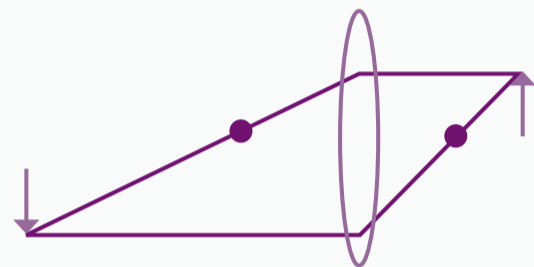




# OPTICS OF VR VIEWERS

Cardboard virtual reality viewers like the ones you assembled are handmade virtual/augmented reality headsets that use your smartphone's existing technology. They use magnification of a lens to create an image on your retina based on an image created on your phone. An "object" is created on your phone's screen in the application. This object is magnified and focused based on the focal length of the convex lenses inside your VR Viewer.

In the diagram, the arrow on the right of the convex lens represents the "object" or picture on your phone. The horizontal lines represent the path that light can travel from the "object" created on your phone to the image that it creates on your eye. The image created on your eye is represented by the inverted arrow to the left of the convex lens. Light bends as it passes through the lens based on the focal length of the lens, magnifying the size and, in this case, inverting the image. Most smartphone VR viewers use a focal length of 4.5 cm. The focal length is represented by the dots on the diagram.

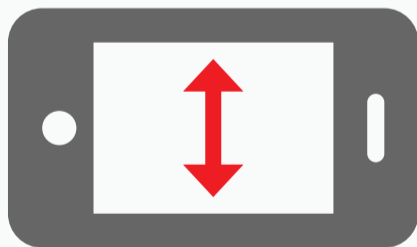


In order to create a focused image on your retina, your phone must be a certain distance from the lens. The height of the object created on your phone differs from the height of the image created on your retina. The ratio of these two heights is equal to how much the original picture was magnified. Let's figure out how much magnification was going on!

## 1. MEASURE THE FOLLOWING INFORMATION

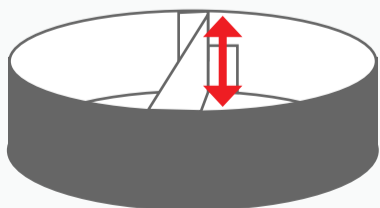
- A.** What is the height of the "object" on your screen?  
Measure the height of your phone when it is on its side.

**HEIGHT OF THE OBJECT = \_\_\_\_\_**



- B.** Measure the distance of the "object" from your eye. This is the distance from the lenses to your phone's screen.

**DISTANCE OF THE OBJECT = \_\_\_\_\_**



## 2. CALCULATE OTHER DISTANCES AND HEIGHTS USING THE INFORMATION THAT YOU MEASURED.

- A.** If your VR Viewer has a focal length of **4.5cm**, what is the distance of the image created on your eye?  
Use the formula below to calculate the distance that creates a perfect image on your retina.

$$\text{DISTANCE OF THE IMAGE} = \frac{\text{DISTANCE OF THE OBJECT} \cdot \text{FOCAL LENGTH}}{\text{DISTANCE OF THE OBJECT} - \text{FOCAL LENGTH}}$$

- B.** If your VR Viewer has a focal length of **4.5cm**, what is the height of the image created on your eye? Use the formula below to calculate the height of the image created on your retina. You'll need to use your answer from 2a.

$$\text{HEIGHT OF THE IMAGE} = \frac{\text{HEIGHT OF THE OBJECT} \cdot \text{DISTANCE OF THE IMAGE}}{\text{DISTANCE OF THE OBJECT}}$$

- C.** The lens magnifies the picture on your screen to focus an image on your eye. Calculate how much the lens magnified using the formula below.

$$\text{MAGNIFICATION} = \frac{\text{HEIGHT OF THE IMAGE}}{\text{HEIGHT OF THE OBJECT}}$$