Homework 1 Solutions

a) What I wanted here was for you to realize that if the path difference equaled an integral number of wavelengths for some particular angle θ then the two waves will arrive exactly in phase and there would be constructive interference on the screen at that location. If, on the other hand, at some angle θ the path difference corresponds to an extra ½ wavelength – so $\lambda/2$, $3\lambda/2$, $5\lambda/2$, etc. – then the two waves will arrive exactly out of phase and cancel producing a dark spot, or complete destructive interference.

b) From the small triangle, we have $\sin\theta$ = (path diff)/d, while from the large triangle, we also have that $\tan\theta = x/D$. At small angles, we have that $\sin\theta \sim \tan\theta \sim \theta$, so that we can write that (path diff)/d = x/D, or solving for x, we have x = (path diff)D/d. Now, to have constructive interference, we must have (path diff) = $n\lambda$, where n is an integer. In that case, we have

$x = nD\lambda/d$ as the locations of bright spots due to constructive interference.

Finally, then the distance between consecutive bright spots will be equal to

$$\Delta x = D\lambda/d.$$

c) Substituing D = 3 m, $\lambda = 632.8 \times 10^{-9}$ m, and d = 0.0005 m, we have

$$\Delta x = 3.8 \text{ mm}$$

While for the argon ion laser at λ = 514.5 nm, we have Δx = 3.1 mm.