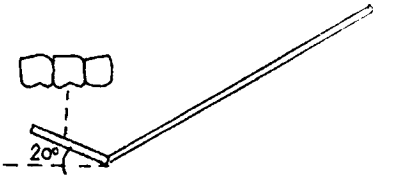
Additional Exercises

A-1: Radio waves travel at the speed of light. How long would it take the Russians to send a message to a spacecraft orbiting Mars at a distance of 7.8×10^{10} m from Earth?

A-2: At the doctor's office, an X-ray of your hand is taken with electromagnetic radiation of frequency 3.00×10^{17} Hz. What is the wavelength of this radiation?

A-3: In order to see your back teeth more easily, your dentist uses a small mirrored instrument that can be easily manipulated in your mouth. If the dentist places this mirror directly under a real molar, and tilts it 20°, at what angle to the normal will the dentist need to look into the mirror in order to see the tooth?



A-4: While decorating his Christmas tree, Vinnie discovers that he can see his reflection in a Christmas tree ball. a) If Vinnie looks into the ornament from a distance of 20.0 cm and focuses on his reflection 4.0 cm behind the ball, what is the focal length of the Christmas ball? b) Is Vinnie's image upright or inverted? c) Is his image larger or smaller?

A-5: Some rear-view mirrors on cars and trucks are curved to allow for a wider field of view. a) Would these mirrors be converging or diverging? b) Why might this be a little dangerous for a driver unaccustomed to this type of mirror? c) If the mirror has a focal length of 20.0 cm and the truck driver looks in the mirror from a distance of 30.0 cm, where does he see his image?

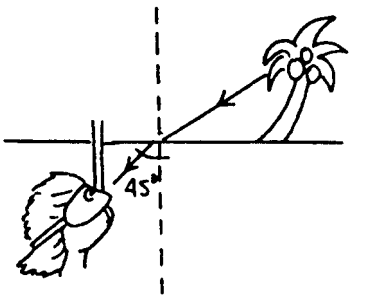
A-6: Wes stands in his hotel room in Cancun and admires his tan in a mirror that allows him to look "larger than life." a) What type of mirror is Wes using? b) Where should Wes stand in relation to the focal point of the mirror in order to appear enlarged? c) If the mirror has a focal length of 75.0 cm, and Wes stands 50.0 cm from the mirror's surface, how far behind the mirror is his image? d) Where does he see his image if he stands 200. cm from the mirror?

A-7: An automobile headlight is made by placing a filament at the focal point of a concave mirrored surface. a) If the focal length of the mirrored surface is 5.0 cm, calculate the image distance. b) Why is this the desired image distance for automobile headlights?

A-8: A blue glow from a bug light strikes the Bradford's swimming pool at an angle of 35.0°. At what angle is the light refracted into the pool? ($n_{water} = 1.33$)

A-9: The index of refraction of ethyl alcohol is 1.36, while the index of refraction of water is 1.33. a) Does light travel faster in alcohol or in water? b) What is the speed of light in each?

A-10: Heather is snorkeling in Oahu's Hanuma Bay when she looks up through the water at a palm tree on the shore. a) If the index of refraction of water is 1.33 and Heather sees the palm tree at an angle of 45°, at what angle is the palm tree really located with respect to the normal?



A-11: Spenser, a cat, enjoys watching the family goldfish from the top of the fish tank. If the goldfish, swimming in water, appears to be at an angle of 28.0° as seen by Spenser, at what true angle is the goldfish from the normal? ($n_{water} = 1.33$)

A-12: Evan has taken Eva out to dinner to propose marriage and he has hidden the engagement ring in her drink as a surprise. When Eva has finished her drink, she spots the ring beneath an ice cube. If Eva looks down into the glass at an angle of 61.0° but the ice cube refracts the ring at an angle of 42.0°, what is the index of refraction of ice?

A-13: In her bedroom, Mia has a fiber optic light that glows as hundreds of fiber optic cables are lit from below. a) If each fiber optic cable has an index of refraction of 1.48, at what critical angle must light enter the cable in order for total internal reflection to occur? b) Explain why total internal reflection is important to a fiber optic lamp.

A1. 260 s

A3. $20°$

A5. c) -12.0 cm

A7. a) ∞

A9. b) alcohol: 2.21×10^8 m/s
water: 2.26×10^8 m/s

A11. $20.7°$

A13. a) $42.5°$