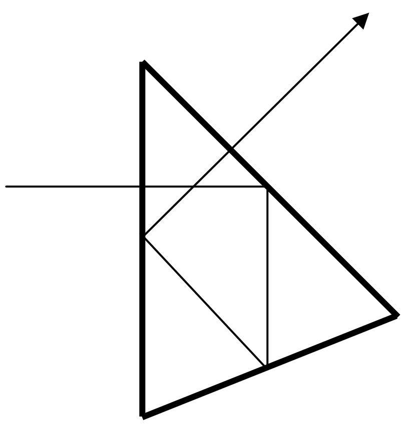
October 12, 2004 Lecture 15 Name__________________________

Closed book; closed notes. An equation sheet is attached and can be removed.
Use the back sides if required.
Do not use any pre-stored information or programs in your calculator.
Note any assumptions you make in solving the problems.
Show your work. Present it in a neat and logical fashion.

Distance Students: Please return the original exam only; do not FAX an additional copy.

1) (10 points) Draw the tunnel diagram for this prism and the ray path shown.



2) (15 points) You are taking a picture of a 6 foot tall person standing 18 feet away from you. The dimensions of the sensor in your camera are 10 mm x 10 mm.

a) Approximately what focal length lens do you need to fit the image of the person onto the sensor?

b) You now want to switch lenses so you can take a “head and shoulders” shot of the person. Approximately what focal length lens should you use?

3) (30 points) Use Gaussian reduction to determine the back focal distance of the following three surface optical system:

$n = n_0 = 1.33$

$R_1 = 25.0$

$n_1 = 1.50$

$t_1 = 5.0$

$R_2 = -40.0$

$n_2 = 1.60$

$t_2 = 5.0$

$R_3 = -60.0$

$n' = n_3 = 1.33$

Note: Solutions obtained using raytrace methods will receive zero credit.

continues…..

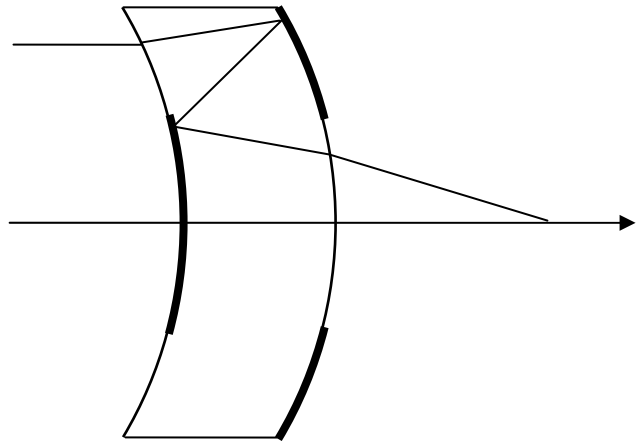
4) (30 points) A catadioptric system uses both reflection and refraction to achieve its focal power. A solid catadioptric system (a solid-cat) can be produced by coating portions of the front and rear surfaces of a lens so that there are transmissive and reflective zones on each surface. In this system, both surfaces have the same radius of curvature.

R1 = R2 = -100 mm

t = 30

n = 1.5

The system is in air



Use a paraxial raytrace to determine the back focal distance and the system focal length.

Surface	0	1	2	3	4	5	6
C							
t							
n							
$-\phi$							
t/n							
y							
nu							
u							
y							
nu							
u							

5) (15 points) A cemented doublet is a lens assembly with two glass elements glued together. The glued surfaces have the same radius of curvature (one concave and one convex).

How does the power of this lens assembly depend on the index of refraction of the thin glue layer? Prove your result.

Spare raytrace sheet

Surface	0	1	2	3	4	5	6
C							
t							
n							
$-\phi$							
t/n							
y							
nu							
u							
y							
nu							
u							
y							
nu							
u							
y							
nu							
u							

OPTI-502 Equation Sheet
Midterm 2004

$$OPL = nl$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$\gamma = 2\alpha$$

$$d = t\left(\frac{n-1}{n}\right) = t - \tau$$

$$\phi = (n' - n)C$$

$$\frac{n'}{z'} = \frac{n}{z} + \phi$$

$$f_E = \frac{1}{\phi} = -\frac{f_F}{n} = \frac{f'_R}{n'}$$

$$m = \frac{z'/n'}{z/n} = \frac{\omega}{\omega'}$$

$$m = \frac{f_{F2}}{f'_{R1}} = -\frac{f_2}{f_1}$$

$$\bar{m} = \frac{n'}{n} m^2$$

$$\frac{\Delta z'/n'}{\Delta z/n} = m_1 m_2$$

$$m_N = \frac{n}{n'}$$

$$P'N' = PN = f_F + f'_R$$

$$\tau = \frac{t}{n} \qquad \omega = nu$$

$$\phi = \phi_1 + \phi_2 - \phi_1\phi_2\tau$$

$$\delta' = \frac{d'}{n'} = -\frac{\phi_1}{\phi}\tau \qquad BFD = d' + f'_R$$

$$\delta = \frac{d}{n} = \frac{\phi_2}{\phi}\tau \qquad FFD = d + f_F$$

$$\omega' = \omega - y\phi$$

$$y' = y + \omega'\tau'$$

$$\bar{u} = \tan(\theta_{1/2})$$