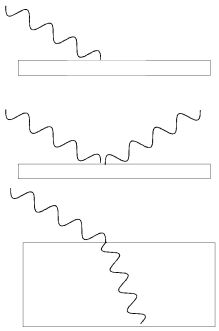
Physics 1161: Lecture 16

Introduction to Mirrors

Light incident on an object

- Absorption
- Reflection (bounces)**
  - See it
  - Mirrors
- Refraction (bends)
  - Lenses
- Often some of each



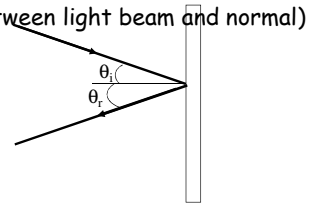
Everything true for wavelengths << object size

Reflection

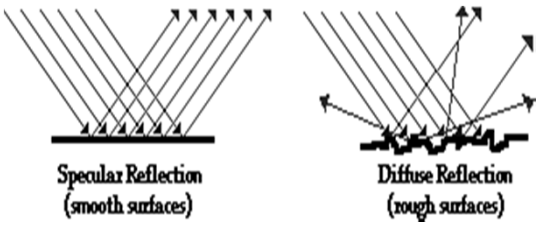
Angle of incidence = Angle of reflection

$\theta_i = \theta_r$

(Angles between light beam and normal)



Diffuse Reflection



Diffuse Reflection

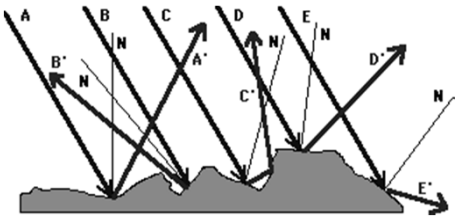


Image Location

Flat Mirror Summary

- Image appears:
  - Upright
  - Same size
  - Located same distance from, but behind, mirror
  - Facing opposite direction: Left/Right inverted
  - Virtual Image: Light rays don't actually intersect at image location.

Checkpoint

- Why do ambulances have "AMBULANCE" written backwards?

Checkpoint
Fido's Tail

Can you see Fido's tail in mirror?

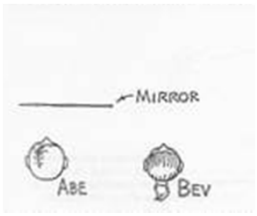
Yes No

mirror

(You) (Fido)

Abe and Bev both look in a plane mirror directly in front of Abe. Abe can see himself while Bev cannot see herself. Can Abe see Bev (and can Bev see Abe)?

1. Yes
2. No



Mirror Images

Abe and Bev both look in a plane mirror directly in front of Abe. Abe can see himself while Bev cannot see herself. Can Abe see Bev (and can Bev see Abe)?

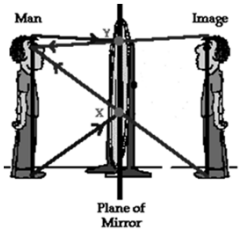
1. Extend edges of mirror with dashed lines.
2. Draw in the images.
3. Connect images and observers with lines of sight.
4. If the connecting lines intersect with the mirror (not the extension of the mirror), they can see each other.

Abe sees himself & Bev

Bev sees Abe but not herself

A man stands in front of a mirror. How tall does the mirror have to be so that he can see himself entirely?

1. Same as his height
2. Less than his height but more than half his height
3. Half his height
4. Less than half his height
5. Any size will do



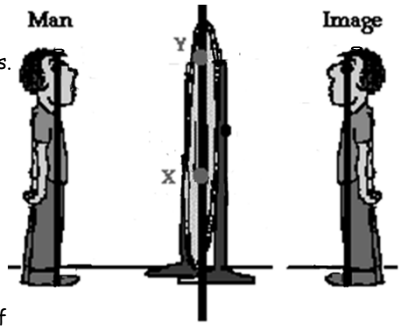
How Big Must the Mirror Be?

Light from feet striking mirror at X reflects to eyes.

Man sees image of his feet by looking toward point X

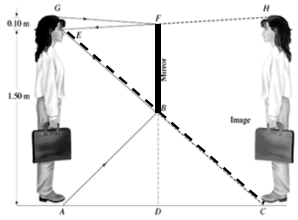
Light from top of head striking mirror at Y reflects to eyes

Man sees image of top of head by looking toward point Y

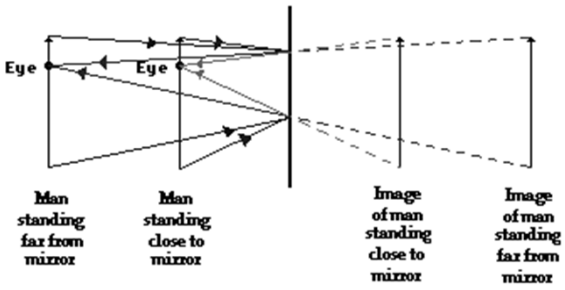


Does this depend on the person's distance from the mirror?

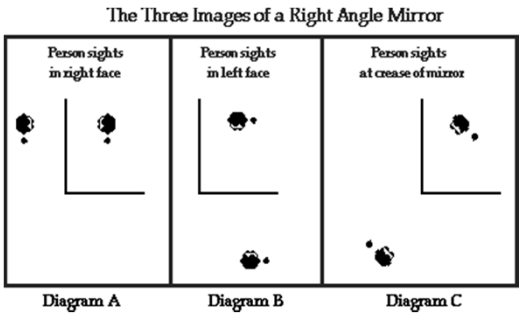
1. NO
2. Yes
3. Depends on the mirror
4. Depends on the person



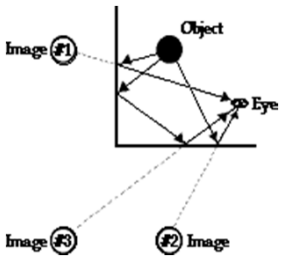
Distance from Mirror Irrelevant



Right Angle Mirror



Right Angle Mirror



- Formation of primary and secondary images

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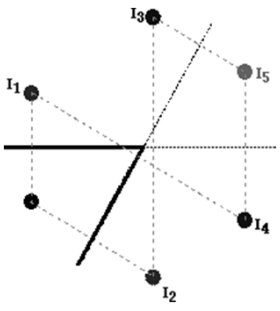
Kaleidoscope



- Angles smaller than 90° produce more than 3 images

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Kaleidoscope Applets

- Hinged Mirror Applet
- Image Formation Applet

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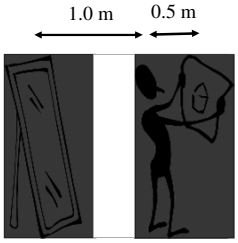
Reflection Applets

- Plane Mirror Image Applets
- Double Mirror Images
- Hinged Mirror Applet
- Rainbow Applets

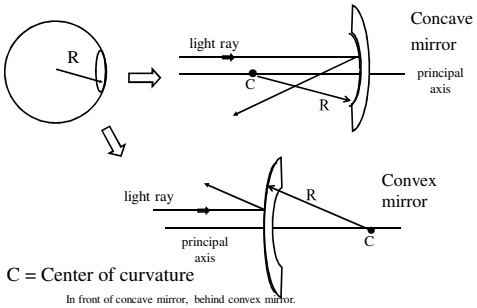
You hold a hand mirror 0.5 m in front of you and look at your reflection in a full-length mirror 1 m behind you. How far in back of the big mirror do you see the image of your face?

1. 0.5 m
2. 1.0 m
3. 1.5 m
4. 2.0 m
5. 2.5 m



Curved mirrors

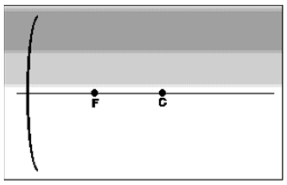
A Spherical Mirror: section of a sphere.



C = Center of curvature

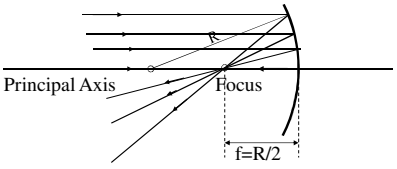
In front of concave mirror, behind convex mirror.

Three Useful Rays



- Ray parallel to the axis reflects through the focus.
- Ray through the focus reflects parallel to the axis.
- Ray through the center of curvature reflects back on itself.

Concave Mirror



Rays are bent towards the principal axis.

Rays parallel to principal axis and near the principal axis ("paraxial rays") all reflect so they pass through the "Focus" (F).

The distance from F to the center of the mirror is called the "Focal Length" (f).

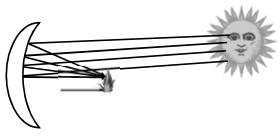
$$f = \frac{R}{2}$$

Checkpoints

What kind of spherical mirror can be used to start a fire?

concave

convex



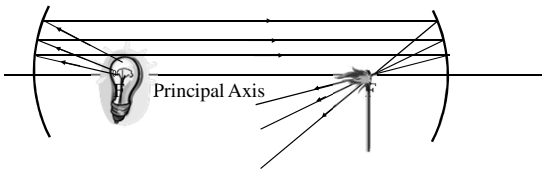
How far from the paper to be ignited should the mirror be held?

farther than the focal length

closer than the focal length

at the focal length

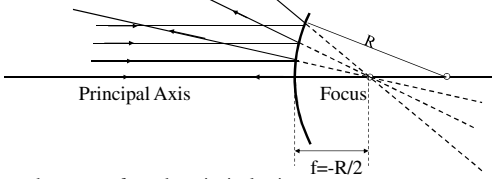
Concave Mirror



Rays traveling through focus before hitting mirror are reflected parallel to Principal Axis.

Rays traveling parallel to Principal Axis before hitting mirror are reflected through focus

Convex Mirror



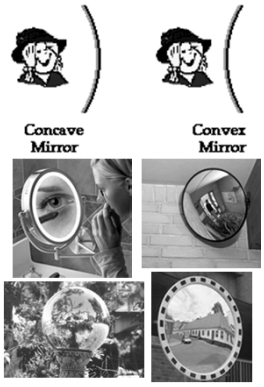
Rays are bent away from the principal axis.

Rays parallel to principal axis and near the principal axis ("paraxial rays") all reflect so they appear to originate from the "Focus" (F).

The distance from F to the center of the mirror is called the "Focal Length" (f).

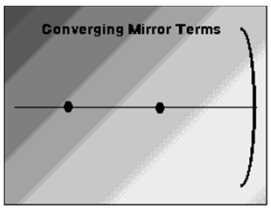
$$f = -\frac{R}{2}$$

Types of Curved Mirrors



- A concave mirror is silvered on the inside of the sphere.
- A concave mirror is also called a converging mirror because it converges parallel light.
- A convex mirror is silvered on the outside of the bowl.
- A convex mirror is also called a diverging mirror because it diverges parallel light.

Concave Mirror Terms & Formulas



- Axis
- Center of Curvature
- Radius of Curvature
- Focus
- Focal Length

$$R = 2f$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

Example

- A 4.00-cm tall light bulb is placed a distance of 45.7 cm from a concave mirror having a focal length of 15.2 cm. Determine the image distance and the image size.