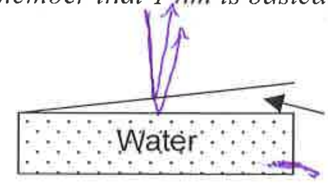
PS #4 SUSTAIN physics Spring 2015 I don't give you enough room to do the work. You'll do it on another sheet of paper.

1) I shine white light on an oil slick on the water. This special oil has an index of refraction of 1.2, and stretches from a thickness of 1 nm at one side to a thickness of 560 nm at the other side.

   a) What, is reflected from the side of the slick that is 1 nm thick? Clearly explain your reasoning with a drawing. *Consider if the reflection is inverted or erect at each interface and how the waves will interfere. Remember that 1 nm is basically zero compared to the wavelength of visible light.*



Both reflections are inverted, so in phase if $\Delta x = 0$, all wavelengths reflect.

   b) What wavelengths of light are reflected from the side that is 560 nm thick? Explain your reasoning and state what color you see. *Be careful. This is not like the soap film on the practice test because the reflections are different. Don't forget to consider that the light is in oil, so the wavelengths are smaller there. I give credit for either red of blue light here, but the correct answer is purple, because the difference in traveling distance corresponds integral distances of both red light and blue light.*

$\Delta x = 2 \cdot 560\,nm = 1120\,nm$ in oil, or $1344\,nm$ in air

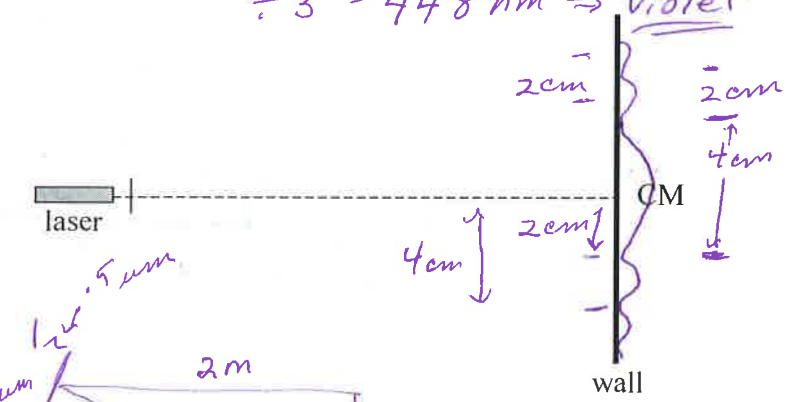
$\frac{1120}{1.2}$ … $\div 2 = 672\,nm$ = red

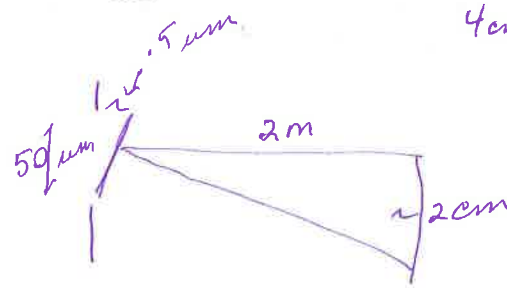
$\div 3 = 448\,nm \Rightarrow$ Violet

2) I do an experiment with one single slit (thickness = 50 um) in front of a new tunable green laser (500 nm). At a distance of 2 m from the slits, there is a wall

   a) Draw the resulting pattern on the wall *Single Slit Diffraction pattern*

   b) Label the relevant distances between bright spots in your drawing *be careful, make sure you understand the difference between single slit and multiple slit diffraction.*





$\frac{\lambda}{slit} = \frac{1}{100} \approx \theta$

   c) Explain with a drawing why there should be this pattern.

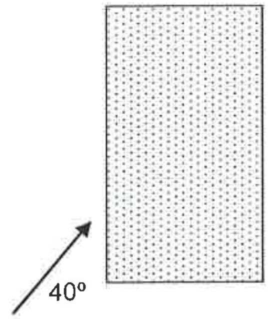
   d) *Make the drawing with the slit and the triangle and theta. Explain in what directions you have destructive interference. Again, make sure you understand the difference between single slit and multiple slit diffraction.*

Explain how $\Delta x = 1\lambda$ means that all ~~wavelengths~~ waves destructively interfere.

3) Below, you see a rectangular piece of glass, (n=1.4).

a) Find the angle of refraction and ***carefully*** finish the drawing of the ray through the rectangle.

In drawing ray paths... remember that the ray must cross the perpendicular, and that the ray always bends toward the slower medium. Additionally, total internal refection can only happen when we are passing into a faster medium.

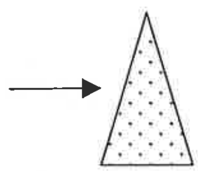


b) Calculate the critical angle in this medium showing work

See B.E. #4

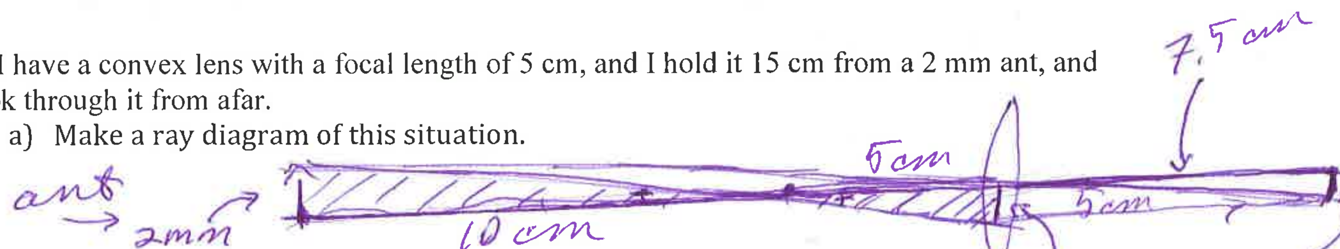
c) Find a way to draw a ray that will experience total internal reflection. Add this ray to the diagram above. Angles should be approximately correct. *It's very surprising how many people got this wrong.*

d) Continue the ray through the glass object at right (no math necessary). Please get the colors correct.



4) I have a convex lens with a focal length of 5 cm, and I hold it 15 cm from a 2 mm ant, and look through it from afar.

a) Make a ray diagram of this situation.



b) (2 pts) Identify the location and size of the image.

Size = 1 mm; Location = ~~30cm~~ 7.5 cm

c) (1 pt) Describe the image I see through the lens. Use words like : real virtual inverted erect enlarged diminished.

d) (3 pts) I slowly move the lens closer to the ant until it is touching the ant. Describe how the image changes during this process. You may make a graph or ray diagram if you like.

image moves further back and gets bigger = 2 mm when Ant is at 10 cm from lens. Image blows up to ∞ when ant is at focus. Inside of focus, Image is virtual + enlarged + Erect, but gets smaller as ant approaches lens; Same size when distance = 0