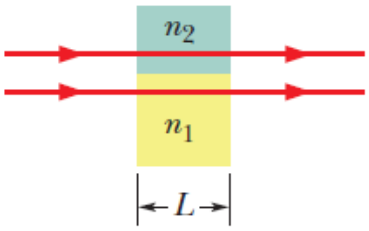
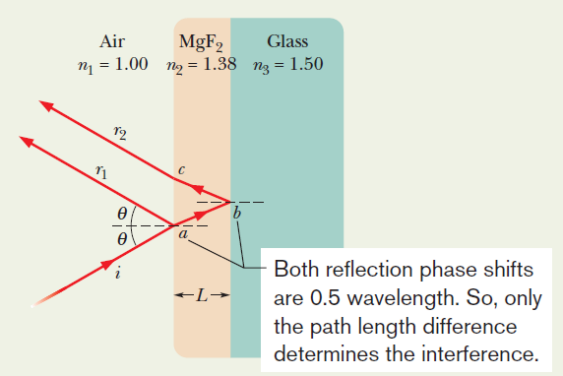
Chapter 27
Example Problems

1. In the figure, two light waves that are represented by the rays have wavelength 550.0 nm before entering media 1 and 2. They also have equal amplitudes and are in phase. Medium 1 is now just air, and medium 2 is a transparent plastic layer of index 1.600 and thickness 2.600 μm. What is the phase difference of the emerging waves in wavelength, radians, and degrees?



2. Two radio-frequency points sources S_1 and S_2 separated by a distance d = 2.0 m, are radiating in phase with λ = 0.50 m. A detector moves in a large circular path around the two sources in a plane containing them. How many maxima does it detect?

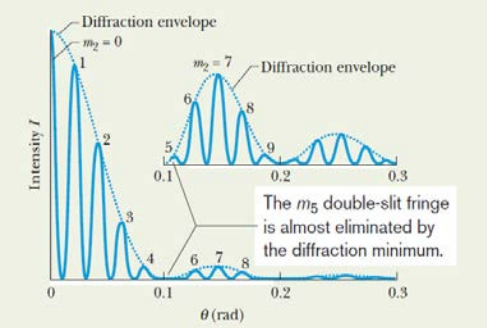
3. A glass lens is coated on one side with a thin film of magnesium fluoride (MgF_2) to reduce reflection for the lens surface. The index of refraction of MgF_2 is 1.38; that of the glass is 1.50. What is the least coating thickness that eliminates the reflections at the middle of the visible spectrum (550 nm)? Assume that the light is approximately perpendicular to the lens surface.



4. A slit of width a is illuminated by white light. For what value of a will the first minimum for red light of wavelength λ = 650 nm appear at θ = 15˚? What is the wavelength λ‘ of the light whose first side of diffraction maximum is at 15˚, thus coinciding with the first minimum of the red light?

5. The figure is a representation of the colored dots on a pointillistic painting. Assume that the average center-to-center separation of the dots is D = 2.0 mm. Also assume that the diameter of the pupil of the eye is d = 1.5 mm and that the least angular separation between dots you can resolve is set only by Rayleigh's criterion. What is the least viewing distance from which you cannot distinguish and dots on the painting?

6. In a double slit experiment, the wavelength of the light source is 405 nm, the slit separation d is 19.44 μm, and the slit width a is 4.050 μm. Consider the interference of the light from the two slits and also the diffraction of the light through each slit.
    a. How many bright interference fringes are within the central peak of the diffraction envelope?
    b. How many bright fringes are within either of the first side peaks of the diffraction envelope?



7. A diffraction grating has 1.26×10^4 rulings uniformly spaced over width $w = 25.4$ mm. It is illuminated at normal incidence by yellow light from a sodium vapor lamp. This light contains two closely spaced emission lines (known as sodium doublet) of wavelengths 589.00 nm and 589.59 nm. At what angle does the first order maximum occur on either side of the center of the diffraction pattern for the line at 589.00 nm?