When a wave reaches a boundary between two materials, some wave bounces back into the first material. The return of a wave back into its original material is called reflection. (579)

When a wave that is traveling at an angle changes its speed upon crossing a boundary between two materials, it bends. This bending is called refraction. (585)

Usually waves are partly reflected and partly refracted when they fall on a transparent material. (578)

When light is incident on a rough surface, it is reflected in many directions, producing diffuse reflection. (582)

<u>Reflection:</u>

Fig. 29.3:

Incident ray: the ray that shines on the mirror

Reflected ray: the ray that reflects from the mirror

Normal: an imaginary line perpendicular to the mirror's surface

Angle of incidence: the angle between the normal and the incident ray

Angle of reflection: the angle between the normal and the reflected ray

The law of reflection states that the angle of incidence and the angle of reflection are equal to each other. (580)

<u>Plane Mirrors</u>

Plane mirrors are flat-shaped. (580)

A virtual image is an image that appears to be in a location where light does not really reach. (581)

Virtual images are right-side-up.

Plane mirrors produce only virtual images. (581)

Figure 29.5:

In a plane mirror, object size equals image size.

In a plane mirror, object distance equals image distance.

Refraction

Changes in the speed of light as it passes from one material to another cause refraction. (587)

When light rays enter a material in which their speed decreases, the rays bend toward the normal. (587)

When light rays enter a material in which their speed increases, the rays bend away from normal.

The more the change in speed, the more the light bean changes direction.

Figure 29.17:

A "wave front" represents the crest of a wave. (585)

As a light waves passes from air into water, its speed decreases, so the light bends toward the normal.

Label the angle of incidence, angle of refraction, both measured from the normal

Light travels as fast as it can possibly go in air. This speed is 300 million m/s, and is labeled *c*.

The index of refraction *n* is defined as , where *c* is the speed of light in air, and *v* is the speed of light in a material. (904)

The index of refraction is a property of a material, and can be looked up for many materials.

[Tables below for use on homework, will be given on tests – do not memorize them.]

Honors Only:

Snell's law says (904)

QUIZ 1

Total Internal Reflection:

Critical angle: The angle of incidence that results in a 90º angle of refraction. (594)

The critical angle only exists when light bends away from the normal.

Total internal reflection is the complete reflection of light back into its original material. (594)

Total internal reflection occurs when the angle of incidence is larger than the critical angle. (594)

Lenses

A real image is formed by converging light. (605)

A real image is inverted, meaning it is upside-down compared to the object. (605)

A real image can be focused on a screen. (605)

A lens forms an image by bending rays of light that pass through it. (603)

Converging lens: thicker in the middle, causing parallel rays to meet at the focal point. (603)

Diverging lens: thinner in the middle, causing parallel rays to bend away from the focal point. (603)

The *focal length* of a lens, whether converging or diverging, is the distance between the center of the lens and its focal point. (604)

The focal lengths on either side are equal, even when the curvatures on the two sides are not. (604)

A converging lens forms either a real or a virtual image. (610)

When the object is between the focal point and a converging lens, the image is virtual.

When the object is farther from a converging lens than the focal point, the image is real.

A diverging lens always forms a virtual image. (610)

<u>Lens Ray Diagrams</u>

Ray diagrams show the principal rays that can be used to determine the size and location of an image. (606)

An arrow is used to represent the object (which may be anything imaged by the lens). (606)

To locate the position of the image, you only have to know the paths of two rays from a point on the object. (607)

Lenses, Figure 30.9:

1. A ray parallel to the principal axis will converge to (or diverge from) the focal point

2. A ray through the center of the lens proceeds in a straight line

We use these particular rays only because their paths through the lens are easy to predict. You should know that ALL light passing through a lens contributes to image formation. (607, mouse quotation)

The image distance is measured along the principal axis from the center of the lens to the location of the image.

The object distance is measured along the principal axis from the center of the lens to the location of the object.

Quiz 2

<u>Mirrors</u>

Converging mirror: shaped like the inside of a spoon, causing parallel rays to meet at the focal point

Diverging mirror: shaped like the outside of a spoon, causing parallel rays to reflect away from the focal point

A converging mirror forms either a real or a virtual image.

When the object is between the focal point and a converging mirror, the image is virtual.

When the object is farther from a converging mirror than the focal point, the image is real.

A diverging mirror always forms a virtual image. (610)

Mirror ray diagrams:

1. A ray parallel to the principal axis will reflect to (or be reflected away from) the focal point

2. A ray through the center of the mirror reflects back toward the center of the mirror.

We use these particular rays only because their paths through the lens are easy to predict. You should know that ALL light reflected off of a mirror contributes to image formation. (607, mouse quotation)

The image distance is measured along the principal axis from the mirror itself to the location of the image.

The object distance is measured along the principal axis from the mirror itself to the location of the object.

<u>*Honors Only:*</u>

The thin lens equation states that , where f is the focal length, d_i the image distance, and d_o the object distance. (604, though with different variables) *This equation is valid for both mirrors and lenses.*

In this equation, all values are positive except:

- *f is negative for diverging lenses or mirrors*
- *d_i is negative for virtual images*

TEST 1