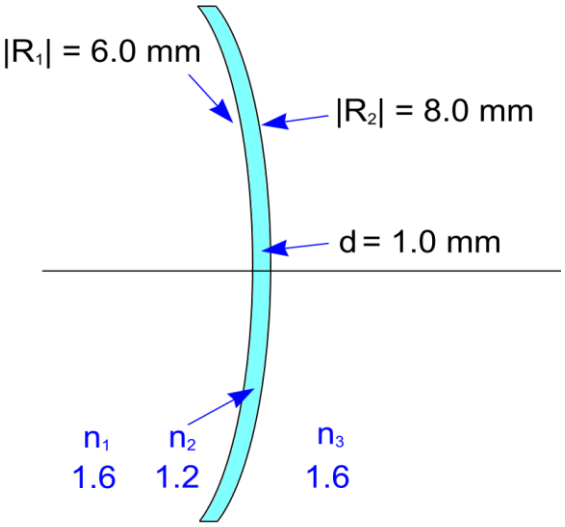
**FINAL Exam OPEN Book, OPEN Notes, OPEN Everything Except People.**
**Timed Exam: 2.5 Hours Plus 1.5 Hour Buffer (includes Preparing the pdf) = 4 Hours.**

**All Work Must be Shown Clearly for Total Credit.** Sig Fig stands for Significant Figures.

[20] P1. An object is 90 cm to the left of a converging lens having focal length $f_1$ = 60 cm. To the right of the converging lens is a diverging lens with focal length $f_2$ = -30 cm and the two lenses are a distance d = 90 cm apart. Find the following.

(a) the location of the final image as measured from the first lens to the nearest cm (10 pts),
(b) the magnification of the final image as compared to the original object (6 pts),
(c) the orientation of the image, i.e., inverted or upright (2 pts),
(d) the image type of the final image, i.e., real or virtual (2 pts).

[20] P2. You will be calculating the power in diopters referring to the figure at the right.




(a) the power for the left surface to 4 sig figs (6 pts),

(b) the power for the right surface to 4 sig figs (6 pts),

(c) the power term that depends on the distance d = 1.0 mm to 4 sig figs (6 pts),

(d) the correct value for the total power of the system to 2 sig figs (2 pts).

[20] P3. The Fresnel reflection coefficient is $r_s = \dfrac{n_1 \cos\theta_1 - n_2 \cos\theta_2}{n_1 \cos\theta_1 + n_2 \cos\theta_2}$. Find $\theta_1$ to the nearest degree for the specific case where $n_1 = 1$, $n_2 = 2$, and $r_s = -\dfrac{1}{2}$. Note that the minus sign means there is a phase change on reflection, but this need not concern you. Just use the data as it is given to you with the minus sign for $r_s$ and proceed with the math.

[15] P4. Laser light with $\lambda = 632.8\ \text{nm}$ is sent through a small single slit of width b. A screen is 1 meter beyond the slit. The angle of a point on the screen in measured from the center of the slit to the screen from the usual optic axis. What is the width of the slit if the angle between the first minimum to the left of the central maximum to the first minimum on the right side of the central maximum is 1°? Report your answer to the nearest micron.

[15] P5. Calculate $A = \int_{-2}^{\infty} e^{i\pi u^2/2} du$. Then calculate the irradiance $I$ to 2 sig figs.

[10] P6. Find the photon wavelength in nm to the nearest nm that is emitted in the hydrogen Bohr atom as an electron makes a transition from the 7$^{th}$ orbit to the 1$^{st}$ orbit.