TRACING RAY DIAGRAMS FOR LIGHT PASSING THROUGH LENSES

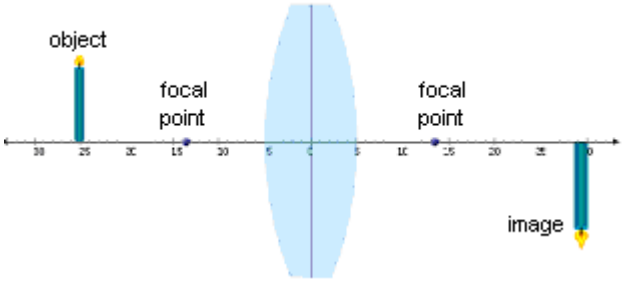
Imagine you are skiing and hit a small patch where the snow has melted and the grass and dirt below are exposed. Assuming you don't fall, this rougher terrain is going to slow you down a bit.

Now imagine that the dirt patch is angled so your right ski hits the patch first. What happens? Your right ski will slow down before your left, and you will turn to the right. This skiing situation is similar to how a curved lens bends light rays. Light moves more quickly through air than through glass, so hitting glass at an angle will bend light rays. When light rays are bent by a curved lens, a focused image can appear.

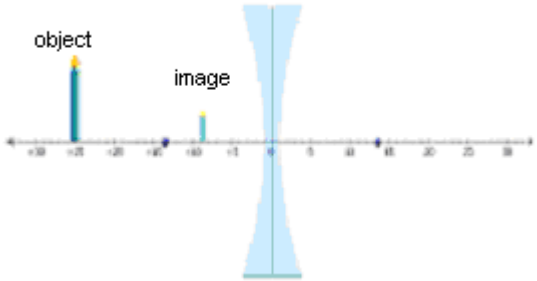
Focal Point and Focal Length

Recall the class activity using the ray boxes and lenses. You found that a double convex (converging) lens made parallel rays of light meet at a certain point past the lens called the **focal point**. A double concave (diverging) lens made parallel rays of light spread out, but the extended rays appeared to come from a point called the **focal** point. The distance between the centre of the lens and the focal point is called the **focal length**. The focal point and focal length of a lens is determined by its shape and the substance it is made of.

Make sure all boxes are un-checked. You can see a candle (object) and its image.



Convex (converging) lens



Concave (diverging) lens

The blue dots on the principal axis represent the **focal points** of the lens. The focal length is the distance from the lens to each focal point. Drag the focal points left and right along the axis.

When you move one focal point, what happens to the other? Both focal points move at the same time in the same way_____

Convex lens

When the lens shape is long and thin, nearly flat, the focal length is ____longer

When the lens shape is short and thick, very curved, the focal length is ____shorter

What happens to the location and size of the image as the focal length increases? The image gets bigger and farther away

Concave lens When the lens shape is long and thin, nearly flat, the focal length is ____longer

When the lens shape is short and thick, very curved, the focal length is _____shorter____ (longer/shorter)

What happens to the location and size of the image as the focal length increases? It gets bigger and farther away form the lens

Ray Diagram for Convex Lens

To help see how each light ray travels and is bent by the lens, turn on **Colorize lines**. Check the boxes marked **Parallel line, Original light lines** and **Transmitted light lines**.

The dark blue ray is the **Parallel line**, which shines parallel to the principal axis and hits the lens "straight on."

Adjust the height of the candle by grabbing the flame and pulling up or down. Watch the transmitted ray.

Move the candle closer and farther away from the lens. Watch the transmitted ray.

Complete the sentence to state one rule of refraction through a lens.

A light ray directed at a convex lens, parallel to the principal axis is transmitted through the focal point

Drag one of the **focal points** to about 12 units from the center of the lens. Make the candle fairly short. Move the candle back and forth and pay attention to the image.

In general, is the image bigger when the candle is near the focal point or far away?

The image is larger when the object is closer to the focal point

What happens when the candle is placed between the focal point and the lens?

The image appears on the same side of the lens as the object and it is very large.

Check the **Apparent light lines** box

(This is the "magnifying glass case." A viewer looking through the lens from the right will see the transmitted rays, and that light will *appear* to be coming from a different location, shown by the dotted apparent light lines. The viewer would be "tricked" into seeing the large virtual image of the candle. This is called virtual because there are no *actual* light rays focused there.)

Check the **Line through focal poin**t box. The green line shows how a ray of light behaves when it is aimed towards the focal point. Continue to adjust the size and position of the candle and watch the transmitted ray.

Complete the sentence to state a second rule of refraction through a lens.

A light ray directed at the focal point of a convex lens, is transmitted parallel to the principal axis

Check the **Central line** box. The red line shows the path of a line directed at the centre of the lens. Continue to adjust the size and position of the candle and watch the transmitted ray.

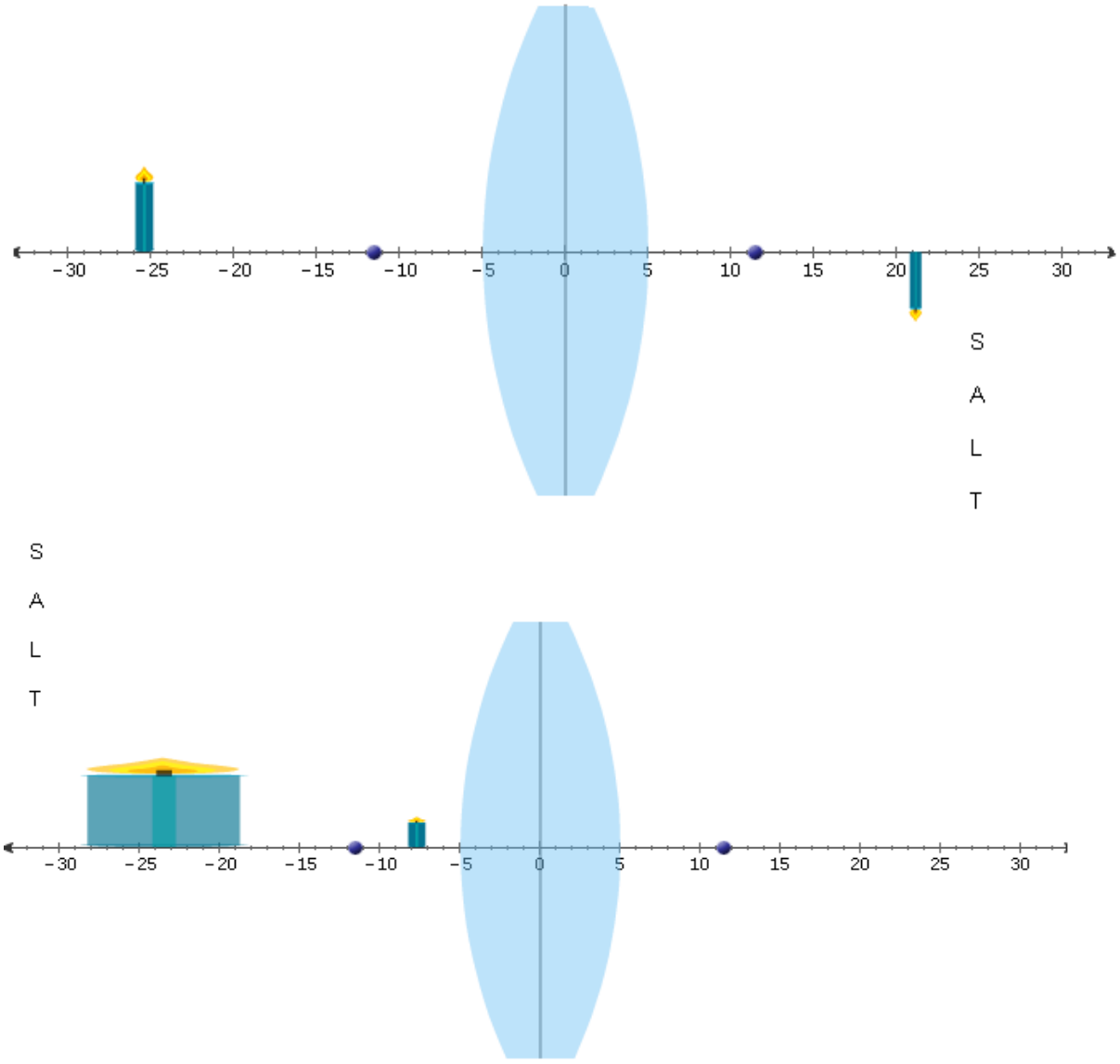
Complete the sentence to state a third rule of refraction through a lens. **A light ray directed at the**

centre of a convex lens, is transmitted straight through without bending

Remember: The image is located where the rays of light meet (real image) or appear to meet (virtual image)

Ray Diagrams in a Convex Mirror

Use a pencil (or pencil crayons) to complete the ray diagrams below. Indicate the characteristics (SA LT) of each image. You may use the Gizmo to help you draw the lines correctly.



Ray Diagram for Concave Lens

Change to a concave lens using the drop-down box. To help see how each light ray travels and is bent by the lens, turn on **Colorize lines**. Make sure the boxes marked **Parallel line, Original light lines**, **Transmitted light lines,** and **Apparent light lines** are all checked.

The dark blue ray is the **Parallel line**, which shines parallel to the principal axis and hits the lens "straight on."

Adjust the height of the candle by grabbing the flame and pulling up or down. Watch the transmitted ray and apparent line.

Move the candle closer and farther away from the lens. Watch the transmitted ray and apparent line.

Complete the sentence to state one rule of refraction through a lens.

A light ray directed at a concave lens, parallel to the principal axis is transmitted _____ .

So when the transmitted ray is extended backwards, it passes through the focal point_

Drag one of the **focal points** to about 12 units from the center of the lens. Make the candle fairly tall. Move the candle back and forth and pay attention to the image.

In general, is the image bigger when the candle is near the focal point or far away?

The image is bigger when the candle is near the focal point

What happens when the candle is placed between the focal point and the lens?

The image moves closer to the lens but is always a virtual image.

Check the **Line through focal poin**t box. The green line shows how a ray of light behaves when it is aimed towards the focal point. Continue to adjust the size and position of the candle and watch the transmitted ray.

Complete the sentence to state a second rule of refraction through a lens.

A light ray directed at the focal point of a lens, is transmitted parallel to the principal axis

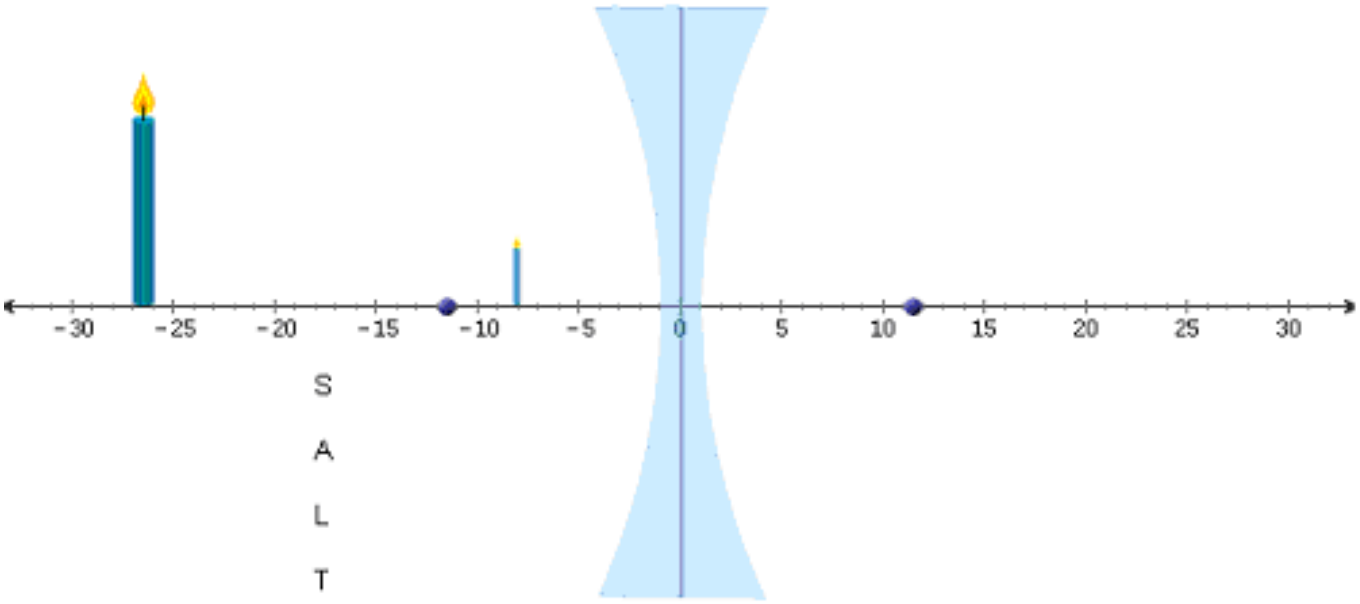
Check the **Central line** box. The red line shows the path of a line directed at the centre of the lens. Continue to adjust the size and position of the candle and watch the transmitted ray.

Complete the sentence to state a third rule of refraction through a lens. **A light ray directed at the centre of a lens, is transmitted** straight through without bending _____

Remember: The image is located where the rays of light meet (real image) or appear to meet (virtual image)

Ray Diagrams in a Concave Mirror

Use a pencil (or pencil crayons) to complete the ray diagrams below. Indicate the characteristics (SA LT) of each image. You may use the Gizmo to help you draw the lines correctly.



What uses can you think of for a convex lens?

- magnifying glass
- binoculars
- telescope
-

What uses can you think of for a concave lens?

_

_

_