Optics Test 2

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1. Where must an object be placed in front of a concave spherical mirror to get an image halfway between the center of curvature and the principal focus?

2. Suppose you have an optical fiber with a cladding of index n_c and a core of index n_f. The core has diameter d_f. Draw a careful diagram and show how to calculate the minimum radius of curvature R around which the fiber may be bent. Your answer may be an implicit relation (or pair of them) involving the indices and an angle. Don't worry about modes, just use a geometric optics approach.

3. An equiconcave lens is to be made of crown glass of index $n = 1.65$. Calculate the radii of curvature if it is to have a power of -2.5 D.

4. Two lenses having focal lengths $f_1 = 8\,\text{cm}$ and $f_2 = -12\,\text{cm}$ are placed $6\,\text{cm}$ apart. If an object $3\,\text{cm}$ high is located $24\,\text{cm}$ in front of the first lens, find (a) the position, and (b) the size of the final image.

5. Derive the Fourier series for a periodic "triangle" wave which rises from 0 to 1 in a length L, and returns to 0 in another length L, so that $\lambda = 2L$. In other words, find the series for

$$f(x) = \begin{cases} \frac{x}{L} & 0 \le x \le L, \\ 2 - \frac{x}{L} & L \le x \le 2L, \end{cases} \tag{1}$$

   which repeats every $\lambda = 2L$. You may use reference works to check yourself, but show your work.

6. Analytically determine the resultant when the two functions $E_1 = 2E_0 \cos \omega t$ and $E_2 = \frac{1}{2} E_0 \sin 2\omega t$ are superimposed. Draw E_1, E_2, and $E_1 + E_2$. Is the resultant periodic; if so, what is its period in terms of ω? (Problem 7.31)