Name: ____________________________ Date: ________________ Period: ________

28.2 Law of Reflection

As Fermat showed, the angle of incident light will be the same as the angle of reflected light. This is the **law of reflection**, and it holds for all angles (Figure 28.5):

The angle of incidence equals the angle of reflection.

The law of reflection is illustrated with arrows representing light rays in Figure 28.6. Instead of measuring the angles of incident and reflected rays from the reflecting surface, it is customary to measure them from a line perpendicular to the plane of the reflecting surface. This imaginary line is called the *normal*. The incident ray, the normal, and the reflected ray all lie in the same plane. Such reflection from a smooth surface is called *specular* reflection. Mirrors produce excellent specular reflections.

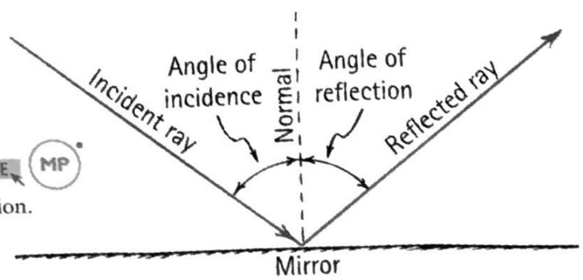


FIGURE 28.6
INTERACTIVE FIGURE MP

The law of reflection.

Plane Mirrors

Suppose a candle flame is placed in front of a plane mirror. Rays of light radiate from the flame in all directions. Figure 28.7 shows only four of the infinite number of rays leaving one of the infinite number of points on the candle. These rays diverge from the candle flame and encounter the mirror, where they are reflected at angles equal to their angles of incidence. The rays diverge from the mirror and appear to emanate from a particular point behind the mirror (where the dashed lines intersect). An observer sees an image of the flame at this point. The light rays do not actually originate from this point, so the image is called a *virtual image*. The image is as far behind the mirror as the object is in front of the mirror, and image and object have the same size. When you view yourself in a mirror, for example, the size of your image is the same as the size your twin would appear if located the same distance behind the mirror as you are in front—as long as the mirror is flat (we call a flat mirror a *plane mirror*).

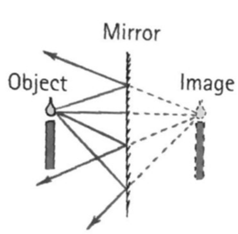
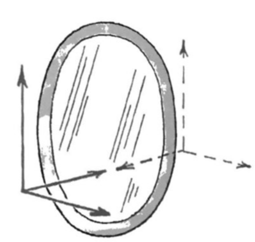


FIGURE 28.7
A virtual image is formed behind the mirror and is located at the position where the extended reflected rays (dashed lines) converge.

FIGURE 28.8
Marjorie's image is as far behind the mirror as she is in front. Note that she and her image have the same color of clothing—evidence that light doesn't change frequency upon reflection. Interestingly, her left–right axis is no more reversed than her up–down axis. The axis that *is* reversed, as shown to the right, is front–back. That's why it seems like her left hand faces the right hand of her image.



the window.

Diffuse Reflection

When light is incident on a rough or granular surface, it is reflected in many directions. This is called *diffuse reflection* (Figure 28.10). If the surface is so smooth that the distances between successive elevations on the surface are less than about one-eighth the wavelength of the light, there is very little diffuse reflection, and the surface is said to be *polished*. A surface, therefore, may be polished for radiation of a long wavelength but not polished for light of a short wavelength. The wire-mesh "dish" shown in Figure 28.11 is very rough for light waves and so is hardly mirrorlike, but for long-wavelength radio waves, it is "polished" and therefore an excellent reflector. Reflection off the walls of your room is a good example of diffuse reflection. The light reflects back into the room but produces no mirror images. Unlike specular reflection, diffuse reflection does not produce a mirror image.

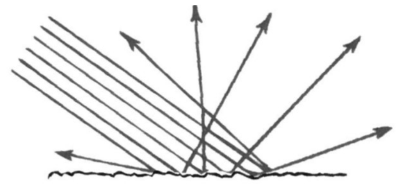


FIGURE 28.10
Diffuse reflection. Although each ray obeys the law of reflection, the many different surface angles that light rays encounter in striking a rough surface cause reflection in many directions.

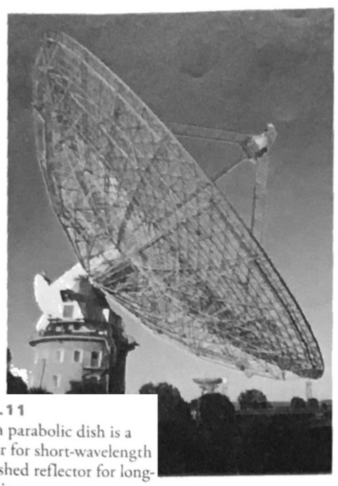


FIGURE 28.11
The open-mesh parabolic dish is a diffuse reflector for short-wavelength light but a polished reflector for long-wavelength radio waves.

Light reflecting from this page is diffuse. The page may be smooth to a radio wave, but it is rough to a light wave. Rays of light that strike this page encounter millions of tiny flat surfaces facing in all directions. The incident light therefore is reflected in all directions, which enables us to see the page or other objects from any direction. You can see the road ahead of your car at night, for instance, because of diffuse reflection by the road surface. When the road is wet, diffuse reflection is less, and it is more difficult to see. Most of our environment is seen by diffuse reflection.

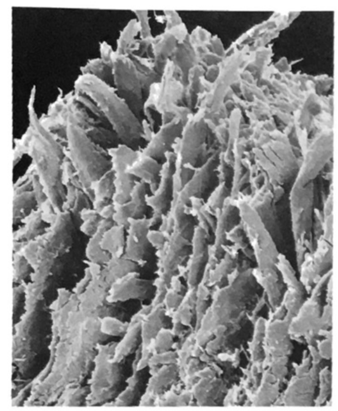


FIGURE 28.12
A magnified view of the surface of ordinary paper.