PH 202 Homework Assignment Chapter on Interference & Diffraction – 20 Problems Total

1. In a Young's double-slit experiment, the angle that locates the second dark fringe on either side of the central bright fringe is 5.4°. Find the ratio d/λ of the slit separation d to the wavelength λ of the light.

Solution for Problem 1

2. In a Young's double-slit experiment, the seventh dark fringe is located 0.025 m to the side of the central bright fringe on a flat screen, which is 1.1 m away from the slits. The separation between the slits is 1.4×10^{-4} m. What is the wavelength of the light being used?
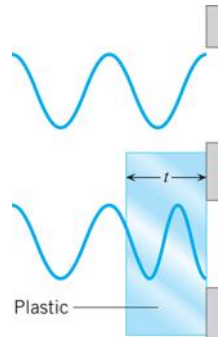
Solution for Problem 2

3. At most, how many bright fringes can be formed on either side of the central bright fringe when light of wavelength 625 nm falls on a double slit whose slit separation is 3.76×10^{-6} m?

Solution for Problem 3

4. In a Young's double-slit experiment the separation y between the second-order bright fringe and the central bright fringe on a flat screen is 0.0180 m when the light has a wavelength of 425 nm. Assume that the angles that locate the fringes on the screen are small enough so that $\sin \theta \approx \tan \theta$. Find the separation y when the light has a wavelength of 585 nm.

Solution for Problem 4

5. A sheet that is made of plastic (n = 1.60) covers *one slit* of a double slit (see the drawing). When the double slit is illuminated by monochromatic light (λ_{vacuum} = 586 nm), the center of the screen appears dark rather than bright. What is the minimum thickness of the plastic?

Plastic

Solution for Problem 5

6. A nonreflective coating of magnesium fluoride (n = 1.38) covers the glass (n = 1.52) of a camera lens. Assuming that the coating prevents reflection of yellow-green light (wavelength in vacuum = 565 nm), determine the minimum nonzero thickness that the coating can have.

Solution for Problem 6

7. When monochromatic light shines perpendicularly on a soap film (n = 1.33) with air on each side, the second smallest nonzero film thickness for which destructive interference of reflected light is observed is 296 nm. What is the vacuum wavelength of the light in nm?

Solution for Problem 7

8. A transparent film (n = 1.43) is deposited on a glass plate (n = 1.52) to form a nonreflecting coating. The film has a thickness that is 1.07 x 10^{-7} m. What is the longest possible wavelength (in vacuum) of light for which this film has been designed?

Solution for Problem 8

9. A film of oil lies on wet pavement. The refractive index of the oil exceeds that of the water. The film has the minimum nonzero thickness such that it appears dark due to destructive interference when viewed in red light (wavelength = 640.0 nm in vacuum). Assuming that the visible spectrum extends from 380 to 750 nm, for which visible wavelength(s) in vacuum will the film appear bright due to constructive interference?

Solution for Problem 9

10. Orange light (λ_{vacuum} = 611 nm) shines on a soap film (*n* = 1.33) that has air on either side of it. The light strikes the film perpendicularly. What is the minimum thickness of the film for which constructive interference causes it to look bright in reflected light?

Solution for Problem 10

11. A diffraction pattern forms when light passes through a single slit. The wavelength of the light is 675 nm. Determine the angle that locates the first dark fringe when the width of the slit is **(a)** 1.8 x 10^{-4} m and **(b)** 1.8 x 10^{-6} m.

Solution for Problem 11

12. Light shines through a single slit whose width is 5.6 x 10^{-4} m. A diffraction pattern is formed on a flat screen located 4.0 m away. The distance between the middle of the central bright fringe and the first dark fringe is 3.5 mm. What is the wavelength of the light?

Solution for Problem 12

13. How many dark fringes will be produced on either side of the central maximum if light (λ = 651 nm) is incident on a single slit that is 5.47 x 10^{-6} m wide?

Solution for Problem 13

14. Two stars are 3.7 x 10^{11} m apart and are equally distant from the earth. A telescope has an objective lens with a diameter of 1.02 m and just detects these stars as separate objects. Assume that light of wavelength 550 nm is being observed. Also assume that diffraction effects, rather than atmospheric turbulence, limit the resolving power of the telescope. Find the maximum distance that these stars could be from the earth.

Solution for Problem 14

15. It is claimed that some professional baseball players can see which way the ball is spinning as it travels toward home plate. One way to judge this claim is to estimate the distance at which a batter can first hope to resolve two points on opposite sides of a baseball, which has a diameter of 0.0738 m. **(a)** Estimate this distance, assuming that the pupil of the eye has a diameter of 2.0 mm and the wavelength of the light is 550 nm in vacuum. **(b)** Considering that the distance between the pitcher's mound and home plate is 18.4 m, can you rule out the claim based on your answer to part (a)?

Solution for Problem 15

16. A hunter who is a bit of a braggart claims that from a distance of 1.6 km he can selectively shoot either of two squirrels who are sitting ten centimeters apart on the same branch of a tree. What's more, he claims that he can do this without the aid of a telescopic sight on his rifle. **(a)** Determine the diameter of the pupils of his eyes that would be required for him to be able to resolve the squirrels as separate objects. In this calculation use a wavelength of 498 nm (in vacuum) for the light. **(b)** State whether his claim is reasonable, and provide a reason for your answer. In evaluating his claim, consider that the human eye automatically adjusts the diameter of its pupil over a typical range of 2 to 8 mm, the larger values coming into play as the lighting becomes darker. Note also that under dark conditions, the eye is most sensitive to a wavelength of 498 nm.

Solution for Problem 16

17. Astronomers have discovered a planetary system orbiting the star Upsilon Andromedae, which is at a distance of 4.2×10^{17} m from the earth. One planet is believed to be located at a distance of 1.2×10^{11} m from the star. Using visible light with a vacuum wavelength of 550 nm, what is the minimum necessary aperture diameter that a telescope must have so that it can resolve the planet and the star?

Solution for Problem 17

18. The wavelength of the laser beam used in a compact disc player is 780 nm. Suppose that a diffraction grating produces first-order tracking beams that are 1.2 mm apart at a distance of 3.0 mm from the grating. Estimate the spacing between the slits of the grating.

Solution for Problem 18

19. The first-order principle maximum produced by a grating is located at an angle of $\theta = 18.0°$. What is the angle for the third-order maximum with the same light?

Solution for Problem 19

20. A diffraction grating has 2604 lines per centimeter, and it produces a principal maximum at $\theta = 30.0°$. The grating is used with light that contains all wavelengths between 410 and 660 nm. What is (are) the wavelength(s) of the incident light that could have produced this maximum?

Solution for Problem 20

| **NMU Physics Department Web Page** | **NMU Main Page** |