SMS-204: Integrative marine sciences II.

Lab 5, Hearing and vision. Looking at light and sound in air and water.

Station 1. Decomposing white light into its components:

a. Use a prism to decompose visible (white) light into its components (use either sunlight or that from a flashlight). For which wavelengths (blue or red) is the index of refraction of the prism higher (the ray's propagation angle is bent the most by the prism)?

b. Look through a spectroscope at white light from in both lab and the natural light outside (through the slit). Describe any difference in color composition you see.

c. Predict what you will see if you looked through a container of water with food coloring.

d. Test your prediction by putting a test tube of water with food coloring in front of the small slit of the spectroscope. Describe the change in the color spectrum seen.

Figure 1. A red dye removes from the ambient light spectra the wavelengths that are not red.
**Station 2.** Color absorption: using red, blue, and green LED lights and containers of red, blue and green water.

a. Predict which wavelengths are likely to be most absorbed in each container and which are most likely to propagate through with least attenuation.

b. Test your prediction by shining the LED flashlights through the containers of colored water.

![Figure 2. Three LEDs (blue, red and green) are shined through water dyed with blue, red and green food coloring. Kayla H. observes how the only light making it through is the one which matches in color to the dye. The color we see is the color that is not absorbed.](image)

**Station 3** scattering.

Shine the laser through the end of an empty tank. Can you see the laser in air?

Do the same in a tank filled with pure water. What do you see?

Finally, shine the light in a tank filled with water where a few drops of Maalox were added (Maalox contain small particles). How did the appearance of the laser change? Why?

Can you relate your experience to lasers shooting in space in science fiction movies?
Figure 3. A beam of laser is not scattered noticeable to our eyes in clean air or water. When shined through a Maalox solution the beam can be observed due to scattering by the particles.

Station 4. Pin-hole optics: Use a pin-hole telescope to look at your hand.
   a. How does your hand look on the internal screen?

   b. Considering the pinhole effect of your eye’s pupil, how do you think the image is projected at the back of your eye?
Figure 4. The pinhole apparatus invert the image of our hand up-down and left-right as the light rays travel in straight line to form the image on the screen.

Station 5. Lenses — converging and diverging lenses:

a. Shine the laser through each lens onto a white paper (or wall). How is the image size of the laser beam modified when going through the lens?

b. Change the relative position of source and lens and see how the image size is affected.
Figure 5. Kate observes how a laser beam expand, contract or stays the same depending on the type of lens it goes through.

Station 6. Refraction of waves passing through mediums with different transmission properties.

\[
\begin{align*}
n_2 & \\
\theta_2 & \\
n_1 & \\
\theta_1 &
\end{align*}
\]

Snell’s Law:

\[n_1 \sin \theta_1 = n_2 \sin \theta_2\]

Shine a laser pointer into the center of the side of the water tank. Observe the angle change due to refraction.

a. At which angle does the light beam change direction the most?

b. Which angle gives the least effect?

c. What is the maximum angle for the light beam in the water?
Figure 6. Nathaniel, Dan, Morgan and Kyle observe how a laser beam refracts as it goes from air to water. The angle between the beam and the line perpendicular to the interface is less steep in the slow medium (water) than in the fast medium (air). Shining the laser from the water side to the air demonstrate total internal reflection as well; when the angle in water exceeds ~48 degrees all the light is reflected from the interface.

Station 8. Refraction.
Put a ruler in a water tank and observe how the angle of entry appears to change in water relative to that in air. Why does the ruler appear to bend in the opposite direction of the light ray in the illustration of Snell’s law above?
Figure 7. Kyle and Dan observe how the ruler in water has a different angle due to refraction of the light coming from the water.

Station 9. Sound in air.

Turn on the power to the buzzer in the jar, and note the sound level. What do you think will happen if air in the jar is removed?

Turn on the vacuum pump for about 15 seconds, and put your finger on the hole in the top of the pump, then turn it off and listen to the buzzer. Let go of the hole (letting air get back into the jar) How and why did the sound change?
Figure 8. Jennifer F. listens to the change in sound as the air is evacuated from the container. Since sounds needs a medium to propagate through the sounds is barely audible when most of the air is evacuated out of the container.

In class you will also see demonstration about the Doppler, resonance and beating.