Ghana Summer School

I. Surface and Internal Waves

Supply List:
- Divided Tank
- Fresh Water
- Salt Water
- Timer (Phone)
- Ruler
- Dye

Fill the tank with freshwater (divider is *not* in the tank and leave an inch at the top so the water doesn't splash). Disturb the surface of the tank with the divider and watch the wave on the surface move back and forth. Record the time it take for one wave to travel the length of the tank. *What is the speed of the wave? Compare this value to* $\sqrt{gH}$ *where H is the depth of the water.* (You may need to time the wave a few times so get a good estimate.)

Now place the divider in the tank. Mix in one tablespoon of salt on one side of your tank, stir it well and add a drop or two of dye to the water. *Talk about what you think will happen when the divider is removed.* Release the divider. *Did your prediction come true?*

Now create a wave on the interface between the two surfaces by gently tipping the tank and then leveling. Record the time it takes for the wave to travel the length of the tank. *What is the speed of the wave? How does it compare to the surface wave's speed?*

Insert the divider again and stir the upper and lower layers on one side of the divider. *Talk about what you think will happen when the divider is removed.* Release the divider. *Did your prediction come true?*

Talk about what you think this means for the different types of waves in the ocean?

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II. Buoyancy Frequency

Supply List:

- 2 Large Containers
- Small Vial w/ String
- Stir Rod
- Eye-Dropper
- Fresh Water
- Salt Water
- Timer (Phone)
- Dye

Make a two-layer fluid: Fill one container about ½ full with fresh water and ½ with salt water. Gently pour the fresh over the salt water until the container is nearly full' use a piece of Styrofoam or plastic to prevent mixing between the two fluids.

The goal is to adjust the density of a small vial with air and water so that the middle (roughly) of the bottle floats at the interface of the two fluids. Lower the bottle carefully with the attached string. Adjust the buoyancy of the bottle by adding or removing water from inside the bottle with an eyedropper. Try not to mix the interface during this process.

Once floating at the interface, depress the bottle slightly with a stick and estimate the period of oscillation T. It is easiest to time several oscillations and divide by the number of oscillations, rather than timing one cycle.

Compute buoyancy frequency: $N = 2\pi/T$ (radians/second). Estimate the density difference from the buoyancy frequency using

$$N^2 = -\frac{g}{\rho_o}\frac{\partial \rho}{\partial z} = -\frac{g}{\rho_o}\frac{\Delta \rho}{h}$$

where *h* is the height of the small vial.

Try the experiment again with a less salty bottom layer.

W*hat is happening to the bottle in terms of the forces acting upon it? How does the movement of the bottle relate to internal waves like that created in Lab I above?*