PHYS 234: Recitation 7
(Quiz: Mar 11, 2020)

1. **Estimation:** In 1774, Ben Franklin observed that a teaspoon of oil (5 cm^3), when placed on the surface of a pond, spread out to about half an acre (2000 m^2):

"…the oil, though not more than a teaspoonful, produced an instant calm over a space several yards square, which spread amazingly, and extending itself gradually till it reached the leeside, making all that quarter of the pond, perhaps half an acre, as smooth as a looking-glass."

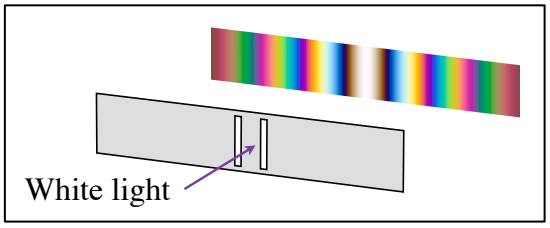
Use Franklin's observation to estimate the size of an oil molecule. Is your estimate reasonable by modern standards? *Clearly state your assumptions and how you came to the numbers you estimate.*

Clapham pond before a drop of oil is added

Clapham pond after a drop of oil is added

Photos from C. H. Giles on the same pond.

2. **Essay:** Explain how a pair of slits separates the colors of white light, as in the figure to the right.

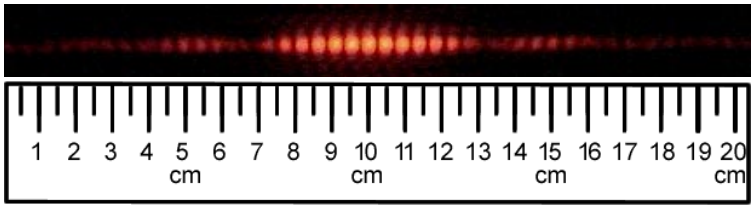


3. Two coherent sources of radio waves, A and B, are 5 m apart. Each source emits waves with wavelength 6 m along the *x* axis.

A. At what distance(s) from source A is there constructive interference? Consider only points between A and B on the *x* axis.

B. At what distance(s) from source A is there destructive interference? Consider only points between A and B on the *x* axis.

4. A red laser with wavelength λ = 630 nm shines through a pair of small slits. On a screen that is L = 10 m away, a



pattern of bright fringes appears, as shown. A centimeter ruler is held up to the screen, as shown.

A. Calculate the distance d between the slits in millimeters, to one significant digit.

B. Calculate the width a of each slit in millimeters, to one significant digit.

C. If the screen is moved farther away, does the distance between the fringes increase, decrease, or stay the same?

D. If a green laser is used instead of a red laser, does the distance between the fringes increase, decrease, or stay the same?

5. A laser beam shines through a prism as shown. The laser enters through the air-prism interface without bending, then exits through the prism-air interface at an angle φ from its original path. The prism is a right triangle with upper angle θ. Find an expression for the index of refraction of the prism n_2 in terms of φ, θ, and the index of refraction of air n_1. **Support your calculation with a diagram or written reasoning.**