35.6

→ initially exactly out of phase

→ finally exactly in phase

$$\Delta L = 2L = \left(m+\tfrac{1}{2}\right)\lambda \qquad m = 0, 1, 2, \dots$$

$$\frac{L}{\lambda} = \frac{1}{2}\left(m+\tfrac{1}{2}\right) = \frac{m}{2} + \frac{1}{4}$$

$\underline{m=0}$ $\quad \frac{L}{\lambda} = \frac{1}{4} = 0.25$

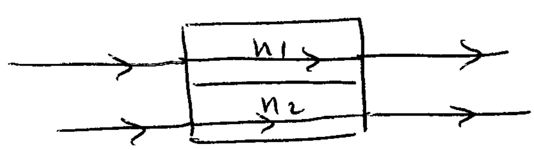
$\underline{m=1}$ $\quad \frac{L}{\lambda} = \frac{3}{4} = 0.75$

$\underline{m=3}$ $\quad \frac{L}{\lambda} = \frac{5}{4} = 1.25$

35.11

$\lambda = 620\,nm \qquad n_1 = 1.45 \qquad n_2 = 1.65$

$\phi = \pi$ rad



$\phi = 0$

in phase

phase diff = π rad

$$N_2 - N_1 = \frac{L}{\lambda}(n_2 - n_1)$$

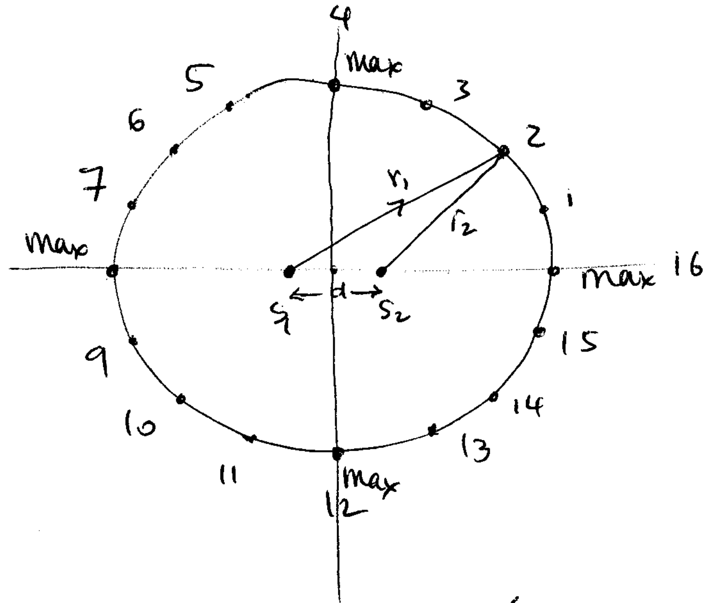
$$L(n_2 - n_1) = \frac{\lambda}{2}, \frac{3\lambda}{2}$$

$$L_1 = \frac{\lambda}{2(n_2-n_1)} = 1550\,nm = \underline{1.55\,\mu m}$$

$$L_2 = \frac{3\lambda}{2(n_2-n_1)} = 4650\,nm = \underline{\underline{4.65\,\mu m}}$$

35.15

For maxima



$d \sin\theta = m\lambda$

$\sin\theta = m \dfrac{\lambda}{d}$

$= 0.25\ m$

$\sin\theta \le 1 \Rightarrow 0.25\,m \le 1 \quad m \le 4$

$m = 0, 1, 2, 3, 4$ first quadrant

than 5, 6, 7 8 second quadrant

than 9, 10, 11, 12 third quadrant

than 13, 14, 15, 16 fourth quadrant

There are 16 maxima!

35.20

$\theta = 20°$ $\quad d = 4.24\ \mu m$ $\quad \lambda = 500\ nm$

a) $d \sin\theta = m\lambda$ $\quad \dfrac{d\sin\theta}{\lambda} = m = 2.9$

phase diff. $\phi = d\sin\theta = 2.9\lambda$

b) $2.9 \times 2\pi = 18.2$ rad

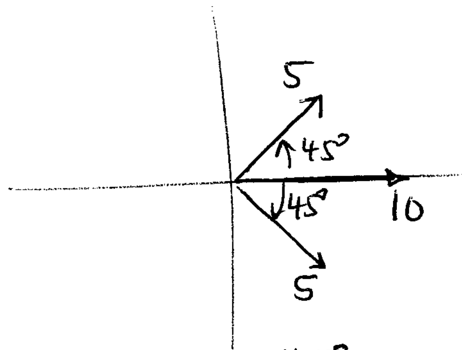
c) $2.9 < 3$ and closer to 3 than to 2.5

$\Rightarrow$ more than the third minimum and closer to the third side maximum.

35.31

Use phasors

$t=0$



$E_x = 10 + 5 \times 2 \cos 45° = 17.1$

$E_y = 0$

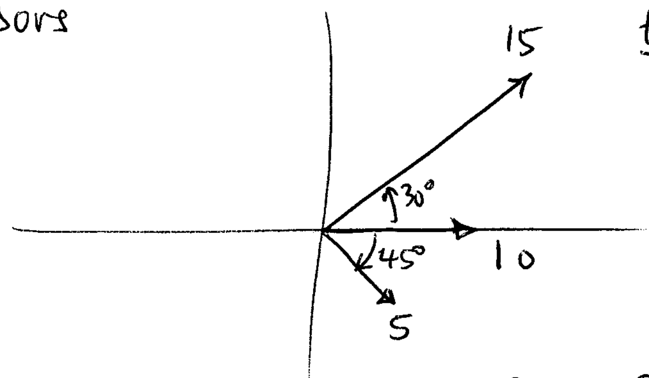
$\phi = 0$

$\underline{\underline{E_{total} = 17.1 \sin(2 \times 10^{14} t)}}$

35.33

Use phasors

$t=0$



$y_x = 10 + 5 \cos 45° + 15 \cos 30° = 26.5$

$y_y = 15 \sin 30° - 5 \sin 45° = 3.96$

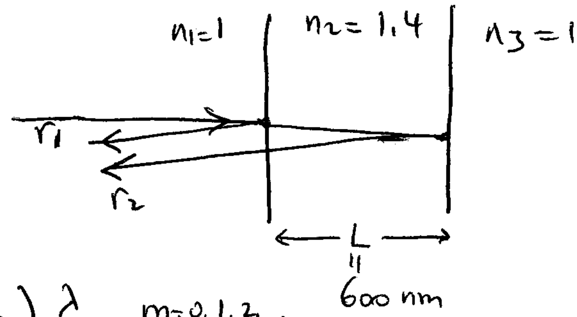
$|y_{total}| = 26.8 = \sqrt{y_x^2 + y_y^2}$

$\beta = \tan^{-1}\left(\frac{y_y}{y_x}\right) = 8.5°$

$\underline{\underline{y_{total} = 26.8 \sin(\omega t + 8.5°)}}$

35.38

$\frac{\lambda}{2}$ due to reflection



$\Rightarrow$ For max. $2L = \left(m + \frac{1}{2}\right)\frac{\lambda}{n_2}$ $m = 0, 1, 2, \ldots$

$\Rightarrow$ For min $2L = m\frac{\lambda}{n_2}$ $m = 1, 2, 3, \ldots$

a) Fully constructive interference

$$\lambda = \frac{2Ln_2}{m + \frac{1}{2}} = \frac{4Ln_2}{2m+1} = \frac{3360\,\text{nm}}{2m+1}$$

$m = 0$ $\lambda = 3360\,\text{nm}$ ✗

$m = 1$ $\lambda = 1120\,\text{nm}$ ✗

$m = 2$ $\lambda = 672\,\text{nm}$ ✓

$m = 3$ $\lambda = 480\,\text{nm}$ ✓

$m = 4$ $\lambda = 373\,\text{nm}$ ✓

$m = 5$ $\lambda = 305\,\text{nm}$ ✓

$m = 6$ $\lambda = 258\,\text{nm}$ ✗

b) Fully destructive interference

$$\lambda = \frac{2Ln_2}{m} = \frac{1680\,\text{nm}}{m}$$

$m = 1$ $\lambda = 1680\,\text{nm}$ ✗

$m = 2$ $\quad \lambda = 840\,nm$ ✗

$m = 3$ $\quad \lambda = 560\,nm$ ✓

$m = 4$ $\quad \lambda = 420\,nm$ ✓

$m = 5$ $\quad \lambda = 336\,nm$ ✓

$m = 6$ $\quad \lambda = 280\,nm$ ✗

35.45 $\qquad n_1 = 1.6 \mid n_2 = 1.4 \mid n_3 = 1.8$

We want a ~~maximum~~ minimum interference

$\lambda = \cancel{482\,nm}$? and ~~2nd value of~~ $L = 200\,nm$ $\quad \longleftarrow L \longrightarrow$

$$2L = m\frac{\lambda}{n_2} \qquad m = 1, 2, 3, \ldots$$

$$\lambda = \frac{2Ln_2}{m} = \frac{2 \times 200 \times 1.4}{m} = \frac{560\,nm}{m}$$

$m = 1$ $\quad \lambda = 560\,nm$ ✓ visible range

$m = 2$ $\quad \lambda = 280\,nm$ ✗ not visible range!

35.52 We want max. and the second least thickness $L = ?$

$n_1 = 1.6 \qquad n_2 = 1.4 \qquad n_3 = 1.8 \qquad \lambda = 632\,nm$

$$2L = \left(m + \frac{1}{2}\right)\frac{\lambda}{n_2} \qquad m = 0, 1, 2, \ldots$$

$$L = \left(m + \frac{1}{2}\right)\frac{\lambda}{2n_2} = \left(m + \frac{1}{2}\right) \times 225.7$$

$m = 1$ $\qquad \underline{\underline{L = 338.6 \text{ nm}}}$

35.79

$$N = \frac{2d}{\lambda}$$

$$\Rightarrow \lambda = \frac{2d}{N} = \frac{2 \times 0.233 \times 10^{-3}}{792} = 5.88 \times 10^{-7} \text{ m}$$

$$\underline{\underline{\lambda = 588 \text{ nm}}}$$

35.82 $\quad \lambda_1 = 589.1 \text{ nm} \qquad \lambda_2 = 589.59 \text{ nm}$

$$N_2 - N_1 = \frac{2L}{\lambda_1} - \frac{2L}{\lambda_2}$$

but $N_2 - N_1 = 1 \quad \Rightarrow \quad L\left(\frac{2}{\lambda_1} - \frac{2}{\lambda_2}\right) = 1$

$$L = \left(\frac{2}{\lambda_1} - \frac{2}{\lambda_2}\right)^{-1} = 3.54 \times 10^{-4} \text{ m}$$

$$= \underline{\underline{354 \ \mu\text{m}}}$$