Lenses Investigation

Station 1: Converging and Diverging Lenses

1. Define Converging in your own words.

2. Define Diverging in your own words.

3. One of the lenses is labelled as converging, while the other is labelled as diverging. Sketch diagrams and describe the physical differences between the two types of lenses.

4. Use diagrams of the lenses and what you know about refraction at the interfaces between air and glass to produce diagrams of how the lenses make light converge or diverge. (Hint: Start with multiple parallel light rays incident on each lens.)

Station 2: Exploring Converging Lenses

1. Use one of the converging lenses to produce a sharp image of the classroom lights on the floor. Measure this distance.

2. Use the converging lens to look at an object on the table. Describe what happens to the image as you change the distance from the object to the lens. Include any observations about size and orientation. Record your observations with diagrams of the arrangement of the objects.

Station 3: Optical Bench

1. The optical bench consists of a light source a lens in a lens holder and screen. Choose three different distances between the light source and the screen. Move the lens along the bench until you identify two different points that will produce a sharp image on the screen. For each position, measure:
    - Distance from the source to the lens (Object distance)
    - Distance from the lens to the screen (Image distance)
    - Height of the image

2. Sketch diagrams for each of the arrangements. Label the values you measured on each diagram.

3. Describe the relationship between the two possible arrangements of a sharp image with the same distance between the source and the screen.

4. Describe a relationship between the positions and the heights.

Station 4: Ray Tracing - Converging Lenses

The bending of light occurs at the surfaces of the lens based on the refractive index of the material. When dealing with “thin” lenses, we reduce the impact of the two surfaces into an overall outcome. In order to help with analysis, we define the optical axis as a line that is normal to the center of the lens. We consider an object as an upright arrow to help with identifying the orientation of the image. We will do analysis based on light from the top of the object with the understanding that the rest of the image will be contained on a line segment that is perpendicular to the optical axis.

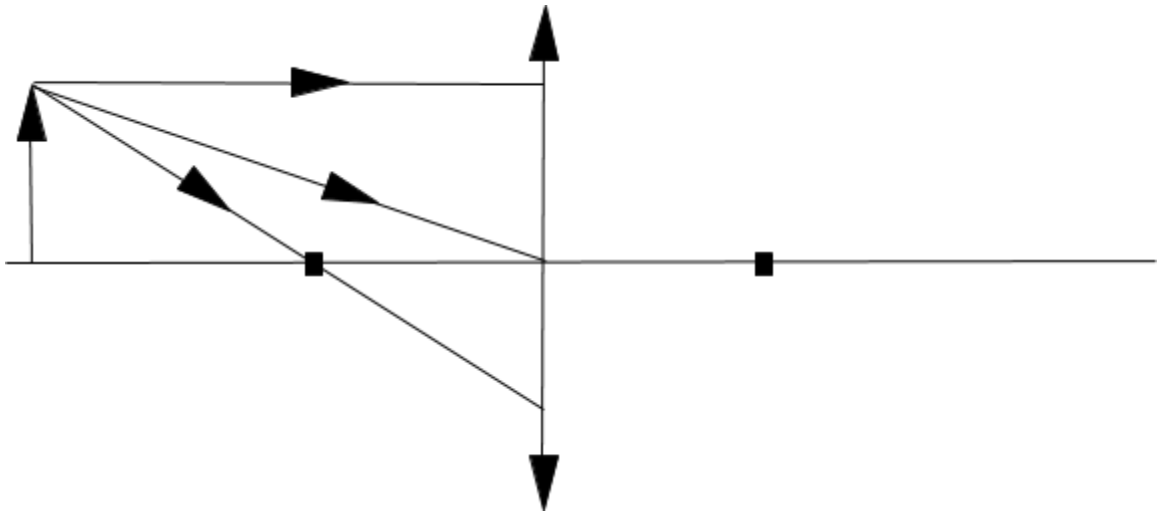
For **converging lenses**, we draw three rays from the top of the object and follow the rules below:

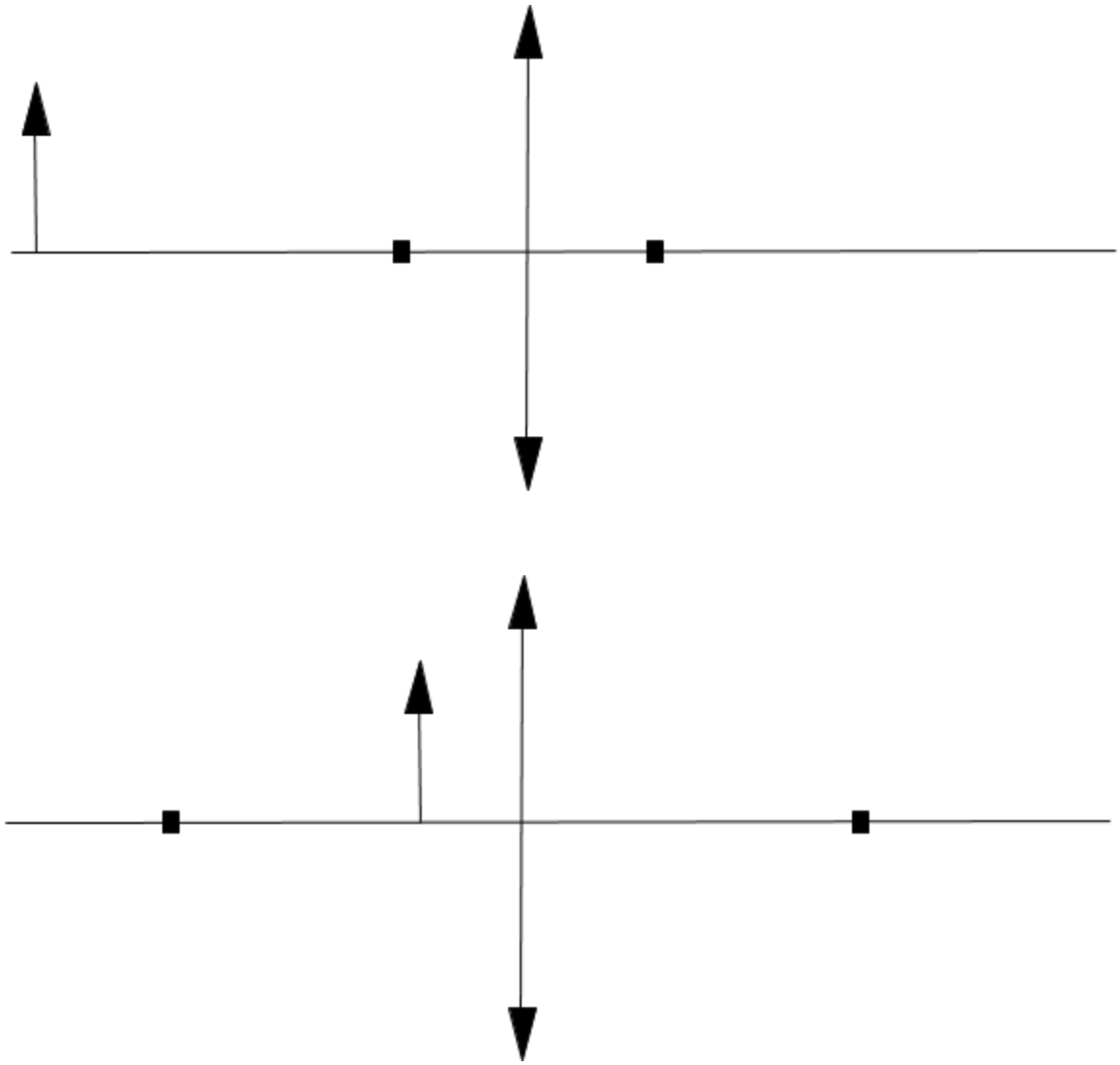
- In parallel to optical axis → out to focal point
- In optical center → continue in a straight line
- In through focal point of lens → out parallel to optical axis

The point where these lines intersect is considered the location of the image of the top of the object.

1. Explain why the point of convergence of the lines would be considered the location of the image.

2. For each of the following arrangements, use a straightedge to complete the diagram and determine the location of the image.





3. Explain why you don’t need all three of the lines to determine the location of the image.

4. Describe the process by which you determine the location of the image if the lines don’t converge in a single location on the opposite side of the lens from the object.

Station 5: Ray Tracing - Diverging Lenses

The outcome of the light rays interacting with a diverging lens is the inverse of a converging lens. The ray analysis follows a similar process, but the outcomes of the reference lines are different.

For **diverging lenses**, we draw two rays from the top of the object and follow the rules below:

- In parallel to optical axis → out as if it came from the focal point
- In optical center → continue in a straight line
- ~~In through focal point of lens~~ →

1. The lines will not meet on the opposite side of the lens from the object. Explain how you will determine the location of the image.

2. For each of the following arrangements, use a straightedge to complete the diagram and determine the location of the image.