Homework 12

Professor Florencia Canelli
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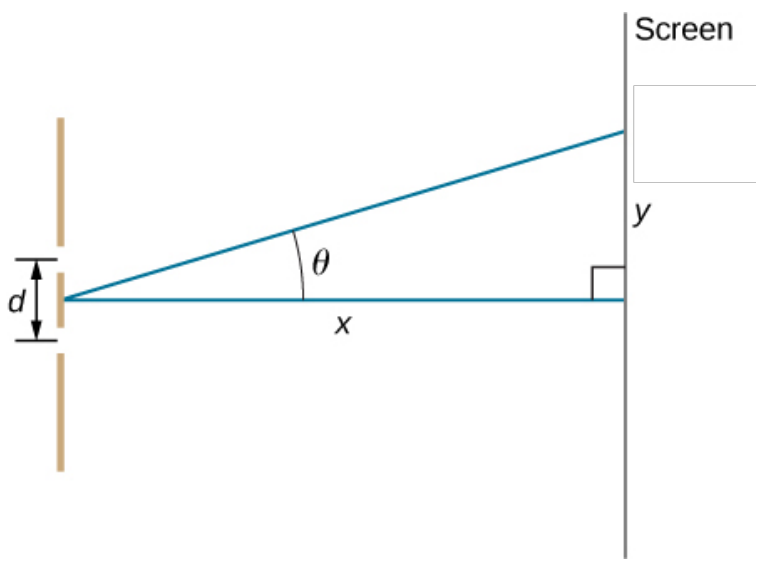
Exercise 1. Double slit. Shown below is a double slit located a distance x from a screen, with the distance from the center of the screen given by y. When the distance d between the slits is relatively large, numerous bright spots appear, called fringes.
a) Find the distance of the fringes in the small angle approximation (where $\sin(\theta) \approx \theta$).
b) Using this setup, is it possible to compare two light sources and find out if they have a different wavelength? what is the separation between two maxima of the same order as a function of the wavelength difference?



Double slit experiment

Exercise 2. Soap bubble. A soap bubble is 200 nm thick and illuminated by white light incident perpendicular to its surface. What wavelength and color of visible light is most constructively reflected, assuming the same index of refraction as water?

Exercise 1. Double slit solution. a)The interference figure on the screen is the effect of the interference between the radiation coming from the two slits. The path difference as a function of θ can be written as:

$$\delta = dsin(\theta) = d\frac{y}{x} \tag{1}$$

The interference is constructive and have a maximum when:

$$\delta = n\lambda \Rightarrow d\frac{y}{x} = n\lambda \Rightarrow y = \frac{x}{d}n\lambda \tag{2}$$

b) One way to use the setup is to check the position of the maxima for one source, and if the position of maxima of the other source lies in the same position.
The maxima and the minima produced by a double slit setup are not sharp object, but a smooth transition between most bright spot and dark spot. The separation between two maxima of the same order is

$$\Delta y = y_1 - y_2 = \frac{x}{d}n(\lambda_1 - \lambda_2) \tag{3}$$

Exercise 2. Soap bubble solution. The interference is between the light reflected on the outer surface and the light reflected from the inner surface of the bubble. The path difference can be written as:

$$\delta = 2nd = 1.33 \times 2 \times 200nm = 560nm \tag{4}$$

Where the factor two takes into account the fact that the light travels two times inside the bubble shell. The yellow radiation is more constructively reflected.