SMS-204: Integrative marine sciences.

Lab 5, Settling, drag and swimming in high and low *Re* flow + some stations from Lab 4.

Today you will investigate the drag experienced by bodies in different flows.

Station 1. Choose two clay models (4 of each kind) and a sphere (2 of the same kind) to represent similar phytoplankton; select the clay ball such that it weighs the same or slightly less than the phytoplankton analogues.

In two graduated cylinders, one with Glycerin and the other with water, measure the settling velocity of your models (one sphere and two phytoplankton similar analogues in two different orientations) using a stopwatch and a ruler. Can you get the non-spherical objects to settle slower than the spheres (even though they may be larger)? In what orientation are they slowest?

Compute the Reynolds number of the flows produced by the models and sphere in water and in glycerin using: $\mu_{glycerin}$=0.016 Pa s, $\rho_{glycerin}$=1.17g cm^{-3}, μ_{water}=0.001 Pa s, ρ_{water}=1.0 g cm^{-3}. How do they compare to phytoplankton in the ocean (assume a phytoplankton of about 10μm settling at about 50m/day):

	Model I				Model II				Sphere in Water	Sphere in Glycerin
	Glycerin		Water		Glycerin		Water			
	Orientation I	Orientation II	Orientation I	Orientation II	Orientation I	Orientation II	Orientation I	Orientation II		
Size										
Weight in Air										
Velocity										
Re										

Station 2. Sinking in stratified fluid. You have a cylinder stratified with normal Karo on the bottom and Karo-light at the top. Observe the settling of several spheres released within a small time interval in the fluid. Is the settling (and spacing between balls) affected by the change of density and viscosity of the fluid? Can you think of oceanic/ limnological (lake) conditions for which this demonstration may be relevant?

Station 3. Sedimentation tube: simulate a nephloid (near-bottom) storm by reversing the tube and letting the particles settle. Watch the settling as function of time as well as the water turbidity. Describe to your team member what is going on.

Station 4. Swimming at low and high *Re*:
You have several bath toys/swimmers. Take one and have it swim in water. Measure its velocity. Now put it in Glycerin. How fast does it swim? Why are there differences?

Station 5. Feeding at low *Re*:
Try to catch plastic balls in glycerin using a spoon, a fork and knife. Do not use the air-corn syrup interface or the glass walls. Which utensil can get closest to the particle and in what orientation? What does it teach us about filter feeding on particle at low *Re*?

<u>Stations from last week's lab:</u>
Station 6. 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 7. 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 8. 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 9. 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 10. 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?)?

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