Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 3 – IPSP

Prof. Dr. J. Käs, Dr. M. Zink

Exercise Sheet 10 (WS 2010/11)

Date of Issue to Students: Jan. 6^{th} 2010

Date of Submission: Jan. 13^{th} 2011

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper.
Only submit the calculations and results for exercise 1-3, exercise 4 will be discussed during the instruction classes.

Exercises:

1. The lens-maker's equation has three design parameters. They consist of the index of refraction of the lens and the radii of curvature for its two surfaces. Thus, there are many ways to design a lens that has a particular focal length in air. Use the lens-maker's equation to design three different thin converging lenses, each having a focal length of 27.0 cm and each made from glass that has an index of refraction of 1.60. Sketch each of your designs. (4 Points)

2. An object is 17.5 cm to the left of a lens that has a focal length of +8.50 cm. A second lens, which has a focal length of -30.0 cm, is 5.00 cm to the right of the first lens. (a) Find the distance between the object and the final image formed by the second lens. (b) What is the overall magnification? (c) Is the final image real or virtual? Is the final image upright or inverted? (7 Points)

3. (a) Show that to obtain a magnification of magnitude $|m|$ using a converging thin lens of focal length f, the object distance must be equal to $\left(1 + |m|^{-1}\right) f$. (b) You want to use a digital camera which has a lens whose focal length is 50.0 mm to take a picture of a person 1.75 m tall. How far from the camera lens should you have that person stand so that the image size on the light receiving sensors of your camera is 24.0 mm? (4 Points)

4. In a convenient form of the thin-lens equation used by Newton, the object and image distances x and x' are measured from the focal points F and F', and not from the center of the lens. (a) Indicate x and x' on a sketch of a lens and show that if $x = s - f$ and $x' = s' - f$, the thin-lens equation ($\frac{1}{f} = \frac{1}{x} + \frac{1}{x'}$) can be rewritten as $xx' = f^2$. (b) Show that the lateral magnification is given by $m = -x'/f = -f/x$.