

Worksheet: Optics

Name: _____ Group name: _____

Insert the slit screen into the front of the ray box so that there is only one ray; place a piece of white paper beneath the box to trace the rays of light.

Note: in optics, angles are measured relative to an axis perpendicular to the surface of the mirror or lens at the point of incidence. For a curved surface, this changes as a the point of incidence changes.

1. State the Law of Reflection:

2. Place a flat mirror in the path of the light ray and rotate it to vary the angle of incidence. Draw ray diagrams on the paper for **two** different angles of incidence. Record the **angle of incidence** and **angle of reflection** for each case and compare to your prediction.

| | Angle of incidence | Angle of reflection (predicted) | Angle of reflection (measured) |
|-----|---------------------------|--|---|
| (a) | | | |
| (b) | | | |

3. Insert the concave mirror, and rotate so that the reflected ray is about 30° away from the incident ray. Draw a ray diagram showing how the law of reflection works for this case:

4. Insert the convex mirror so that the reflected ray is about 30° away from the incident ray. Draw a ray diagram showing how the law of reflection works for this case:

5. Change the slit screen so you have 5 parallel beams. If the beams are not parallel, you can slide the bulb within the ray box to make it so.

(a) Observe what happens for the plane, convex and concave mirrors. Write the name of one of the mirrors in each blank to describe the behavior for parallel rays:

Parallel: _____ Diverging: _____ Converging: _____

(b) Light from distant objects forms parallel rays. Which mirror would be useful for focusing the light from a distant star onto a photographic plate to make an image?

6. Refraction occurs when light travels from one material into another for example from air into water, plastic or glass. Which of the following changes when light crosses the boundary? (circle all that apply):

propagation velocity

wavelength

frequency

7. Insert the trapezoidal plastic prism into the path of the parallel rays so that the light is incident on the longest side. Rotate the prism from 0° incident angle to about 15° . What happens to the transmitted rays? (circle one)

(a) At 0° : unbent bent towards the normal to the surface bent away from the normal

(b) At 15° : unbent bent towards the normal to the surface bent away from the normal

(c) Explain:

8. Insert the "lenses" (plastic pieces with curved surfaces). Match the shape to the behavior:

Flat

Converging

Convex

Diverging

Concave

Parallel

9. The **focal length** of the lens is the distance from the lens (front surface) to the image (point of focus) for parallel incident rays.

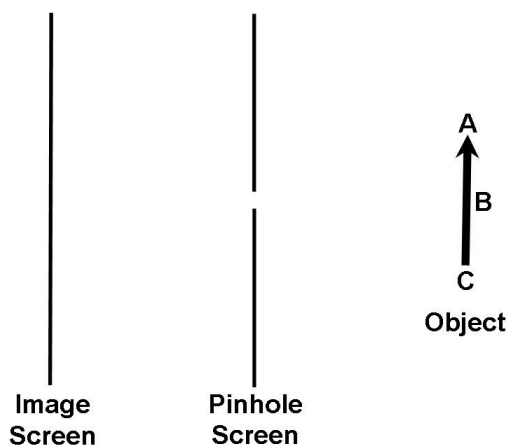
(a) Find the focal length for the convex lens for different kinds of light:

| Color | Wavelength (approximate -- research) | Focal length |
|-------|---|--------------|
| red | | |
| green | | |
| blue | | |

(b) These are different. Why? (remember the last lab)

10. Pinhole camera:

(a) Start by **ray tracing**: draw at least two rays that pass from point A on the object to the screen. Do the same from points B and C. The rays from each point converge to dots (not sharp points) on the screen forming an image.



(b) Do you expect the image to be **upright** or **inverted**? (circle one)

- (c) Use the holes in the aluminum plate to form an image of the light-bulb filament on a screen. Note the sharpness, and brightness of each. Rank the brightness (1 most bright – 3 least bright), the sharpness (1 most sharp – 3 least sharp), and note whether the images upright or inverted

| Color | Brightness | Sharpness | Upright/Inverted |
|--------------|-------------------|------------------|-------------------------|
| Large hole | | | |
| Medium hole | | | |
| Small hole | | | |

- (d) Explain the behaviour of sharpness vs. brightness using the ray tracing diagram:

11. What changes about the image as you increase the distance from object to pinhole and pinhole to screen?

12. Make an image of the filament with the magnifier lens.

(a) Which is sharper (pinhole or lens) _____; why? _____

(b) Which is brighter (pinhole or lens) _____; why? _____