Sean Keith/Kate Howard Physics Review Chapter 24 Geometric Optics

Vocabulary

Plane Mirror - A flat, smooth surface on which light is reflected.

Image - The brain's interpretation of the rays from a reflection in a mirror. When the image's rays do not converge at a single point, it is called a virtual image.

Erect Image - When the image and object are pointing in the same direction. For example, when you look in a mirror and you are facing the same way, not upside down. Left and Right are reversed when you look into a mirror, but this does not make the image not erect.

Concave Mirror - Spherical mirror whose surface is "caved in". Light reflects from the inside surface. Concave mirrors can form real images

Convex Mirror - Spherical Mirror that is protruding, light reflects from the outer surface. Rays from convex mirrors diverge, so they never form real images.

Principal Axis - Straight line perpendicular to the surface of the center of the mirror.

Focal Point - The point where a the reflection of a ray of light off a mirror's surface converges with the principle axis. Marked as "F" on a diagram. Half the distance between the Center of Curvature and the mirror.

Focal Length - The distance from the focal point to the the center of the mirror on the principle axis. The focal length is equal to half the radius of curvature.

Real Image - Rays converge and pass through the image. Real images can be projected, reflected, and seen on other surfaces, such as paper or canvas.

Virtual Images - Rays do not converge and the image cannot be projected or reflected, because the rays never meet at any point. Virtual images are the result of convex mirrors.

Spherical Aberration - There is a disk image formed by parallel rays in a large spherical mirror, as opposed to a single point. Many rays converge at the focal point, others at other points close to the mirror. This occurs in concave mirrors only.

Lens- Transparent material made of glass or plastic usually, with a refractive index that is greater than the amount in air.

Convex Lens - Thicker at the center of the lens than at the edges. The rays passing through this lense converge. These lenses create real images.

Concave Lens- Thinner in the center than at at the edges. The rays passing through this lense diverge. These lenses will not have real images, only virtual images.

Chromatic Aberration - The light passing through a lens becomes distributed near the edges giving it color due to white light being refracted, and images viewed through a lens are often tinged with color. This effect of lenses is not shared with mirrors.

Achromatic Lens- When a concave lens joins a convex lens, a different scale of refraction is caused. The combination cancels the light dispersion, while the lenses combine for an index of refraction that allow the rays to still converge, creating a real image. This allows the lens to not have a tinted or spectrum-ringed color, and the achromatic lens is transparent and is what is used for contact lenses, glasses, and other optical devices where no color distortion is desired.

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Helpful equations and facts

2f = r (Two times the focal length is equal to the radius of the curvature of the mirror)

Distance of object (Do) is positive for real objects
Distance of object (Do) is negative for virtual objects
Distance of image (Di) is positive for real images
Distance of image (Di) is negative for virtual images
f (focal length) is positive for concave mirrors
f (focal length) is negative for convex mirrors

Lens/Mirror equation

1/f = 1/di (distance of image) + 1/do (distance of object)

This equation is used to determine focal length, or distance of object/image depending upon given variables

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Magnification equation

m= hi (size of image) / ho (size of object)

m = -di / do

hi/ho = -di/do

Examples of concave mirrors = Handheld mirrors, shaving/makeup mirrors. These mirrors want to make the object appear bigger.

Examples of convex mirrors = Rearview mirrors in cars, mirrors on the hood of a schoolbus, mirrors in malls to monitor shoppers. Mirrors that want the image to appear smaller, but increase field of view.

Useful lens information

f is positive for convex lenses
f is negative for concave lenses
di is positive when the image on the other side of the lens is real
di is negative on the object side of the lens when the image is virtual

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Practice Problems

Multiple Choice

1) A convex mirror can produce real images
A) Yes B) No

2) Chromatic Aberration is prevented by
A) Changing the refractive index of a convex lens
B) Combining a convex and concave lens
C) Using two concave lenses with high indexes of refraction

3) The goal of concave and convex mirrors, respectively are
A) Decrease/Increase Image Size B) Increase/Decrease Image size C) Increase Both D) Decrease both

4) A real image can only be seen through which of these lenses
A) Concave Lens B) An achromatic lens C) Convex lens D) An chromatic aberration lens

5) The height of an object is 2 meters, it's distance from the mirror is 200 meters. The distance of the image from the mirror is 45 meters, what is the height of the image? Round to the nearest tenth.
A) 8.5 meters B) 9.2 meters C) 8.9 Meters D) 8.7 Meters

Written Questions

1) Find the magnification of the object, and the distance of image. Given information Hi= 5.5cm Ho= 7.5cm Do= 10cm

2) The focal length for this mirror is 25 cm. The distance of the object is 12 cm. Find the distance of the image.

3) 60 cm away from a convex mirror lies a 10 cm real object. The focal length is 20cm. Find the location and size of the image

4) An object lies 65 cm from a convex lens that has a focal length of 18cm. What is the distance of the image.

5) A convex mirror has a radius of curvature of 0.5 m. A 1m high object is 2.5 m from the mirror. What is the location and size of the image?

ANSWERS

Mult Choice

1-A
2-B
3-B
4-C
5-C

Written

Answer 1) 7.33cm, 0.73 times magnified

Answer 2) -23.077 cm

Answer 3) - Location= -7.50cm inverted, real image. Size = 1.25 cm height

Answer 4) = -24.894 cm

Answer 5) -.25 cm upright, reduced