User's Guide

to the

2006 SOCK

SPS Outreach Catalyst Kit

Developed by Katherine Zaunbrecher
Contributions by Jackie Michalek
2006 SPS Interns

In conjunction with

ABSOLUTE ZERO and the Conquest of Cold

Contents

Dear SOCK Recipient,

You have begun your first step in physics outreach by showing an interest in the SPS Outreach Catalyst Kit. To get you started, we have included sample lessons for a range of ages and situations, and ideas of how to use the materials. It's up to you to decide what age students you want to work with, if you will work in groups or with individuals, and how you will scale the SOCK to fit your own situation.

The theme for the 2006 SOCK is temperature, in conjunction with the *Absolute Zero Campaign*, who will be launching a special program on public television in the spring about cold temperature physics. The materials that are included in the SOCK were chosen based on their potential to be used in a classroom. There are items to be used as demonstrations, this User's Guide for ideas on how to begin, and a dropping experiment with data collection tables to complete and return to us. Liquid nitrogen is something that could not be included in the kits but definitely should not be overlooked. So if you have access to liquid nitrogen, there are some activities for that as well.

These activities are only a starting point. Use the materials to come up with your own ideas, and then tell us what you did! We hope you will find numerous uses for your SOCK within your chapter and beyond into your community. Your input is necessary to keep improving the SOCKs to better meet your needs, so please fill out a SOCK feedback form and return it to us before the end of the year.

Thank you for taking part in this year's SOCK project. Have fun exploring the lessons and send any questions or comments to sps@aip.org.

Best of luck on your future outreach endeavors!

Katherine Zaunbrecher
2006 SPS Intern

Jackie Michalek
2006 SPS Intern

History of the SOCK

The SPS Outreach Catalyst Kit (SOCK) began in 2001 as part of an outreach effort by the national office of the Society of Physics Students (SPS). We hope that the lesson ideas and demonstration materials will help stimulate an interest in physics through SPS chapters starting outreach programs with students from kindergarten through college. For younger students there are qualitative lessons to introduce critical thinking and brainstorming skills. More advanced students can be challenged with quantitative aspects of the lessons, reinforcing critical thinking skills and learning to apply mathematics to real situations. The demonstrations are hands-on to encourage active participation, and the lessons can be adjusted to fit any situation.

The first SOCK was created by SPS intern Mark Lentz in 2001. The SOCK was titled *Rainbow Suite* and sought to teach different properties of rainbows. This started the legacy of light demonstrations that have been present in every subsequent SOCK. The 2002 SOCK was put together by SPS interns Lauren Glas and Jason Tabeling. *Dimensions in Physics* explored geometry in a variety of settings. The 2003 SOCK was constructed by SPS interns Stacey Sude and Ashley Smith. *Spanning Space* included all the popular light elements, and brought in the first experimental component with a nation-wide cylinder dropping experiment.

The 2005 SOCK was a joint effort of the 2004 SPS interns Heather Lunn and Matthew Shanks and the 2005 SPS interns Morgan Halfhill and Rebecca Keith. Entitled *The World Year of Physics 2005*, it was a celebration of the World Year of Physics. It added a new twist to the ever-popular light elements and included a special lesson to commemorate Einstein's discoveries in 1905 with an experiment to measure the speed of light.

This year's SOCK is constructed based on the theme, *Absolute Zero and the Conquest of Cold,* and built from scratch by the 2006 interns, Katherine Zaunbrecher and Jackie Michalek. Its activities are based on temperature, and it includes a new dropping experiment.

The SOCK project is supported by the Society of Physics Students and its associated honor society, Sigma Pi Sigma. SPS is the professional society for physics students and their mentors. It operates within the American Institute of Physics (AIP), an umbrella organization for ten other professional societies.

Beginning Your Outreach

Some of the members of your chapter may have experience with outreach. There are many types and levels of outreach that may vary depending on your community. After establishing a willingness to do outreach within your chapter, the next step is to make connections. Talk to your advisor and other faculty and ask them who they know in the surrounding area. Call local high school physics or math teacher (if they are in the area) and tell them what you are interested in doing.

SPS's primary goal for the SOCK is are to offer an opportunity to present science as activities to be enjoyed, discoveries to be explored, and inquiries to be pursued. Involved SPS Chapters should strive to revive and continue a student's natural curiosity about the world and the universe. Temperature is a vital component to universal structure and balance. The impact of temperature on our society will always be an area of study that invokes great interest and investigative research.

As the name suggests, the kit is meant to serve as a catalyst, prodding your chapter to begin an outreach activity with a local school or in your community. You will likely need to supplement the materials in this SOCK in order to engage students effectively; we have provided contact information for all of the vendors we used for your convenience.

General Objectives

Upon completion of the SOCK activities, the students will be able to:

- Measure temperature using different types of thermometers;
- Compare different temperature scales;
- Differentiate between evaporation and boiling of a liquid;
- Experiment to find bounce height for drop at different temperatures;
- Summarize the quest for absolute zero and it's impact on the universe;
- Identify further investigative methods; and
- Effectively participate in inquiries, discoveries and discussions.

All while exploring liquid crystals, hand boilers, instant hot/cold packs, liquid nitrogen, and rainbow glasses.

What is the *Absolute Zero Campaign*?

The *Absolute Zero Campaign* is devoted to answering the question, "How does low-temperature physics affect our daily lives?" A two-part television special entitled *Absolute Zero* will be aired on public television in the spring of 2007. The campaign web site offers educational materials, activities, and historical information, as well as additional resources.

Why *Absolute Zero*?

SPS, along with the American Institute of Physics, is a national partner of the *Absolute Zero Campaign*. It has been chosen as a theme for SPS national activities in the 2006-2007 school year.

To access additional activities and resources, visit the *Absolute Zero* web site, **http://www.absolutezerocampaign.org/get_involved/resources.htm**, and click on *Get Involved*.

Resources, Activities and Experiments

- Topic 1: Measuring the Cold - Thermometers
- Topic 2: Understanding Heat and Energy
- Topic 3: States of Matter
- Topic 4: Refrigeration
- Topic 5: Cryogenics
- Topic 6: The Quest for Absolute Zero
- Topic 7: How Animals Survive the Cold
- Topic 8: Superconductivity
- Topic 9: Astronomy
- Topic 10: Spaceflight
- Topic 11: Agriculture
- Topic 12: Cold Medicine

Supply List

Happy/Unhappy Balls 

 Hand Boilers

Absolute Zero and the Conquest of Cold by Tom Shachtman 

Liquid Crystal Sheets

Mood Beads

Thermometers 

 Cold/Hot Packs

 Rainbow Glasses

As well as a list of all the materials put into the SOCK, there is interesting scientific information describing each item and suggested activities and experiments to do in the classroom with these things. These activities are suggestions. They can be modified depending on the group's level of scientific knowledge.

If there are other things that can be done with the materials, please feel free to explore and be creative. A lot of additional material can be found on the internet. There are also activities listed on the *Absolute Zero Campaign* website. There is a link to these on the "Other Activities and Demonstrations" page.

Happy/Unhappy Balls

Those who have received a SOCK in the past may remember the "dropping" experiments. This year's experiment is a little different. Instead of having wooden cylinders or several balls made of different materials, there are six rubber balls included. They are known as happy and unhappy balls and may look the same but behave quite differently if you drop them. That is because the happy ball is made of neoprene, a common type of rubber, and the unhappy ball is made of rubber called Norbornene polymer. This rubber has good impact absorption properties that cause it to behave the way it does. Some other characteristics include a low restitution elasticity, good energy absorption under normal temperature ranges, and very good absorption and insulation of high frequency vibrations.

When testing the temperature dependence on the bounce of both balls we were very surprised to find that both had interesting responses. We would like the help of SPS chapters around the nation in exploring these findings in greater detail. There are procedures outlined for an experiment in which you test the temperature dependence of the balls with the students. There is also a data sheet to record the data. We hope that you will explore the behavior of the data with the students, comparing to their predictions, graphing the results, and even sharing their reactions with us. We also would ask that you send the data back to us so that we might compare results from different landing surfaces and locales. Related ideas include coefficient of restitution and elastic and inelastic collisions.

Materials:

3 pair of happy/unhappy balls (included in SOCK)
2 thermometers (included in SOCK)
1 meter stick
2 bowls, one filled with near-freezing water (ice water) and the other with hot water
data sheet included in front pocket of user's guide

For this experiment, there will be two sets of balls (one happy and one unhappy ball per set) that will be heated and cooled. It is important that the sets be separate and distinguishable.

Procedures:

- Predict what will happen to the balls as they are heated and cooled.

- Record the temperature of the room; the balls should not be handled for a few minutes before the experiment so that they are in equilibrium with the room temperature. Perform an **initial** drop, using all six balls. (Have a way of distinguishing each set of balls throughout the experiment. It is very important that they do not get mixed up.) Drop each of them from a height of one meter onto a hard, smooth surface, recording the maximum height of the ball after it bounces onto the data sheet provided in the SOCK. Do this three times for each ball.

- Place one set of balls (Set 1) into a bowl of near-freezing temperature water. Wait for the balls to reach equilibrium and record the temperature of the water with balls. Drop each ball three times from one meter and record the heights of the bounce. Place the two balls into water again and wait for an increase in temperature (about 5-10 degrees Celsius). Repeat the drops until the water and balls reach room temperature. Set these balls off to the side as to not confuse them with the others. They will eventually be used later on in the experiment, but will be placed in hot water instead of cold.

- Place both balls in Set 2 into the bowl of hot water. Water from the tap is fine, as long as there is a considerable temperature difference. Wait for the balls to reach equilibrium and record the temperature. Drop each ball using the procedures from the above step. Place the balls in the water again and wait for a decrease in temperature. Repeat the drops and placing them in the water until the temperature decreases until they have reached room temperature. Place Set 2 to the side. They will be used again but will be placed in the cold water.

- Now place Set 1 into a fresh bowl of hot water. Again, wait for the balls to reach equilibrium, record the temperature, and begin the dropping. Repeat the above-mentioned steps and record the data.

- Place Set 2 into a fresh bowl of near-freezing water. Repeat the waiting, dropping, and recording.

Results and Conclusion:

Look at the data. Were your predictions correct? What happened to the balls?

Construct a graph of height versus temperature for both sets of balls with the data you collected. It can be one graph with both sets of balls or two separate graphs. You can use any program. If you would like to show the students the results in a graph you can even sketch one on the board. This could be a great opportunity for a lesson on graphs, depending on the students' capabilities.

Send us your information and let us know how your experiment and outreach experience was!

Hand Boilers

These hand boilers appear to 'boil,' making the holder have the impression that they are hot. But what is really happening? It is expanding vapor forced through the lower temperature liquid that gives the appearance that the liquid in the glass bulb is boiling.. The warmth from the hand on the hand boiler increases the pressure in the glass chamber in two ways; increasing the temperature of the gas and vaporizing more of the liquid. Subsequently, the colored liquid (an ethanol and dye combination) is pushed into the upper chamber of the glass bulb by the increase in pressure. Is this identical to boiling? Actually, not exactly.

The boiling point usually refers to the temperature at which a substance changes phase from a liquid to a gas at a given pressure. The boiling point of ethanol is 78.3°C, or 172.9° F, at standard (1) atmospheric pressure, but the boiling point of ethanol at 0.13 atm (approximately the pressure in the hand boilers) is 34.9°C, or 94.8° F. While your hand will cause the temperature of the bulb to rise, generally, the term 'boiling' is used when the entire liquid is at the boiling point temperature, and bubbles can be formed any point within the liquid. The liquid in the hand boiler probably does not achieve 94.8 F uniformly, but the increased pressure in the bulb and the peculiar geometry of the glass tubing force the vapor through the liquid when the liquid level goes below the lip of the glass straw. The bubbles that form from this pressure increase are not caused by exactly the same phenomenon that causes water on your stove to boil, or even that causes liquid nitrogen to boil at room temperature, so some prefer 'vaporizing' to the term 'boiling'.

Activity: Hand boiler…is it boiling?

Procedure:

1. Hold the hand boiler by the bottom glass bulb in the palm of your hand and gently clasp your fingers around it for 20 seconds.
2. Observe the reaction of the liquid.
3. Record the results.

Variation Suggestions:

- Hold the hand boiler by the top glass bulb. Observe/discuss the results.

- Rub your hands together, then hold the hand boiler by the bottom glass bulb. Observe/discuss the results.
- Hold an ice cube in your hand for 30 seconds, then hold the hand boiler by the bottom glass bulb. Observe/discuss the results.
- Place an upside-down hand boiler in a cup of ice water for 10 minutes. (Add salt to the ice water to speed the results.) Observe the separation of the ethyl alcohol and the dye. Discuss the results.

Discussion Suggestions:

Definition of temperature.

Definition of pressure.

Definition of boiling.

Definition of evaporation.

What is the relationship between temperature and pressure?

Extended Discussion Suggestions:

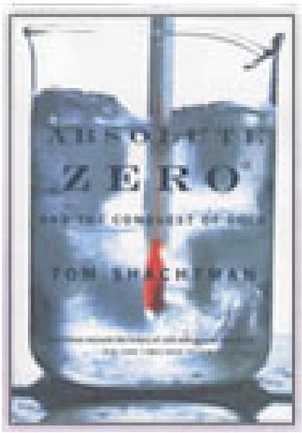
Closed Distillation Apparatuses

Volatility

Compressors

Refrigerators

Absolute Zero and the Conquest of Cold
by Tom Shachtman



In keeping with the theme of this year's SOCK, Shachtman's book is included for those who are interested in going a step further. This book, chosen by the *Absolute Zero Campaign*, explores the history of the "discovery" of cold. It begins in early seventeenth century England with Cornelis Drebbel's attempt to "air condition" Westminster Abbey. From there, Shachtman tells the stories of the well-known and not so well-known pioneers in the science of cold.

This book is not a mandatory read. The information that one might gain from reading it may assist in the outreach. It is merely placed in the SOCK for those who are interested in furthering their understanding of physics.

Liquid Crystal Sheets

Technology today uses liquid crystals in devices such as computer monitors and cell phones for the display screens. We have included two liquid crystal sheets so that you can provide visual testing and demonstrations in the classroom. Each sheet has a different temperature range. The darker one will respond if you place your hand on it. Try writing on the lighter one with water and watch how it reacts.

How Liquid Crystals Work

Liquid crystals are aptly named, exhibiting qualities of a liquid and a solid crystal, flowing like a liquid but orientating and arranging like crystals. This is known as the *mesomorphic phase*. Liquid crystals are organic moieties which are rod-shaped and about 25 Angstroms long and **can be polarized**. Their ordering is a function of temperature and can be controlled by an electric field (which is what happens in liquid crystal displays). Two types, known as nematics and smectics, have no positional order but maintain their orientation order. The smectics have one more degree of orientation order than nematics and are found at lower temperatures. The transitions observed (change in color) depend upon external parameters, such as a change in temperature or an electric field. If you view liquid crystals under a microscope with a polarized light, the structure and alignment of the molecules can be seen.

Mood Beads

Some of the older SPS members might remember having a mood ring. These mood beads are essentially the same thing. When worn, the change in color let you know the "mood" you are in. They are another good example of how thermotropic liquid crystals work. Use them in the classroom as smaller visualizations.

Thermometers

metal-back thermometers
adhesive temperature strips

Suggested activities listed below.

Cold/Hot Packs

A cold pack contains ammonium nitrate (NH_4NO_3) and water. When the pack is broken and the two are mixed, they react endothermically. This means that the reaction requires heat energy in order to mix, absorbing the heat energy and leaving the mixture cool. The hot packs work in a similar way, only exothermically instead of endothermically. There is calcium chloride or magnesium sulfate and water. When broken, the exothermic reaction gives off heat.

Suggested Activities:

Get the students to predict how cold or hot the packs get. Let them use the temperature strips to measure the temperature and check their predictions.

Temperature Test

Use the strip thermometers to measure the temperature between your hands, under your arm, on your forehead, etc. Do you get the same temperature in each case? Do your friends have the same temperature as you do?

Heat Detective

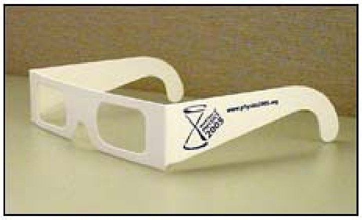
You can use the liquid crystal sheets to detect where someone has been sitting or even where their hand has been resting. While you have your eyes closed, have a friend press their hand firmly onto a table top for a few seconds. You can identify exactly where their hand was by placing the liquid crystal paper onto the table top and looking for the outline of their hand caused by the residual temperature difference.

Moving Colors

Activate one of the hot packs and place it on a table with the liquid crystal sheet nearby. Note the pattern of colors that result. Do the isotherms (curves with the same color) behave as you expect? Compare the patterns on different types of surfaces.

Use the thermometers with the cold and hot packs to study how their temperatures vary with time? Do the hot packs cool down exponentially with time once they achieve their maximum temperature? Do the cold packs warm up exponentially? Does it matter what the ambient temperature is? Does it matter if they are immersed in water?

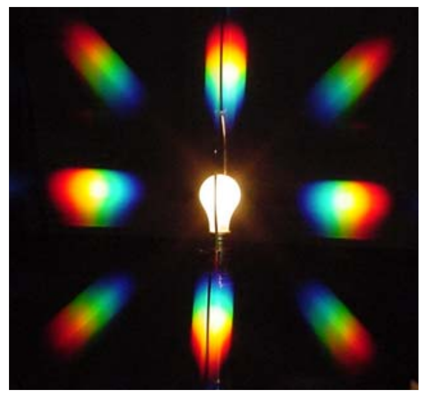
SPS Rainbow Glasses



Use Rainbow Glasses to see things in a new light.

Any white light source is revealed in its full rainbow splendor; the smaller and brighter the source, the more dramatic the rainbows. Paperboard frames house diffraction gratings with striations in both horizontal and vertical directions; spacing between striations is roughly 4.5 microns, meaning that there are about 2200 lines per cm or 5500 lines per inch. See things like you've never seen them before---fireworks, holiday lights, flames, etc.

Not all light sources give off the same colors of light. The rainbow glass separate out the colors according to their wavelengths: Pure red light has a wavelength of about .0000025 inches or 6.5×10^{-7} meters and bluish light has shorter wavelengths, around .0000016 inches or 4.0×10^{-7} meters. You may be able to see a second or third square pattern of rainbows further from the center; this can be thought of as 'echoes' of the first square pattern.



Electromagnetic radiation table

	Wavelength (m)	Frequency (Hz)	Energy (J)
Radio	$> 1 \times 10^{-1}$	$< 3 \times 10^{9}$	$< 2 \times 10^{-24}$
Microwave	$1 \times 10^{-3} - 1 \times 10^{-1}$	$3 \times 10^{9} - 3 \times 10^{11}$	$2 \times 10^{-24} - 2 \times 10^{-22}$
Infrared	$7 \times 10^{-7} - 1 \times 10^{-3}$	$3 \times 10^{11} - 4 \times 10^{14}$	$2 \times 10^{-22} - 3 \times 10^{-19}$
Optical	$4 \times 10^{-7} - 7 \times 10^{-7}$	$4 \times 10^{14} - 7.5 \times 10^{14}$	$3 \times 10^{-19} - 5 \times 10^{-19}$
UV	$1 \times 10^{-8} - 4 \times 10^{-7}$	$7.5 \times 10^{14} - 3 \times 10^{16}$	$5 \times 10^{-19} - 2 \times 10^{-17}$
X-ray	$1 \times 10^{-11} - 1 \times 10^{-8}$	$3 \times 10^{16} - 3 \times 10^{19}$	$2 \times 10^{-17} - 2 \times 10^{-14}$
Gamma-ray	$< 1 \times 10^{-11}$	$> 3 \times 10^{19}$	$> 2 \times 10^{-14}$

Playing with Liquid Nitrogen

The purpose of this lesson is to demonstrate the changes in objects and materials due to exposure to extreme cold and the subsequent freezing and material property changes the object undergoes. This lesson is designed around the use of liquid nitrogen because it is extremely cold and fits in perfectly with the theme of this year's SOCK.

Suggested Materials:

Demo:

- Balloons
- Nail
- Board
- Racquetball
- Bananas
- Liquid Nitrogen

Safety Preparation:

- Small Ice Chest/Thermos
- Safety Goggles
- Gloves and Tongs

Balloons:

- Balloons
- Liquid Nitrogen
- Small Ice Chest
- Gloves and Tongs

Ask the students how many balloons you can fit into an ice chest with liquid nitrogen in it. Do they predict that the balloons will shrink? Let them discover what happens to the air in the balloon. Explain the effect of cooling air.

Racquetball:

- Racquetball
- Liquid Nitrogen
- Small Ice Chest
- Gloves and Tongs

The racquetball can be used to demonstrate how the chemical bonds become more rigid when an object is cooled. Throw the ball against a wall while it is at room temperature, then freeze it in the nitrogen and repeat. If you have cooled the ball enough it should shatter when the ball hits the wall.

Nail, Board, and Bananas:

- Nail
- Board
- Bananas
- Small Ice Chest
- Liquid Nitrogen
- Gloves and Tongs

Another fun demonstration is to have a student hammer in a nail with a banana. Have him/her first try to hammer a nail into a board with a room temperature banana. Then freeze a second banana. Give them a glove to hold the frozen banana and let them try again. Remember to freeze the banana long enough.

Liquid Nitrogen Ice Cream Recipe:
Makes ~ ¾ Gallon Ice Cream

1 ½ quarts half and half
1 ½ quarts heavy cream
3 tbsp vanilla
1 ½ cup sugar
large **stainless steel** bowl
wooden spoon for mixing
liquid nitrogen
gloves and eye protection

Mix all of the ingredients in the bowl until dissolved. Pour in liquid nitrogen while constantly stirring until the ice cream reaches the desired consistency. Serve.

Caution:
Be sure to wear proper safety attire whenever handling liquid nitrogen. Also make sure the students stay back. Let the fog boil off objects being taken out of the liquid nitrogen before touching them with bare hands. If you have little or no experience handling liquid nitrogen, try these activities before you take them into a classroom.

Final Notes:
These are just a few demonstrations with liquid nitrogen that can be instructive in a classroom setting; the web has lots more.

Other Activities and Demonstrations

Different Colors, Different Temperatures?

Materials:

4 squares of different colored felt
(black, white, green, pink, etc)
4 thermometers
1 heat lamp

Procedure:

Wrap a small piece of different colored felt around the bottom of each thermometer. Place them under the lamp. Ask the students what they think will happen to each one. They can even predict the temperatures of each color. After 15 minutes or so, have the students check the temperatures. Record them on the board.

Discussion:

Were their predictions correct? Explain why the different colors are different temperatures (or ask the students if one of them could explain).

Alcohol and Water on Your Skin

Materials:

Rubbing alcohol
Water
Cotton balls

Procedure:

Ask for a volunteer (or two). Soak one cotton ball in water and the other in alcohol. Rub one cotton ball on a student's arm and the other cotton ball on the student's opposite arm. Ask them to tell the class what they feel. Discuss what is happening.

Hot or Cold?

Materials:

3 bowls, one with cold water, one with hot, and one with room temperature

It is important for the water to be hot and cold, but not too extreme. The students will be placing their hands in it and keeping them in for a minute or so.

Procedure:

Set up the bowl on a table. Have the hot and cold water on either side of the room temperature water. Ask for a volunteer to come to the front and place one hand in the cold water and the other in the hot. After about a minute, tell them to take their hands out of the cold and hot water and place them both in the room temperature water. Ask them to describe what their hands feel like.

Discussion:

The students' reactions will vary. If they are indecisive, have them repeat the procedure. Discuss why their hands felt different in the room temperature water.

Ice Melting Relay

Materials:

Small, flat areas of different materials (such as plastic, metal, styrofoam, or glass)
ice cubes

Procedure:

Have the students guess which material will cause an ice cube to melt the fastest when placed on the surface.

Vendor Information

Absolute Zero and the Conquest of Cold - Amazon.com
http://www.amazon.com/s/ref=br_ss_hs/102-6582419-7108160?platform=gurupa&url=index%3Dblended&keywords=Absolute+Zero+and+the+Conquest+of+Cold&Go.x=10&Go.y=11&Go=Go

Hand Boilers - Edmund Scientifics
http://scientificsonline.com/product.asp?pn=3052382&cmc=CROSS_SELL&Hand+Boilers&bhcd2=1152281311&bhcd2=1153316353

Liquid Crystal Sheets - Edmund Scientifics
http://scientificsonline.com/product.asp_Q_pn_E_3072375_A_cmc_E_CROSS_SELL_A_Temperature+Sensitive+Liquid+Crystal+Sheets

Adhesive Temperature Strips – Data Clean
http://www.dataclean.com/temperature_strips.htm

Metal Back Thermometers - Cynmar Corporation
http://www.cynmar.com/product_info.php?products_id=8248

Cold/Hot Packs - Payless Medical Supplies
http://www.paylessmedical.net/Instant-Cold-Packs---Bx-24.htm
http://www.paylessmedical.net/Instant-Hot-Packs.htm

Happy/Unhappy Balls – Nada Scientific
http://gallery.bcentral.com/GID4801557P1473164-Physics/Mechanics/Motion/HAPPY-UNHAPPY-BALLS-10-PRS.aspx

Mood Beads - Collective Cottage
http://www.beadlinks.com/cgi-bin/beadabead2/index.cgi?exact_match=yes&product=Mood_Beads

Rainbow Glasses - SPS

Standards (National Science Education Standards)

As you communicate with teachers about visiting a classroom, you might be asked about science education standards. While each state defines its own standards, most are based on the National Science Education Standards, published in 1996 by the National Academy of Science (http://www.nap.edu/catalog/4962.html#toc on the National Academies Press website). These standards cover K-12 and include ideas such as heat, states of matter, and energy transfer. Here is a sample sentence from the physical science content standards:

In grades 5-8, students observe and measure characteristic properties, such as boiling and melting points, solubility, and simple chemical changes of pure substances, and use those properties to distinguish and separate one substance from another.

More generally the content topics for each age group are indicated below. Note that all include references to the ideas that are emphasized in the SOCK (heat, transfer of energy, properties of matter, etc.).

Physical Science
CONTENT STANDARD B:

As a result of the activities in grades K-4, all students should develop an understanding of
* Properties of objects and materials
* Position and motion of objects
* Light, heat, electricity, and magnetism

As a result of their activities in grades 5-8, all students should develop an understanding of
* Properties and changes of properties in matter
* Motions and forces
* Transfer of energy

As a result of their activities in grades 9-12, all students should develop an understanding of
* Structure of atoms
* Structure and properties of matter
* Chemical reactions
* Motions and forces
* Conservation of energy and increase in disorder
* Interactions of energy and matter