Conceptual Questions

25.2 The Law of Reflection

1.

Using the law of reflection, explain how powder takes the shine off of a person's nose. What is the name of the optical effect?

25.3 The Law of Refraction

2.

Diffusion by reflection from a rough surface is described in this chapter. Light can also be diffused by refraction. Describe how this occurs in a specific situation, such as light interacting with crushed ice.

3.

Why is the index of refraction always greater than or equal to 1?

4.

Does the fact that the light flash from lightning reaches you before its sound prove that the speed of light is extremely large or simply that it is greater than the speed of sound? Discuss how you could use this effect to get an estimate of the speed of light.

5.

Will light change direction toward or away from the perpendicular when it goes from air to water? Water to glass? Glass to air?

6.

Explain why an object in water always appears to be at a depth shallower than it actually is? Why do people sometimes sustain neck and spinal injuries when diving into unfamiliar ponds or waters?

7.

Explain why a person's legs appear very short when wading in a pool. Justify your explanation with a ray diagram showing the path of rays from the feet to the eye of an observer who is out of the water.

8.

Why is the front surface of a thermometer curved as shown?

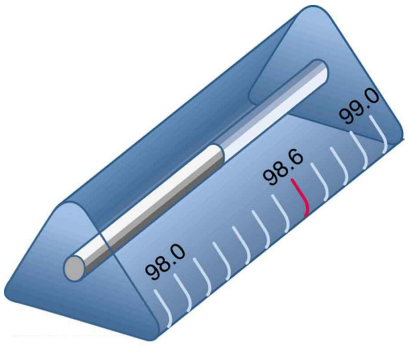

Figure 25.45 The curved surface of the thermometer serves a purpose.

9.

Suppose light were incident from air onto a material that had a negative index of refraction, say –1.3; where does the refracted light ray go?

25.4 Total Internal Reflection

10.

A ring with a colorless gemstone is dropped into water. The gemstone becomes invisible when submerged. Can it be a diamond? Explain.

11.

A high-quality diamond may be quite clear and colorless, transmitting all visible wavelengths with little absorption. Explain how it can sparkle with flashes of brilliant color when illuminated by white light.

12.

Is it possible that total internal reflection plays a role in rainbows? Explain in terms of indices of refraction and angles, perhaps referring to Figure 25.46. Some of us have seen the formation of a double rainbow. Is it physically possible to observe a triple rainbow?

Figure 25.46 Double rainbows are not a very common observance. (credit: InvictusOU812, Flickr)

13.

The most common type of mirage is an illusion that light from faraway objects is reflected by a pool of water that is not really there. Mirages are generally observed in deserts, when there is a hot layer of air near the ground. Given that the refractive index of air is lower for air at higher temperatures, explain how mirages can be formed.

25.6 Image Formation by Lenses

14.

It can be argued that a flat piece of glass, such as in a window, is like a lens with an infinite focal length. If so, where does it form an image? That is, how are d_{i} and d_{o} related?

15.

You can often see a reflection when looking at a sheet of glass, particularly if it is darker on the other side. Explain why you can often see a double image in such circumstances.

16.

When you focus a camera, you adjust the distance of the lens from the film. If the camera lens acts like a thin lens, why can it not be a fixed distance from the film for both near and distant objects?

17.

A thin lens has two focal points, one on either side, at equal distances from its center, and should behave the same for light entering from either side. Look

through your eyeglasses (or those of a friend) backward and forward and comment on whether they are thin lenses.

18.

Will the focal length of a lens change when it is submerged in water? Explain.

25.7 Image Formation by Mirrors

19.

What are the differences between real and virtual images? How can you tell (by looking) whether an image formed by a single lens or mirror is real or virtual?

20.

Can you see a virtual image? Can you photograph one? Can one be projected onto a screen with additional lenses or mirrors? Explain your responses.

21.

Is it necessary to project a real image onto a screen for it to exist?

22.

At what distance is an image *always* located—at d_{o}, d_{i}, or f?

23.

Under what circumstances will an image be located at the focal point of a lens or mirror?

24.

What is meant by a negative magnification? What is meant by a magnification that is less than 1 in magnitude?

25.

Can a case 1 image be larger than the object even though its magnification is always negative? Explain.

26.

Figure 25.47 shows a light bulb between two mirrors. One mirror produces a beam of light with parallel rays; the other keeps light from escaping without being put into the beam. Where is the filament of the light in relation to the focal point or radius of curvature of each mirror?

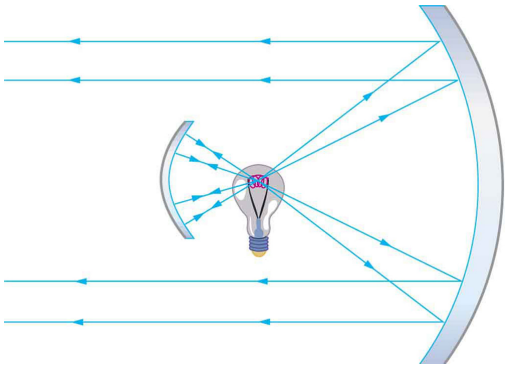

Figure 25.47 The two mirrors trap most of the bulb's light and form a directional beam as in a headlight.

27.

Devise an arrangement of mirrors allowing you to see the back of your head. What is the minimum number of mirrors needed for this task?

28.

If you wish to see your entire body in a flat mirror (from head to toe), how tall should the mirror be? Does its size depend upon your distance away from the mirror? Provide a sketch.

29.

It can be argued that a flat mirror has an infinite focal length. If so, where does it form an image? That is, how are d_{i} and d_{o} related?

30.

Why are diverging mirrors often used for rear-view mirrors in vehicles? What is the main disadvantage of using such a mirror compared with a flat one?