Homework assignment

Due Monday, Feb 4th 2019.

Problems: Young's double slit experiment

Configuration 1

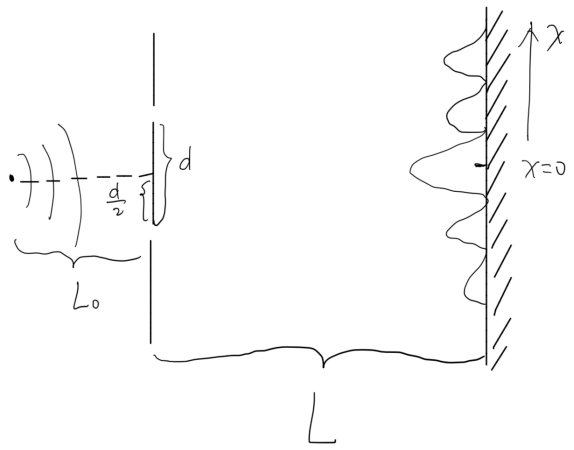

Figure 1: Configuration 1 of Young's double slit experiment.

MATH HINT: $(1+x)^n \approx 1+nx$, when $x \ll 1$. n can be any real number.

A light source emits light wave as: $E_0(r,t) = E_0 cos(\omega t - kr)$, where $k = 2\pi/\lambda$ is the wave-vector, r is the distance that the wave has propagated from the source.

(a) Can you write down the wave at two slits? Are they the same?

When light goes through each slit, we can treat it as a new light source. For slit one, one can define $E_1 = E_c cos(\omega t - kr_1 + \phi_1)$, where r_1 is the distance that the wave has propagated from slit 1, and $\phi_1 = -k\sqrt{L_0^2 + d^2/4}$. You can have similar definition for wave from slit two.

(b) What is the wave of the light at position x on the screen, $E(x,t)$? For simplicity, you can assume the distance between the slit and the screen is very large, such that: $L \gg d$ and $L \gg x$. You can use this to simplify your result.

(c) We know that the intensity of the light is proportional to E^2. Can you find the positions on the screen where the light intensity is zero?

Configuration 2

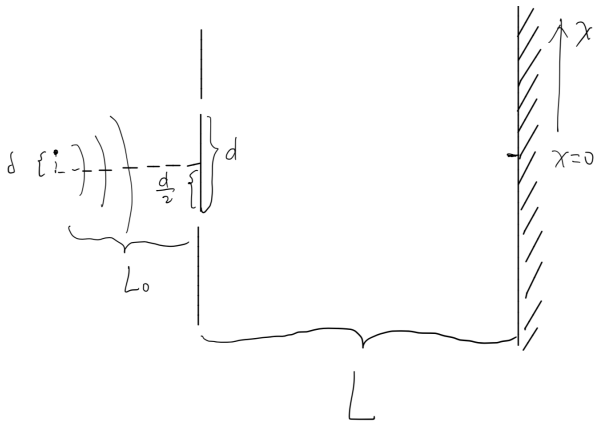

Figure 2: Configuration 2 of Young's double slit experiment.

Now we move the light source up by a small amount δ, where $\delta \ll d \ll L_0$.

(a) What is the light wave at slit one and two? Are they identical?

(b) Again when light goes through each slit, we can treat it as a new light source. For slit one, one can define $E_1 = E_c cos(\omega t - kr_1 + \phi_1)$. For slit two, one can define $E_2 = E_c cos(\omega t - kr_2 + \phi_2)$. What is ϕ_1 and ϕ_2 in configuration 2?

(c) What is the wave of the light at position x on the screen, $E(x,t)$?

(d) Can you find the positions on the screen where the light intensity is zero?

(e) What is the minimum δ one would need to turn the zero intensity position in Configuration 1 into maximum intensity position in Configuration 2?

Bonus Problem

The flash light on your iPhone/smartphone can be considered as a light source. Borrowing another phone from your roommate/classmate, now you have two light sources. Fire them on and light up a wall in your room. Do you think this experiment is the the same as Young's double slit experiment? Can you see interference pattern? If not, why? If yes, can you take a photo of the interference pattern?