SMS-204: Integrative marine sciences.

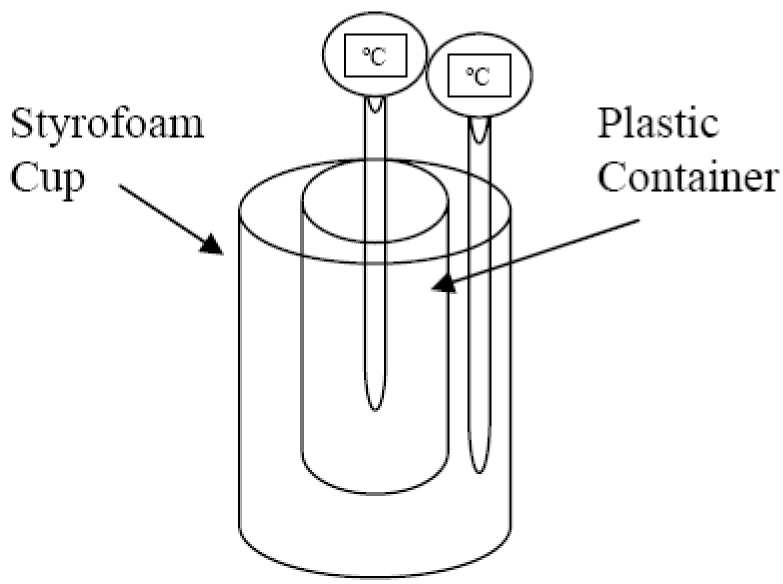
Lab 4, Heat and temperature.

Today we will look at several aspects of heat and temperature.

In all of these experiments think about heat and how heat is moving (heat flux). Is it radiative, convective (advective) or conductive heat flux that takes place?

Station 1: Heat exchange and latent heat.

1. Below is a cartoon of the experimental set up. What would be the direction of the heat transport if the small container would contain ice-cold water and the Styrofoam cup would contain hot water? (Draw arrows to show it)? What would happen to the temperature of the water in the small container? In the Styrofoam cup?



2. Fill the small plastic container to the top with ice-cold water (no ice!). Record the initial temperature of the water in the container. Affix this container to the clamp.

3. Fill the Styrofoam cup with hot tap water to the marked line (so the volume of water in the container equals the volume of water in the cup). Record the initial temperature of the water in the cup.

4. Slide the arm of the clamp down and place the small container inside the cup so that it is immersed in the hot water. Record the temperature in the container and the cup every 30 seconds for four minutes. Using the rod of the thermometer, mix the water in the cup and the container while doing the measurements to eliminate any temperature gradients that might be developing. (In other words, don't allow light, warm water to accumulate and float on top of cold, denser water.)

5. Plot the temperature in the container and the cup as a function of time. Do your observations agree with your prediction? What do you expect the temperature difference to be after a longer period of time?

6. Assume that you repeat the experiment, but this time you fill the small plastic container with ice + water and fill the cup with hot tap water (don't do it yet!). Do you expect to see similar changes in temperature in this setup? Why or why not?

7. Fill the small container to the top with ice and water (approximately 60% ice and 40% water). Record the initial temperature of the water in the container.

8. Repeat Steps 4 and 5. Do you see the same trend as you saw in Step 5? Why or why not?

Note: Make sure to mix the outer cup before measuring temperature.

Station 2. Wet/dry bulb temperature
A sling psychrometer is a device that allows us to measure relative humidity by comparing the temperature of a thermometer wrapped in a wet cloth (the wet bulb) with the temperature of a dry bulb.

1. How do you expect the temperature between the two thermometers to vary as a function of humidity? Why might there be a difference between the two readings?

2. Swing the psychrometer for 20 seconds and then note if there is any difference in temperature between the two thermometers (repeat three times and record the median for each).

3. Under what conditions would you expect no differences between the thermometers?

Station 3. Thermal sensitivity.
Materials: 3 containers with hot, ice-cold, and room-temperature water.

Place both hands in room-temperature waters for 30s.
Next place one hand in the hot water and the other one in the ice water for about a minute.

Put your hands back in the room-temperature water.

How does the room-temperature water feel to each hand?

What does it say about our heat-sensing capabilities?

Station 4. Conduction
Materials: 3 types of materials at the same temperature – wood, metal and cloth. 2 black plates with rubber O-rings.

Which type do you think will feel colder?

Briefly place a hand on each type of material.

Which type feels coldest? Which type feels warmest?

Given that they are at the same temperature, why do they feel different?

Put an ice cube within each O-ring. Explain what is happening to the ice.

Station 5. Absorption.
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 among the cans?

Will the temperature increase forever or will a steady state in temperature be eventually reached? What will be the balance of heat-fluxes after a very long time?

Station 6. Galileo's thermometer.
Can you explain how this thermometer works (each glass ball has constant volume and mass of colored fluid within it. How does its buoyancy change?)?

Station 7. Thermistor.
A common method to measure temperature is using a thermistor. Thermistors are electronic components whose resistance changes with temperature. Change in resistance modifies the current through them.

You have a thermistor attached to a multimeter. Put the multimeter in the Ω position (Ω stands for Ohm the unit we measure resistance with). Read the value in air and between your fingers. Do you notice a significant change? Note that current passing through a resistor heats it up, above ambient temperature. If not accounted for, this effect can bias temperature readings. How could you minimize this effect?

For more: http://en.wikipedia.org/wiki/Thermistor

Reference:

Sorbjan, Z., 1996. Hands-on meteorology, stories, theories, and simple experiments. American meteorological society.