Physics 11
Example 2 Solution

(a) Since both reflections are from high to low, the reflective phase shifts are both π, and don't matter–there is no relative phase difference between the two reflected beams due to reflection. Thus, the phase shift is entirely due to path difference. The beam that reflects off the oil/water interface travels a distance $2t$ farther than the beam that reflects from the top surface of the oil. So,

$$\Delta\phi = k\Delta x = \frac{2\pi}{\lambda_{oil}}(2t)$$

The reflected light is seen in air, so we want the wavelength in air:

$$\Delta\phi = \frac{2\pi n_{oil}}{\lambda}(2t)$$

For constructive interference (maximum reflection):

$$\Delta\phi = m(2\pi) = \frac{2\pi n_{oil}}{\lambda}(2t)$$

$$\longrightarrow t = \frac{m\lambda}{2n_{oil}}$$

Use $m = 1$ (why not $m = 0$?) for the minimum thickness:

$$t = \frac{\lambda}{2n_{oil}} = \frac{720\text{nm}}{2(1.2)} = 300\text{nm}$$

(b) The condition for destructive interference is

$$\Delta\phi = (2m+1)\pi$$

Thus,

$$\frac{2\pi n_{oil}}{\lambda}(2t) = (2m+1)\pi \longrightarrow \lambda = \frac{4n_{oil}t}{2m+1}$$

Try $m = 0$:

$$\lambda = \frac{4n_{oil}t}{1} = 1440\text{nm}$$

Not visible. Try $m = 1$:

$$\lambda = \frac{4n_{oil}t}{3} = 480\text{nm}$$

This is blue. Note: $m = 5$ gives $\lambda = 288$, which is not visible–it is in the ultraviolet region.

Example 3 Solution
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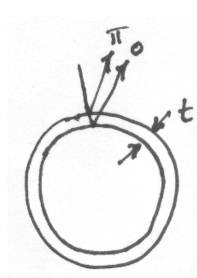
The bubble does one surface that causes a phase shift upon reflection and one that does not:



Thus, for constructive interference in the reflected light:

$$2\pi \frac{2t}{\lambda_b} = \pi,$$

for the minimum thickness ($3\pi, 5\pi$,etc. would also work).

$$\longrightarrow 2n_b \frac{2t}{\lambda} = 1$$

$$t = \frac{\lambda}{4n_b} = \frac{480\text{nm}}{4(1.33)} = 90\text{nm}$$