Physics 25 Problem Set 4

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due Monday, May 1

Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Derive symbolic answers, and then plug in numbers after a symbolic answer is available.

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1. The *power* of a lens is defined with respect to the angle β through which a ray parallel to the axis of the lens, but displaced an amount y, is bent by the lens. The power K is then defined by the relation:
$$\beta = -Ky \ .$$
   (a) Make a clear diagram displaying β.
   (b) Show that $K = 1/f$, where f is the focal length of the lens, where angles are assumed to be very small.
   (c) Now place a second lens a distance d from the first lense; both lenses share a common axis. Make a good diagram, assuming angles are small, and show that the power of the combined system is:
$$K = K_1 + K_2 - K_1 K_2 d.$$
   (d) When both K_1 and K_2 are positive, it is still possible for the combined power to be negative. Interpret the meaning of this possibility, with a clear diagram.
   (e) For the combined system, the initally parallel ray eventually intersects the axis. What is the displacement f_{12} of this intersection point from the second lens? Does $f_{12} = 1/K$, where K is the power of the combined system?
   (f) Interpret the physical meaning of f_{12} and K when $d = f_1 + f_2$. This is the situation for both Galillean and Keplerian refracting telescopes.
   (g) Power K is measured in *diopters*, which are just inverse meters. The power of the human eye is about 40 diopters. If you're nearsighted, your eye is too powerful, and your eye might have 42 diopters of power. Compare the power of a corrective lens needed as a contact lens ($d = 0$) and as glasses ($d = 2\,\text{cm}$) to correct the combined power to 40 diopters.
2. Welford 3.1
3. Welford 3.3
4. Welford 3.6
5. Welford 3.7
6. Welford 3.11
