PH 221 Homework Assignment Chapter on Wave Interference – 16 Problems Total

1. A fourth – order bright fringe of $590.0\ \mathrm{nm}$ light is observed at an angle of $37.3°$ when the light illuminates two closely spaced slits. What is the distance between the two slits?

Solution for Problem 1

2. A pair of slits are separated by a distance $(\mathrm{d} = 0.46\ \mathrm{mm})$ apart. If two different wavelengths of light $(\lambda_\mathrm{A} = 485.0\ \mathrm{nm}\ \mathrm{and}\ \lambda_\mathrm{B} = 630.0\ \mathrm{nm})$ shine on the slits, how far apart (S) are the third – order fringes on a screen located $(\mathrm{L} = 2.00\ \mathrm{m})$?

Solution for Problem 2

3. Light of wavelength $(\lambda = 586.\,\mathrm{nm})$ falls on a two – slit apparatus. The resulting interference pattern finds the fourth – order fringe lies a distance $(\mathrm{y} = 4.14 \times 10^{-2}\ \mathrm{m})$ from the central maximum on a screen that is located a distance $(\mathrm{L} = 1.75\ \mathrm{m})$ away from the slits. How far apart are the two slits?

Solution for Problem 3

4. In Physics Class demonstration, a physics professor sets up a double slit apparatus with a screen located a distance $(\mathrm{L} = 5.00\ \mathrm{m})$ from the slits. On this screen the distance between the $\mathrm{m} = 2$ and the $\mathrm{m} = 0$ bright fringes is measured to be $(\mathrm{y} = 5.00 \times 10^{-1}\ \mathrm{m})$. the spacing between the two slits is $(\mathrm{d} = 1.27 \times 10^{-5}\ \mathrm{m})$. The professor has the students determine the wavelength of the light used in this demonstration, what do they find the wavelength to be?

Solution for Problem 4

5. Blue light $(\lambda = 480.\,\mathrm{nm})$ is incident upon a pair of slits in Young's apparatus. The third order maximum is found on a screen. What visible wavelengths of light happen to have a minimum (dark fringe) that exist at the same physical spot as this bright fringe?

Solution for Problem 5

6. A Young's double slit apparatus consists of two slits located a distance $(\mathrm{d} = 5.68 \times 10^{-6}\ \mathrm{m})$ apart, a screen for the interference pattern that is a distance $(\mathrm{L} = 6.50 \times 10^{-1}\ \mathrm{m})$ away from the slits, and the light used has a wavelength $(\lambda = 510.\,\mathrm{nm})$.

(a) If the apparatus is in air $(\mathrm{n}_{\mathrm{air}} = 1.000)$, how far apart are the $\mathrm{m} = +5$ and the $\mathrm{m} = -5$ fringes?

(b) How many total bright fringes would appear on the screen in air?

(c) If the apparatus is in water $(\mathrm{n}_{\mathrm{water}} = 1.333)$, how far apart are the $\mathrm{m} = +5$ and the $\mathrm{m} = -5$ fringes?

(d) How many total bright fringes would appear on the screen in water?

Solution for Problem 6

7. A soap film has a thickness $(\mathrm{t} = 85.0\ \mathrm{nm})$ and an index of refraction $(\mathrm{n}_{\mathrm{soap}} = 1.320)$ and it is surrounded on both sides by air $(\mathrm{n}_{\mathrm{air}} = 1.000)$. Which wavelengths of visible light are reflected strongly by white light directly over the film?

Solution for Problem 7

8. A soap film $(\mathrm{n}_{\mathrm{soap}} = 1.320)$ has a thickness (t). It has air $(\mathrm{n}_{\mathrm{air}} = 1.000)$ on either side of the film. The film is illuminated from directly above by light with wavelength $(\lambda = 565.0\ \mathrm{nm})$.

(a) What is the smallest thickness of the soap film that would appear black?

(b) What are the next two thicknesses that would also appear black?

(c) If the thickness were much smaller than the wavelength of the light, why would the soap film appear black?

Solution for Problem 8

9. A thin layer of oil $(\mathrm{n}_{\mathrm{oil}} = 1.500)$ floats on water $(\mathrm{n}_{\mathrm{water}} = 1.333)$. When white light is directed from above on the oil from air $(\mathrm{n}_{\mathrm{air}} = 1.000)$, two colors are brightly reflected from this system, red $(\lambda_{\mathrm{red}} = 650.\,\mathrm{nm})$ and violet $(\lambda_{\mathrm{violet}} = 390.\,\mathrm{nm})$. What is the thickness (t) of the oil layer?

Solution for Problem 9

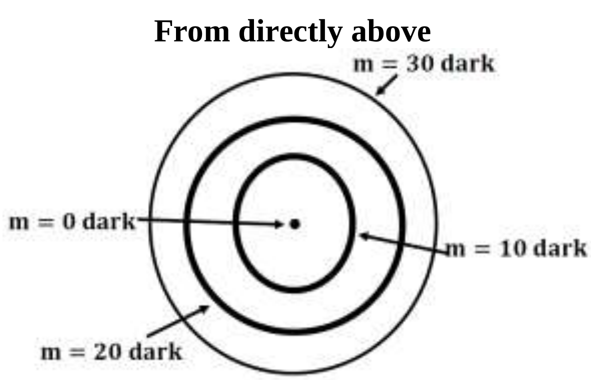
10. A thin layer of magnesium fluoride $\left(n_{MgF} = 1.380\right)$ is used to make a non-reflecting coating on a camera lens made of glass $\left(n_{glass} = 1.658\right)$. What is the minimum non-zero thickness of this layer of MgF that will prevent yellow green light $(\lambda = 575.\,nm)$ from reflecting in air?

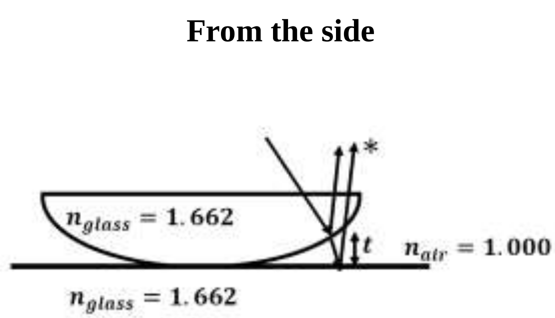
Solution for Problem 10

11. A transparent coating $\left(n_{coating} = 1.472\right)$ is applied with a thickness $(t = 127.\,nm)$ onto a glass plate $\left(n_{glass} = 1.547\right)$ to make a non-reflecting coating when illuminated from above in the air $(n_{air} = 1.000)$. What is the longest wavelength for which this coating will be non-reflective?

Solution for Problem 11

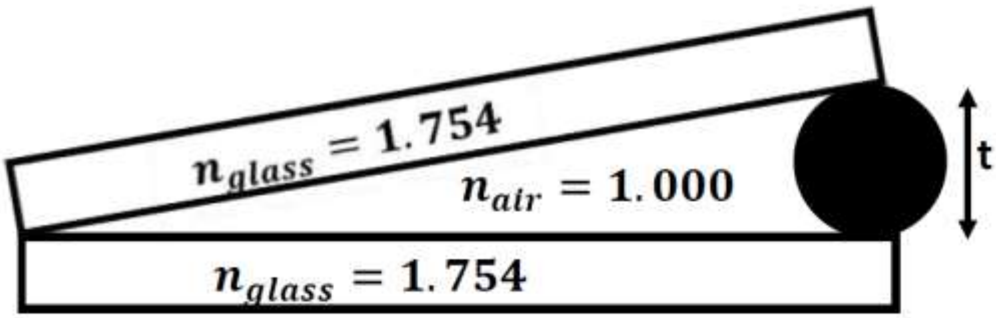
12. Newton's rings are a set of dark rings that form when a curved piece of glass sits on a flat piece of glass. The interference between two rays forms these rings. One ray is reflecting from the bottom of the curved glass and the other is reflecting from the flat glass piece. So, the optical path difference is the amount of air between the curved glass piece and the flat glass piece. In a set-up using sodium light $(\lambda = 589.\,nm)$ from above you notice 30 dark rings around a central dark spot. The index of refractions are $(n_{air} = 1.000)$ and $\left(n_{glass} = 1.662\right)$. How much thicker is the center of the curved glass compared to its edges?





Solution for Problem 12

13. The diameter of a human hair is $7.50 \text{ x } 10^{-5} \text{ m}$. The hair is placed between two optically flat pieces of glass as shown below. The air gap between the plates creates a set of interference fringes. The dark ones are due to destructive interference. The edge where the glass sits on glass is dark $(\text{m} = 0)$. How many total dark fringes would this human hair create on the plates when light of wavelength $(\lambda = 540. \text{nm})$ illuminates the set-up from directly overhead?



Solution for Problem 13

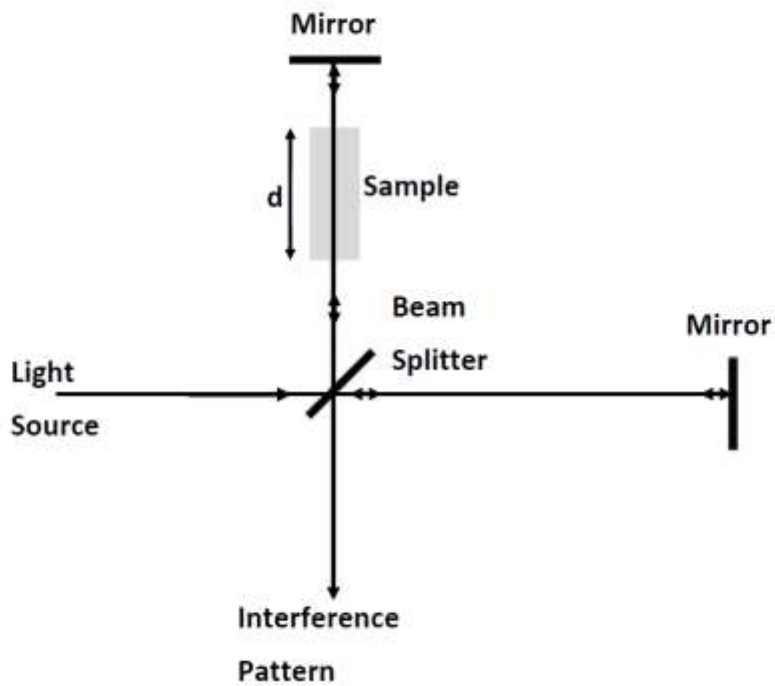
14. A wavelength of orange light $(\lambda = 605. \text{nm})$ is incident on an interferometer. The adjustable mirror is moved and a total of 496 fringes passes through the interference pattern. How far in space was the adjustable mirror moved?

Solution for Problem 14

15. A micrometer is connected to the moveable mirror of an interferometer. When the micrometer is tightened down on a thin film, the net number of bright fringes that moves through the interference pattern is 367. If the wavelength of the light used is $(\lambda = 589.0 \text{ nm})$. How thick is the thin film?

Solution for Problem 15

16. One way to measure indices of refraction is to use an interferometer similar to the one shown below. One sets up the interferometer and establishes the interference pattern then one places a sample in one arm and counts how many fringes move in the interference pattern. From that number, one can determine the index of refraction. For this assume you have light of wavelength (630.0 nm) used and $(9000.)$ Fringes pass through the pattern. The length of the sample is $(\text{d} = 4.00 \text{ mm})$. What is the index of refraction for the sample?



Solution for Problem 16

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