

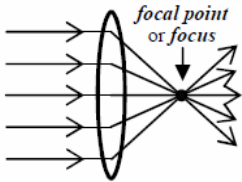
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Optics Basics

Focal Point

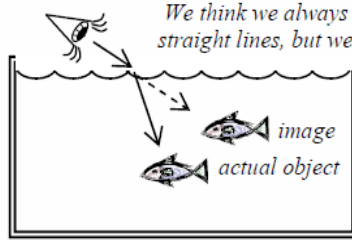
Every lens or mirror has a place where incoming parallel light rays will meet. This is known as the **focal point** or **focus**.



The focal point is NOT where the image is in focus (unless the object is at infinity).

Straight Lines

Mirrors and lenses make things look bigger or smaller because our eyes always think that light comes from straight lines, even if they have been refracted or reflected.



Object vs. Image

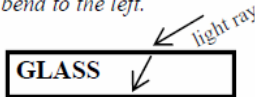
The **image** is what you think you see: it can be enlarged, reduced, or moved.

The **object** is what you are looking at: the actual thing (*the actual fish*).

Refraction

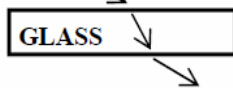
Light **refracts** when passing between two substances **at an angle**.

Light slows down in glass. If the left side hits first, it slows down first, causing it to bend to the left.



Light speeds up in air. Here the left side speeds up first causing the light to bend to the right.

The right side hits first it bends to the right.



If the light does not enter at an angle, it does not bend.

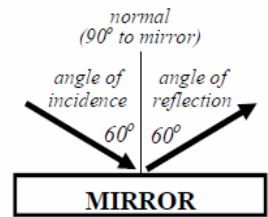
Reflection

Light reflects at shiny boundaries we call mirrors.

Normal – an imaginary reference line perpendicular (90°) to a surface.

Angle of Incidence – the angle between the incoming ray and the normal.

Angle of Reflection – the angle between the outgoing ray and the normal.



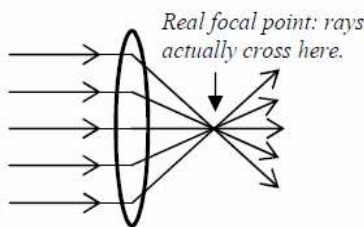
angle of incidence = angle of reflection

Lenses

Lenses and mirrors work opposite of each other. A concave lens is divergent, but a concave mirror is convergent.

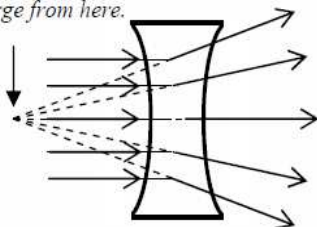
Mirrors

Lenses work by refraction.



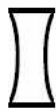
A convex lens is convergent—the light rays come together.

Virtual focal point: rays seem to diverge from here.



A concave lens is divergent—the light rays spread apart.

Concave or Convex?

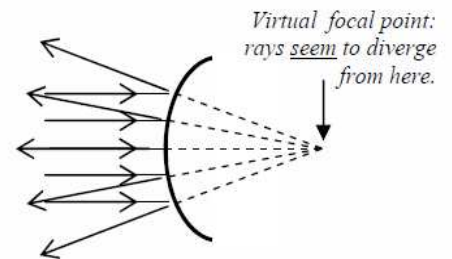


Concave looks like the sides have caved in.

Convex—the middle is bigger than the ends.

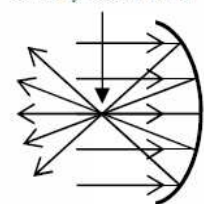


Mirrors work by reflection.



A convex mirror is divergent—the light rays spread apart.

Real focal point: rays actually cross here.



A concave mirror is convergent—the light rays come together.

Real Images

Just because you can see an image does not mean it is real. In optics a real image is defined as one that can be projected (onto a screen or paper). Real images are always inverted (flipped) and can only occur past the focal point, when the light rays have crossed. Therefore, only convergent devices can produce real images!

1. Optics	A. The study of how light behaves.	1. Normal	A. A line drawn perpendicular to the surface of a mirror or lens.
2. Image	B. A lens or mirror that is bigger in the middle.	2. Mirror	B. An optical device uses refraction to bend light.
3. Object	C. Light rays that spread apart.	3. Angle of incidence	C. From the normal to the incoming ray.
4. Concave	D. Produced by a lens or mirror.	4. Angle of reflection	D. From the normal to the outgoing ray.
5. Convex	E. Light rays that come together.	5. Lens	E. Where all parallel rays converge.
6. Convergent	F. What you are actually looking at.	6. Focus	F. An optical device that works by reflection.
7. Divergent	G. A lens or mirror that is bigger at the ends.		

The angle of incidence is: _____
 The angle of reflection is: _____
 The normal is: _____
 The incident ray is: _____
 The reflected ray is: _____

You stand 2 feet in front of a mirror. How far away from you does your image in the mirror seem?

Convergent or Divergent?
 Concave lens? Convex mirror?
 Concave mirror? Convex lens?

The angle *between* the incident ray and reflected ray is 60° .
 What is the angle of reflection?

 The angle of reflection is 40° . What is the angle of incidence?

Real or Virtual focal point?
 Concave lens? Convex mirror?
 Concave mirror? Convex lens?

Which letter shows where the incoming light ray will go?

What is a real image?

 Will a real image ever occur with a divergent device?

 Why or why not?

Which arrow shows the correct path of the light ray?

Can produce a real image?
 Concave lens? Convex mirror?
 Concave mirror? Convex lens?

Draw where the rays will go and label the type of mirror.

When you look into your bathroom mirror, are you upside down (inverted) or right side up (upright)?

 Is this a real or virtual image?
 Why?

 What is the focal length of a bathroom (flat) mirror?

The graphic shows what you would see when looking at the object thru a lens.
 Is the image it real or virtual?

 Why?

Why can we see virtual images?