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 or conductive heat flux that takes place?

**Station 1**: Change of boiling point of water with pressure.

Material: Pyrex bottle, boiling water.
Carefully pour boiling water into a bottle.
Seal the bottle, invert over a sink and pour cold water over it.
Observe what happens.

Try to explain the observation given that:
1. For gas, pressure is proportional to its temperature.
2. The boiling point of water decreases with decreasing pressure.

Can you relate it to pressure cookers?

**Station 2**: Why is it colder in the winter?

Material: inflatable globe, flash light.

Place a flashlight at a given distance from the ball equator and shine it. Keep the light level and raise the light such that the region near the pole is illuminated.

Where is the amount of radiative flux per unit area larger?

How are your results related to the changes in temperature between morning and noon, seasonality, etc.?

It turns out that the change in area illuminated varies like the cosine of the angle between the local zenith (a line perpendicular to the globe at the point the light illuminates) and the flashlight. Is it consistent with your observations?
**Station 3.** Water thermometer.
Materials: bottle, one-hole stopper, long glass tube.
Fill the bottle with water so it extends to 1/3 of the length of the straw above the stopper.
Put the bottle in a container of hot water. Mark the position of the water. Place the bottle in ice water. Mark the position. You have made a thermometer.

Do you think your thermometer calibration will be applicable to Mt. Everest?

**Station 4.** 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 5.** Conduction
Materials: 3 types of material at the same temperature – wood, metal and cloth

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?

**Station 6.** Convection.
Materials: convection set-up, color.

Put ice in one basin and warm water in the other. What direction of flow would you expect for the water in the convection setup? Add drops of dye to the two columns and observe whether they agree with your prediction.

**Station 7.** Radiometer.
Put the radiometer away from a light source. Put it near a light source. Explain how a radiometer works (think about pressure, temperature, and gas).
**Station 8.** Absorption.
Two thermometer 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 for ever or will a steady state in temperature be eventually reached?

What will be the balance of heat-fluxes after a very long time?

**Station 9.** 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 10.** Sling psychrometer.
A sling psychrometer is a device allowing us to measure relative humidity by measuring the temperature of a thermometer wrapped in a wet cloth (the wet bulb) and a dry one.

How do you expect the temperature between the two to vary as function of humidity?

Why should there be a difference between the two readings?

Swing the psychrometer for 20s and then note the difference in temperature between the two thermometers. Use a table to compute the relative humidity in the lab. How accurate do you think this method is?

**Reference:**

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