Chapter 36

2. Using the expression v = c/n, we can find the speed of light in each of the two materials. In diamond $v_d = (3 \times 10^8$ m/s$)/2.42 = 1.23 \times 10^8$ m/s; in sapphire $v_s = (3 \times 10^8$ m/s$)/1.77 = 1.69 \times 10^8$ m/s. So the difference is 1.69×10^8 m/s - 1.23×10^8 m/s = 4.6×10^7 m/s

9. The lower beam goes through a path length of $\delta_1 = L_1/(\lambda/n_1)$; the upper beam goes a path length of $\delta_2 = L_2/(\lambda/n_2) + (L_2 - L_1)/\lambda$. The difference between the two in wavelengths is

$$\Delta\delta = \frac{1}{\lambda}\left(n_1L_1 - n_2L_2 - (L_1 - L_2)\right) = \frac{1}{\lambda}\left(L_1(n_1 - 1) + L_2(1 - n_2)\right) = \frac{1}{600\times10^{-9}\,m}\left(4\times10^{-6}\,m(1.4-1) + 3.5\times10^{-6}\,m(1-1.6)\right)$$

= 0.83 wavelengths
(b) This two waves would nearly add completely constructively.

23. Think of the waves as each a hand on a stop watch. When the hands are 60° out of phase they would add like this…

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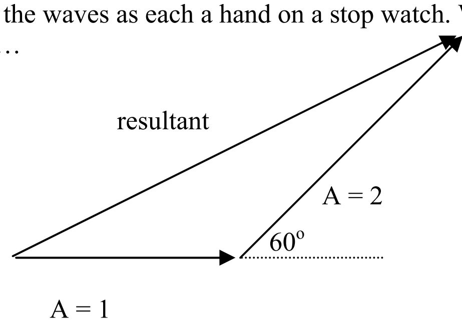


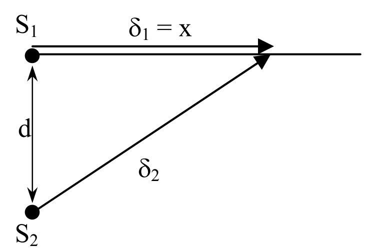
The length of the resultant vector is given by Pythagorean theorem.

$$A_{res} = \sqrt{(1 + 2\cos 60)^2 + (2\sin 60)^2} = 2.65$$

27. (a) The path length for waves from S_1 are given by δ_1; from S_2 the path length is $\delta_2 = \sqrt{\delta_1^2 + d^2}$. To get maxima, the path length difference must equal and integer number of wavelengths:

$$\delta = m\lambda = \sqrt{\delta_1^2 + d^2} - \delta_1^2 = \sqrt{x^2 + d^2} - x^2$$

The easiest thing to do now is plug-in numbers, then solve for x.
m = 1; d = 4 m → x = 7.5 m
m = 2; d = 4 m → x = 3 m
m = 3; d = 4 m → x = 1.2 m



(b) No, the intensity from S_2 will be less than the intensity from S_1 because the S_2 traveled farther.

33. Using the expression from the text for a soap bubble $2t = (m+1/2)\lambda_n$. Plugging in the given values and m = 0 we get t = 117 nm. For m = 1, t = 352 nm.

34. Again, this is just like the example in the book for the camera lens $2t = (m+1/2)\lambda_n$. For mimum thickness, $m = 0 \rightarrow t = (¼)\lambda/n = \lambda/5$.

Chapter 37

1. Using the expression for the minima $d\sin\theta = m\lambda$, we can solve for the slit width $d = m\lambda/\sin\theta$. In this case, $m = 1$ and $\theta = 1.2/2 = 0.6$, so $d = 633 \times 10^{-9}$ m/sin(0.6) = 6×10^{-5} m.

2. (a) Looking at figure 37-4, we see $\tan\theta = y/L \rightarrow \theta = \tan^{-1}(0.15 \text{ m}/2 \text{ m}) = 0.43^{o}$.
(b) Using the angle from above, we find $d = m\lambda/\sin\theta = 2\ (441 \times 10^{-9} \text{ m})/\sin(0.43) = 1.2 \times 10^{-4}$ m