PHYS 1150: Quiz #4 – SOLUTIONS

/10 **Problem 1:** An oil film (index of refraction $n = 1.45$) floating on water ($n = 1.33$) is illuminated by white light (from the air above) at normal incidence. The film is 280 nm thick. Find:

(a) the wavelength (in air) of visible light that is most strongly reflected, and

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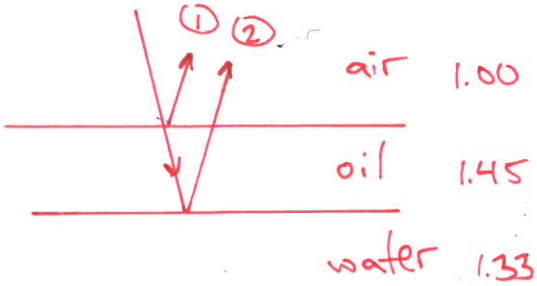
- Reflected light will be strongest when the reflected waves are **in phase**.
- The first reflected wave is inverted (since 1.33 > 1.00) so the two reflections are a half-wavelength **out of phase** before any phase shift due to path length difference.
- To put the reflected waves in phase we require that the path length difference δ be equal to half the wavelength in oil, $\lambda_o = \lambda/1.45$ (plus any integer multiple of this wavelength):

$$\delta = 2t = \frac{\lambda_o}{2} + m\lambda_o = (m + \tfrac{1}{2})\lambda_o = (m + \tfrac{1}{2})\frac{\lambda}{1.45} \implies \lambda = \frac{1.45(2t)}{m + \frac{1}{2}} \quad (m = 0, 1, 2, \ldots).$$

With $t = 280$ nm this gives several possible wavelengths:

m	λ
0	1620 nm
1	541 nm
2	325 nm
⋮	⋮



Of these only the $\boxed{541\text{ nm}}$ light is visible.

(b) the wavelength (in air) of visible light that is most strongly transmitted through the film.

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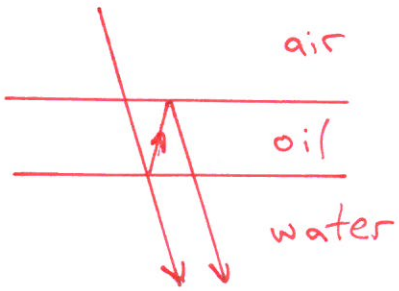
- Transmitted light will be strongest when the transmitted waves are **in phase**.
- Neither of the transmitted waves undergo inversion on reflection (both encounter a *lower* index of refraction at the reflection) so the two waves are **in phase** before any phase shift due to path length difference.
- To put the reflected waves in phase we require that the path length difference δ be an integer multiple of $\lambda_o = \lambda/1.45$:

$$\delta = 2t = m\lambda_o = m\frac{\lambda}{1.45} \implies \lambda = \frac{1.45(2t)}{m} \quad (m = 1, 2, \ldots).$$

With $t = 280$ nm this gives several possible wavelengths:

m	λ
1	812 nm
2	406 nm
3	271 nm
⋮	⋮



Of these only the $\boxed{406\text{ nm}}$ light is visible.