
This website provides descriptions and pictures of homes in various parts of the world.

Houses Around the World
http://www.hgpho.to/wfest/house/house-e.html
This website provides descriptions and pictures of homes in various parts of the world.

PREPARATION AND PROCEDURE

Homes Around the World
http://www.ict.mic.ul.ie/websites/2002/Imelda_Fitzgerald/Homes%20Around%20the%0World-1.htm
This website provides descriptions and pictures of homes in various parts of the world.

Students will present their findings through an oral presentation
24-hour Scavenger Hunt: Students make a list of every example of heat radiation they see over a 24-hour span.

WHERE TO GO FROM HERE

- Student can compare their data and "model home" to other students who used different variables
- From here students can start to understand the function of insulation and can start to investigate how windows impact the heating and cooling process.

SUGGESTIONS FOR ASSESSMENT

- Rubrics for Oral Presentation, Gallery Walk Posters, and Graph

REFERENCES AND RESOURCES

1. *Eisenkraft*, Arthur, (2000). *Active Physics Home* (1st ed.). New York: It's About Time, Inc.

2. *It's About Time: Active Physics*
http://www.its-about-time.com/htmls/ap.html
A curriculum website for the Introductory Physics course taught in the Boston Public Schools district. Accessed on December 17, 2010.

3. *Advancement Via Individual Determination (AVID) Write Path Curriculum*
http://www.avid.org
Curriculum that supports the write, inquiry, collaborate, read (W.I.C.R.) model. Accessed on April 7, 2011.

4. Internet Treasure Hunt websites:
   a. *Homes Around the World*
   http://www.ict.mic.ul.ie/websites/2002/Imelda_Fitzgerald/Homes%20Around%20the%20World-1.htm
   This website provides descriptions and pictures of homes in various parts of the world. Accessed on December 17, 2010.
   b. *Houses Around the World*
   http://www.hgpho.to/wfest/house/house-e.html
   Website containing pictures and blurbs about houses around the world created by the Haga Library in Japan. Accessed on December 17, 2010.
   c. Shelter Online
   http://www.shelterpub.com/_wonderful_houses/wh-toc.html
   Website based off of the book Wonderful Houses by Yoshio Komatsu, Eiko Komatsu, and Akira Nishiyama. Accesssed on December 17, 2010.

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INQUIRY LAB Name: _____ Date: _____

Follow this worksheet to guide you through this lab.

Write down two questions your group has about the theme of the warm up on describing the relationship between heating and cooling:

Question #1:

Question #2:

Given the materials you have in your classroom, design and carry out an experiment that helps you answer the warm up question.

I hypothesize that:

Procedure:

Your procedure needs to be approved before you begin the experiment

Data and analysis: Use the table provided to collect data. Use the space below to describe how your data is a possible answer to the warm up question. Create a graph displaying your data using a graph sheet of paper.

This is what I can say about my hypothesis, based on the data I collected:

I could improve my experimental procedure if I…

ORAL PRESENTATION RUBRIC: Heating and Cooling Around the World

CATEGORY	4	3	2	1
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Comprehension	Student is able to accurately answer almost all questions posed by classmates about the topic.	Student is able to accurately answer most questions posed by classmates about the topic.	Student is able to accurately answer a few questions posed by classmates about the topic.	Student is unable to accurately answer questions posed by classmates about the topic.
Vocabulary	Uses vocabulary appropriate for the audience. Extends audience vocabulary by defining words that might be new to most of the audience.	Uses vocabulary appropriate for the audience. Includes 1-2 words that might be new to most of the audience, but does not define them.	Uses vocabulary appropriate for the audience. Does not include any vocabulary that might be new to the audience.	Uses several (5 or more) words or phrases that are not understood by the audience.
Preparedness	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but might have needed a couple more rehearsals.	The student is somewhat prepared, but it is clear that rehearsal was lacking.	Student does not seem at all prepared to present.

GALLERY WALK RUBRIC

Criteria	Distinguished	Proficient	Basic	Unacceptable
Data table: Easy to read collected data				
Graph: Clearly labeled and displayed Easy to understand trend				
Set up: Experiment materials are present and organized in a way that one could understand how the experiment was performed				

GRAPH RUBRIC

Criteria	Novice (1)	Developing (2)	Standard (3)	Exemplary (4)
Label	Student did not use any labels on graph	Student labeled title but did not label both axes.	Student accurately and clearly labeled title and one axis or both axis labeled but no titled	Student accurately and clearly labeled title and variable on horizontal and vertical axis.
Data Points	1/4 or fewer data points are accurately plotted.	1/2 of data points are accurately plotted.	3/4 of data points are accurately plotted.	All data points are accurately plotted.
Intervals	None Expected	Student does not accurately use intervals on either axis.	Student accurately uses intervals on one axis.	Student accurately uses intervals on both axes.