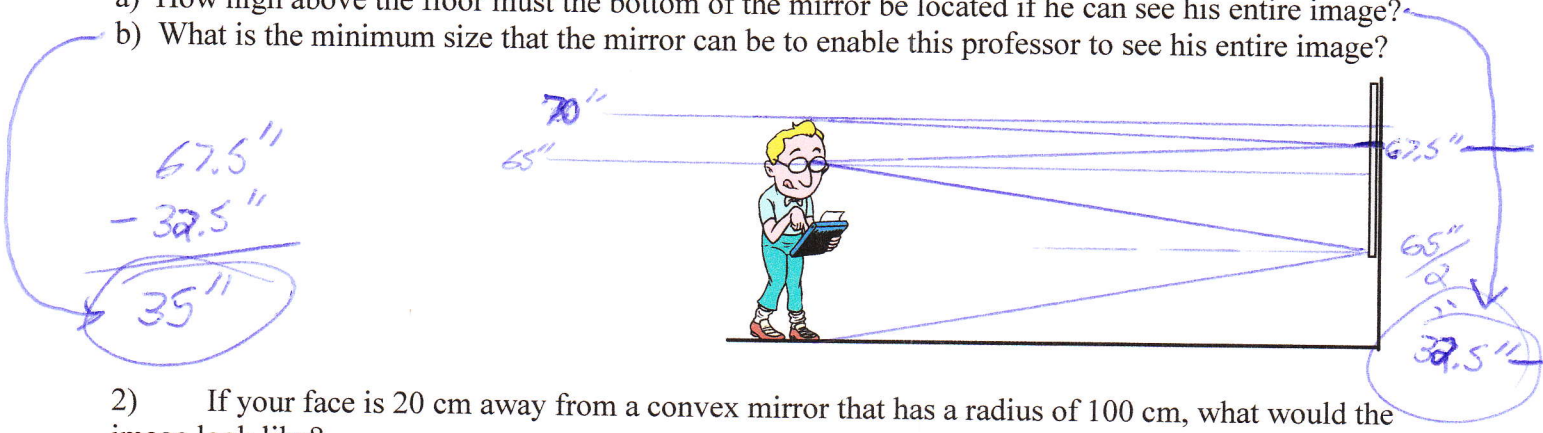
Scheller | **Physics 176**
Exam #4 | **Spring 2009**
9 a.m.

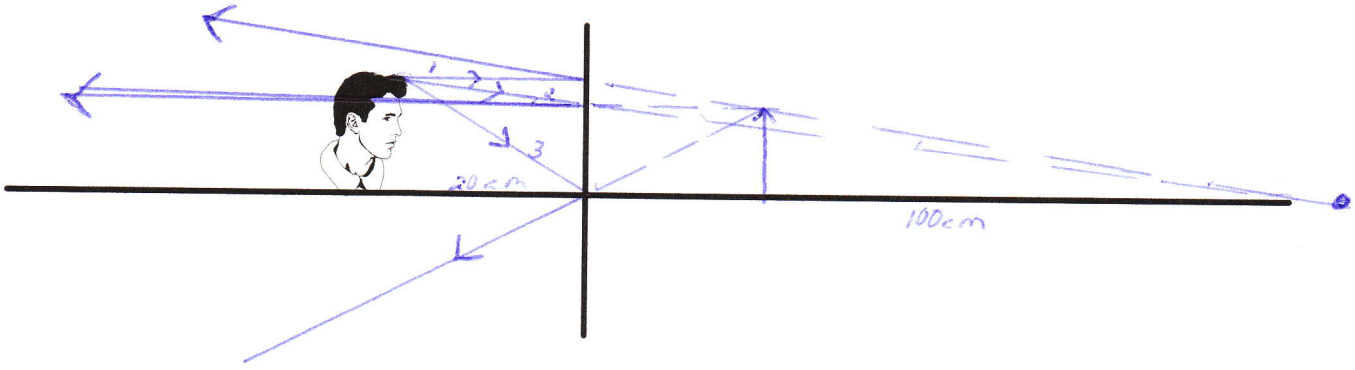
Read these instructions carefully. Work rapidly. Write your name in the upper right hand corner of this page. Do all your work on the test pages. Explain all work completely. **Answers without units are incomplete.**

Constants: $c = 3x10^8$ m/s

1. A really cool physics professor stands 5 ft 10 in tall and is standing 10 feet away from a 3 ft tall mirror hanging on the wall. If his eyes are 5 inches below the top of his head,
a) How high above the floor must the bottom of the mirror be located if he can see his entire image?
b) What is the minimum size that the mirror can be to enable this professor to see his entire image?



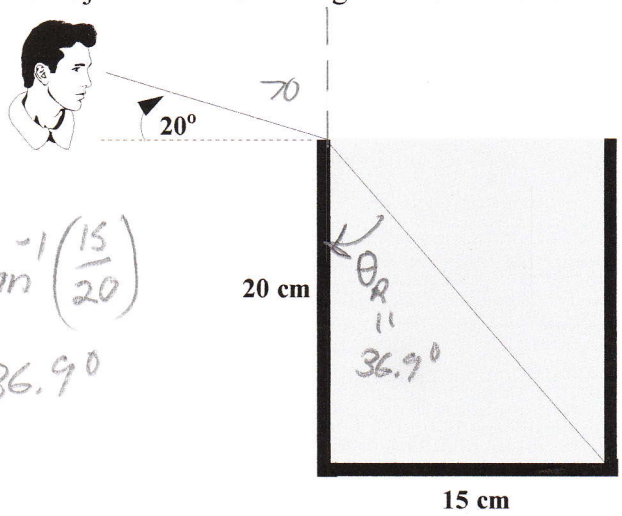
2) If your face is 20 cm away from a convex mirror that has a radius of 100 cm, what would the image look like?
a) Calculate the image distance
b) Draw the ray diagram
c) Is the image real or virtual?
d) If your face is 10 inches tall, how tall is your face in the mirror?



3. We wish to determine the index of refraction of a liquid filling a small tank as shown. By moving up and down, it is found that the back edge of the container is just visible at an angle of 20° above the horizontal.

a) What is the index of refraction of the fluid?

b) What is the speed of light in this fluid?



$(1)\sin 70 = n \sin(36.9)$

$n = 1.565$

$\theta_R = \tan^{-1}\left(\frac{15}{20}\right) = 36.9°$

$V = \frac{c}{n} = \frac{3\times10^8}{1.565} = 1.92\times10^8 \frac{m}{s}$

4. A light bulb is 0.75 m in front of a thin convex lens with a focal length of 0.25 m.

a) Draw the ray diagram to scale

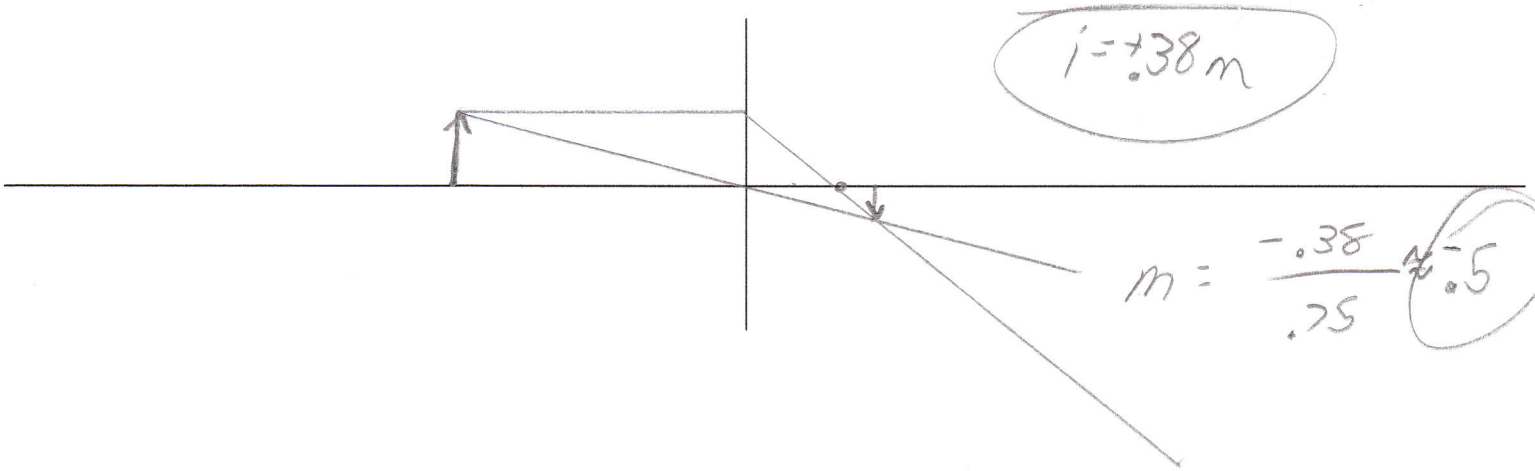
b) Calculate the image distance and the magnification

c) Is the image real or virtual

x2

$\frac{1}{.25} = \frac{1}{.75} + \frac{1}{i}$

$i = +.38\,m$



$m = \frac{-.38}{.75} \approx .5$

5. A converging lens of focal length 40 cm is placed 10 cm in front of a diverging lens with a focal length of 20 cm. For a 5 cm object placed 15 cm in front of the converging lens:

a) On the back of this sheet, draw the ray diagram to scale.

b) Calculate the final image distance for the combination.

c) What is the height of the final image?

d) Is it real or virtual?

$m_T = m_1 m_2 = \left(\frac{-(24)}{15}\right)\left(\frac{-(12.6)}{34}\right)$

$= +.59$

So $h = .59 \times 5\,cm = 2.96\,cm$

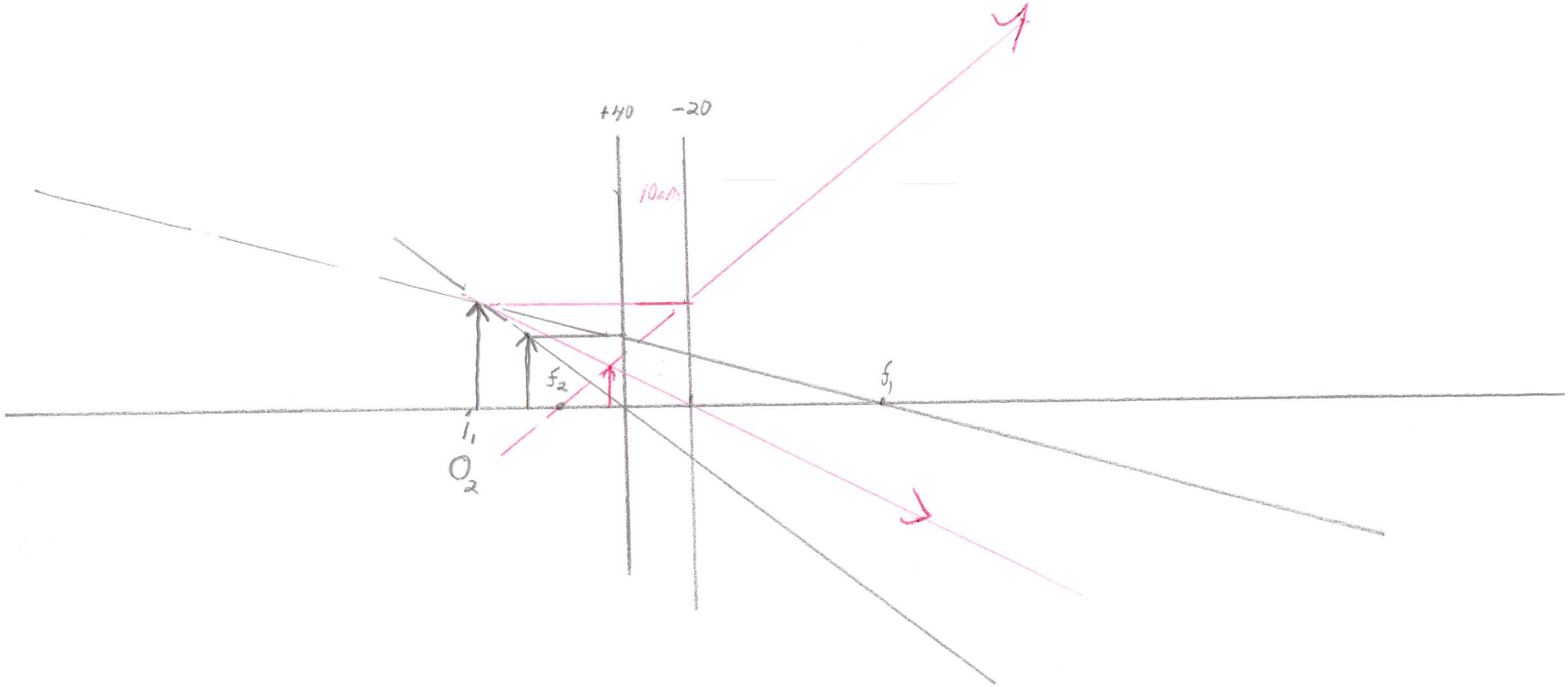
$\frac{1}{40} = \frac{1}{15} + \frac{1}{i_1}$

$i_1 = -24\,cm$

$O_2 = +34$

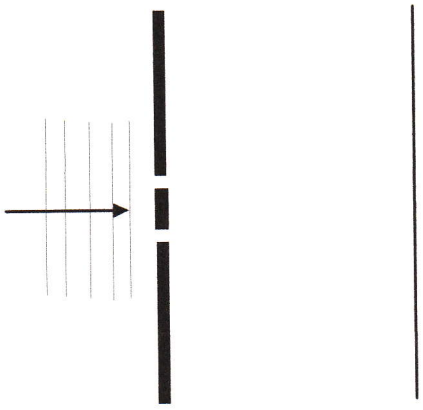
$\frac{1}{-20} = \frac{1}{34} + \frac{1}{i_2}$

$i_2 = -12.6\,cm$


+40
-20
10cm
f_2
f_1
I_1
O_2

6. White light falling on two long, narrow slits (d=0.05 mm) emerges and is observed on a distant screen. If red light of 780 nm has its first order fringe overlap with the second order fringe of violet light, what is the wavelength of the violet color?

Bright Bright



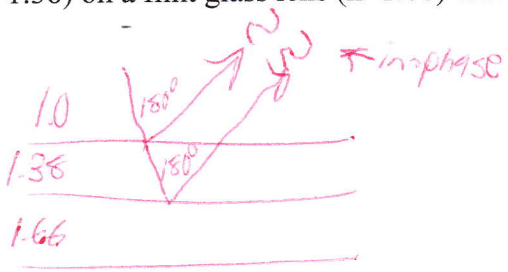
Red/ $(1)780 = (.05\,mm)\sin\theta$

Violet/ $2(\lambda) = (.05\,mm)\sin\theta$

Divide $\frac{780}{2\lambda} = 1$

$\lambda = 390\ nm$

7. Non-reflective coatings are deposited on camera lenses to maximize the amount of light transmitted through the cameras. Find the minimum thickness of a layer of magnesium fluoride (n=1.38) on a flint glass lens (n=1.66) that will minimize the reflection of 550 nm light.



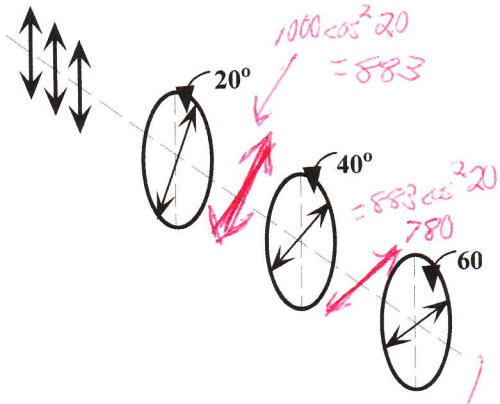
destructive

So $2t = (m+\frac{1}{2})\lambda_n$

$2t = (0+\frac{1}{2})\frac{550\,nm}{1.38}$

$t = 99.6\ nm$

8. Vertically polarized light of 1000 W/m^2 is incident on three polarizing disks in a row whose transmission axes are 20, 40, and 60 degrees to the vertical as shown. What intensity of light emerges from the 3rd disk?



$1000\cos^2 20 = 883$

$883\cos^2 20 = 780$

$I_3 = 780\cos^2 20$

$= 689\ W/m^2$