# OPTICS

BASIC PROBLEMS

1. A light ray hits a mirror. Show that when the mirror is rotated by an angle α about an axis in the plane defined by itself, the light ray is deflected by twice this angle.

2. A light ray hits two mirrors arranged at right angles (see figure). Show that the light reflected from the first and then the second mirror is parallel to the incoming ray. Does this also hold true if the direction of the incoming light ray is changed?
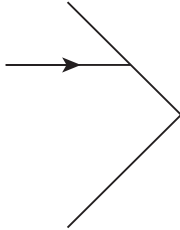
3. How long does it take light to travel the distance between Porto and New York (about 5'600 km) in water?

4. Calculate the refractive angles for red light and blue-violet light hitting the water surface at an incident angle of 24° each.

5. When passing from air into heave flint glass ("Jenaer Glas SFS1), a light ray is deflected by 9.5° from its initial direction. Calculate the corresponding angle of incidence. You may use the calculator's numerical solver.

6. For a certain type of glass the critical angle for total internal reflexion is measured to be 43°. Calculate the refractive index for this glass.

7. Calculate the critical angle for total internal reflexion for light going from "Jenaer Glas BK7" into acrylic glass (Plexiglas M222).

8. A simple camera contains a convex lens with a focal length of 50 mm. It is used to take a picture of an object 55 cm from the lens. How far behind the lens do you have to place the film in order to get a sharp image? What is the object's maximum width if the film is 35 mm wide?

9. An object 50 cm from a convex lens has a sharp image on a screen 30 cm behind the lens. The object is moved 10 cm closer to the screen. Where do you have to place the screen to find a sharp image again?

SUPPLEMENTARY PROBLEMS

10. An observer can see the tip of a tower in a small mirror on the floor in front of him. The tower is 42 m, the mirror 2.0 m away from the observer, and they all are on a horizontal plane. Assuming the observers's eye is 1.6 m above the ground, what is the height of the tower?

11. A diver observes the environment through her goggles.
    a) Explain why she sees everything in focus but too close and too big.
    b) What does the world above the water surface look like from this point of view?

12. The image of a nail 3 cm long is placed 7 cm from a convex lens with focal length 3 cm.
    a) Construct the nail's image and determine the image distance and the lateral magnification.
    b) Calculate the object distance for which you get a sharp image on a screen 30 cm from the lens.

13. A candle is placed 20 cm from a convex lens with focal length 10 cm. Where do you have to place a second, identical lens in order to observe a sharp image on the wall 90 cm behind the lens? How large is the image?

NUMERICAL SOLUTIONS: 3. 25 ms; 4. 17.8°, 17.7°; 5. 19.5°; 6. 1.47; 7. 79.5°; 8. 5.5 cm, 35 cm; 9. 35 cm; 10. 32 m; 12. 5.2 cm, 0.73, 3.3 cm; 13. 58 cm or 87 cm from candle, 5.6 cm or 0.55 cm