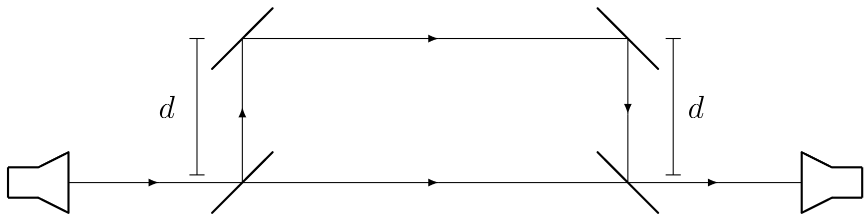
Assignment 2; Phys 186 Name ______________

Note: You can ask me for help; for example, have me check if an answer is correct. Talk to me: you'll learn some physics, and that's the point of the course.

1. (30 points) You have the following interferometer set up in a lab:

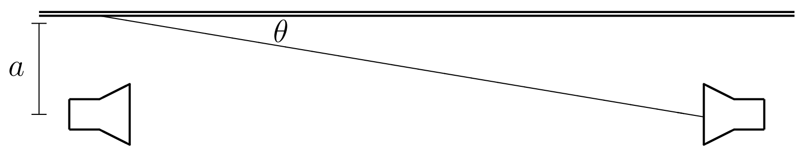


You have a microwave source on the left, and a microwave detector on the right. The microwaves have a wavelength of 3.00 cm.The two diagonal lines on top stand for fully silvered mirrors; the two diagonal lines lined up with the source and detector are half-silvered mirrors that reflect and transmit half the incident microwave intensity. The distance between the pairs of fully silvered and half-silvered mirrors is $d = 10.0$ cm. All other distances are irrelevant to the problem.

In other words, you split the microwave beam in two, and make one part travel a longer distance before joining the original beam.

Now you start increasing d (on both sides). Find the next two values of d for which you get *constructive* interference (an intensity maximum at the detector).

2. (30 points) You have the following set up in a lab:



You have a microwave source on the left, and a microwave detector on the right. The microwaves have a wavelength of 3.00 cm. The double lines above represent an oven liner, which reflects the microwaves. The detector can be moved through an angle $0 < \theta < 90°$, as shown. The source is a distance $a = 2.75\,\text{cm}$ to the mirror.

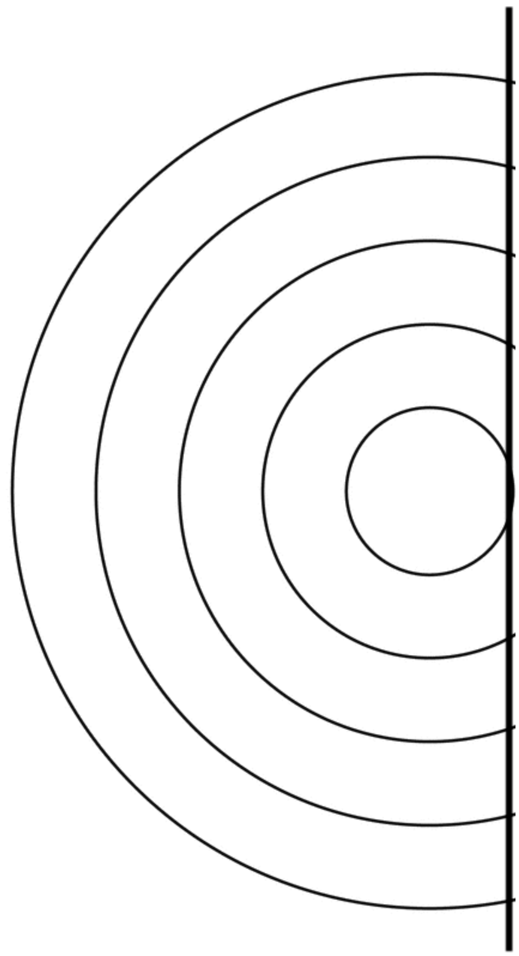
In any textbook, you will see that the effect of a mirror is equivalent to having an identical second source of a light wave located a distance a on the *other side* of the mirror; for example, Figure 25.38 in the online textbook I listed in the syllabus. The oven liner will work the same way with microwaves. And then, there is the extra phase shift to consider, just the same as in Part 2 of your Lab 3.

Sketch a qualitative graph of how the detected intensity will vary with the angle θ, much like Part 3 of your Lab 3. Explain your reasoning. You will be able to find the angles for some maxima or minima of intensity. Calculate these angles. (This will be hard to do if you don't talk to me and ask me questions as you are working on this problem!)

3. (20 points) Say you have a diffraction grating with with slit spacings just slightly larger than visible light wavelengths. When you shine a narrow beam of white light through this grating onto a screen, you will see a bright white spot straight down the middle, and after some darkness, a rainbow pattern on either side. Will the rainbow pattern have red light closest to the white in the middle, with violet farthest away, or violet closest to the middle, with red farthest away? Explain, using the appropriate equations.

4. (20 points) You have water waves on the surface of a lake, with wavefronts that spread as concentric circles from a central source, traveling at a constant speed v_{deep}. The straight line indicates a boundary where the lake bottom suddenly steps up, so the waves enter a shallow region where $v_{\text{shallow}} < v_{\text{deep}}$.

(a) Draw how the wavefronts will look in the shallow part of the lake.



(b) Briefly explain your reasoning.

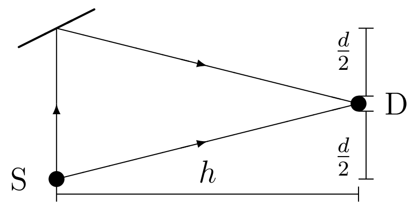
Extra Problems (not graded)

5. (0 points) Your microwave optics lab included a double-slit experiment where $d = 5.5\,\text{cm}$ and $\lambda = 3.0\,\text{cm}$. You were only able to observe the $m = 0, \pm 1$ peaks of intensity.

(a) With a different d, you might have been able to observe the $m = \pm 2$ peaks. Find a d value that would allow you to see these peaks but not $m = \pm 3$. Make reasonable assumptions about what you need to be able to see peaks with the setup we used.

(b) If you had a diffraction grating instead of two slits, the intensity peaks would have been sharper, making a more precise experiment. Why do you think I didn't give you a grating? (For example, do you think its cost might have been too high?)

6. (0 points) You have the following interferometer setup in a lab, with a wave source labeled S, detector D, and a mirror to produce two wave paths between source and detector. There is a distance of d between the source and the mirror, and you keep the length h constant while changing d. The wavelength of the waves is λ.



Make a qualitative graph of how the intensity detected will depend on the distance d. Be careful about the relative peak heights, and whether the intensity is ever exactly zero. Explain your decisions, and how you made your graph.