

Lenses FAQ:

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

A real image is formed when light rays originating from a point on one side of a lens (i.e. the object) are refracted by the lens so that they focus (come together) to a point on the other side of the lens at the image location. This happens when the object is farther away from the (converging) lens than the focal length.

A virtual image is formed when light rays originating from a point on one side of a lens (i.e. the object) are refracted by the lens so that they diverge (move apart from each other) on the other side of the lens. When these rays are traced back in a straight line (ignoring that they were actually bent by the lens) then appear to diverge from a point on the same side of the lens as the object (this is the location of the virtual image). This happens when the object is closer to the (converging) lens than the focal length.

2. Why can't I see a virtual image on a screen?

In order to see an image on a screen, light rays must come to a focus on a screen. But there are no actual light rays that come together at the virtual image location. This means that they cannot reflect from a screen at that point.

3. Which can I see with my eye, a virtual image or a real image?

You can see either with your eye. Your eye has a lens that makes a real image on your retina. It takes rays that can be traced back to a point outside of your eye and refracts them so they converge at a single point on your retina. It doesn't matter if these rays actually originate from that point in space (real image), or whether they need to be extended back to that point.

4. Suppose I see a real image on a screen behind a lens. When I take the screen away, is the real image still there?

Let's not get philosophical here. A physics question would be "can I still see the image?" You see an image on the screen because of light reflected from the screen. This light is from rays that were focused to a point on the screen, then scattered in all directions – rays radiate out from that point on the screen in all directions. Your eye lens focuses some of these on your retina, and you see an image. If the screen were not there, you wouldn't see the scattered light. But the rays would then continue on, diverging out from the point where they focused. If you move your eye to the appropriate position, these rays could enter your eye and be focused on your retina by your eye lens. You would then see the image.

5. How do a microscope and telescope work?

In both cases the objective forms a real image on the opposite side of the lens from the object. The eyepiece is used as a magnifying glass to see the real image more closely.

Just as a normal magnifying glass, the eyepiece forms a virtual image that your eye lens uses as an object to make an image on your retina. The real image formed by the objective is inverted, and the virtual image produced by the eyepiece of this is upright relative to this object (does not change the orientation). So the final image is inverted with respect to the original object.

6. What does it mean for the magnification to be negative?

This is a convention that means the image is inverted (upside down) with respect to the object. This works if you also use the convention that the image and object distances have the same sign when they are on opposite sides of the lens, and are of opposite signs when they are on the same side of the lens, along with $M = -\frac{\text{image distance}}{\text{object distance}}$. If you think this is confusing, then you and I are thinking the same way! It's a lot easier to just trace some of the rays to determine whether the image is upright or inverted.