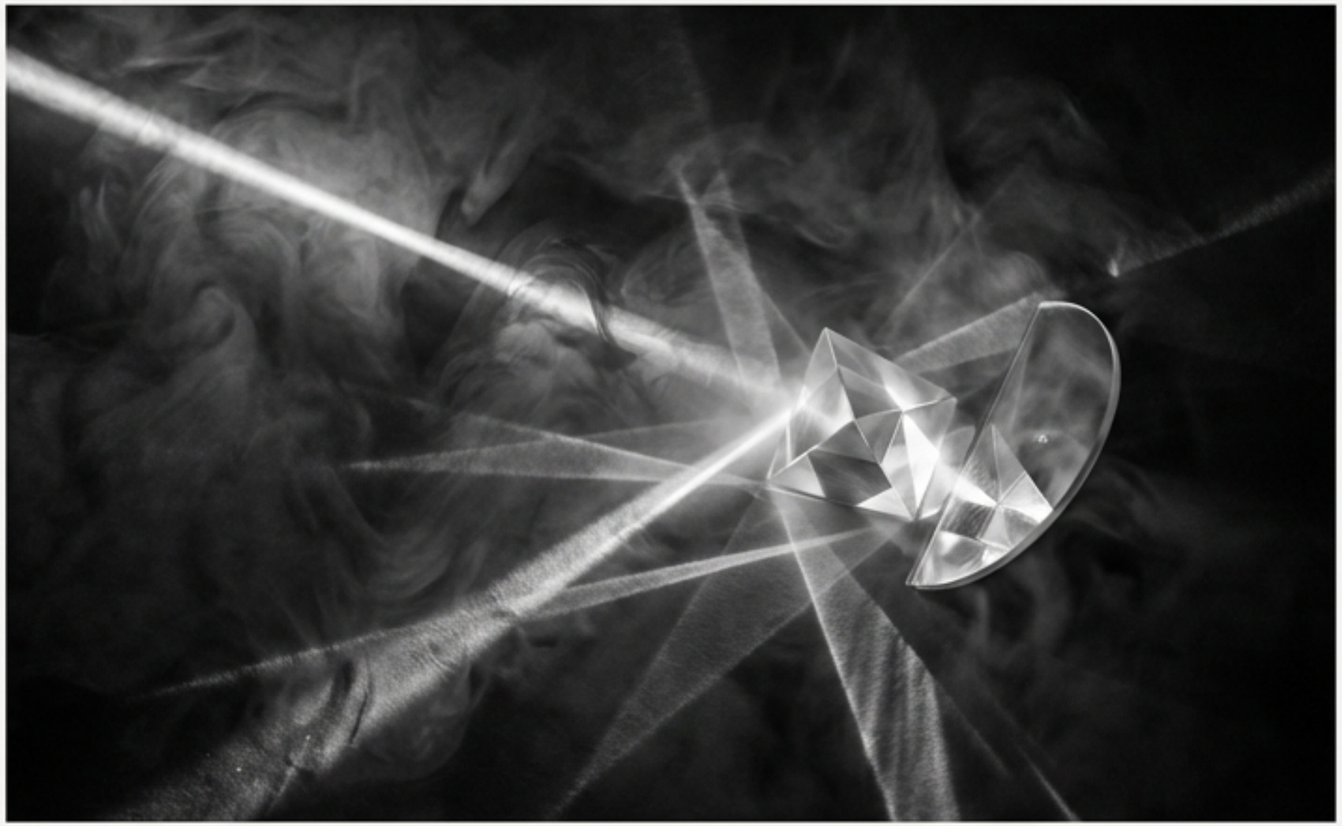
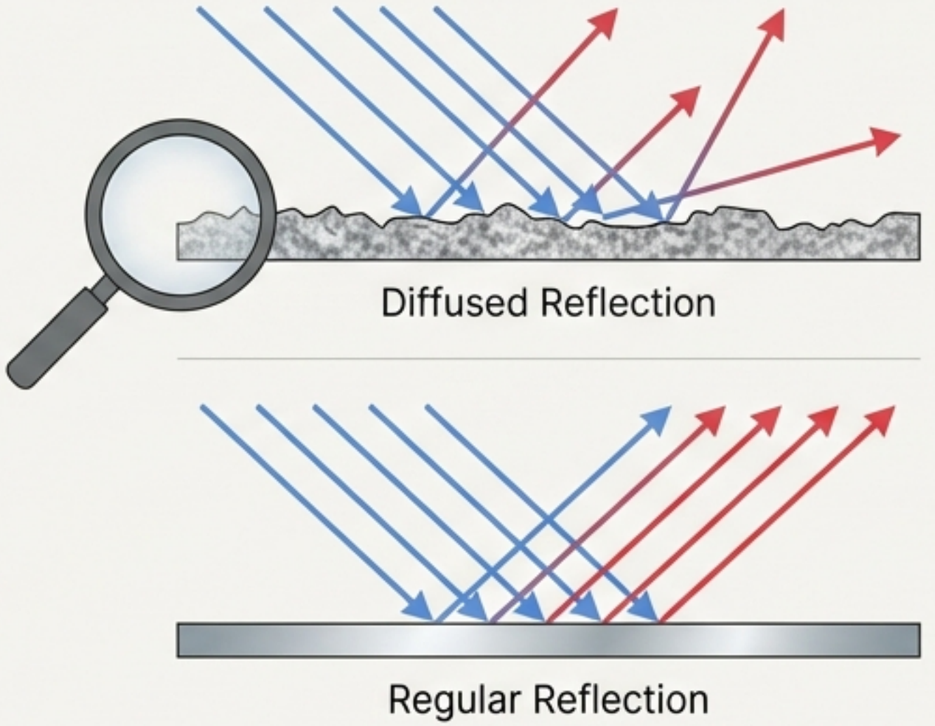
The Architecture of Light

Unraveling the Physics of Reflection, Geometry, and Image Formation



We do not see light; we see what it touches. The mirror is the tool that allows us to command this unseen messenger.

The Medium and The Surface



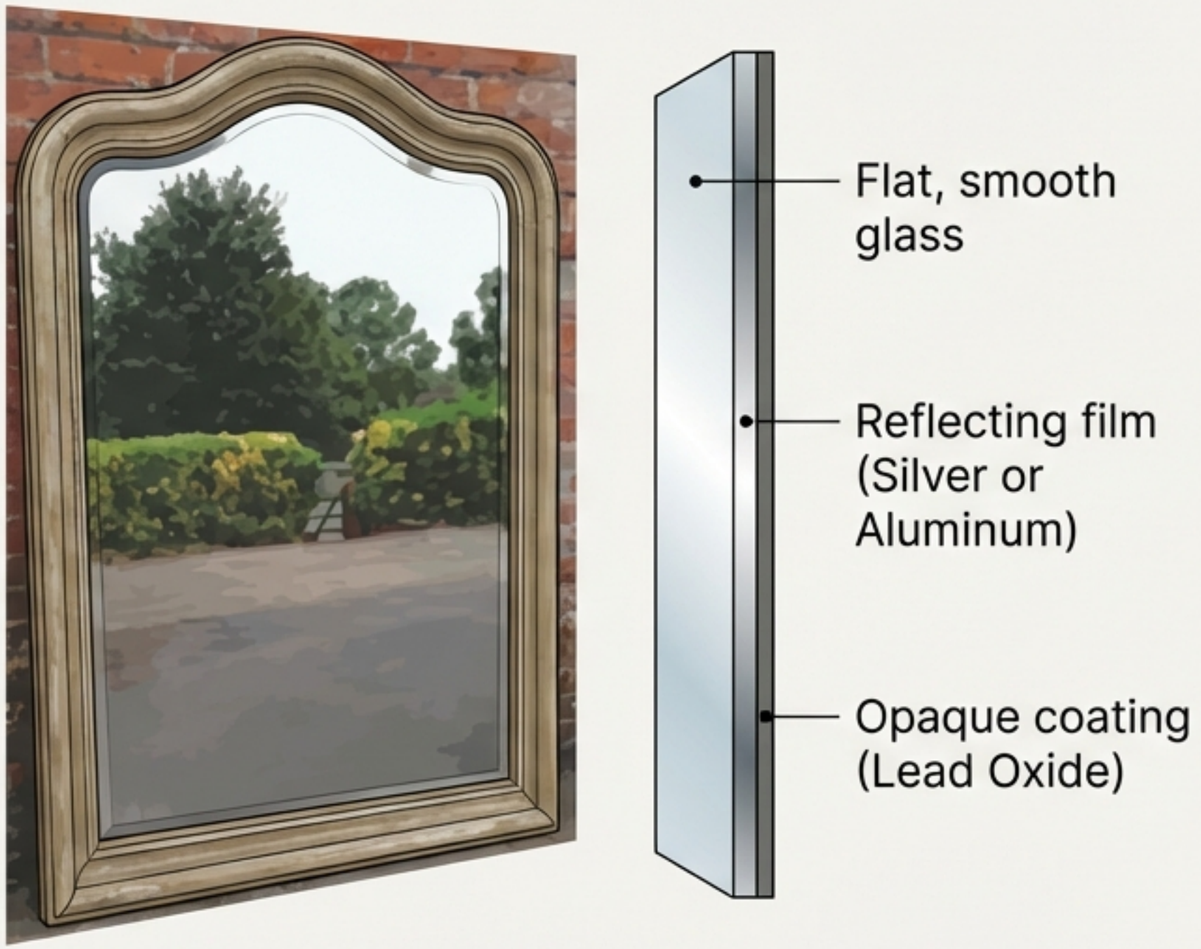
Light: Electromagnetic radiation that provides environmental information.

To manipulate light, we need order. Polished surfaces absorb less light and reflect maximum light in a regular pattern.

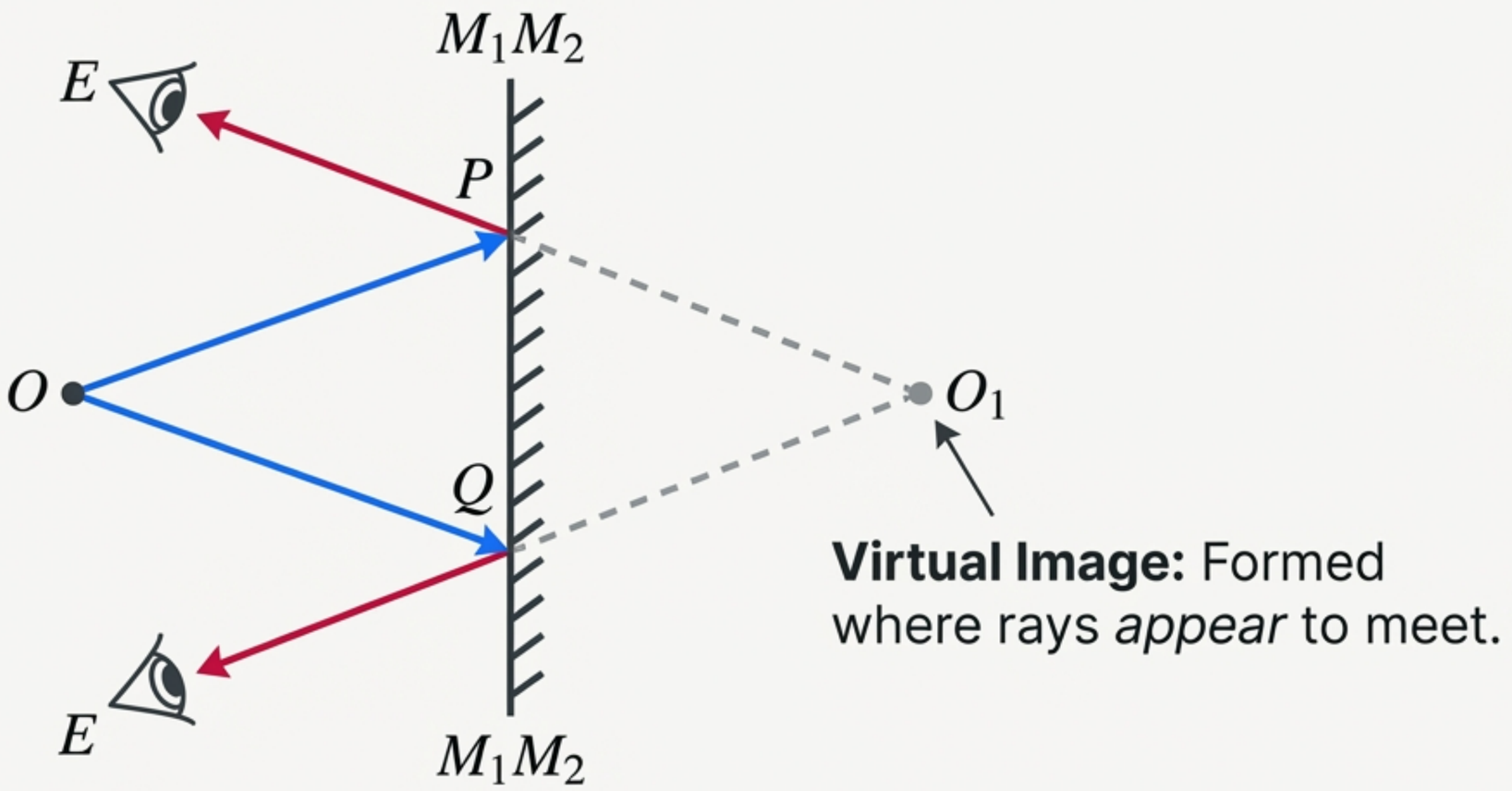
Definition: In scientific language, a surface which reflects light and creates clear images is called a ***mirror***.

The Silvered Glass Mirror

The mirror as we know it is a triumph of chemistry. German scientist **Justus von Liebig** revolutionized optics by coating one side of a plane glass surface with silver metal.

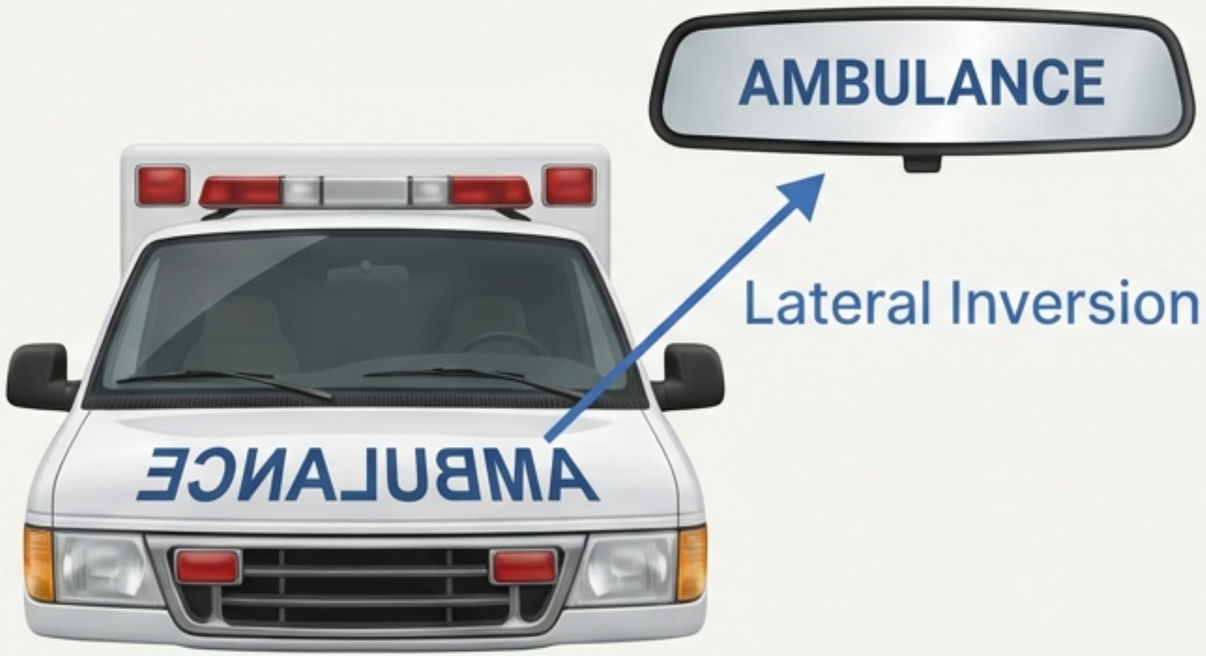


The Plane Mirror: Proving the Virtual Image



Distance of Object (O) = Distance of Image (O_1)

Lateral Inversion



The image of every point on a word is formed behind the mirror at the same distance as the point itself.

This causes the left side of the object to appear as the right side of the image.

A H I M O T U V W X Y

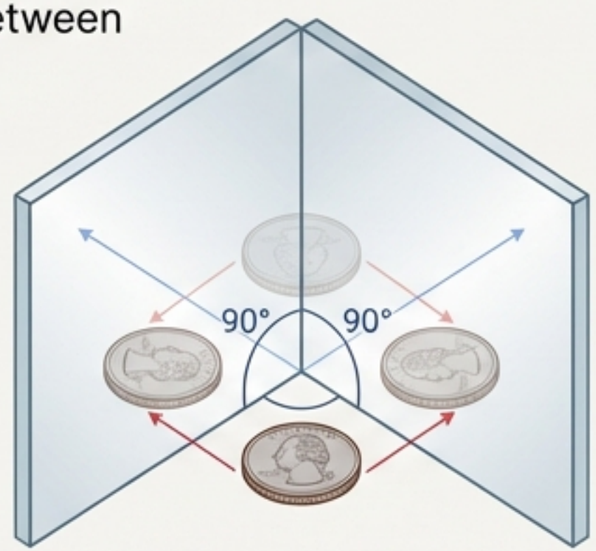
Symmetrical letters that look identical in a mirror.

The Physics of the Kaleidoscope

THEORY

$$n = \left(\frac{360°}{A}\right) - 1$$

n = number of images
A = angle between mirrors



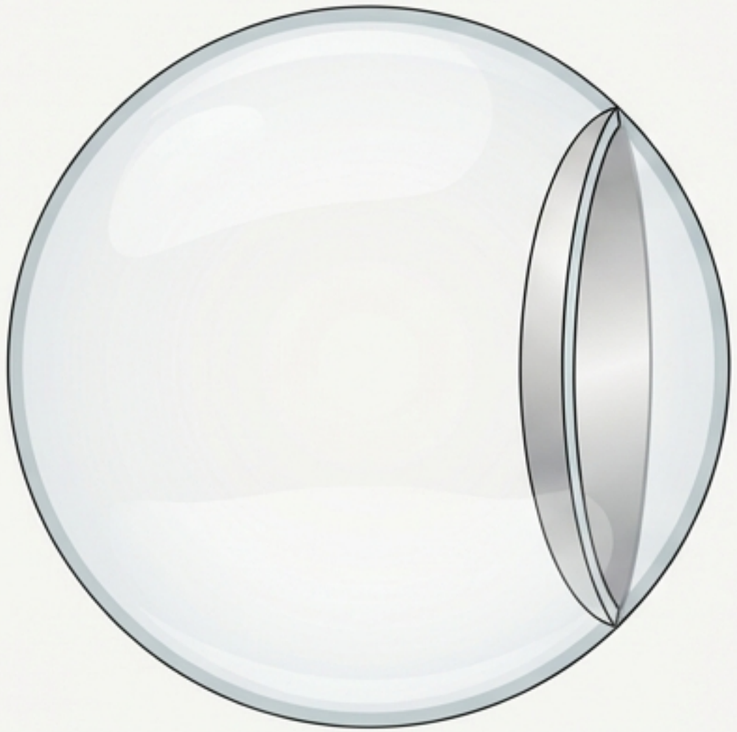
DATA

Angle (A)	Image Count (n)
120°	2 Images
90°	3 Images
60°	5 Images
45°	7 Images
30°	11 Images

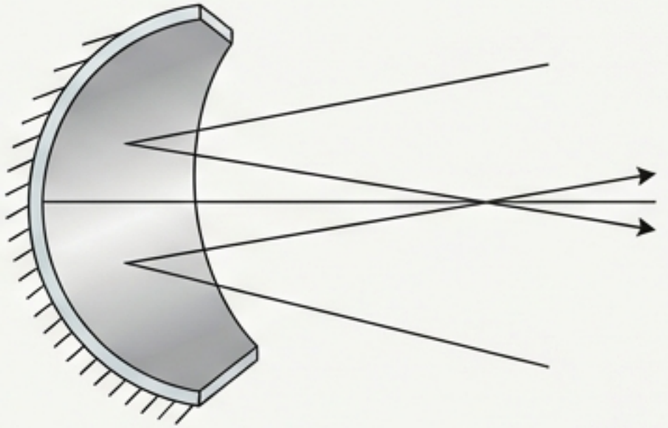
Insight: As the angle decreases, the number of reflections increases exponentially.

Bending Reality: Spherical Mirrors in DM Serif Display

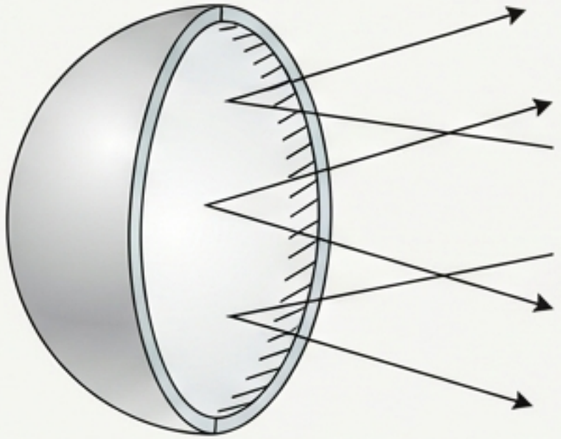
Inter: Plane mirrors are flat. Spherical mirrors are sections of a hollow sphere. This curvature creates the distorted reality seen in a ‘Laughing Chamber’ or the wide view of a car mirror.



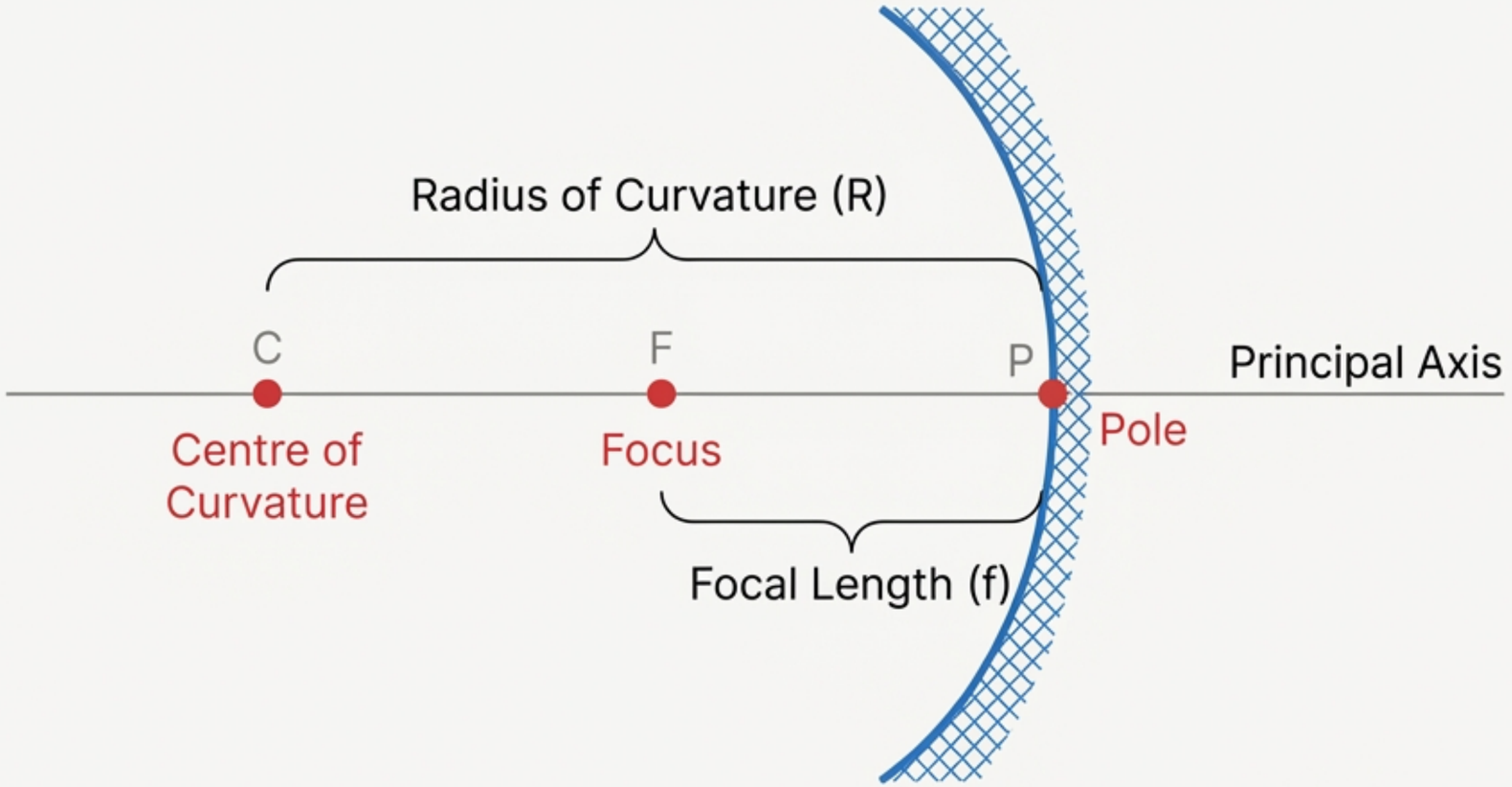
Concave
(Inner surface reflects)



Convex
(Outer surface reflects)



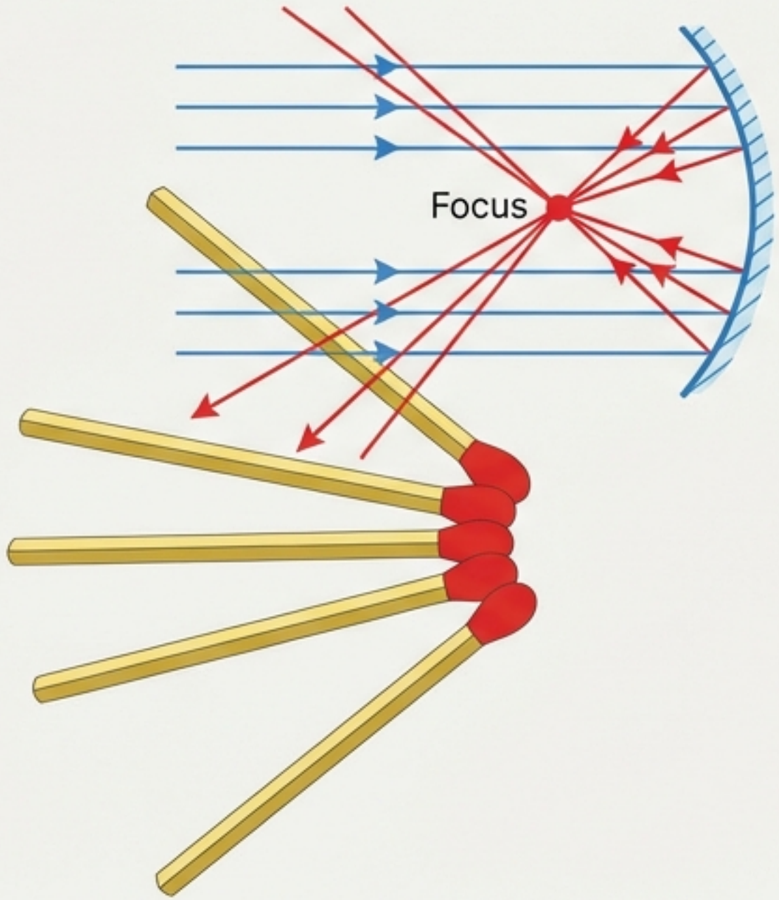
“The Geography of a Mirror” in DM Serif Display



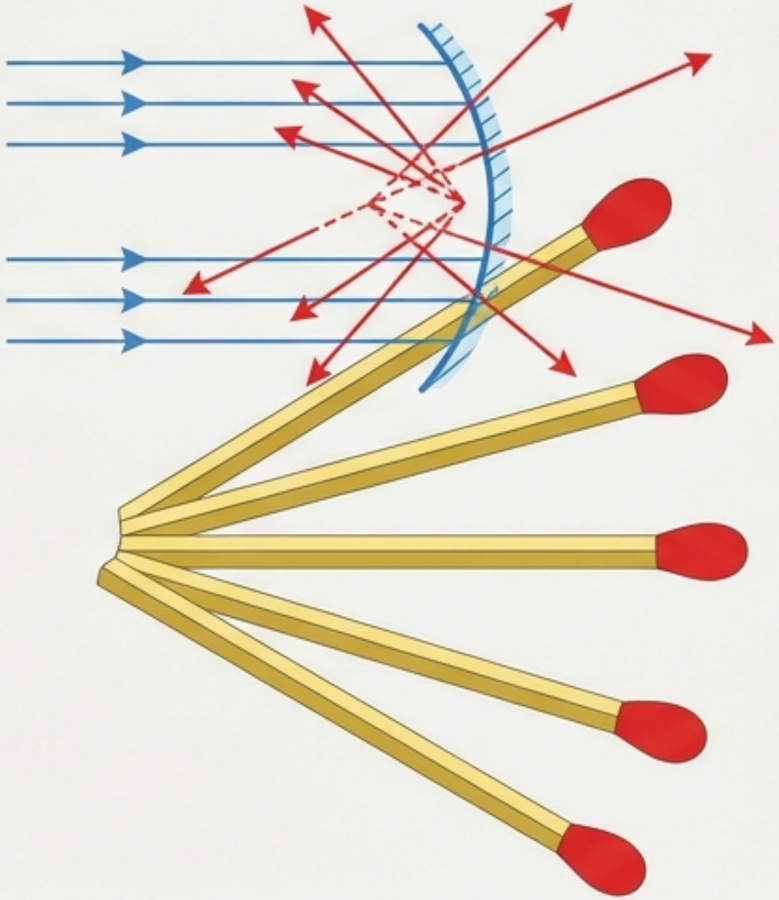
$$f = \frac{R}{2}$$

Convergence vs. Divergence

The Converger (Focusing)

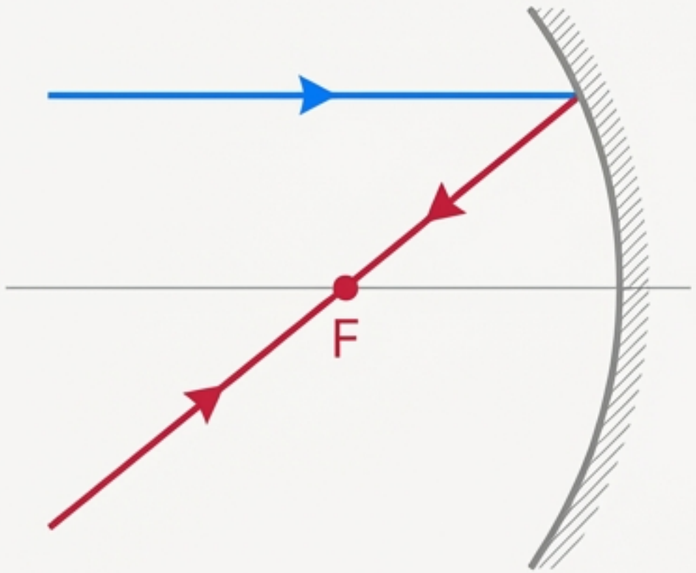


The Diverger (Dispersing)



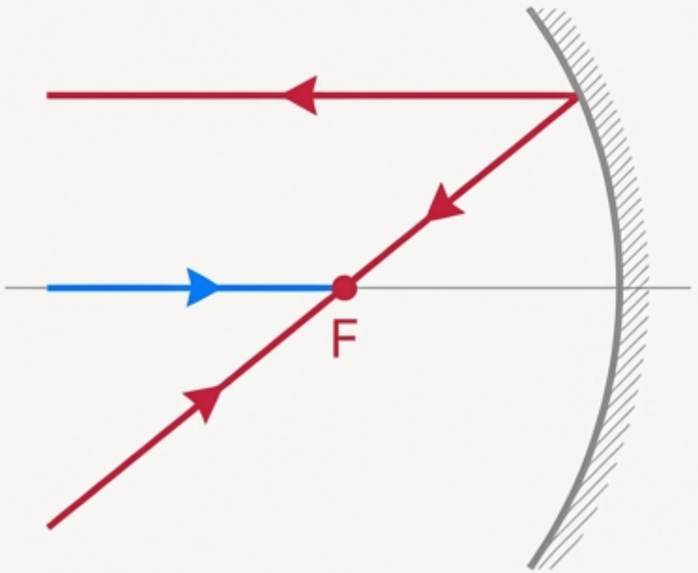
The Rules of the Road: Ray Tracing

Parallel → Focus



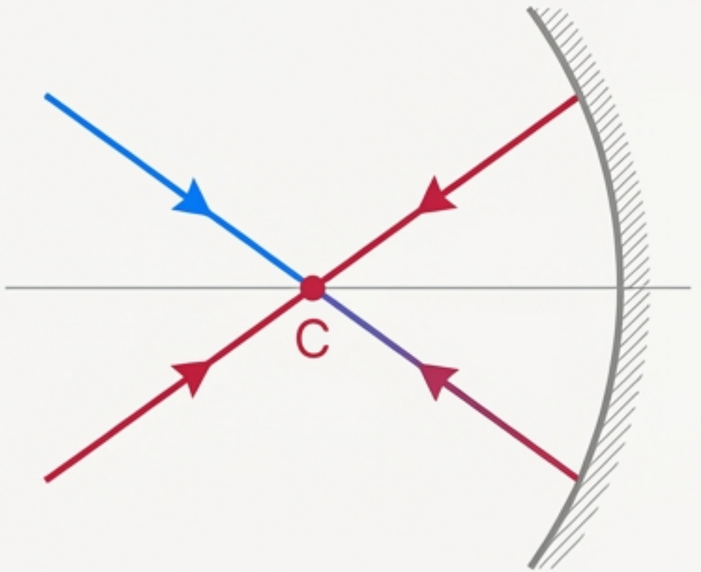
Parallel → Focus

Focus → Parallel



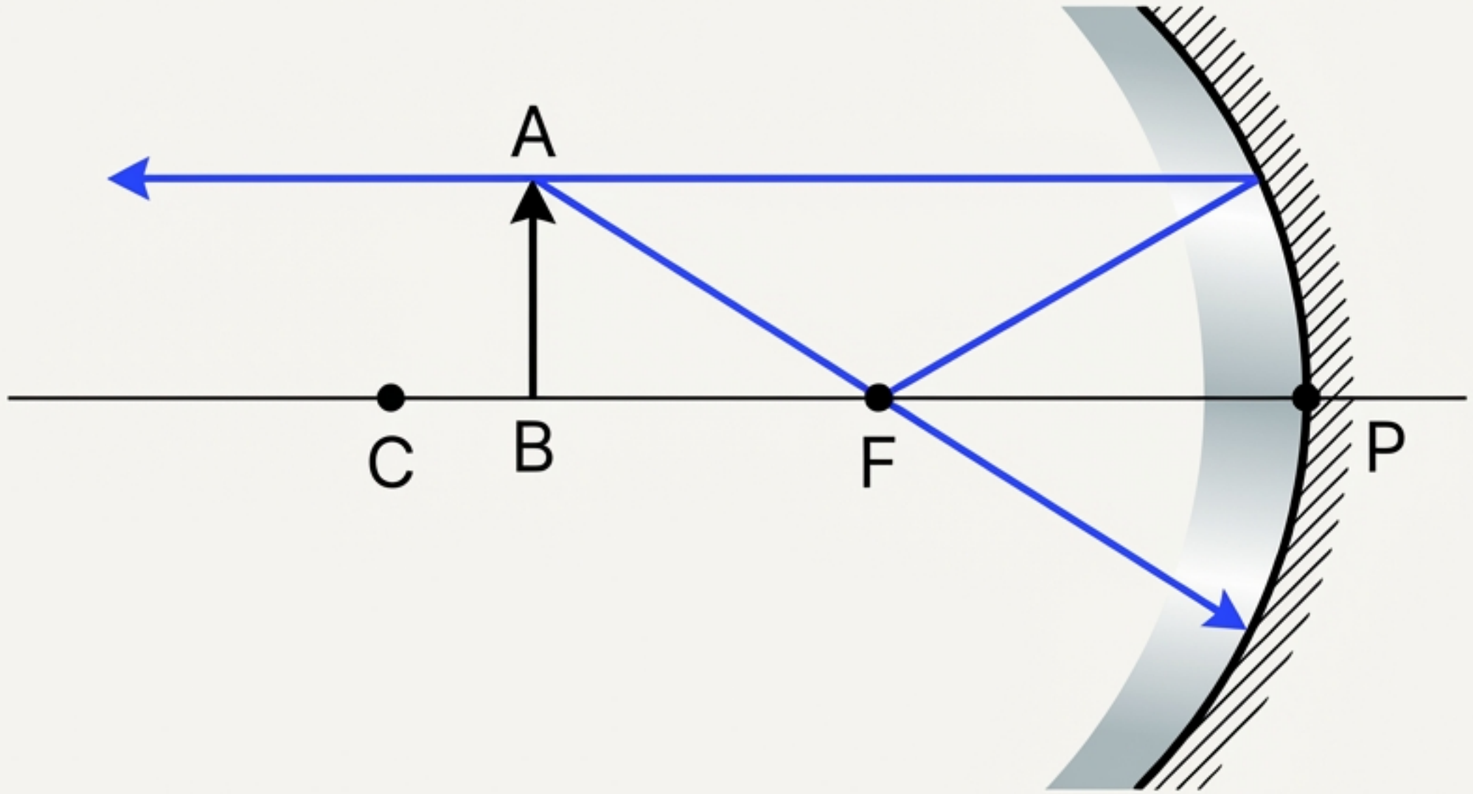
Focus → Parallel

Centre → Bounce Back



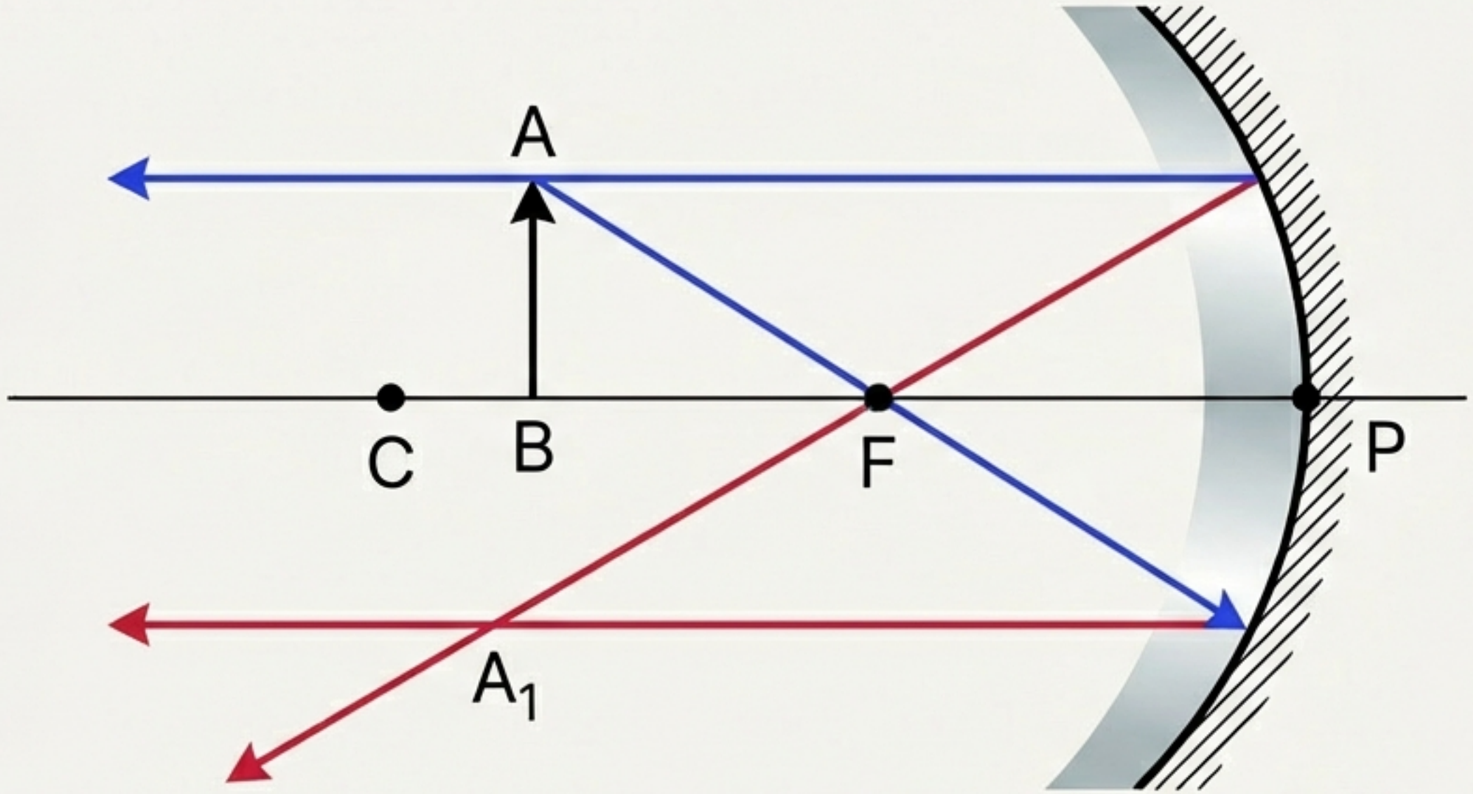
Centre → Bounce Back

Building the Image: Step 1 (Incident Rays)



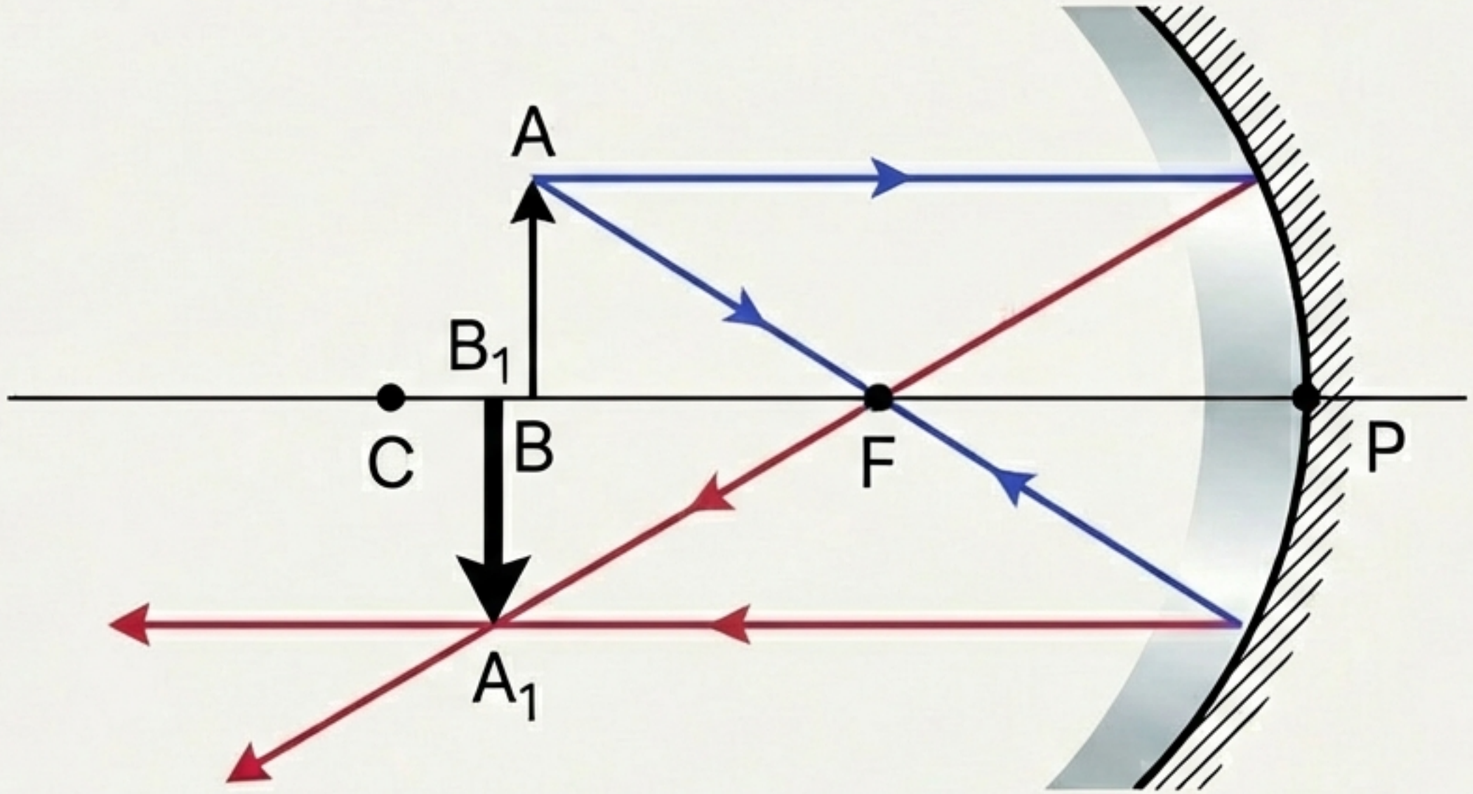
Scenario: Object placed between F and C. We track two specific rays starting from point A.

Building the Image: Step 2 (Reflection)



Following the rules, the reflected rays from A intersect at A_1, forming the image of point A.

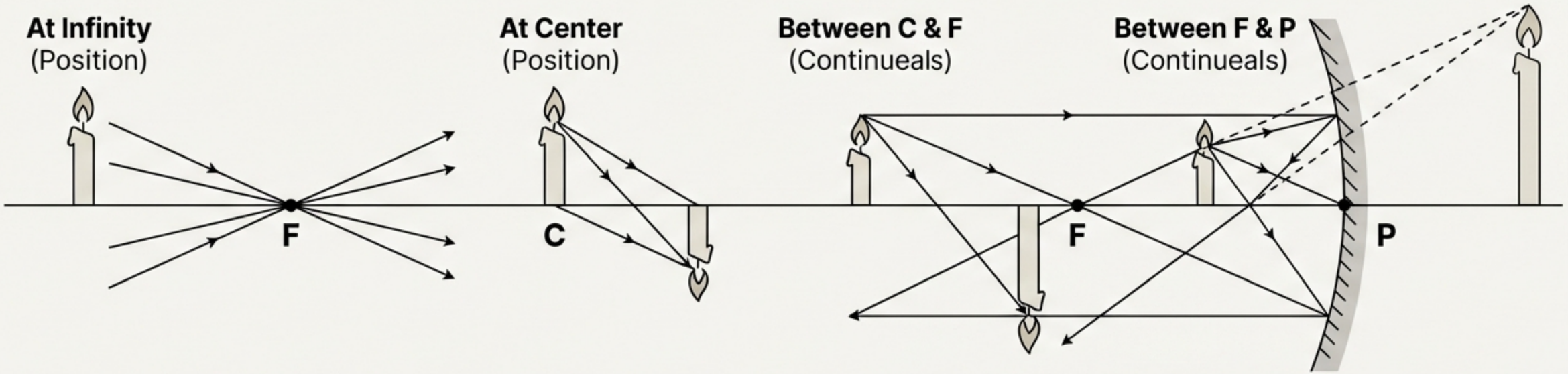
Building the Image: Step 3 (The Result)



Analysis

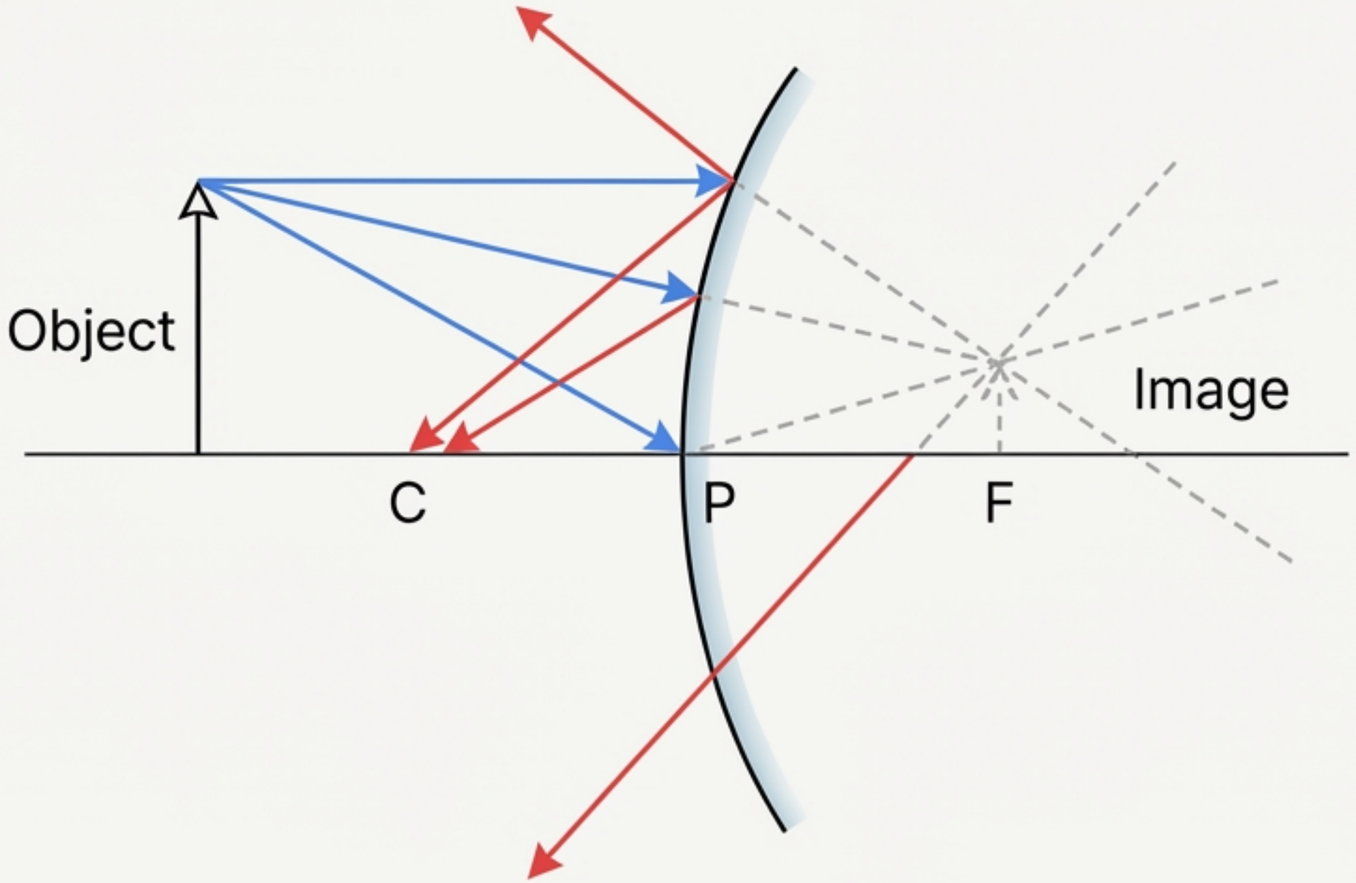
Position: Beyond Centre of Curvature
Size: Magnified
Orientation: Inverted
Nature: Real (Formed by actual intersection)

The Shapeshifter: Concave Mirror Scenarios



Concave mirrors are versatile: they can produce both Real and Virtual images depending on distance.

The Reliable Convex Mirror



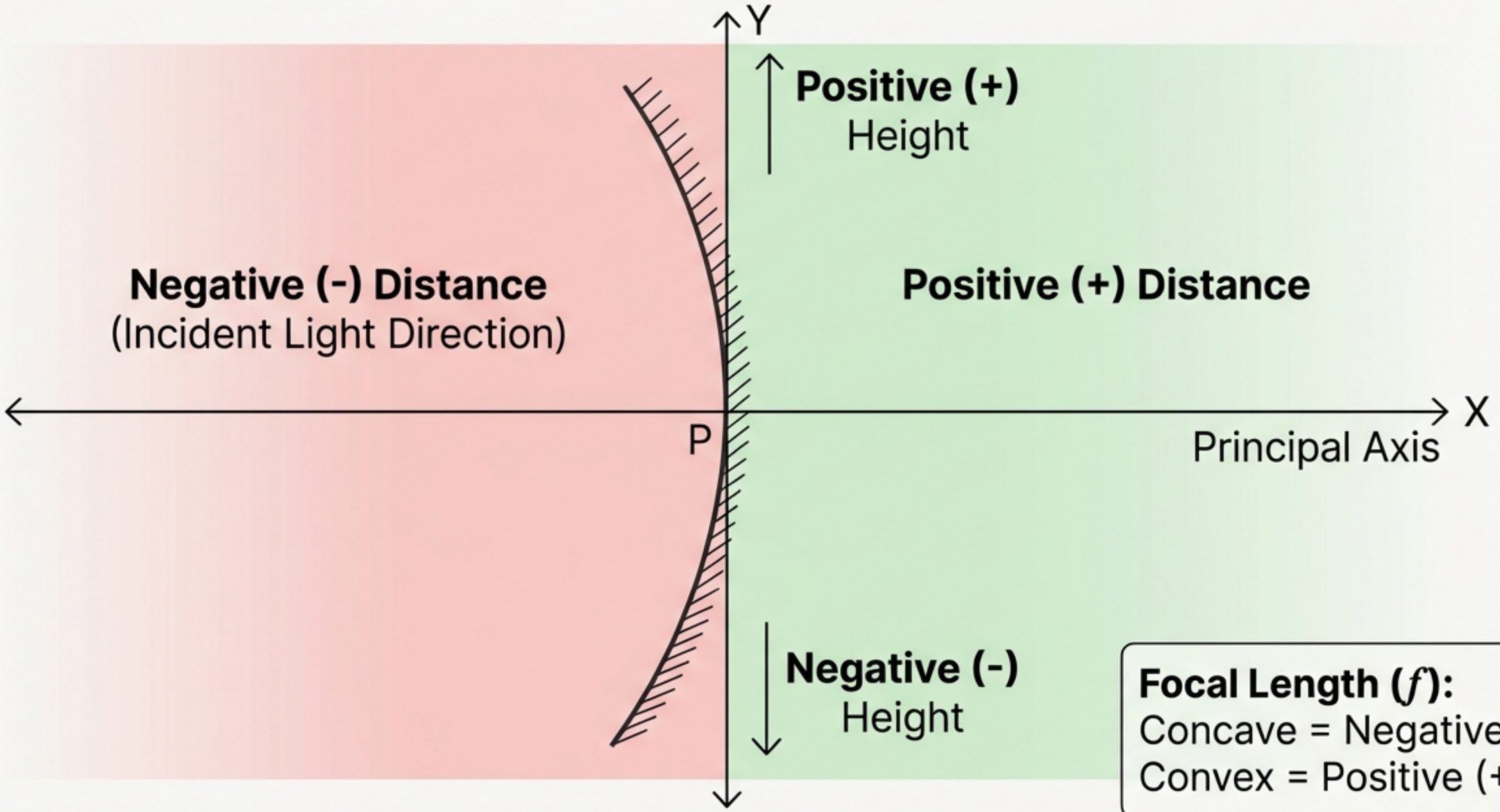
Always **Virtual**

Always **Erect** (Upright)

Always **Diminished** (Small)

Perfect for safety. You will never see an upside-down car in a rear-view mirror.

Cartesian Sign Convention



Focal Length (f):
Concave = Negative (-),
Convex = Positive (+)

“The Calculator: Mirror Formulas” in DM Serif Display

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

Image distance

Object distance

Focal length

Height of image

$$M = \frac{h_2}{h_1} = -\frac{v}{u}$$

Height of object

These two equations allow us to predict the exact position, sisition, size, and nature of an image without drawing a single line.

Prediction in Practice

Rajashree places an object 30cm from a concave mirror (f=10cm). Where should she place the screen?

THE CALCULATION (STEP-BY-STEP VISUAL)

Knowns: u = -30, f = -10

Step 1: $\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$ $\longrightarrow$ Mirror formula

Step 2: $\frac{1}{v} = \frac{1}{-10} - \frac{1}{-30}$ $\longrightarrow$ Substitute known values

Step 3: $\frac{1}{v} = \frac{-3+1}{30} = \frac{-2}{30}$ $\longrightarrow$ Solve for 1/v

Result: **v = -15 cm**

CONCLUSION

The screen must be placed **15 cm to the left** of the mirror.
The image is **Real**.

Reflection in Action: Concave Mirrors

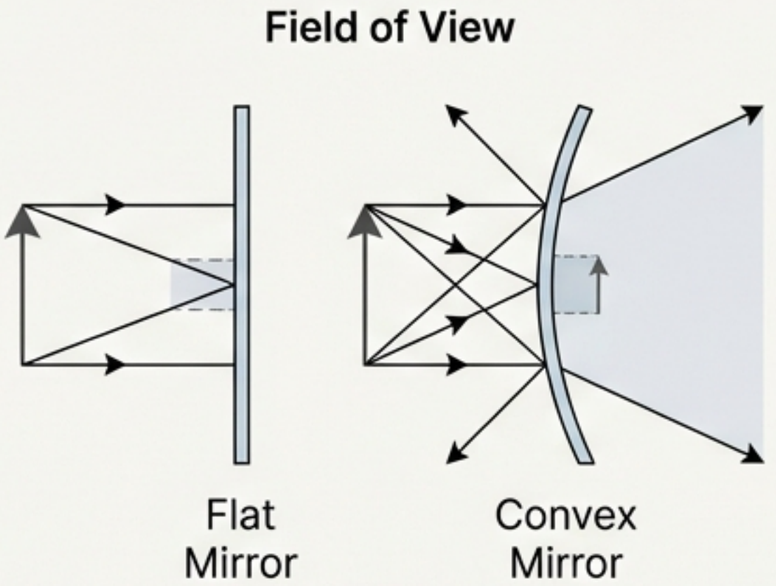
Precision

Precision: When the object is within the Focus, the image is upright and magnified.

Power

Power: Parallel rays from the sun converge at the Focus to generate intense heat.

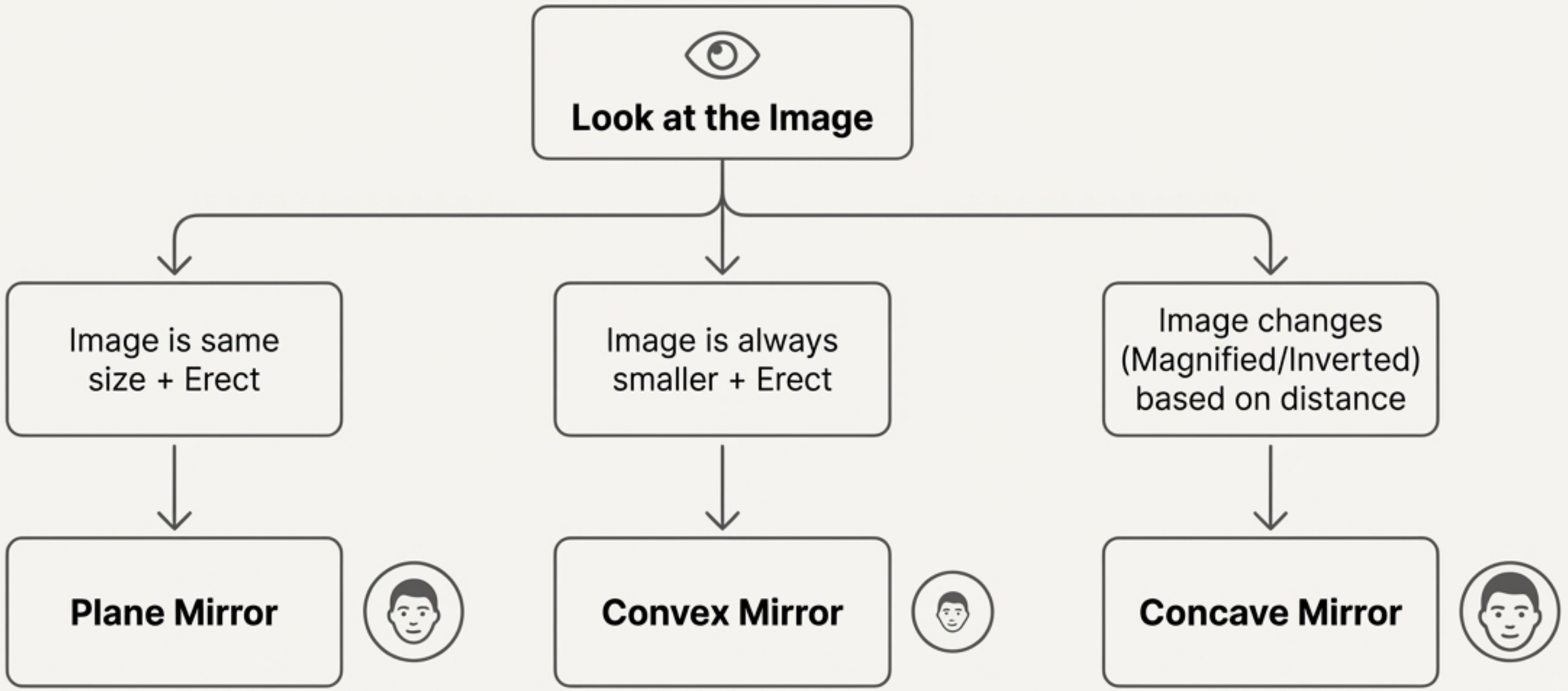
Reflection in Action: Convex Mirrors



Because the image is diminished (smaller), the mirror captures a much wider field of view, critical for safety.

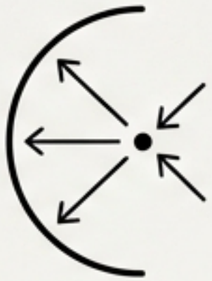
Identifying the Mirror

How to identify a mirror without touching the surface.



The Duality of Light

Plane Mirrors: Show us the world as it is, strictly lateral.



Concave Mirrors: Focus energy and magnify reality. Creators of the Real and the Virtual.

Convex Mirrors: Compress the world. Guardians of the wide view.

By understanding the geometry of reflection, we don’t just observe light—we control it.