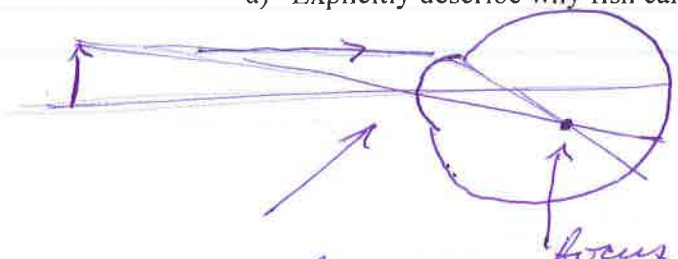
SUSTAIN Physics II, Problem Set 5, Due Monday May 11 Name_____

1) You decide to be the first fish to sprout legs and venture onto land to begin the species of lizards, birds, and mammals that are today terrestrially teeming everywhere! You're immediately distressed because nothing in the dry world appears clear to you, and return to the briny deep.
   a) Explicitly describe why fish can't see well on land AND elucidate it with a ray diagram.



focus too far in f is too short!

too much refraction because difference in n is way big.

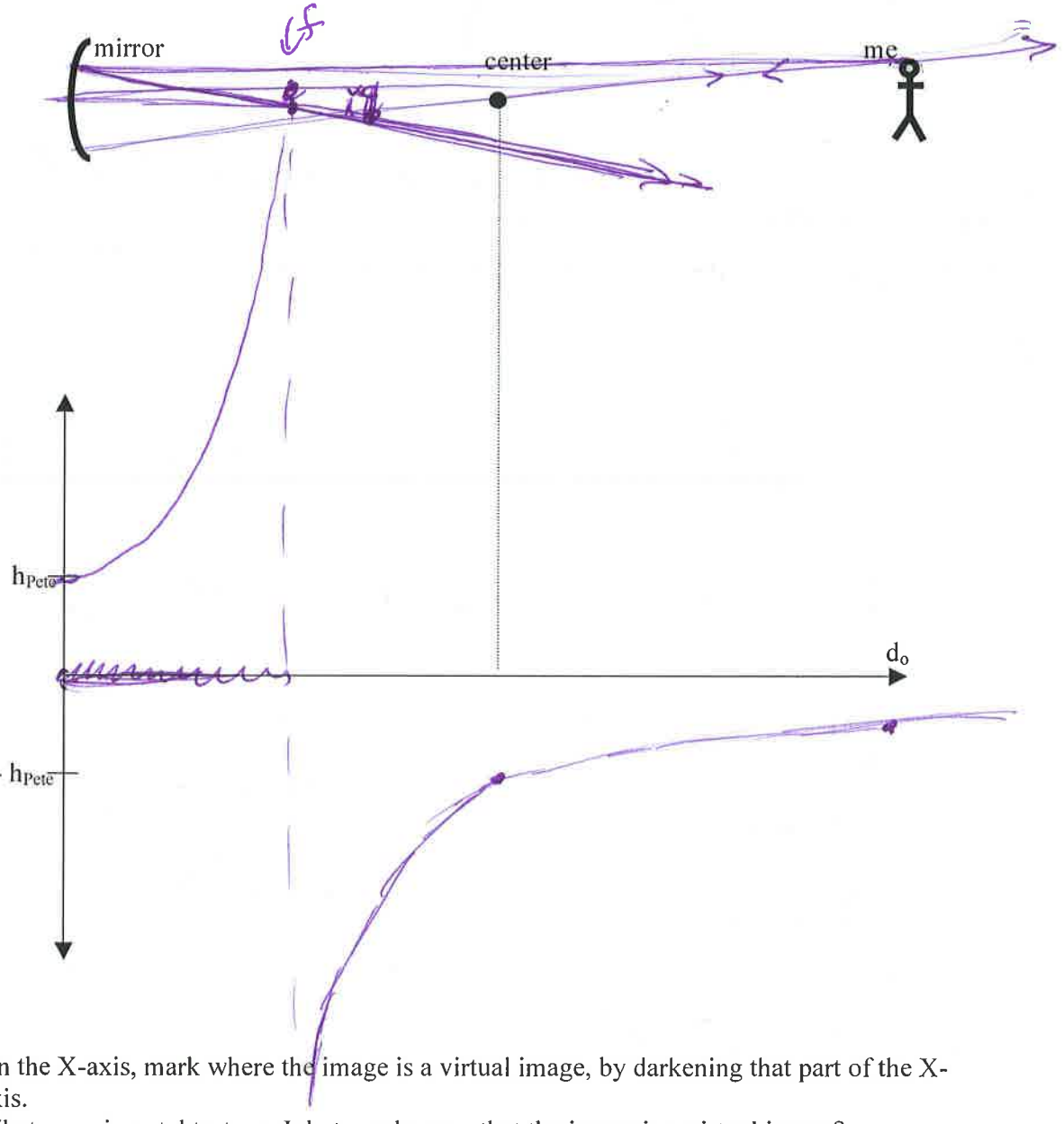
   b) You return to your underwater optometrist who diagnoses your problem and solves it for you. What does she diagnose as your problem above water (near-sighted, far-sighted, astigmatic, glaucoma, ADD…etc.), and how does she solve it? Again, show it with a ray diagram.

Make a good raydiagram showing how you could

1) use concave lenses.
2) put goggles on the fish full of water
3) just have the fish stand very close to people in conversation.

2) I'm standing very far away from a concave mirror and you are watching my image in the mirror. Then I walk toward the concave mirror until my face is pressing against the mirror. You are watching my image the whole time.

a) Please graph below, the height of my image as a function of **my** distance from the mirror. I have given you the axis and marked both my height and the **center of the radius** of the spherical mirror. If the image is inverted, make sure that the height is negative. Draw as many ray diagrams as you think you may need to help you.



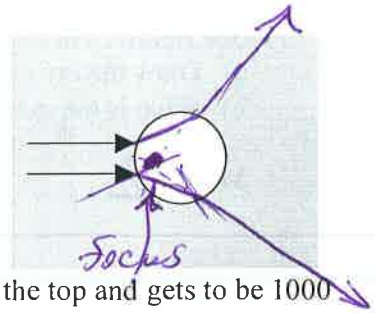
b) On the X-axis, mark where the image is a virtual image, by darkening that part of the X-axis.

c) What experimental test can I do to make sure that the image is a virtual image?

Put a light sensor at the image to see if there is really light there.

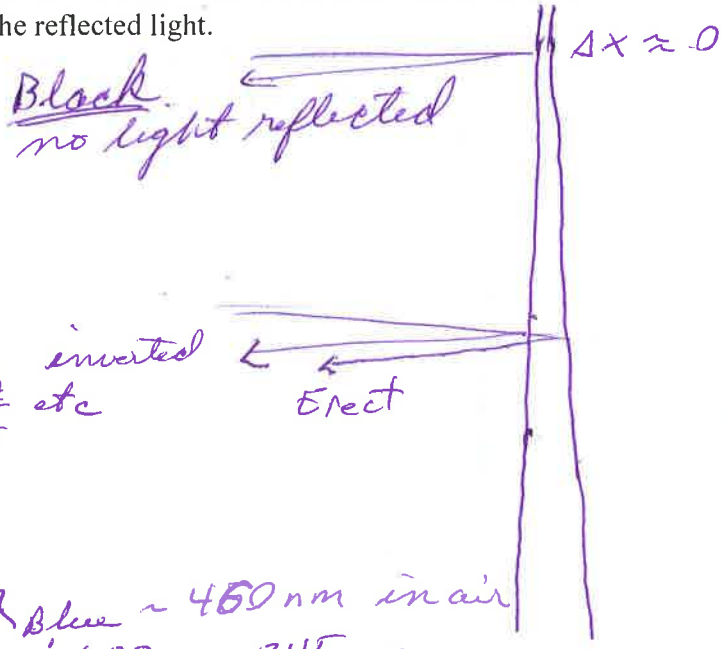
3) Shown is a bubble of air in oil.
   a) (2 pts) Complete the ray diagram.
   b) (1 pts) Locate and label the focus of this "lens".
   c) (1 pts) State whether it is a converging or a diverging lens.

diverging



4) I shine white light onto a vertical soap film that is only 10 nm thick at the top and gets to be 1000 nm thick at the bottom. The wavelength of visible light is 450 nm – 700 nm, and the index of refraction of soapy water is 1.33, the same as water. We must find the thicknesses of the film where you will see the top 3 bands of blue in the reflected light.
   a) (3 pts) Make the appropriate drawing at right to describe the interference pattern.

Black
no light reflected



   b) (3 pts) describe how you know which thickness are allowed.

$\Delta x = 2\,\text{thickness} = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}$ etc

~~2t~~

   c) (3 pts) (Find the thickness of the top 2 bands of reflected blue light.

$\lambda_{Blue} \sim 460\,nm$ in air
$\div 1.33 \approx 345\,nm$

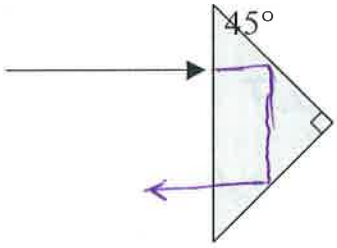
$2t = \frac{345\,nm}{2}, \frac{3 \cdot 345\,nm}{2}$

$t = 86\,nm, 260\,nm$

(It may not be a bad idea to calculate the critical angle for the next two problems)

5) (3 pts) Light is normally incident on a glass (n=1.5) 45° prism from air. Finish the ray diagram to show all reflected and refracted rays. Indicate all exact angles.

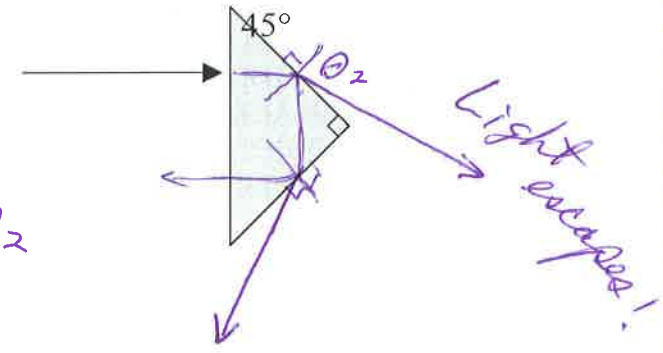
$\theta_c < 45°$ TIR



6) (2 pts) Now, the same prism is placed in water (n=1.33) and light is again incident on the glass surface as shown. Again, finish the ray diagram indicating all exact reflected and refracted angles.

$\theta_c > 45°$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ (45° ↓)



7) See Below. An object distance is half the focal length, f, of a converging lens.
   a) Draw the ray diagram to show the image
   b) What is the magnification?

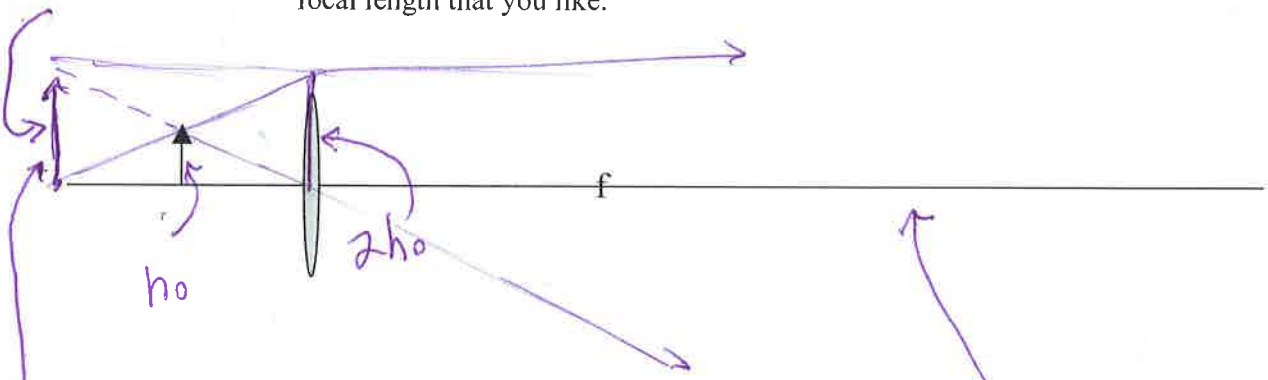
M= 2

c) Is the image real or virtual? How do you know?

real
no rays come from image!

image at focal pt!

d) Show where you would put a second lens so that a real image would occur – pick a lens of any focal length that you like.



e) Sketch a ray diagram (*including* the second lens, its focal points and the final image formed by the second lens.)

f) Could you have used either a converging or a diverging lens? Briefly state your reasoning.

put a converging lens with the image outside the focal pt & draw a ray diagram from using this image as the object

g) Which of the following must be true for the *second* lens to form a real image

doesn't matter.

A. The second lens must have a LARGER focal length than the first lens.
B. The IMAGE of the first lens must be OUTSIDE the focal length of the second lens.
C. The IMAGE of the first lens must be INSIDE the focal length of the second lens.
D. The OBJECT itself must be INSIDE the focal length of the second lens.
E. The OBJECT itself must be OUTSIDE the focal length of the second lens.