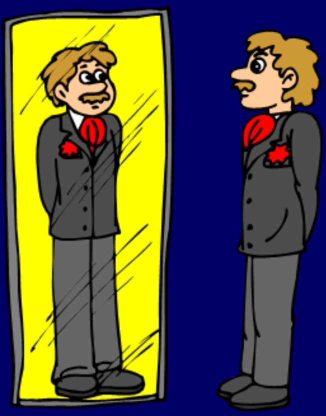
Physics 102: Lecture 16

Introduction to Mirrors



Phys 102 recent lectures

Light as a wave

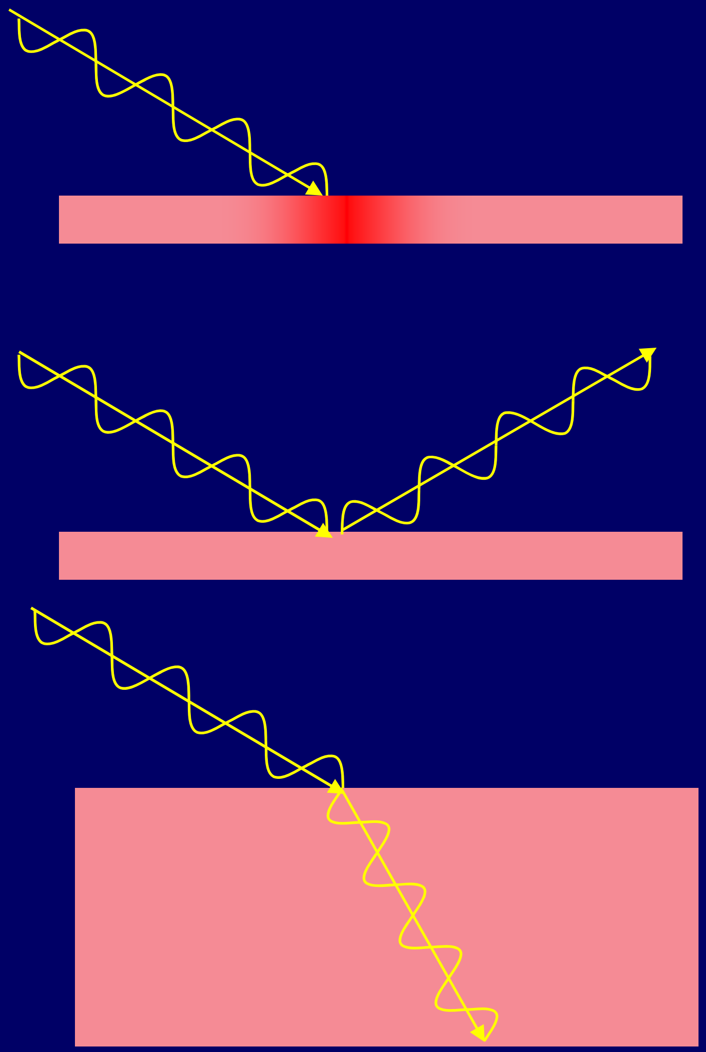
- Lecture 14 – EM waves
- Lecture 15 – Polarization
- Lecture 20 & 21 – Interference & diffraction (coming soon!)

Light as a ray

- Lecture 16 – Reflection
- Lecture 17 – Spherical mirrors & refraction
- Lecture 18 – Refraction & lenses
- Lecture 19 – Lenses & your eye

Light incident on an object

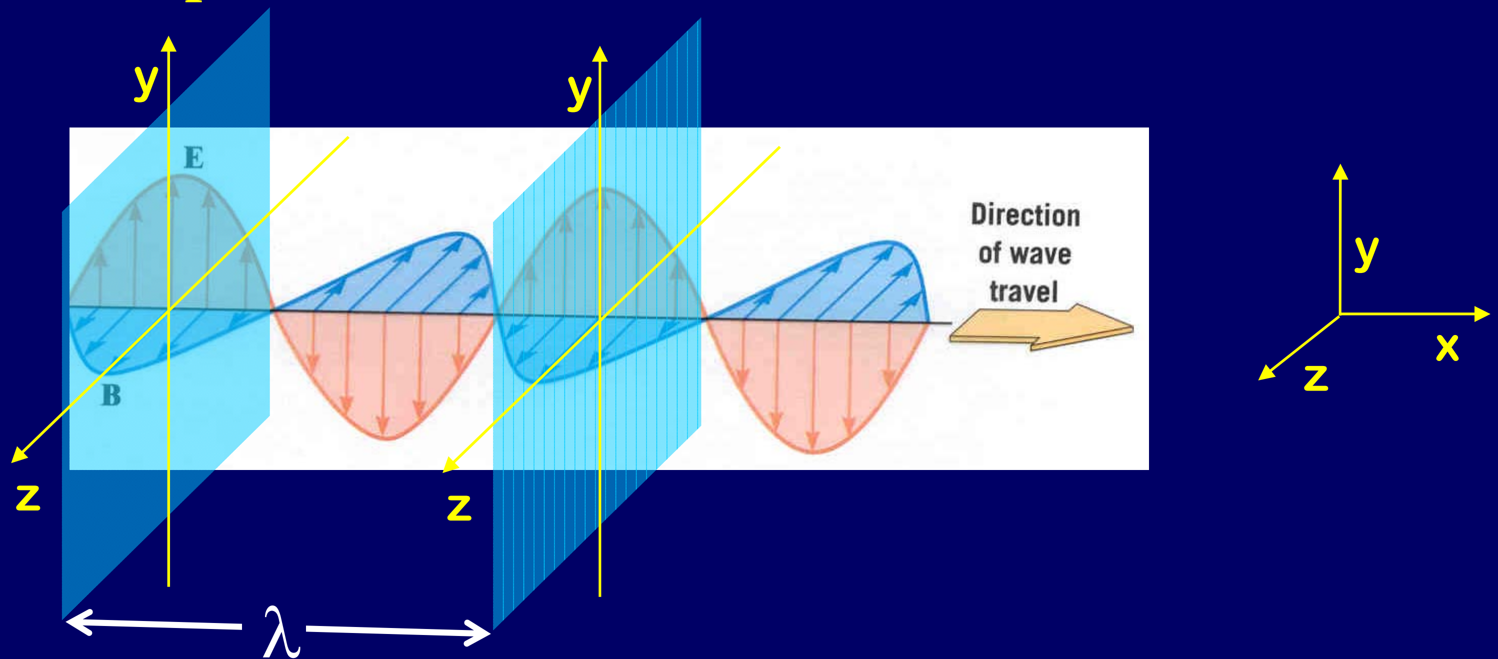
- Absorption
- Reflection (bounces)
  - See it
  - Mirrors
- Refraction (bends)
  - Lenses
- Often some of each



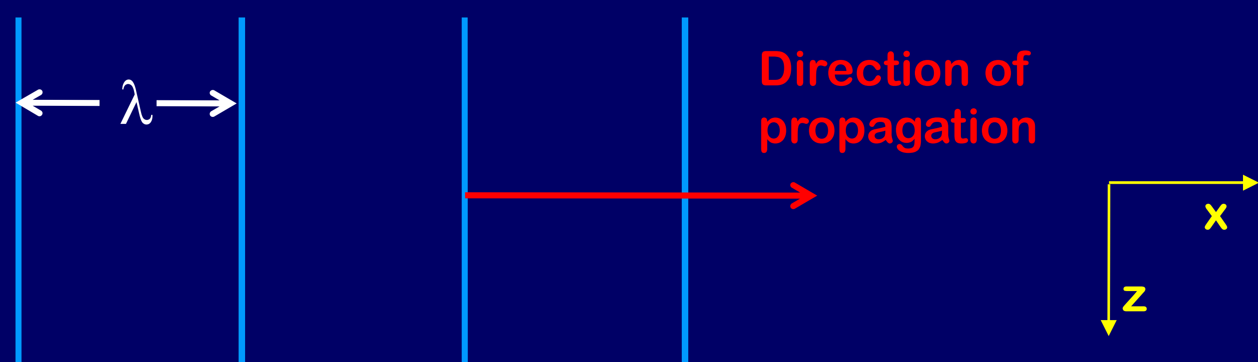
Everything true for wavelengths << object size

Recall: wavefronts

Wavefronts represent "crests" of EM wave



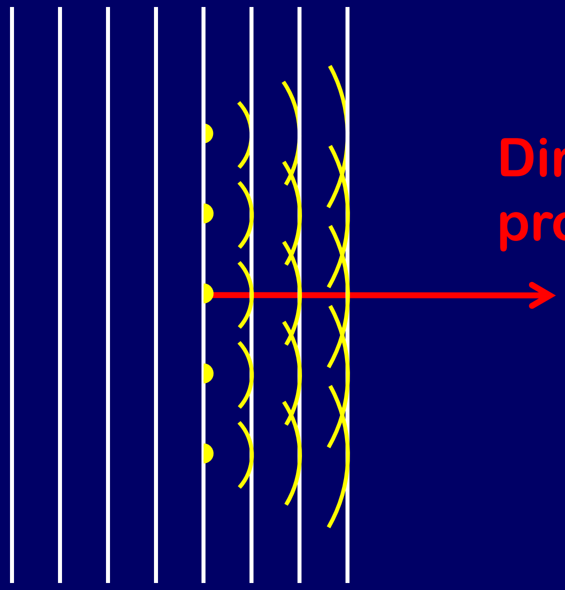
Top view:



Huygens' principle

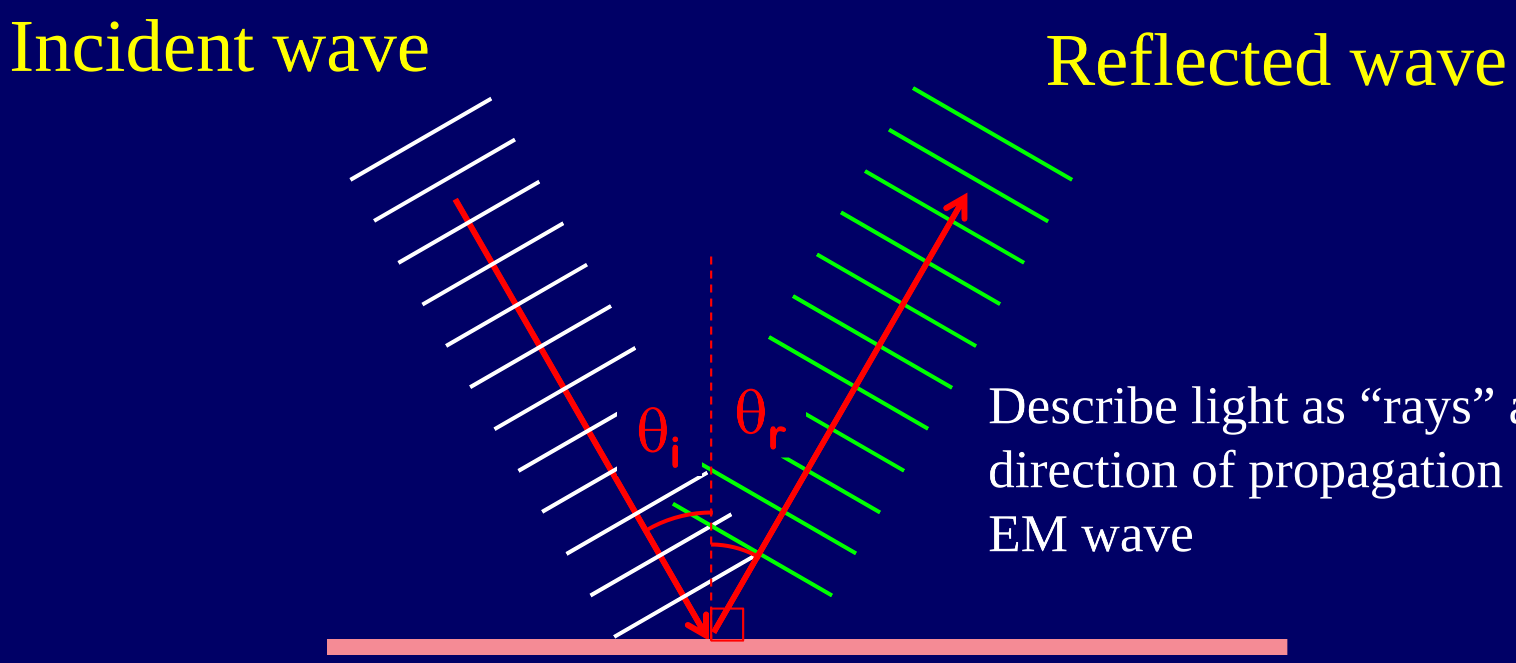
Every point on a wavefront acts as a source of tiny "wavelets" that move forward.

"wavelet"



wavefront

Law of Reflection



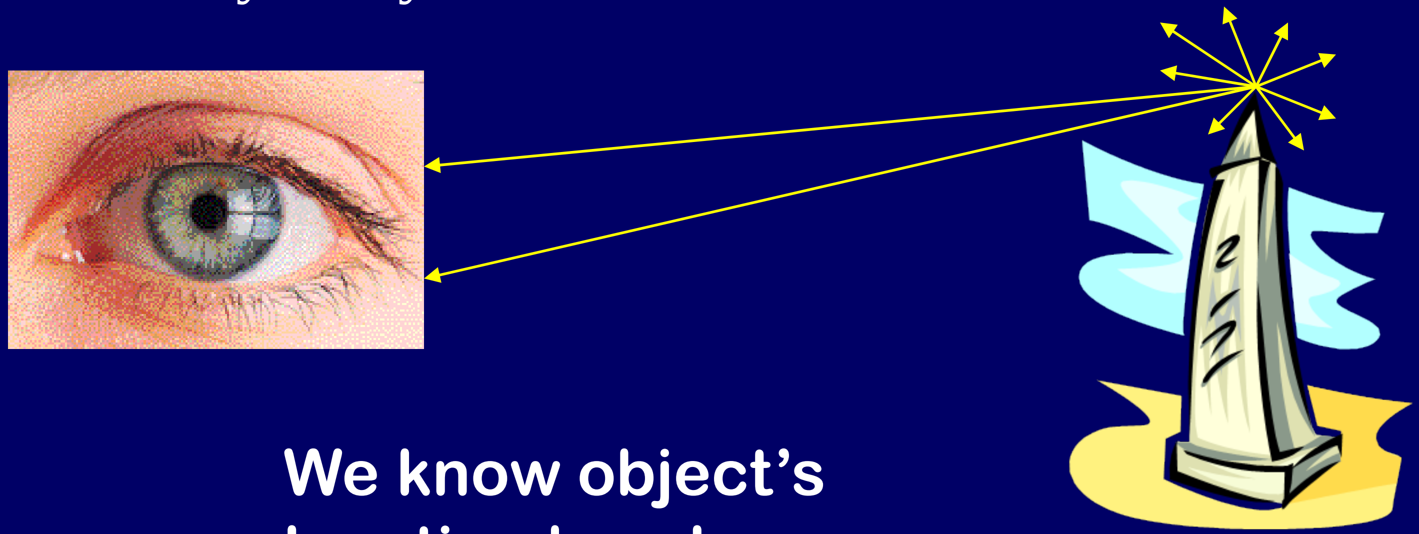
Describe light as “rays” along direction of propagation of EM wave

Angle of incidence = Angle of reflection

$$\theta_i = \theta_r$$

Object Location

- Light rays from sun bounce off object and go in all directions
  - Some hit your eyes

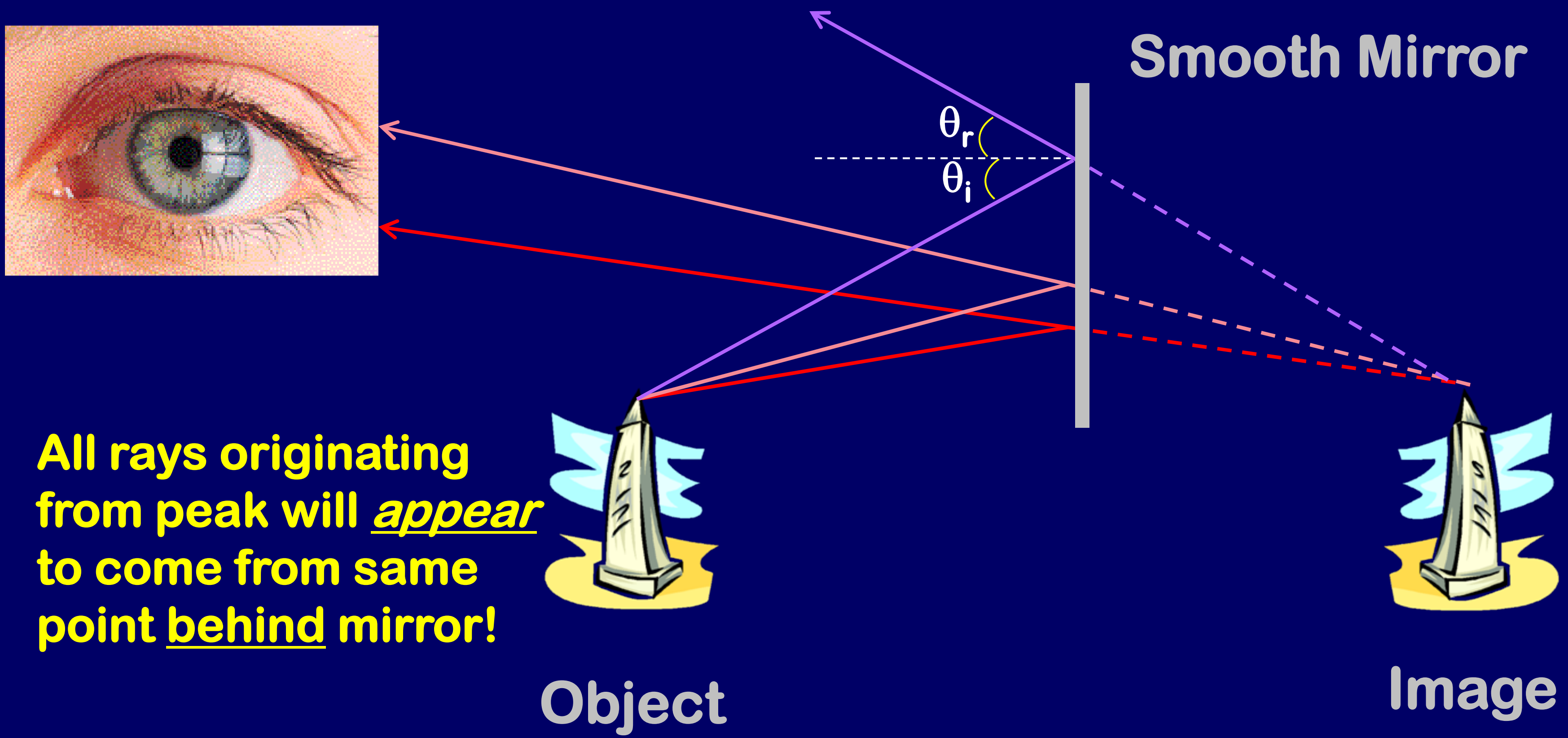


We know object's location by where rays come from.

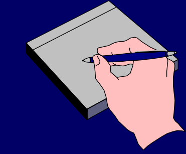
- Color results from some light being absorbed by object before bouncing off.

Flat Mirror

- All you see is what reaches your eyes
  - You think object's location is where rays <u>appear</u> to come from.



All rays originating from peak will *appear* to come from same point behind mirror!



Flat Mirror

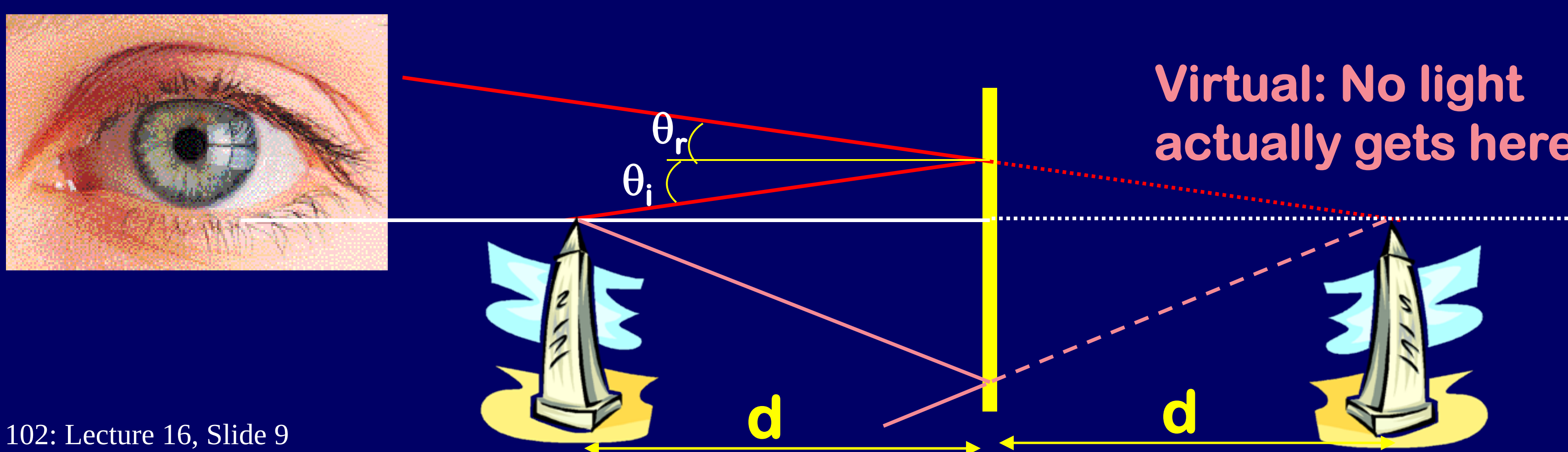
(1) Draw first ray perpendicular to mirror $0 = \theta_i = \theta_r$

(2) Draw second ray at angle. $\theta_i = \theta_r$

(3) Lines appear to intersect a distance d behind mirror. This is the image location.

Example

Light rays don't really converge there, so it's a **"Virtual Image"**



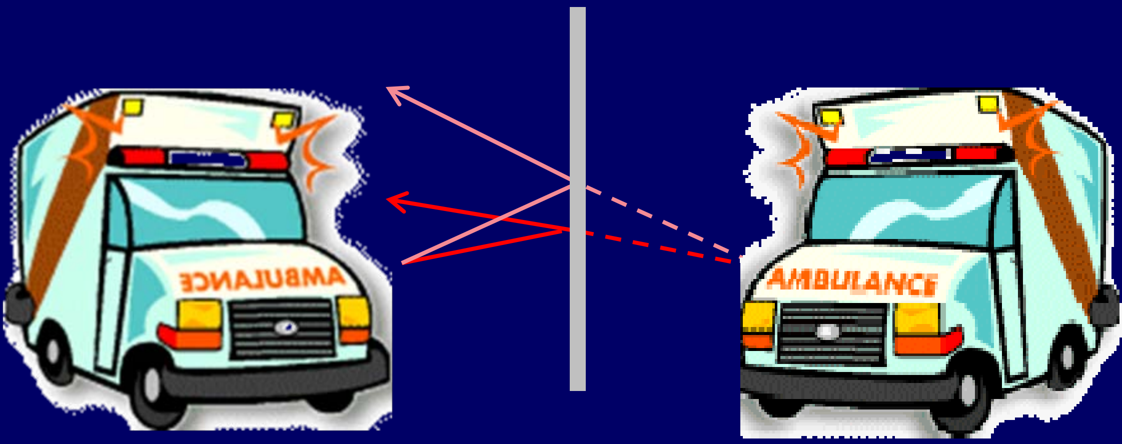
Flat Mirror Summary

- 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.

Preflight 16.1

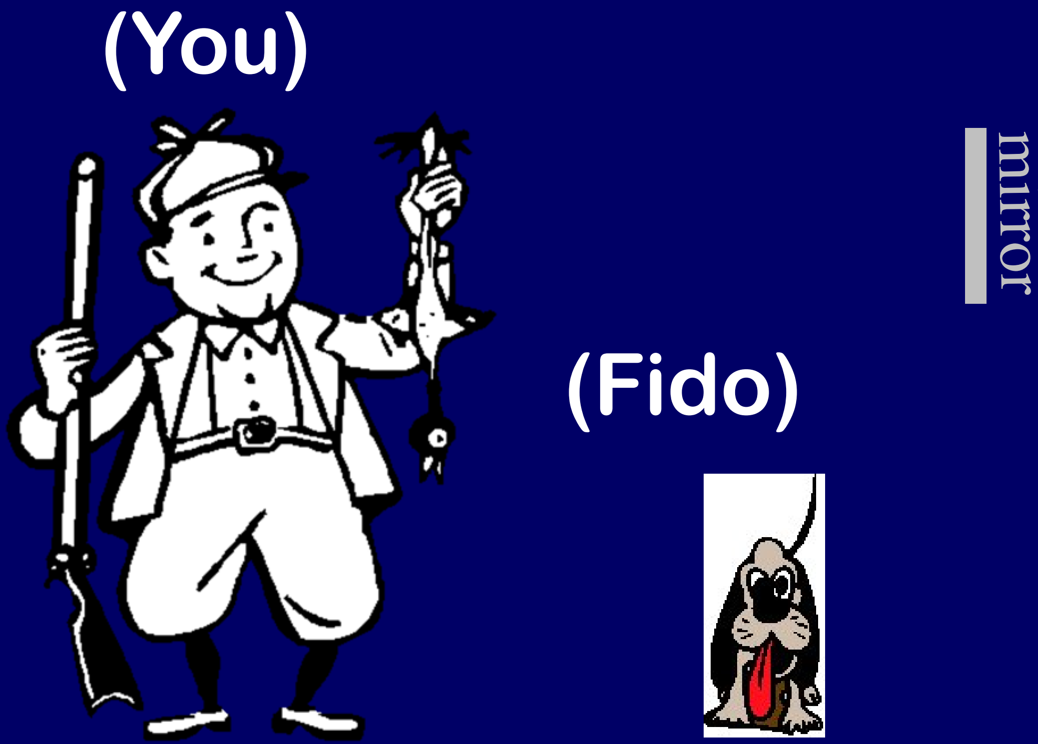
Why do ambulances have "AMBULANCE" written backwards?

So you can read it in your rear-view mirror!



Preflight 16.3

Can you see Fido’s tail in mirror?



ACT: Flat Mirrors

You are standing in front of a short flat mirror which is placed too high, so you can see above your head, but only down to your knees. To see your shoes, you must move

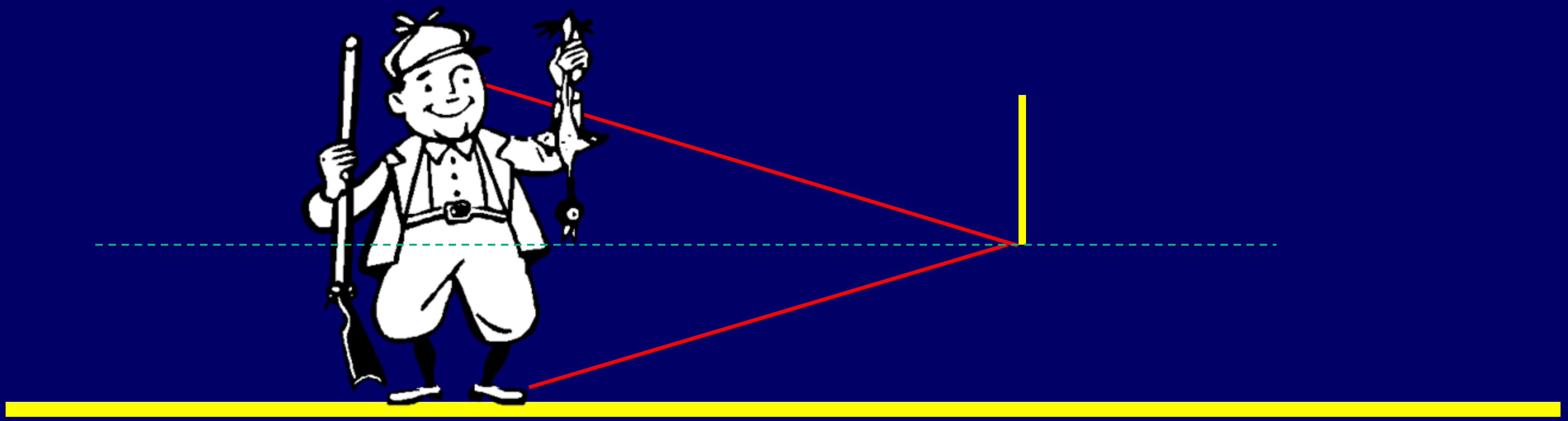
(1) closer to the mirror.

(2) further from the mirror.

(3) to another mirror.

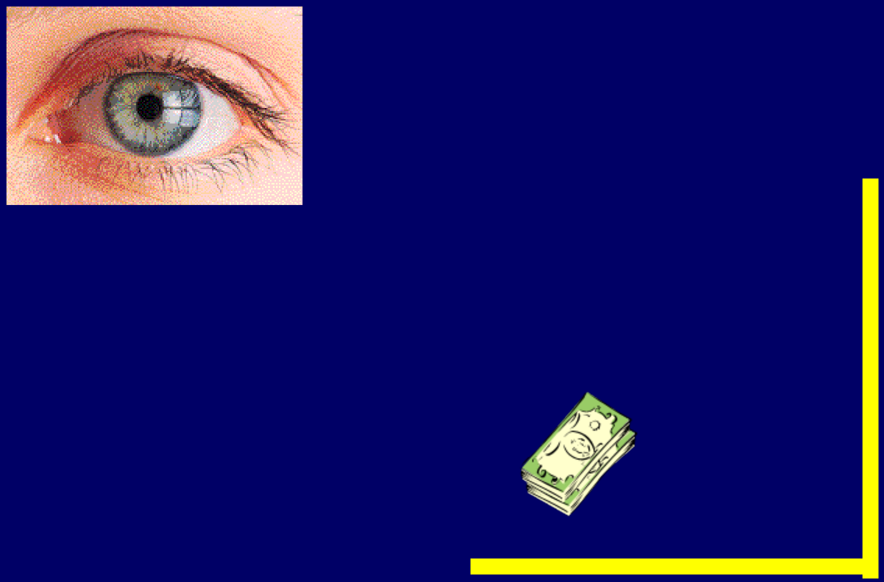
ACT: Flat Mirrors

to see feet, bottom of mirror must extend at least as low as midpoint between eyes and feet—independent on how far you are from the mirror.

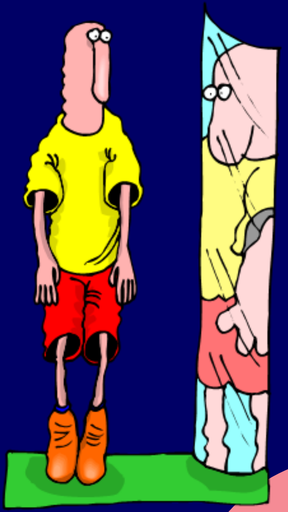


ACT/Two Mirrors

How many images of money will you see (not including the actual money)?

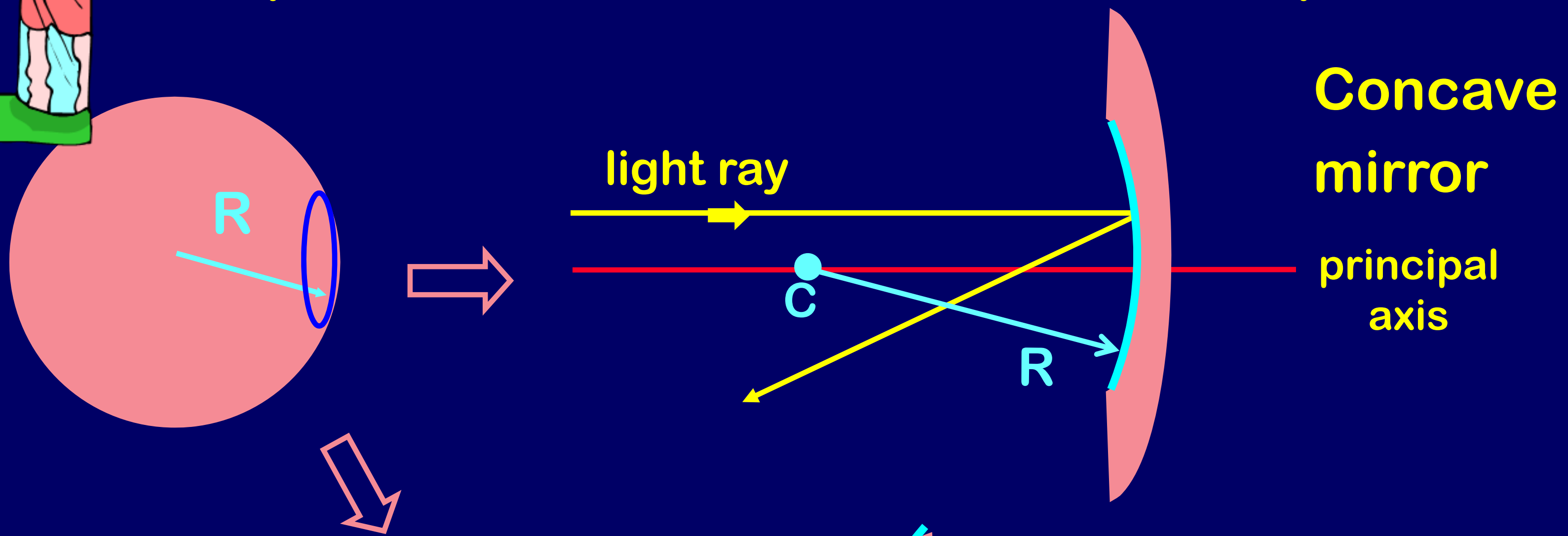


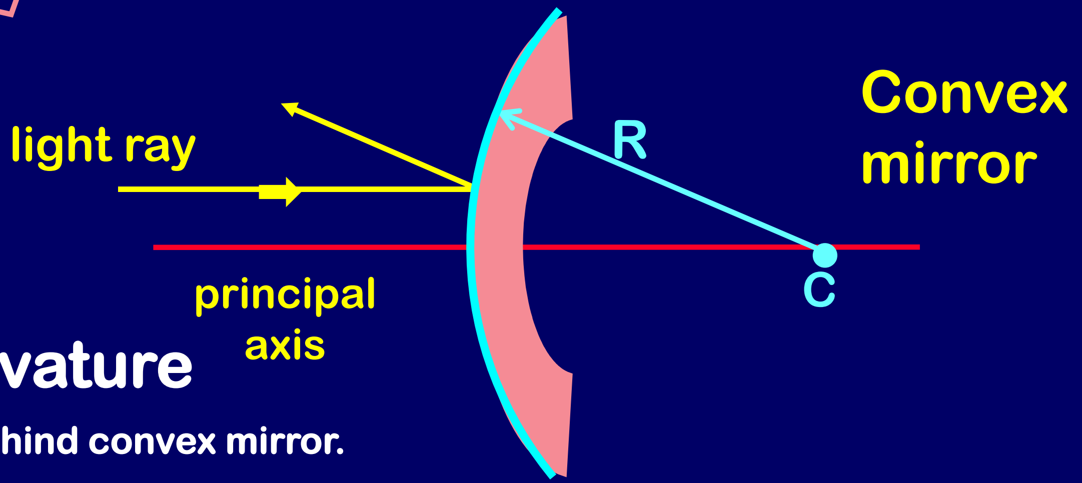
a. 1
b. 2
c. 3
d. 4
e. 5



Curved mirrors

A Spherical Mirror: section of a sphere.





C = Center of curvature

In front of concave mirror, behind convex mirror.

Preflight 16.2

An organic chemistry student accidentally drops a glass marble into a silver nitrate mirroring solution, making the outside of the marble reflective.

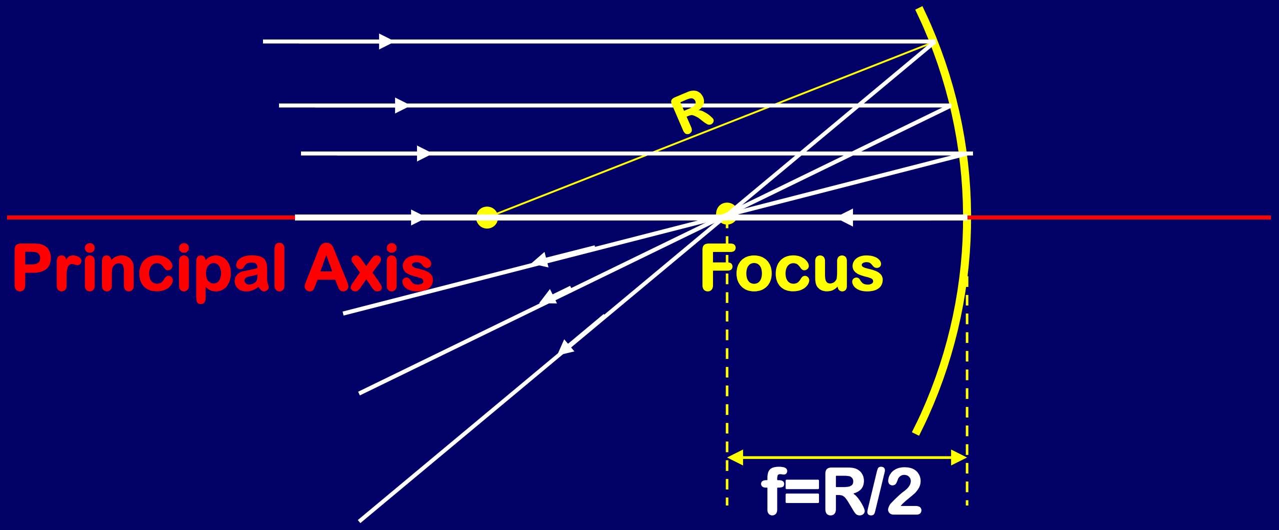
What kind of mirror is this?

(1) concave

(2) convex

(3) flat

Concave Mirror



Angle of incidence = angle of reflection. Thus 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).

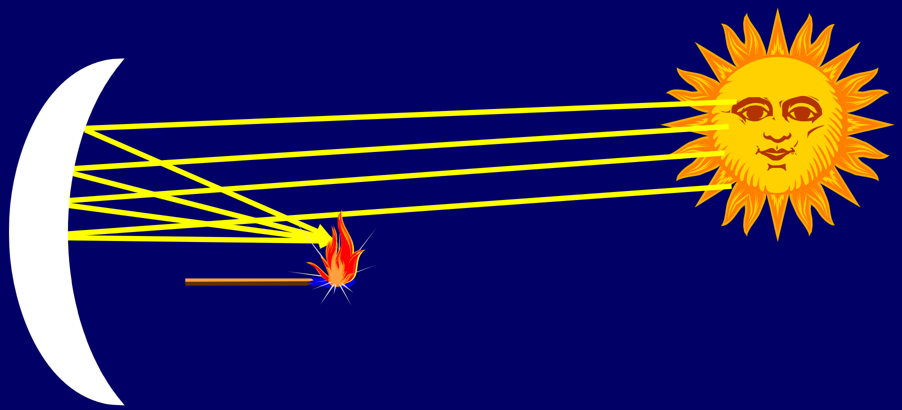
$$f = \frac{R}{2}$$

Preflight 16.4, 16.5

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

concave

convex



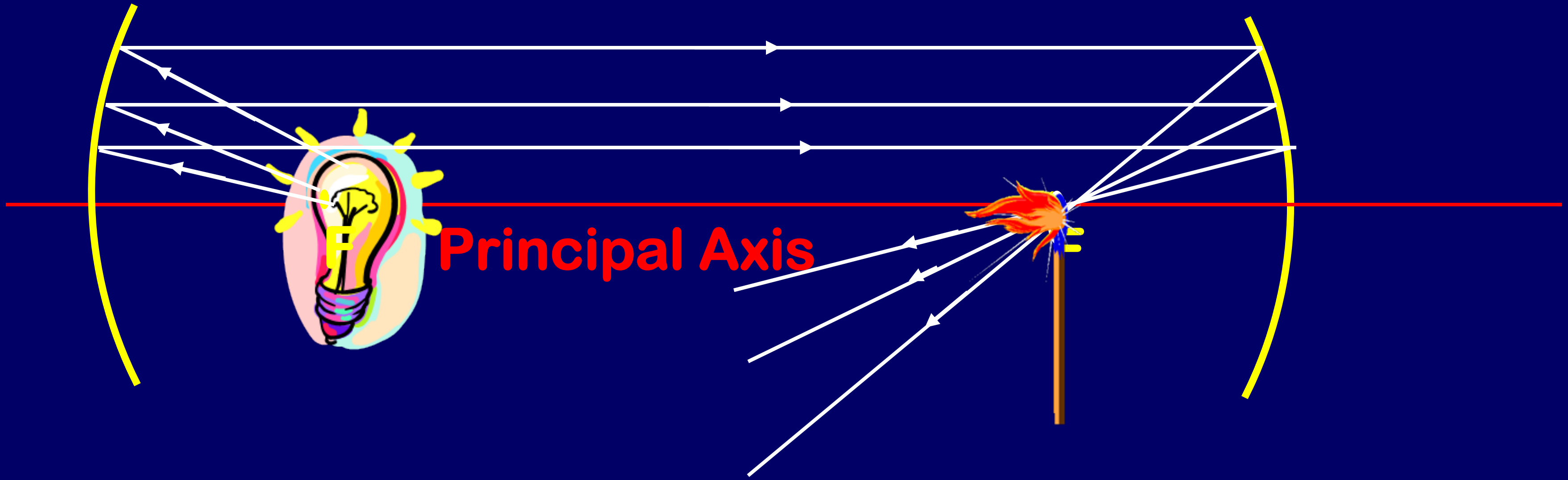
How far from the match to be ignited should the mirror be held?

farther than the focal length

closer than the focal length

at the focal length

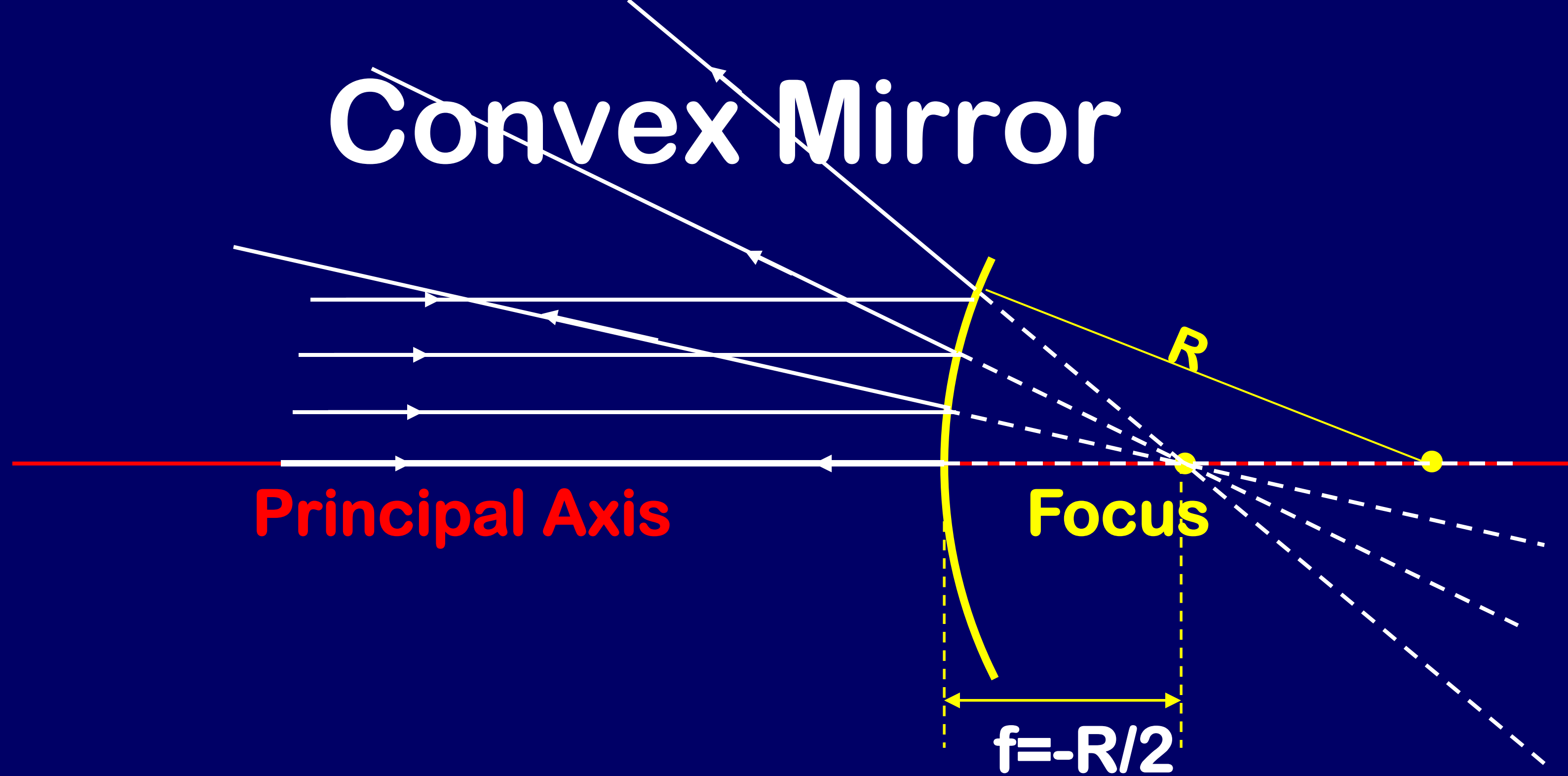
Concave Mirror



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).

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

ACT: Mirror Focal Lengths

A concave mirror has a positive focal length $f > 0$

A convex mirror has a negative focal length $f < 0$

What is the focal length of a flat mirror?

(1) $f = 0$

(2) $f = \infty$