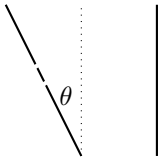
Exercise 1. Two-Slit Interference I

Suppose light passes trough two thin slits in a sheet of paper a distance d apart and hits a wall a distance ℓ away. What is the condition for constructive interference and destructive interference? Assuming the light has wavelength λ, write an equation for the position of contructive interference (maxima) and an equation for destructive interference (minima) with relation to an origin on the wall midway between the slits.

Exercise 2. Two-Slit Interference II

Now, suppose that the paper is tilted at an angle θ relative to the wall. What are the conditions for interference maxima and minima on the wall now?



Exercise 3. Two-Slit Interference III

Suppose now that the paper is parallel to the wall, but that someone puts some plastic wrap on the right slit that introduces a phase shift of $+\pi/2$ relative to the light emerging from the left slit. What are the conditions for interference maxima and minima on the wall now?

Exercise 4. Thin Film Interference I

Suppose that a film of soap with thickness d and refractive index n is adsorbed on the surface of a perfectly reflective mirror. If half the light that is incident on the surface of the film is reflected, and all the light that bounces off the mirror exits the film and there is no phase shift at interfaces, at what free-space wavelengths will there be constructive interference?

Exercise 5. Thin Film Interference II

Now, suppose that there is a phase shift of π whenever light is reflected, at what free-space wavelengths will there be constructive interference?

Exercise 6. X-Ray Diffraction

Bragg's law says that $n\lambda = 2d\sin(\theta)$, if a hexagonal Boron Nitride sample is illuminated with light of wavelength $\lambda = 1.5418 \times 10^{-10}$ [m] and exhibits its largest peak at $\theta = 13.5°$, what is the separation of layers, d for this peak? Assume $n = 1$.

Citation: Celik, Ay, and Goncu, Particulate Science and Technology **31**, 501 (2013).

Exercise 7. Single Slit Diffraction

Light of wavelength 600 nm falls on a single slit and produces its third diffraction minimum at an angle of 30° relative to the incident direction of the light. What is the slit width?

Exercise 8. Diffraction Grating

Are the interference maxima for a diffraction grating uniformly spaced? Is this different than for a single slit?

Exercise 9. Circular Diffraction Grating

The intensity of the light from a circular diffraction grating is proportional to $(J_1(\pi r)/\pi r)^2$ where J_1 is a Bessel function. The first few zeros of this function are at: 1.2197, 2.2331, 3.2383, 4.2411, and 5.2428. If the Arecibo telescope has an aperture of $d = 305$ [m], at what angles will radio waves with a wavelength of 61 [m] experience their first, second, third, and fourth diffraction minima in the Arecibo telescope? Is there a fifth diffraction minima? Hint: $\sin(\theta_i) = z_i\lambda/d$, where z_i is the ith zero.

Exercise 10. Beats

Suppose that a He-Ne laser that emits yellow light at 594.1 nm and a Kr laser that emits red light at 647.1 nm are shown in the same direction. Since these wavelengths are different, interference will be alternatingly constructive and destructive forming beats with $f = |f_1 - f_2| = |c/\lambda_1 - c/\lambda_2|$. How far apart is one constructive interference maxima from the next constructive interference maxima?

(a) 620.6 [nm]

(b) 1154 [nm]

(c) 7253 [nm]*

(d) 45576 [nm]