1. (6 points) Suppose two parallel plates of glass are separated uniformly by a very small distance. Show that constructive interference occurs when the thickness and wavelength are related by

$$2t = (m + 1/2)\lambda$$

Here, $t$ is the thickness of the air gap and $m$ is an integer, 0, 1, 2, etc. You will provide a diagram and a narrative clearly showing how you obtain this expression. (You don’t need to worry about the thickness of the glass plates themselves.)

2. (3 points) In the problem above, how would the expression be modified if there were water or oil between the plates instead of air?

3. (4 points) A bubble made of soapy water is suspended in air. In one section of the soap film, the thickness is 400 nm. What two wavelengths of visible light will constructively interfere when reflected from the bubble’s surface there? Assume that the film’s refractive index is the same as that of water, 1.33, and keep in mind that visible light wavelengths range from 400 nm to 750 nm. Round the answer to two significant figures, since we know that the wavelengths will not be really sharply defined. (710 nm and 430 nm)

4. (5 points) A soap bubble is seen to constructively reflect light of wavelength 580 nm. We know (from other experiments) that the bubble is thinner than 400 nm. What are the possible thicknesses of the region which reflects the 580-nm light? (There is more than one possibility.) Assume that the index of refraction is the same as that of water: $n = 1.33$. 