5- To trim stray light from the edge of a helium-neon laser beam (wavelength = 632.8 nm) you pass it through a hole of diameter 1.25 mm at the exit of the laser. If there is nothing else put into the beam, what is the very smallest diameter spot this beam can create on a screen 9.0 m from the laser exit? (Express your answer in mm)

**$1.11\times10^{1}$**

$$\theta = \frac{2.44\lambda}{a}$$

a is the diameter of the hole

w (diameter to solve for ) = $\theta L$ (L = distance from hole to screen)

$$\theta = \frac{2.44(632.8\ x\ 10^{-9})}{(1.25\ x\ 10^{-3})} = 0.0012352256$$

W = $\frac{0.0012352256*9.0}{1000}$ = 11.11 mm

9a)- Two slits separated by a distance of d = 0.110 mm are located at a distance of D = 840 mm from a screen. The screen is oriented parallel to the plane of the slits. The slits are illuminated by a coherent light source with a wavelength of lambda = 534E-6 mm. The interference pattern shows a peak at the center of the screen (m=0) and then alternating minima and maxima.
What is the pathlength difference between the two waves from the two slits at the first (m=1) maximum on the screen?

**$5.34\times10^{-4}$ mm**

Path differerence = lamda

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9b)- What is the pathlength difference between the two waves from the two slits at the first (m=0) minimum on the screen?

**$2.67\times10^{-4}$ mm**

Path differerence = ½ lamda

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9c)- Calculate the distance on the screen between the central maximum (m=0) and the first (m=1) maximum (You can assume sin(theta) = tan(theta) = theta with theta expressed in radians).

**4.08 mm**

θ= λ/d = 5.34 x 10^-7 /1.1 x 10^-4 = 0.0048545455
y = θL =( 0.0048545455)(0.84) = 0.0040778 m

10- Air has a small, usually negligible index of refraction. It is 1.0002926. This causes the Sun to actually be below the horizon when it appears to be just on the verge of sinking below it. Suppose you are on the sea-shore watching the Sun apparently sinking into the ocean. When only its upper tip is still visible, by what fraction of the diameter of the Sun is that tip actually already below the surface? As an approximation, take the earth's atmosphere as being of uniform density out to a thickness of 7.70 km, beyond which there is no atmosphere. This means that, with the Earth's radius being 6400 km, your line

of sight due West along the ocean surface to the horizon will intersect this "upper surface" of the atmosphere at about 314.0 km from your eye. (If you enjoy trigonometry you can check this figure for yourself.) (The diameter of the sun subtends 0.500 degrees at your eye.)
**0.731**

Arctan (6400/314) = 87.1911781 deg
Sin (87.1911781) x 1.0002926 = 0.9990908525
Arcsin(0.9990908525) = 87.5566386
87.5566386 - 87.1911781 = 0.3654604952

0.3654604952 / 0.5 = 0.730920