313. For problem 312, find the bowl's radius of curvature.

314. A concave spherical mirror on a dressing table has a focal length of 60.0 cm. If someone sits 35.0 cm in front of it, where is the image?

315. What is the magnification in problem 314?

316. An image appears 5.2 cm behind the surface of a convex mirror when the object is 17 cm in front of the mirror. What is the mirror's focal length?

317. If the object in problem 316 is 3.2 cm tall, how tall is its image?

318. In order for someone to observe an object, the wavelength of the light must be smaller than the object. The Bohr radius of a hydrogen atom is $5.291\,770 \times 10^{-11}$ m. What is the lowest frequency that can be used to locate a hydrogen atom?

319. Meteorologists use Doppler radar to watch the movement of storms. If a weather station uses electromagnetic waves with a frequency of 2.85×10^{9} Hz, what is the wavelength of the radiation?

320. PCS cellular phones have antennas that use radio frequencies from 1800–2000 MHz. What range of wavelengths corresponds to these frequencies?

321. Suppose you have a mirror with a focal length of 32.0 cm. Where would you place your right hand so that you appear to be shaking hands with yourself?

322. A car's headlamp is made of a light bulb in front of a concave spherical mirror. If the bulb is 5.0 cm in front of the mirror, what is the radius of the mirror?

323. Suppose you are 19 cm in front of the bell of your friend's trumpet and you see your image at 14 cm. If the trumpet's bell is a concave mirror, what would be its focal length?

324. A soup ladle is like a spherical convex mirror with a focal length of 27 cm. If you are 43 cm in front of the ladle, where does the image appear?

325. What is the magnification in problem 324?

326. Just after you dry a spoon, you look into the convex part of the spoon. If the spoon has a focal length of −8.2 cm and you are 18 cm in front of the spoon, where does the image appear?

327. The base of a lamp is made of a convex spherical mirror with a focal length of −39 cm. Where does the image appear when you are 16 cm from the base?

328. Consider the lamp and location in problem 327. If your nose is 6.0 cm long, how long does the image appear?

329. How fast does microwave radiation that has a frequency of $1.173\,06 \times 10^{11}$ Hz and a wavelength of 2.5556 mm travel?

330. Suppose the microwaves in your microwave oven have a frequency of 2.5×10^{10} Hz. What is the wavelength of these microwaves?

331. You place an electric heater 3.00 m in front of a concave spherical mirror that has a focal length of 30.0 cm. Where would your hand feel warmest?

332. You see an image of your hand as you reach for a doorknob with a focal length of 6.3 cm. How far from the doorknob is your hand when the image appears at 5.1 cm behind the doorknob?

333. What is the magnification of the image in problem 332?

Chapter 14 Refraction

334. A ray of light in air enters an amethyst crystal ($n = 1.553$). If the angle of refraction is 35°, what is the angle of incidence?

335. Light passes from air at an angle of incidence of 59.2° into a nephrite jade vase ($n = 1.61$). Determine the angle of refraction in the jade.

336. Light entering a pearl travels at a speed of 1.97×10^{8} m/s. What is the pearl's index of refraction?

337. An object in front of a diverging lens of focal length 13.0 cm forms an image with a magnification of +5.00. How far from the lens is the object placed?

338. An object with a height of 18 cm is placed in front of a converging lens. The image height is −9.0 cm. What is the magnification of the lens?

339. If the focal length of the lens in problem 338 is 6.0 cm, how far in front of the lens is the object?

340. Where does the image appear in problem 339?

341. The critical angle for light traveling from a green tourmaline gemstone into air is 37.8°. What is tourmaline's index of refraction?

342. Find the critical angle for light traveling from ruby ($n = 1.766$) into air.

343. Find the critical angle for light traveling from emerald ($n = 1.576$) into air.