PHYS-2020: General Physics II
Problem Set 4, Spring 2025

There are two sections to this Problem Set, the first section of problems are located on the textbook publisher's *WebAssign* web site:

https://webassign.com

These problems will be graded and must be completed by 6:00 p.m. on **Wednesday**, April 30, 2025. **Start working on these problems immediately once they are posted on *WebAssign*. Don't wait until the last day to start them. One never knows when the network will go down, and you will not be able to use this as an excuse for not doing your *WebAssign* problems.** As a matter of fact, there will be no allowed excuses for not doing your *WebAssign* homework.

Once you click on the *WebAssign* web site above, click on the "Enter Class Key" button on the upper right of this web page. The class key for this course is:

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A Quick Start Guide for using this web site can be found on the course web page. Should you need additional assistance with *WebAssign*, you can contact Technical Support information at:

https://webassign.com/support/student-support/

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1-800-354-9706

by telephone.

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1. An underwater scuba diver sees the Sun at an apparent angle of 45.0° from the vertical. What is the actual direction of the Sun?

2. A beam of light both reflects and refracts at the surface between the air and glass (see the figure in the solutions). If the index of refraction of the glass is n_g, find the angle of incidence, θ_1, in the air that would result in the reflected ray and the refracted ray being perpendicular to each other. (*Hint:* Remember the identity $\sin(90° - \theta) = \cos\theta$.)

3. A certain kind of glass has an index of refraction 0f 1.650 for blue light of wavelength 430 nm and an index of refraction of 1.615 for red light of wavelength 680 nm. If a

beam containing these two colors is incident at an angle of 30.00° on a piece of this glass, what is the angle between these two beams inside the glass?

4. Consider a common mirage formed by superheated air just above a roadway. A truck driver whose eyes are 2.00 m above the road, where $n = 1.0003$, looks forward. She has the illusion of seeing a patch of water ahead on the road, where her line of sight makes an angle of 1.20° below the horizontal. Find the index of refraction of the air just above the road surface. (*Hint:* Treat this as a problem involving total internal reflection.)

5. A concave spherical mirror has a radius of curvature of 20.0 cm. Locate the images for object distances of (a) 40.0 cm, (b) 20.0 cm, and (c) 10.0 cm. In each case, state whether the image is real or virtual, and upright or inverted, and find the magnification.

6. A diverging lens has a focal length of magnitude 20.0 cm. (a) Locate the images for object distances of (i) 40.0 cm, (ii) 20.0 cm, and (iii) 10.0 cm. For each case, state whether the image is (b) real or virtual and (c) upright or inverted. (d) For each case, find the magnification.

7. The desired overall magnification of a compound microscope is 140×. The objective alone produces a lateral magnification of 12×. Determine the required focal length of the eyepiece.

8. A spy satellite circles the Earth at an altitude of 200 km and carries out surveillance with a special high-resolution telescopic camera having a lens diameter of 35 cm. If the angular resolution of this camera is limited by diffraction, estimate the separation of two small objects on Earth's surface that are just resolved in yellow-green light ($\lambda = 550$ nm).

9. Intense white light is incident on a diffraction grating that has 600 lines/mm. (a) What is the highest order in which the complete visible spectrum can be seen with this grating? (b) What is the angular separation between the violet edge (400 nm) and the red edge (700 nm) of the first-order spectrum produced by the grating?