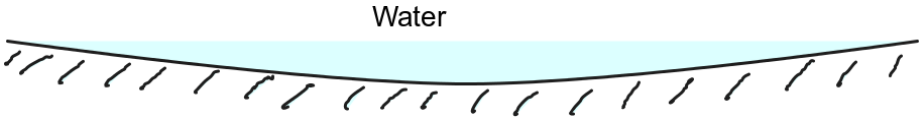
Due Mar. 13, Thursday

All problems must be solved symbolically first. Then, any numerical answer, when required, can be computed by substituting numbers into the symbolic expression at/near the very end. Solving problems symbolically means deriving the answer in terms of symbols, instead of numerical values. All problem numbers refer to those in the textbook. (Not all problems may be graded in detail, due to limited man power; however, you must do all problems.)

For each problem, you are required to use sensible symbols, by defining or adopting them yourself, for your symbolic solution. If you are unsure how to do so, feel free to ask (or look back at homework 1)!

Problem 1 (20 points) A concave spherical mirror is placed on the ground. Overnight, a small amount of rain water accumulated above the mirror surface, as shown. Assuming that the radius of curvature of the mirror $R = 10.0$ m, the refractive index of water $n = 1.333$, answer the following questions.



A concave spherical mirror with the radius of curvature, R

(a) Find the new focal length, f', of this water-containing mirror, by considering the effects of three optical elements that the light encounters, separately in turn, with three optical elements being the water lens, the mirror, and the water lens again, and prove that

$$\frac{1}{f'} = \frac{1}{f_m} + \frac{2}{f_l},$$

where f_m is the focal length of the spherical mirror without water, and f_l is the focal length of the water lens that formed above the mirror.

(b) A small bird is flying directly above the center of the mirror, 10 m high. Where is the image, and what is the lateral magnification?

Problem 2 (20 points) Problem 35.28 (Telescope and Rayleigh criterion).

Problem 3 (10 points) Problem 35.46 (Diffraction grating, Resolving power).

Problem 4 (10 points) Problem 35.81 (X-ray diffraction).

There won't be any homework for chapters 12 and 13. However, you are advised to try some problems yourself, e.g., 12.9, 12.53, 12.57, 13.15, 13.40, and 13.54.
