
PHYS 1120 Discussion 11. Interference and Diffraction

1. Double slit diffraction

A mask is made of two narrow slits separated by a distance of half a millimeter. This mask is illuminated by the monochromatic, coherent light of a helium-neon laser (633 nm).

- At what angles to the side of the central line are the first four bright fringes in the diffraction pattern?
- How close together would the two slits of the mask need to be for the first bright fringe to be 5.0 degrees from the central line?

2. Single slit diffraction

Microwaves with a wavelength of 2.00 cm pass through a slit that is 10.0 cm wide.

- How many nodal surfaces (dark bands, if you call microwaves “bright”) are in the diffraction pattern?
- At what angles are the dark bands?

3. Oil film on water

A thin film (750×10^{-9} m) of oil (index of refraction = 1.52) lies on the surface of a puddle of water (index of refraction = 1.33). Light shines onto the puddle. Some light reflects directly off the film of oil, and some passes through the oil and reflects off the surface of the water beneath. The light reflected from these two surfaces interferes.

Light that reflects off a surface of a medium with a higher index of refraction reverses its phase upon reflection. Light that reflects off a medium with a lower index of refraction does not change its phase.

- If light has a wavelength of λ_0 in air, what is its wavelength λ in a medium with index of refraction n ?
- When light travels a distance of its wavelength λ , its phase advances by 2π . What is the phase increase when it travels a distance d ?
- Some of the incoming light reflects from the surface of the oil. What is the phase advance φ_1 of this reflected light?
- How many wavelength distances does it travel through the oil to reach the water surface?
- What is its phase advance traveling through the oil?
- The light then reflects off the surface of the water. What is its phase change upon reflection?
- The reflected light travels back through the oil film to the air. What is its phase advance traveling through the oil?

H. What is the phase change φ_2 of the light when it finally emerges from the surface of the oil film?

The two different beams of light combine, and how they combine depends on their difference in phase, $\varphi_2 - \varphi_1$. If their phase difference is $2\pi m$, where m is an integer, they combine constructively. If their phase difference is $(2m + 1)\pi$, they interfere destructively.

I. In terms of n , d , and m , what is the wavelength λ of light for which the two reflections interfere *constructively*?

J. For the 750×10^{-9} m film of $n = 1.52$ oil, what are the wavelengths of visible light (400 nm–700 nm) that reflect constructively? Find the values of λ using the formula from part I with the values of m that give wavelengths in the visible range.