Work two of the following six problems in Chapter 24:
One from \{1, 2, 3\}, and one from \{4, 5, 6\}.

1) A lens forms a real image that is 214 cm away from the object and 1.6667 times its length. What kind of lens is this, and what is the focal length? (Hints: The image is real so \( s' > 0 \) and \( s + s' = 2.14 \text{ m} \) and \( m = -\frac{s'}{s}, f = \frac{ss'}{(s+s')} \)).

2) A luminous object is 4.00 m from a wall. You are to use a concave mirror to project an image of the object on the wall, with the image 2.25 times the size of the object. How far should the mirror be from the wall? What should its radius of curvature be? (Hints: \( \frac{1}{s} + \frac{1}{s'} = \frac{2}{R} \) and \( m = -\frac{s}{s'} \)).

3) A concave mirror is to form an image of the filament of a headlight lamp on a screen 8.0 m in from the mirror. The filament is 6.0 mm tall, and the image is to be 36.0 cm tall. (a) How far in front of the vertex of the mirror should the filament be placed? (b) To what radius of curvature should you grind the mirror? (Hints: \( \frac{1}{s} + \frac{1}{s'} = \frac{2}{R} \) and \( m = -\frac{s}{s'} \)).

4) A layer of benzene (\( n = 1.50 \)) 2.60 cm deep floats on water (\( n = 1.33 \)) that is 6.50 cm deep. What is the apparent distance from the upper benzene surface to the bottom of the water layer when it is viewed at normal incidence? (Hints: \( \frac{n_b}{s} + \frac{n_w}{s'} = \frac{n_b-n_w}{R} \) and \( R \to \infty, \text{ find } s' \text{ for both interfaces} \)).

5) A lens has one convex surface of radius 6.00 cm and one concave surface of radius 10.0 cm. When an object is placed 35.0 cm from the lens, a real image is formed 50 cm from the lens. (a) What is the focal length of the lens? (b) What is the index of refraction of the lens? (Hints: \( \frac{1}{f} = (n-1) \left( \frac{1}{R_1} + \frac{1}{R_2} \right) \)).

6) An object is placed 18.0 cm from a screen. (a) At what two points between object and screen may a converging lens with a 3.00 cm focal length be placed to obtain an image on the screen? (b) What is the magnification of the image for each position of the lens? (Hints: \( \frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \) and \( m = -\frac{s}{s'} \)).

Work four of the following six problems in Chapter 25:
Two from \{7, 8, 9\}, and two from \{10, 11, 12\}.

7) The objective mirror of the Hubble Space Telescope has a focal length of 57.6 m. The planet Mars’s closest approach to the Earth is about \( 5.63 \times 10^{10} \text{ m} \). Use the fact that Mar’s diameter is \( 6.80 \times 10^6 \text{ m} \) to calculate size of the real image of Mars formed by the Hubble’s objective mirror when the planet is closest to Earth. (Hints: \( \frac{1}{s} + \frac{1}{s'} = \frac{1}{f}, \left| \frac{y'}{1\text{yr}} \right| = \left| \frac{ss'}{s} \right| \)).
8) Curvature of the cornea. In a simplified model of the human eye, the aqueous and vitreous humors and the lens all have a refractive index of 1.40, and all refraction occurs at the cornea, whose vertex is 2.60 cm from the retina. What should be the radius of curvature of the cornea such that the image of an object 40.0 cm from the cornea’s vertex is focused on the retina? (Hints: \( \frac{n_a}{s} + \frac{n_b}{s'} = \frac{n_b-n_a}{R} \) find \( R \)).

9) You are examining a flea with a converging lens that has a focal length of 4.00 cm. If the image of the flea is 6.50 times the size of the flea, how far is the flea from the lens? Where, relative to the lens, is the image? (Hints: \( m = -\frac{s}{s'} \) and \( \frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \) to find \( s' \)).

10) Laser eye surgery. The distance from the vertex of the cornea to the retina for a certain nearsighted person is 2.75 cm, and the radius of curvature of her cornea is 0.700 cm. She decides to get laser surgery to correct her vision. Using the simplified mode of the eye described in Problem 8 above, calculate the radius of curvature for her cornea that the surgeon should aim for, in order to allow her to view distant objects with a relaxed eye. (Hints: \( \frac{n_b}{s} + \frac{n_w}{s'} = \frac{n_b-n_w}{R} \), solve for \( R \))

11) A microscope with an objective of focal length 8.00 mm and an eyepiece of focal length 7.50 cm is used to project an image on a screen 2.00 m from the eyepiece. Let the image distance of the objective be 18.00 cm. (a) What is the lateral magnification of the image? (b) What is the distance between the objective and the eyepiece? (Hints: \( \frac{1}{f} = \frac{(n-1)}{R_1} + \frac{1}{R_2} \), \( M = -\frac{f_1}{f_2} \), Length of the telescope = \( f_1 + f_2 \)).

12) Galileo’s telescopes, II. The characteristics that follow are characteristics of two of Galileo’s surviving double-convex lenses. The numbers given are magnitudes only: you must supply the correct signs. \( L_1 \): front radius = 930 mm, rear radius = 27,000 mm, refractive index = 1.538, \( L_2 \): front radius = 535 mm, rear radius = 50,500 mm, refractive index = 1.550. (a) What is the largest angular magnification that Galileo could have obtained with the two lenses? (b) How long would this telescope be between the two lenses? (Hints: \( \frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right) \), \( M = -\frac{f_1}{f_2} \), Length of the telescope = \( f_1 + f_2 \)).