Heat and Temperature

Climate change and global warming are subjects of great concern and interest to scientists, politicians and the general public. Today’s class will provide several examples for activities that can be used to address different aspects of heat, temperature and their links to climate change and global warming.

I. Class demonstration and discussion: absorption of radiation
Goal: get your wheels spinning

Observe the two thermometers; one immersed in a shiny tin can the other in a black one. The same light source shines on both. Why is there a difference in temperature between the cans?

Will the temperature increase forever or will a steady state in temperature be eventually reached?

II. Group activity: heat properties of water and soils
Goal: get your hands wet and your head in a ‘teacher’ mode. Use your notebook to record thoughts and notes as you do this activity.

The following material is provided to you:
Cups, sand, water, soil, a heat lamp, food coloring and a thermometer.

1. Discuss in your group questions about heat and temperature in the Earth-Ocean system that can be investigated using the materials provided to you.

2. Set up an experiment (student activity) that will address one or some of these questions.

3. Predict what you think will be the result of the experiment and test your prediction.

**Homework:** summarize your results and write an explanation (or a follow up discussion) that will solidify concepts demonstrated by your activity with students.
III. Class demonstration and discussion: latent heat (modified after Windows to the Universe http://www.windows.ucar.edu/)
Goal: review this important, yet complicated process and provide an example for a possible activity.

Material: heat pack, beaker with water, thermometer.
1. Observe and feel the heat pack and describe it (e.g., material and temperature).
2. Fill and beaker with room temperature water and record the initial temperature.
3. Activate the heat pack by pressing the button (use the ball of your fingers; don’t use your nails as they might damage the pack).
4. Record starting temperature immediately.
5. Continue recording the temperature, once every minute for 10 minutes.
6. What causes the change in temperature? How does this pack work? (Hint: does the material in the pack look the same before and after you activated the pack?)

Journal prompts:
The reaction in the pack that you have just observed is similar to what occurs during ice or cloud formation. Do you agree (or disagree) with this statement? Why?

IV. Class demonstration and discussion: The greenhouse effect
Goal: discuss common misconceptions about the greenhouse effect and provide an example for a hands-on activity that can be used in class to demonstrate the concept

Based on what you have learned in previous classes or read elsewhere- what is the greenhouse effect? What causes it? Is the greenhouse effect good or bad for the planet?

Demonstration:
1. Place the bottles under a heat source (lamp)
2. Place 4 tablets of Alka Seltzer in bottle # 3 and immediately record the temperature in each of the bottles.
3. Continue recording the change in temperature every 2 minutes for 10 minutes.

Homework:
1. Use the data we have recorded to plot temperature (X-axis) as a function of time for each of the bottles (on the same plot).
2. What was the maximal temperature at each of the bottles by the end of the experiment?
3. How does the rate of change of temperature compare among the 3 bottles?
4. Write an explanation for this experiment, including explanation of the results and a short discussion that solidifies the concept of greenhouse effect. Where does the analogy of this experiment break down?
V. Class demonstration and discussion: Thermal expansion and sea-level change

Goal:
Materials: bottle, one-hole stopper, long glass tube.

1. Fill the bottle with water so it extends to 1/3 of the length of the straw above the stopper.
2. Put the bottle in a container of ice water. Mark the position of the water. Place the bottle in hot water. Mark the position.
3. What happened to the water in the flask when it warmed up?

Journal prompts:
1. What process associated with sea level change can be taught using this demonstration?
2. What other processes affect sea level?

Homework:
Would the melting of land-based ice and floating ice have the same effect on sea level? Why? How would you demonstrate it to your students?

* Note: Galileo Galilei applied the knowledge of thermal expansion to measure temperature and this is still the principle by which some thermometer (including some we used today in the lab) work. This activity can alternatively be used to discuss how thermometers operate and to build a thermometer with your students. (reference: Hands-on Meteorology, Zbigniew Sorbajan (author), 1996. American Meteorology Society).