

## CLASS EXERCISE #23 - 28 July 2005

Light of wavelength 520 nm is incident normally (perpendicularly) from air onto an interface with a thin oil film ( $n = 1.30$ ) that is floating on water ( $n = 1.33$ ).

(a) What is the frequency of this light?

$$f = c/\lambda = (3 \times 10^8 \text{ m/s})/(520 \times 10^{-9} \text{ m}) = 5.8 \times 10^{14} \text{ Hz}$$

(b) What is the wavelength of this light in the oil?

$$\begin{aligned}\lambda_{\text{oil}} &= v_{\text{oil}}/f = (c/n_{\text{oil}})/f = (c/f)/n_{\text{oil}} \\ &= (520 \times 10^{-9} \text{ m})/(1.30) = 400 \text{ nm}\end{aligned}$$

(c) What are the phase changes, if any, of the light reflected from the top and bottom of the oil film?

Top:  $180^\circ$  (because  $1.00 < 1.30$ )

Bottom:  $180^\circ$  (because  $1.30 < 1.33$ )

(d) What is the smallest thickness of the oil film that would produce destructive interference for this light?

Since the phase changes are the same, destructive interference will require that the extra path length  $\delta = 2t$  be equal to  $(m + \frac{1}{2})\lambda_{\text{oil}}$  so, using  $m = 0$  to obtain the smallest thickness,

$$t_{\text{min}} = \frac{1}{2}(0 + \frac{1}{2})\lambda_{\text{oil}} = (0.5)(0.5)(400 \text{ nm}) = 100 \text{ nm}.$$