Interference and Diffraction Exercises:

1. In the Fresnel double mirror, λ0 = 589 nm, the distance of the screen from the two virtual sources (Fig. 9.12) is s = 2 m, R = 1 m, and the separation of fringes is Δy = 0.5 mm. Determine the inclination angle α between the mirrors.

Sin(α) = s λ/2 ΔyR

So α = .0675 degrees

1. A piece of paper (d = 76.18 µm) separates two glass plates (e.g., microscope slides) at one end while the plates touch at their other end. Determine the no. of fringes seen across the length of the two glass plates

Well, assuming that the same wavelength of light which we used (633nm), then the number of fringes would be = 2\*d/ λ = 240.695 or 240 fringes.

1. Find the position of the first minimum for a single slit of width 0.04 millimeters on a screen 2 meters distant, when light from a He-Ne laser λ = 632.8 nm is shone on the slit.

Y = m λD/d = 1\*632.8e-9\*2/.04e-3 = .03164m

1. If we have a single slit 0.2 centimeters wide, a screen 1 meter distant, and the second maximum occurs at a position 1 centimeter along the screen, what must be the wavelength of light incident on the screen?

Average between second minima and third minima

Y = (2λD/d + 3λD/d)/2 = 2.5λD/d

λ = 8000nm?

1. What is the position of the fourth maximum for a double-slit apparatus with slits 0.05 centimeters apart and a screen 1.5 meters distant when performed with monochromatic red light of frequency 384×1012 Hz?

Y = m λD/d

Y = 4\* 3e8/384e12\*1.5/.05e-2

Y = .009375m

1. In a Young's Double Slit experiment, what is the ratio of the irradiance at a distance 1 centimeter from the center of the pattern, irradiance of each individual beam entering through the slits (assume the same set up as before: light of frequency 384×1012 Hz, 0.05 centimeters between the slits, and a screen 1.5 meters away)?

I = 4\*I0\*cos(Yd(pi)/ λD)^2

I = 1.791I0

So a ratio of 1.791?

1. Explain why constructive interference will appear at the point P when the path length is equal to an integral number of wavelengths of the monochromatic light.

Viewing light traveling from each slit, if the path length distance traveled between the two slits is equal to a whole number multiple of the wavelength then the two light rays have a full integer period multiple phase shift from one another. And of course if you shift a sinusoidal function by a whole number multiple of its period it doesn’t change, therefore the two photons have the same wave pattern, and line up perfectly experiencing constructive interference. This is opposite to a half wavelength phase shift which will cause destructive interference.

1. Based on the geometry of the double slits, show that the condition for constructive interference becomes d sinθ = mλ, m = 0, ±1, ±2, ±3, ...

As stated above, constructive interference occurs when the path length of the two slits differs by a whole multiple of the wavelength. When drawing a right triangle with the hypotenuse as the distance between the slits, and one of the sides of the triangle on the one path of the light ray, we can see that the sin(theta) = (path length difference between the two rays)/(distance between slits)

Since constructive interference occurs at any whole multiple of the wavelength (see questions 7) we get sin(theta) = mλ/d

1. Explain why destructive interference will appear at the point when the p length is equal to an odd integral number of half wavelengths d sinθ = (m + ½) λ, m = 0, ±1, ±2, ±3, ...

Similar to what was stated in 7 above, if the path length difference between the two slits causes a half period phase shift between the two waves, then they will be inversely aligned and it will cause constructive interferences. This can be compared to adding sin waves with difference phase shifts. If the phase shifts are a whole period multiple then the waves line up perfectly (constructive interference). But if the phase shift is a half period difference (ignoring even multiples of a half wavelength, since 2 \* ½ = 1 full period, etc. this is why its m+1/2) then they will be opposites (+1/-1) and destructively interfere.

1. Draw a picture of two traveling waves that add up to form constructive interference. And Draw a picture of two traveling waves that add up to form destructive interference.

Drawing turned out terrible, but here is a picture: The solid lines represent peaks/maximum, while the dotted lines represent troughs/minima. Where two peaks/troughs meet they add together and you get constructive interference. But where a peak and trough meet they cancel and you get destructive interference.

Source: http://images.slideplayer.com/13/3866857/slides/slide\_69.jpg