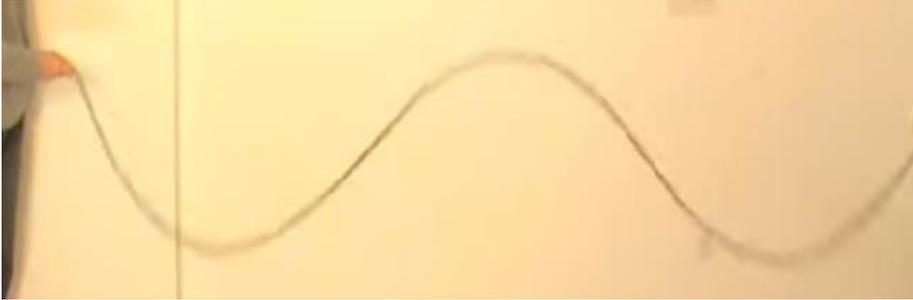


## Iridophore Optics Worksheet



1. A magic hand wiggles string up and down completing one cycle at time interval  $T$ , equivalently the hand wiggles up and down with frequency of  $f = 1/T$  (units of Hz). The wave propagation speed,  $v$ , depends on the optical material in which it is traveling,  $v = c/n$ , where  $c$  is the speed of light in free space (constant  $3.0 \times 10^8$  m/s) and  $n$  is the index of refraction. Show the wavelength obeys the relation  $n\lambda = \text{constant}$ .
2. Assume we have a wave with wavelength in air  $\lambda_o = 700$  nm. Pretty red color, nice. What is wavelength in cytoplasm? Protein plate?
3. Assume the cytoplasm layer thickness is  $d_c = 100$  nm. Firstly, draw a nice wave and clearly indicate on your plot on a scale bar indicating the wavelength in cytoplasm  $\lambda_c$ . Overlay a vertical line indicating the 100 nm thickness of the cytoplasm layer. What is the phase change of the wave as it propagates from the front to the back boundary in the cytoplasm layer? What is the phase difference for a cytoplasm layer that is 253.15 nm thick?
4. Repeat the phase change calculations from part 3, but this time the wave travels from front to back and then back to front of the cytoplasm layer—i.e, (traverses the cytoplasm layer 'going in' and 'coming out'.
5. Write a general relation describing the phase change in the wave as a function of distance traveled  $\Delta x$  and the wavelength in air  $\lambda_o$ .
6. Now fill out Table 1, computing the phase change for each of the 3 reflected waves (see next page).
7. Lastly, we'll discuss how to derive the ***Ideal Stack*** relation, which simply requires all the reflected waves to be *in phase*.

Wave	Boundary Reflection Phase Change (radians)	Extra distance traveled $\Delta x$	Path Distance Phase Change (radians)	Total phase change
$E_1$				
$E_2$				
$E_3$				

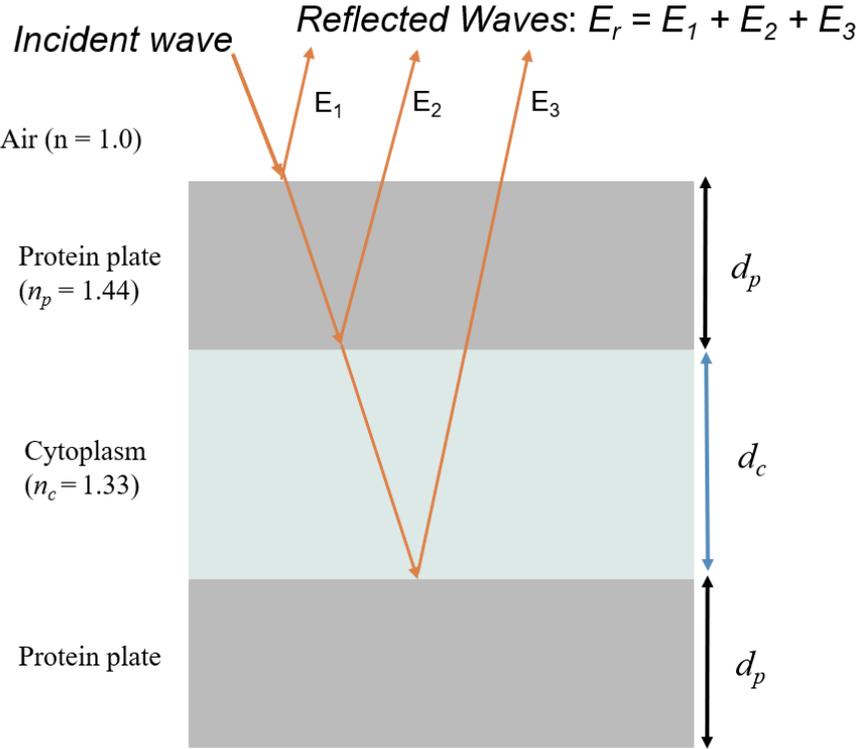


Figure 1. Simplified iridophore model. Actual incidence angle of  $\sim 0$  deg exaggerated for clarity.