PHYS1001B College Physics IB Homework 3 – Optics Due Date: 22/11/2024

1. (a) A tank containing methanol has walls 2.50 cm thick made of glass of refractive index 1.550. Light from the outside air strikes the glass at a $41.3°$ angle with the normal to the glass. Find the angle the light makes with the normal in the methanol. (b) The tank is emptied and refilled with an unknown liquid. If light incident at the same angle as in part (a) enters the liquid in the tank at an angle of $20.2°$ from the normal, what is the refractive index of the unknown liquid?

2. In a material having an index of refraction n, a light ray has frequency f, wavelength λ, and speed v. What are the frequency, wavelength, and speed of this light (a) in vacuum and (b) in a material having refractive index n' ? In each case, express your answers in terms of only f, λ, v, n, and n'.

3. At the very end of Wagner's series of operas Ring of the Nibelung, Brünnhilde takes the golden ring from the finger of the dead Siegfried and throws it into the Rhine, where it sinks to the bottom of the river. Assuming that the ring is small enough compared to the depth of the river to be treated as a point and that the Rhine is 10.0 m deep where the ring goes in, what is the area of the largest circle at the surface of the water over which light from the ring could escape from the water?

4. A beam of polarized light passes through a polarizing filter. When the angle between the polarizing axis of the filter and the direction of polarization of the light is θ, the intensity of the emerging beam is I. If you now want the intensity to be $I/2$, what should be the angle (in terms of θ) between the polarizing angle of the filter and the original direction of polarization of the light?

5. Three polarizing filters are stacked, with the polarizing axis of the second and third filters at $23.0°$ and $62.0°$, respectively, to that of the first. If unpolarized light is incident on the stack, the light has intensity $75.0\ \mathrm{W/cm^2}$ after it passes through the stack. If the incident intensity is kept constant, what is the intensity of the light after it has passed through the stack if the second polarizer is removed?