Physics 10164 - Exam 3B

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle or a box and remember to include correct units and significant figures.

1. (20 pts) A person stands 75.0 cm away from a mirror and produces an upright image that is 1.35 times larger than the person. At what distance from the mirror should the person stand to produce an inverted image that is only 75.0% as large as the person?

$p = 75.0\ cm$

$M = +1.35 = -\frac{q}{p} \Rightarrow q = -1.35p$

$= -101.25\ cm$

$\frac{1}{75} + \frac{1}{-101.25} = \frac{1}{f} \Rightarrow \boxed{f = 289\ cm}$

$M = -0.75 = -\frac{q}{p} \Rightarrow q = 0.75p$

$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$

$\frac{1}{p} + \frac{1}{0.75p} = \frac{1}{f}$

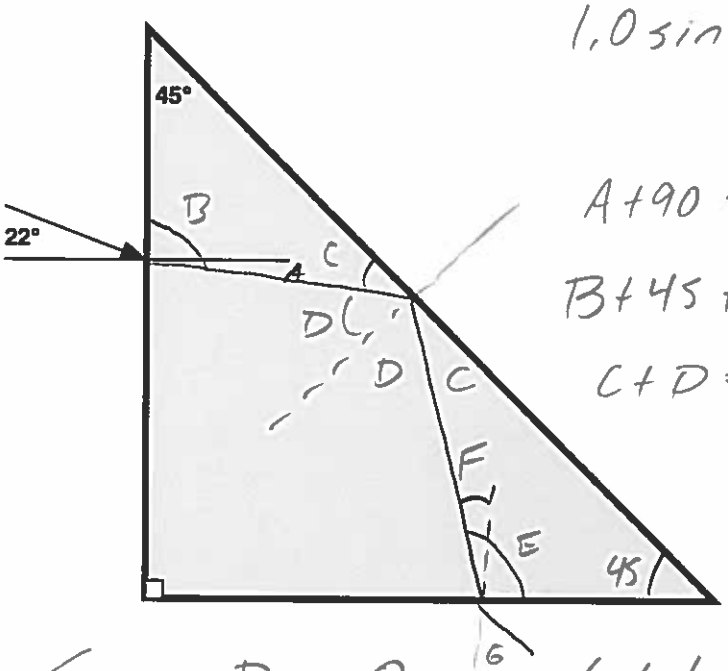
$\frac{0.75}{0.75p} + \frac{1}{0.75p} = \frac{1}{f}$

$\frac{1.75}{0.75p} = \frac{1}{f}$

$0.75p = 1.75f$

$\boxed{p = 675\ cm}$

2. (25 pts) Light is incident on a prism (n = 1.56) surrounded by air on all sides as shown below. Show on your diagram which face the light exits the prism, and also calculate the angle of refraction upon exiting the prism.



$1.0 \sin 22° = 1.56 \sin A$

$\Rightarrow A = 13.9°$

$A + 90 = B \Rightarrow B = 103.9°$

$B + 45 + C = 180 \Rightarrow C = 31.1°$

$C + D = 90° \Rightarrow D = 58.9°$

$\theta_c = \sin^{-1}\left(\frac{1}{1.56}\right) = 39.9°$

Since $D > \theta_c \Rightarrow$ total internal reflection

$C + 45 + E = 180° \Rightarrow E = 103.9°$

$E - 90 = F \Rightarrow F = 13.9° < \theta_c$

$1.56 \sin 13.9 = 1.0 \sin G$

$\boxed{G = 22.0°}$

#3. (25 pts) The normal near point for a person is 25 cm. The normal far point is infinity. A nearsighted person has a far point that is 55 cm in front of her eyes, and she wants to wear glasses that will be located 2.0 cm in front of her eyes. near pt = 21 cm

a) What must be the focal length of the lenses?
b) What is the new near point for this person?

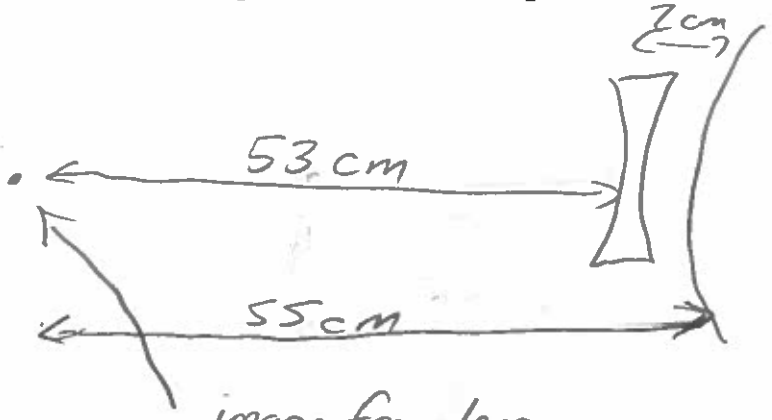
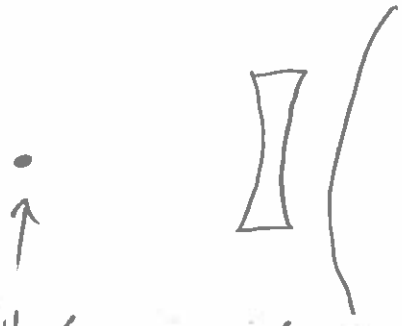


image from lens
= object for eye, 55 cm from eye
53 cm from lenses

For $p = \infty$, need $q = -53\,cm$

$$\Rightarrow \boxed{f = -53\,cm}$$

$$\frac{1}{p} + \frac{1}{-19} = \frac{1}{-53}$$



$p = 29.6\,cm$ in front of lenses,

or $\boxed{32\,cm \text{ in front of eye}}$

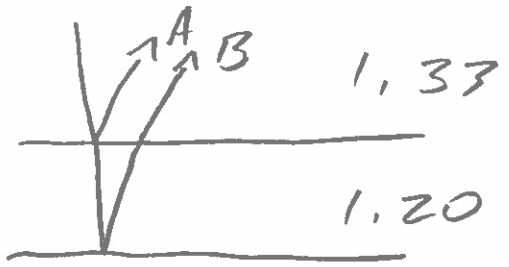
What p results in an image 21 cm in front of eye, 19 cm in front of lenses?

#4. (30 pts) A volume of water (n = 1.33) is horizontally bisected by a horizontal thin film of plastic (n = 1.20). A vertical light ray shines through the water and is incident on the film, which has water on either side. Assume the wavelength given below is a reference wavelength for light in air, even though the light in this problem is always either in water or the plastic film.

a) What is the smallest thickness of film that results in bright reflection for light of wavelength 632 nm?
b) What is the smallest thickness of film that results in bright transmission for light of wavelength 632 nm?

$\phi_A = 0$

$\phi_B = \frac{2nt}{\lambda_0} + \frac{1}{2}$



$\phi_B - \phi_A = 0, 1, 2 \ldots$

$\frac{2nt}{\lambda_0} + \frac{1}{2} = 0 \times$

$\frac{2nt}{\lambda_0} + \frac{1}{2} = 1$

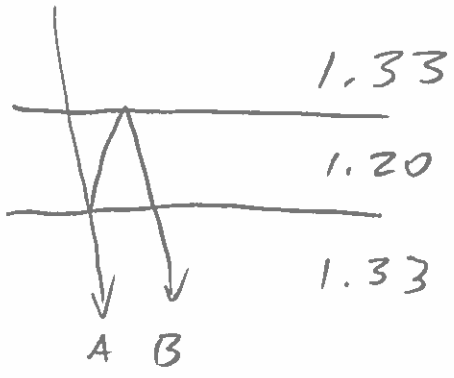
$\frac{2nt}{\lambda_0} = \frac{1}{2}$

$t = \frac{\lambda_0}{4n} = \boxed{132\ nm}$

$\phi_A = 0$

$\phi_B = \frac{2nt}{\lambda_0} + \frac{1}{2} + \frac{1}{2}$

$\frac{2nt}{\lambda_0} + 1 = 0, 1 \times$



$\frac{2nt}{\lambda_0} + 1 = 2 \Rightarrow \frac{2nt}{\lambda_0} = 1 \quad t = \frac{\lambda_0}{2n} = \boxed{263\ nm}$