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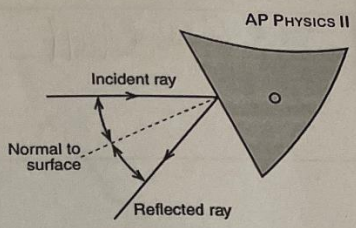
LAB. RAY OPTICS: MIRRORS

AP PHYSICS II

Driving Question | Objective

What is the relationship between a ray which is incident (incoming) to a mirror and the ray that is reflected?



Materials and Equipment

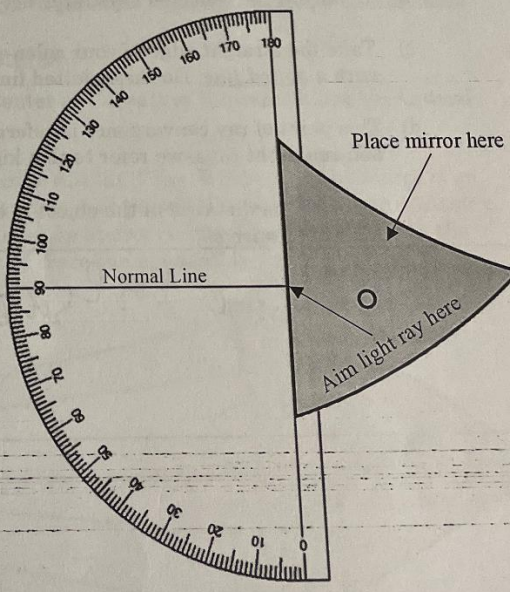
- Mirror
- Light Source
- Mirror
- Protractor Paper
- Ruler

Part 1 – Plane Mirrors

1. Place the light source in ray-box mode on this sheet of paper.
2. Place the mirror on the paper and position the planar (flat) surface of the mirror in the location indicated on the bottom of this page.
3. Point the light source toward the mirror, assuring the incident ray (incoming ray) touches the center of the paper protractor.
4. Measure the angle of incidence of the incident ray. This is the angle between the normal line and in incident ray.
5. Measure the angle of reflection of the reflected ray. This is the angle between the normal line and the reflected ray.
6. Do this for 3 different angles of incidence and their respective angles of reflection and record your values in the table below.

Table 1

Angle of Incidence	Angle of Reflection
100	100
200	200
300	300



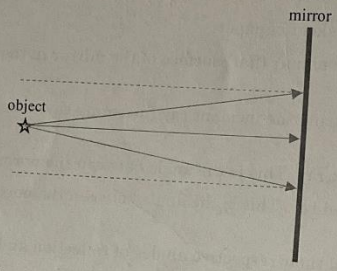
Analysis

1. Based on our data, what is the relationship between the angles of incidence and reflection?

they are equal

3. Consider the example below. A point source is emitting light in all directions. We are going to look at a select three to attempt to locate the "image" of the light source. An *image* is defined as a location where light rays intersect or at least "look like" they *intersect after reflection*.

a) On the diagram, draw the reflected rays of the 3 incident rays depicted. Be sure to use a protractor



b) Do any of the reflected rays intersect each other? **Yes or No**

c) Take the straight edge of your ruler and extend each reflected ray behind the mirror. Be sure to do this with a *dotted line*. Do these dotted lines intersect? **Yes or No**

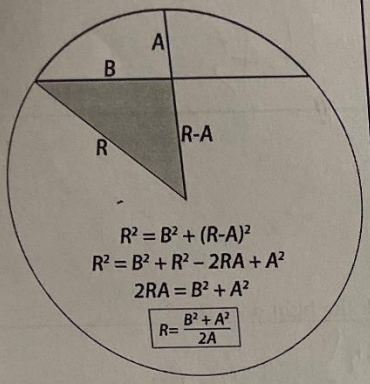
d) This point of ray convergence is referred to as an ***image***. However, since this image is formed through non-real light rays, we refer to this kind of image as a ***virtual image***.

e) Measure the distance of the object to the mirror. How does this compare to the distance between the image and mirror?

They are the same

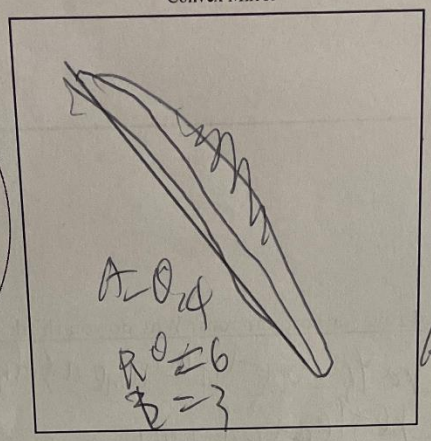
Part 2 – Curved Mirrors

1. You will first need to determine the radius of curvature of both the concave and convex mirrors. Use the space below to trace the concave and convex portions of your mirror. Measure the A and B values with the ruler and use the Arc-Radius Theorem to determine the radius of each side of the mirror.

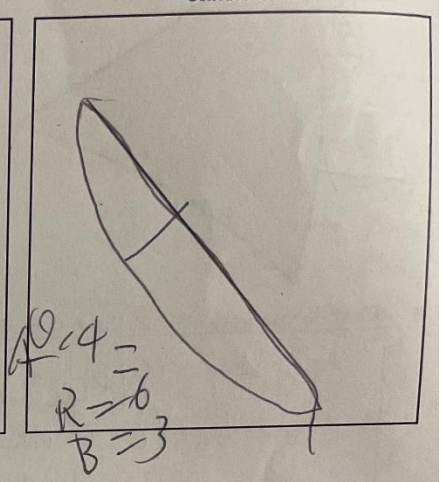


$$R^2 = B^2 + (R-A)^2$$
$$R^2 = B^2 + R^2 - 2RA + A^2$$
$$2RA = B^2 + A^2$$
$$R = \frac{B^2 + A^2}{2A}$$

Convex Mirror



Concave Mirror



2. Record the radius of curvature for each mirror in the table below for future reference.

Table 1

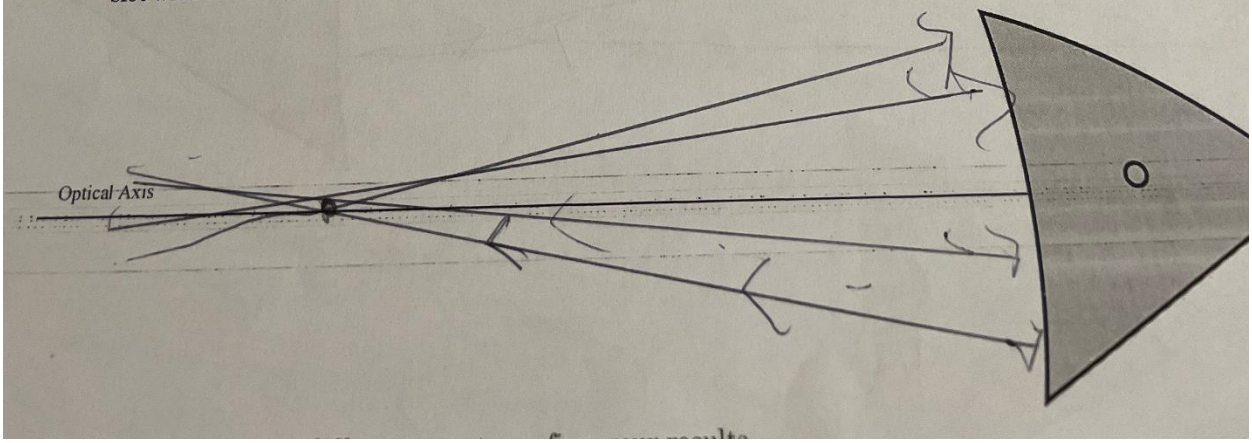
Convex Mirror Radius (cm)	11.45
Concave Mirror Radius (cm)	11.45

3. We will be testing the behaviors of 3 different special incident rays to generate rules and methods to determine image locations and sizes.

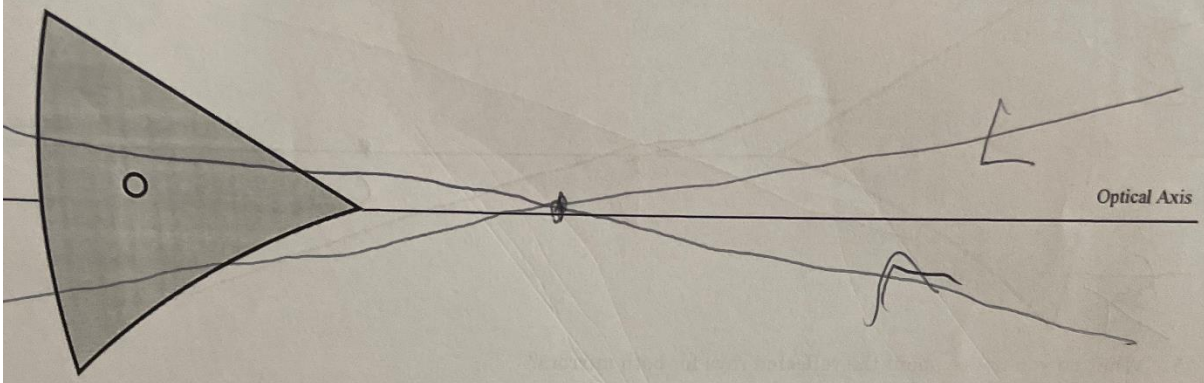
Experimental Design – Incident Rays Aimed at Center of Curvatures

1. Before we start, first indicate, on each figure below, where the Center of Curvature is located along the Optical Axis. Label this point with a *"C"* for *"Center."*

2. Do not set your mirror on the slot yet. First, set your Light Source to display 1 ray. While the light source is on the LEFT side of the sheet of paper, shine the incident ray to the right, **not parallel** to the Optical Axis. Assure this ray passes through the Center of Curvature. Once you are lined up appropriately, place the mirror in the slot with the concave portion facing the incident rays. Observe and trace the incident and reflected rays.



et's now try the same thing with a convex mirror. Before you place the mirror down, assure the light source is till on the LEFT side of the paper and shine 3 incident rays to the right, parallel to the Optical Axis. Once you re lined up, place the mirror in the slot and observe/trace the reflected rays.



5. Do the reflected rays (real or virtual) intersect as some point along the Optical Axis? If so, mark along the Optical Axis where this point occurs.

6. Record the Focal Length of each mirror in Table 2 below.

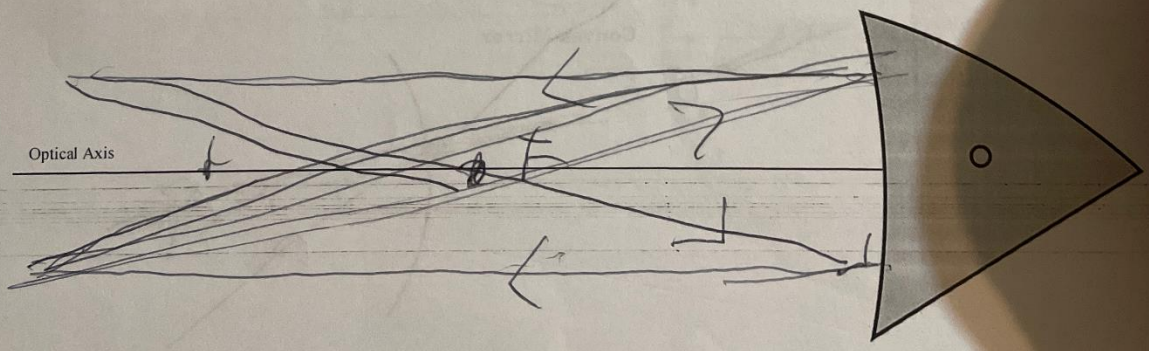
Table 2

Convex Mirror Focal Length (cm)	2.4 cm
Concave Mirror Focal Length (cm)	2.3 cm

Experimental Design – Incident Rays Aimed at Focal Points

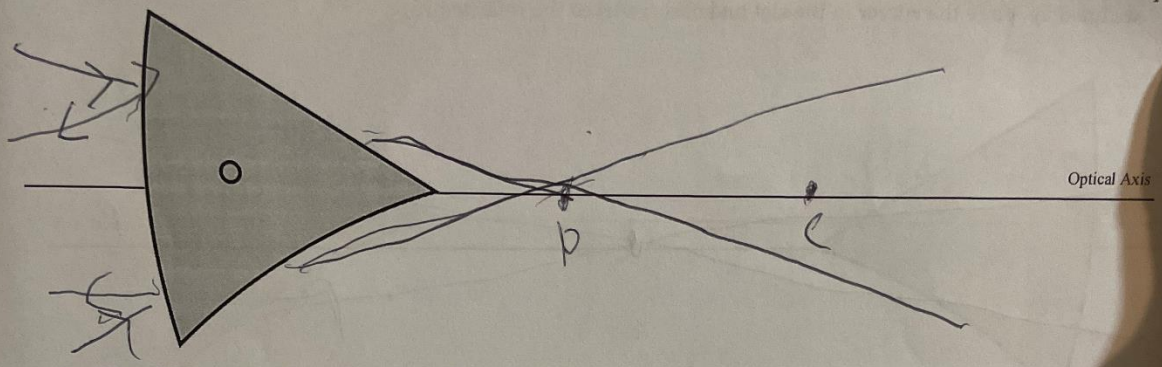
1. Before we start, first indicate, on each figure below, where the Center of Curvature is located along the Optical Axis. Label this point with a *"C"* for *"Center."* Also indicate where your Focal Point is located and label it with an *"F"* for *"Focal Point."*

2. Do not set your mirror on the slot yet. First, set your Light Source to display 1 ray. While the light source is on the LEFT side of the sheet of paper, shine the incident ray to the right, **not parallel** to the Optical Axis. Assure this ray passes through the Focal Point. Once you are lined up appropriately, place the mirror in the slot with the concave portion facing the incident rays. Observe and trace the incident and reflected rays.



3. Do this with at least 3 different rays to confirm your results.

4. Try the same thing with the Concave Mirror, assuring that the Light Source is still on the LEFT side of your paper. Remember to first aim the ray to the Focal Point, then only place the mirror down once you are lined up.

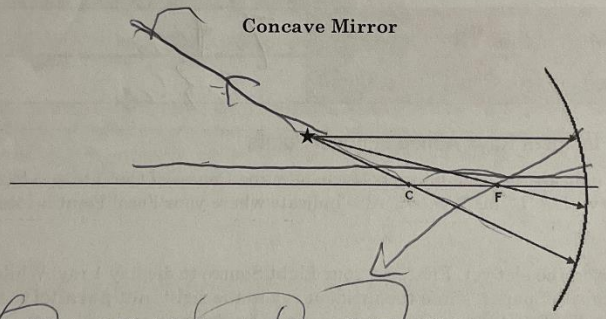


5. What do you notice about the reflected rays for both mirrors?

Putting it Together

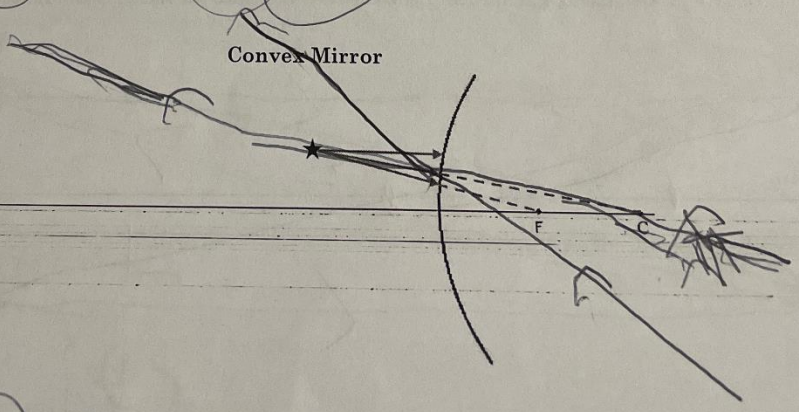
1. It is time to apply what we have learned about the 3 special incident rays for convex mirrors.
2. On the diagrams below, use what you have learned about the reflected ray of our 3 special incident rays. Attempt to locate the image formed by each mirror and mark the location with an "I" for "Image."

Concave Mirror



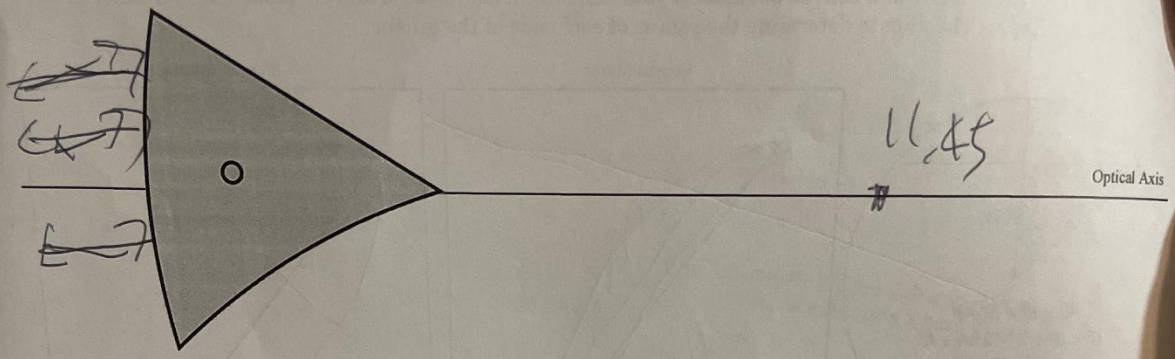
3. *Describe this image.* Real/Virtual, Upright/Inverted, Magnified/Minified?

Convex Mirror



4. *Describe this image.* Real/Virtual, Upright/Inverted, Magnified/Minified?

4. Try the same thing with the Concave Mirror, assuring that the Light Source is still on the LEFT side of your paper. Remember to first aim the ray to the center of curvature, then only place the mirror down once you are lined up.



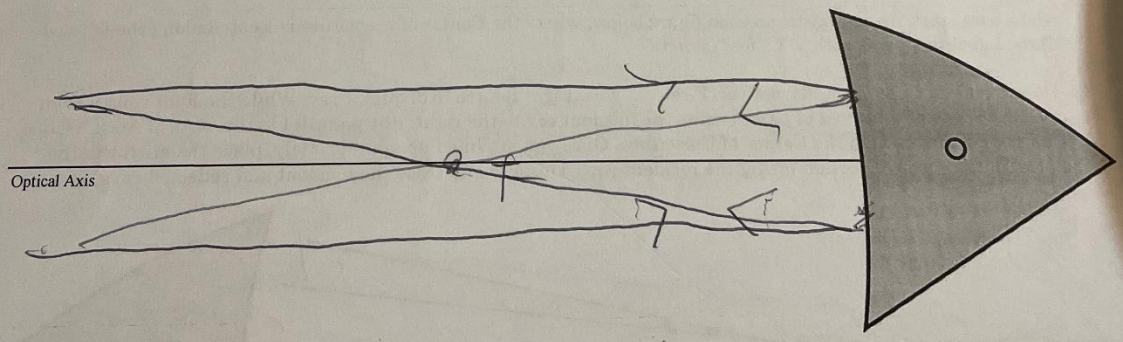
5. What do you notice about the reflected rays for both mirrors? Why do you think the light does this?

The reflected rays are the same as the incident rays b/c the reflected light is perpendicular to the concave line.

Experimental Design – Incident Rays Parallel to the Optical Axis

1. Before we start, first indicate, on each figure below, where the Center of Curvature is located along the Optical Axis. Label this point with a *"C"* for *"Center."*

2. Do not set your mirror on the slot yet. First, set your Light Source to display 3 parallel rays. While the light source is on the LEFT side of the sheet of paper, shine the incident rays to the right, **parallel** to the Optical Axis. Once you are lined up appropriately, place the mirror in the slot with the concave portion facing the incident rays. Trace the incident and reflected rays with solid lines.



3. *Do the reflected rays (real or virtual) intersect as some point along the Optical Axis? If so, mark along the Optical Axis where this point occurs.*

Yes