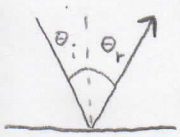
PH202-1G
Spring 2014

Worksheet March 5

Propagation of light

Describe the propagation of light using Huygen's principle.

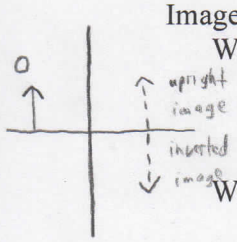
Light propagates as spherical wavefronts. Light rays travel perpendicular to the spherical wavelengths.



Describe the law of reflection. What is the difference between specular and diffuse reflection? Do they both obey the law of reflection?

Law of reflection is $\theta_i = \theta_r$. Specular reflection smooth and preserves parallel orientation, while diffuse reflection scatters light. Both obey the law of reflection for each individual light ray.

Images

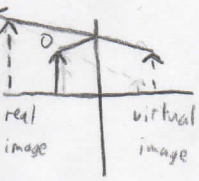


What is the difference between an upright image and an inverted image?

An upright image points in the same direction as the object. An inverted image points in the opposite direction.

What is the difference between a real image and a virtual image?

A real image occurs at the intersection of actual light rays. A virtual image occurs at the intersection of the light rays that would exist if there was no mirror.



What does a positive object or image distance indicate? What does a negative object or image distance indicate?

A positive image distance indicates that the image is in front of the mirror.

A negative image distance indicates that the image is behind the mirror.

Define magnification in terms of both distances and heights. Why is the sign of the magnification important?

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

The sign of the magnification tells you whether the image is upright (+) or inverted (-).

Plane mirrors

What kind of images do plane mirrors produce? Upright or inverted? Real or virtual?

Plane mirrors produce upright, virtual images whose size is the same as the object.

What is the magnification of a plane mirror?

The magnification of a plane mirror is +1.

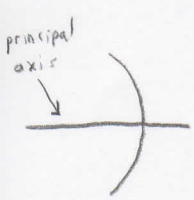
Spherical mirrors

What is the center of curvature of a spherical mirror? What is the focal point of a spherical mirror?

$F = \frac{1}{2}R$

The center of curvature is the center of the sphere which defines the geometry of a spherical mirror. The Focal point is halfway between the center of curvature and the mirror.

What is the principal axis? What happens to rays which are traveling parallel to the principal axis when they strike a spherical mirror?



The principal axis bisects the mirror and goes through the center of curvature. Rays parallel to the principal axis are reflected toward the Focal point.

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What is a ray diagram? What three rays should be drawn in a ray diagram?

Ray diagrams are used to find the image created by a mirror. Rays from the top of the object should be drawn through the center of curvature, through the focal length, and parallel to the principal axis.

Give a mathematical expression relating the image distance and object distance for a spherical mirror.

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

What kind of images do concave mirrors produce? Does it depend on the object distance? – For concave, yes.

If $d_o < f$, the image will be virtual, upright, and enlarged. If $f < d_o < R$, the image will be real, inverted, and enlarged. If $d_o > R$, the image will be real, inverted, and diminished.

What kind of images of convex mirrors produce? Does it depend on the object distance?

For convex, no.

Convex mirrors produce virtual, upright, and diminished images.

Problems

1. An 1.0-m tall object is placed 1.33 m in front of a concave mirror with a radius of curvature of 2.00 m. a) Predict qualitatively what the image will look like. Will it be real or virtual? Upright or inverted? Larger or smaller? b) Draw a ray diagram to determine the approximate location and height of the image. Were your predictions in part (a) correct? c) Calculate the image distance, magnification, and image height. Include the signs for each of these quantities. Do your values and signs match your results from the ray diagram in part (b)?

$$f = \frac{R}{2} = \frac{2.00\ m}{2} = 1.00\ m$$

a) For a concave mirror and an object placed in between the focal point and radius, the image will be real, inverted, and enlarged.

b)

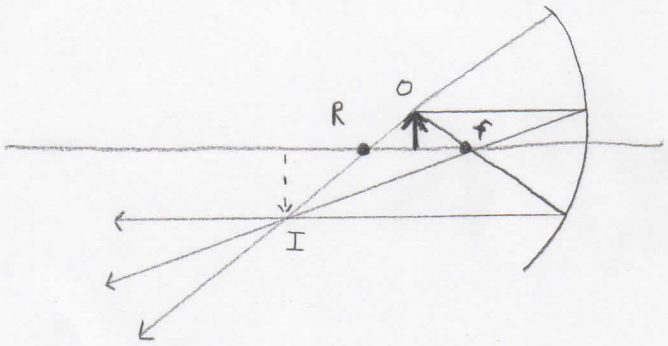

Image is real, i.e. the light rays actually pass through the image.

Image is inverted and enlarged.

c) Image distance: $\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o} \Rightarrow d_i = \left(\frac{1}{f} - \frac{1}{d_o}\right)^{-1} = \left(\frac{1}{1.00\ m} - \frac{1}{1.33\ m}\right)^{-1}$

$$d_i = 4.00\ m$$

Magnification: $M = -\frac{d_i}{d_o} = -\frac{4.00\ m}{1.33\ m} = -3.00$

Image height: $h_i = M h_o = -3.00 \cdot 1.0\ m = -3.0\ m$