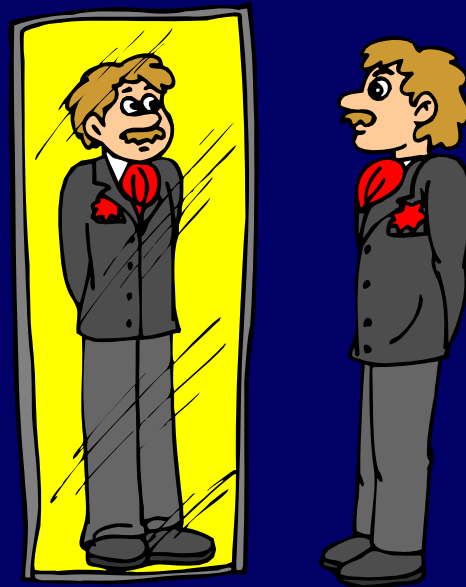


# Announcement on HW 8

- HW 8 originally due this Wednesday, Mar. 13
- Now due FRIDAY, Mar. 15 at 8:00am

# Physics 102: Lecture 16

## Introduction to Mirrors



# Physics 102 recent lectures

## Light as a wave

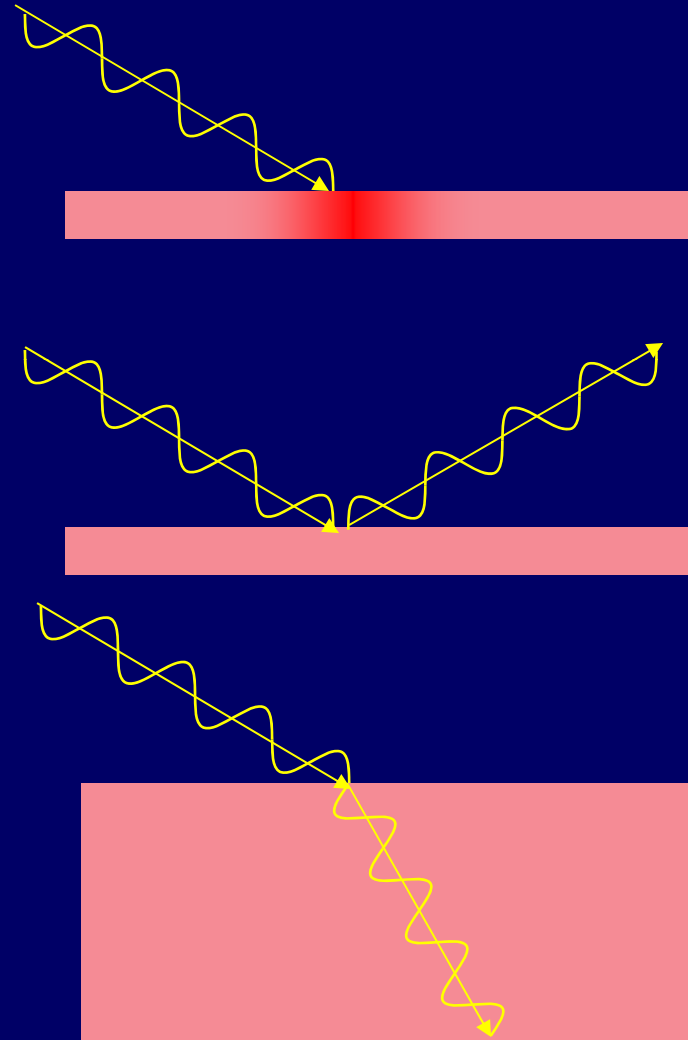
- Lecture 14 – EM waves
- Lecture 15 – Polarization
- Lecture 20 & 21 – Interference & diffraction (coming soon!)

## 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

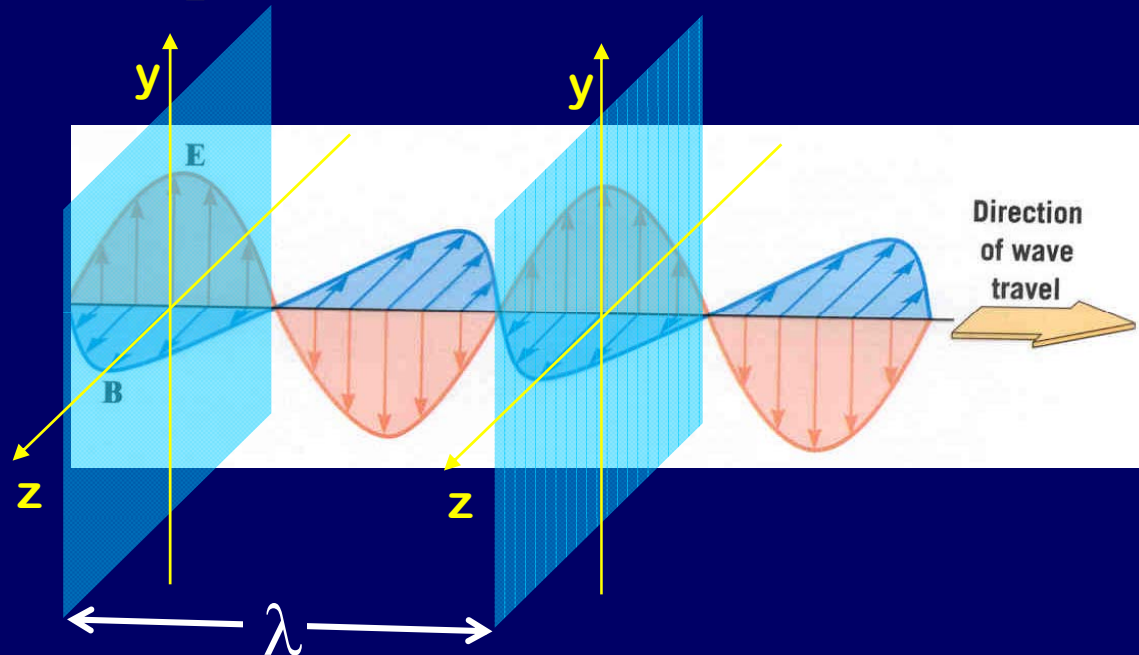
- **Absorption**
- **Reflection** (bounces)
  - See it
  - Mirrors
- **Refraction** (bends)
  - Lenses
- **Often some of each**



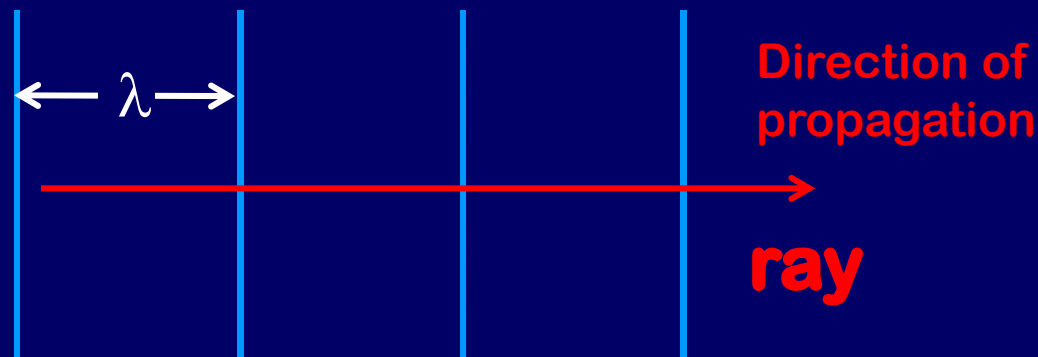
Everything true for wavelengths  $\ll$  object size

# Recall: wavefronts

Wavefronts represent “crests” of EM wave

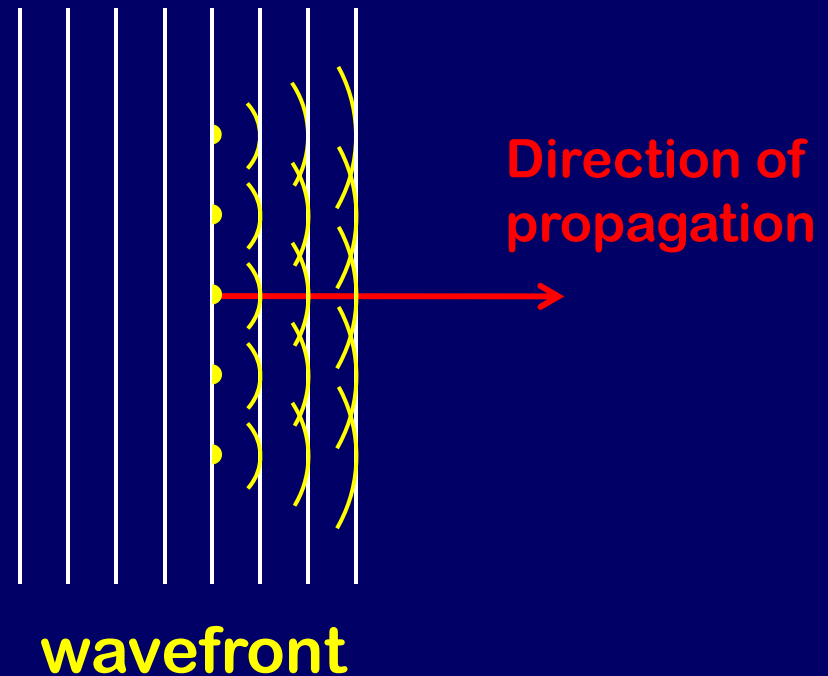
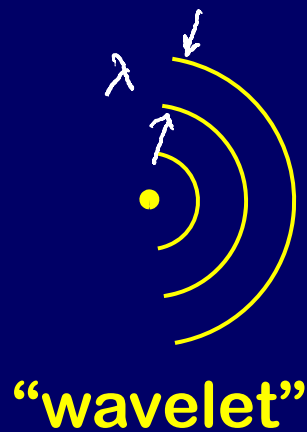


Top view:



# Huygens' principle

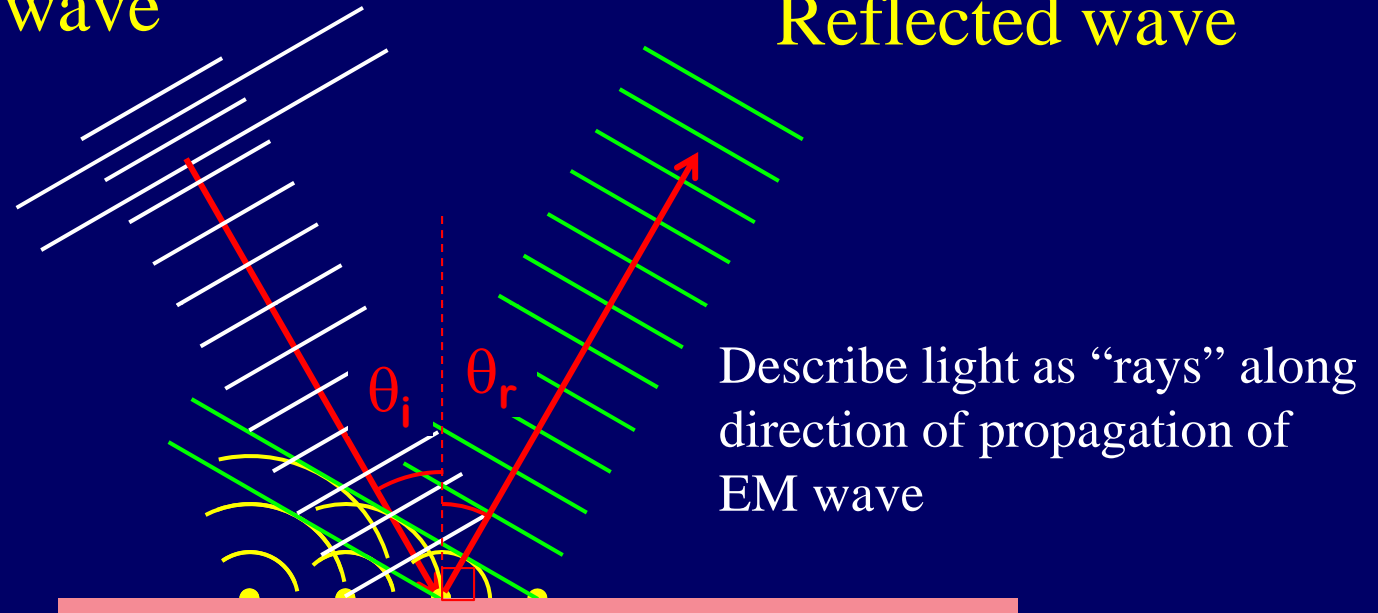
Every point on a wavefront acts as a source of tiny “wavelets” that move forward.



# Law of Reflection

Incident wave

Reflected wave

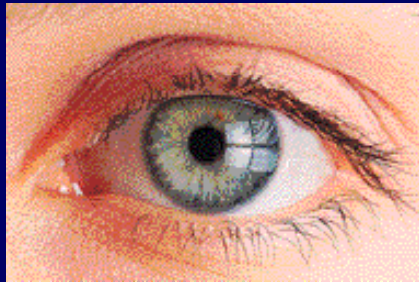


Angle of incidence = Angle of reflection

$$\theta_i = \theta_r$$

# Object Location

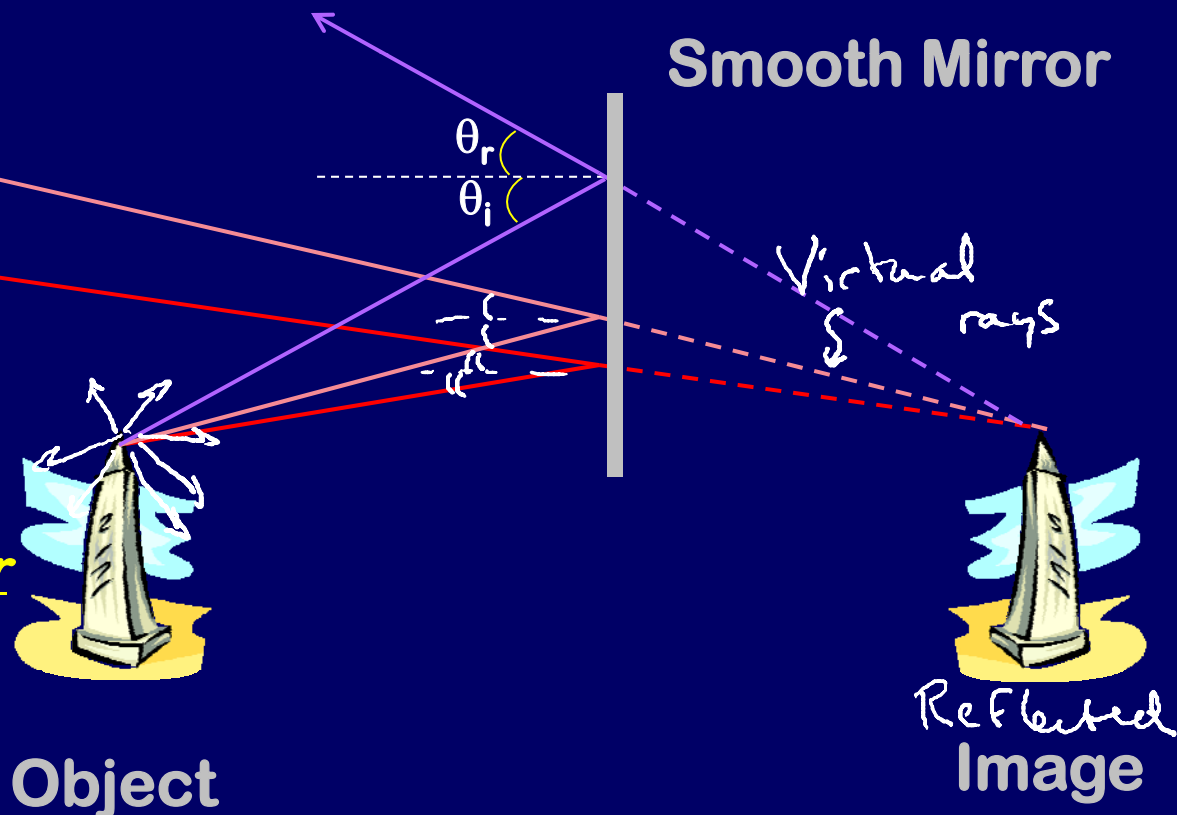
- Light rays from sun bounce off object and go in all directions
  - Some hit your eyes



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

# Flat Mirror

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



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

Object

Reflected Image

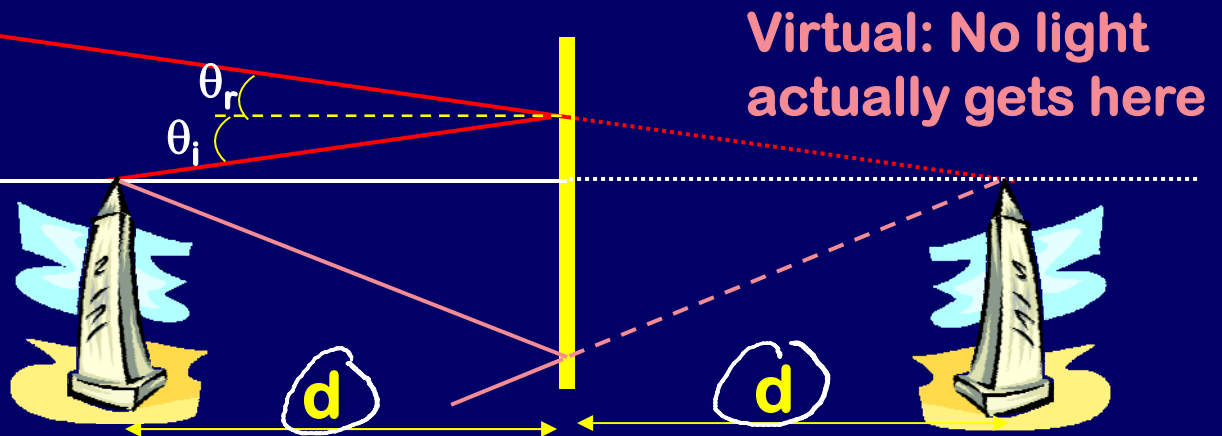
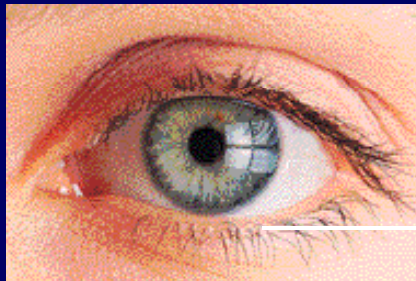


# Flat Mirror

- (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”**



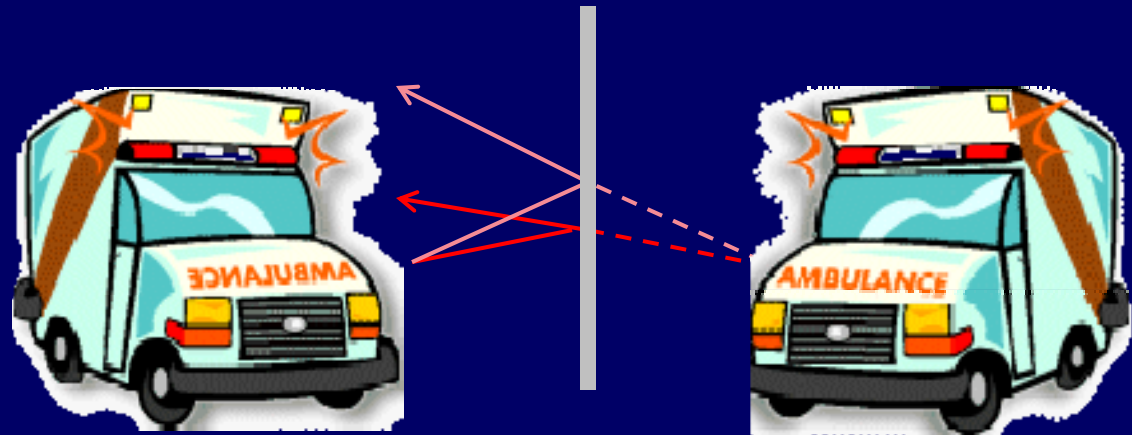
# Flat Mirror Summary

- 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.

## Checkpoint 1.1

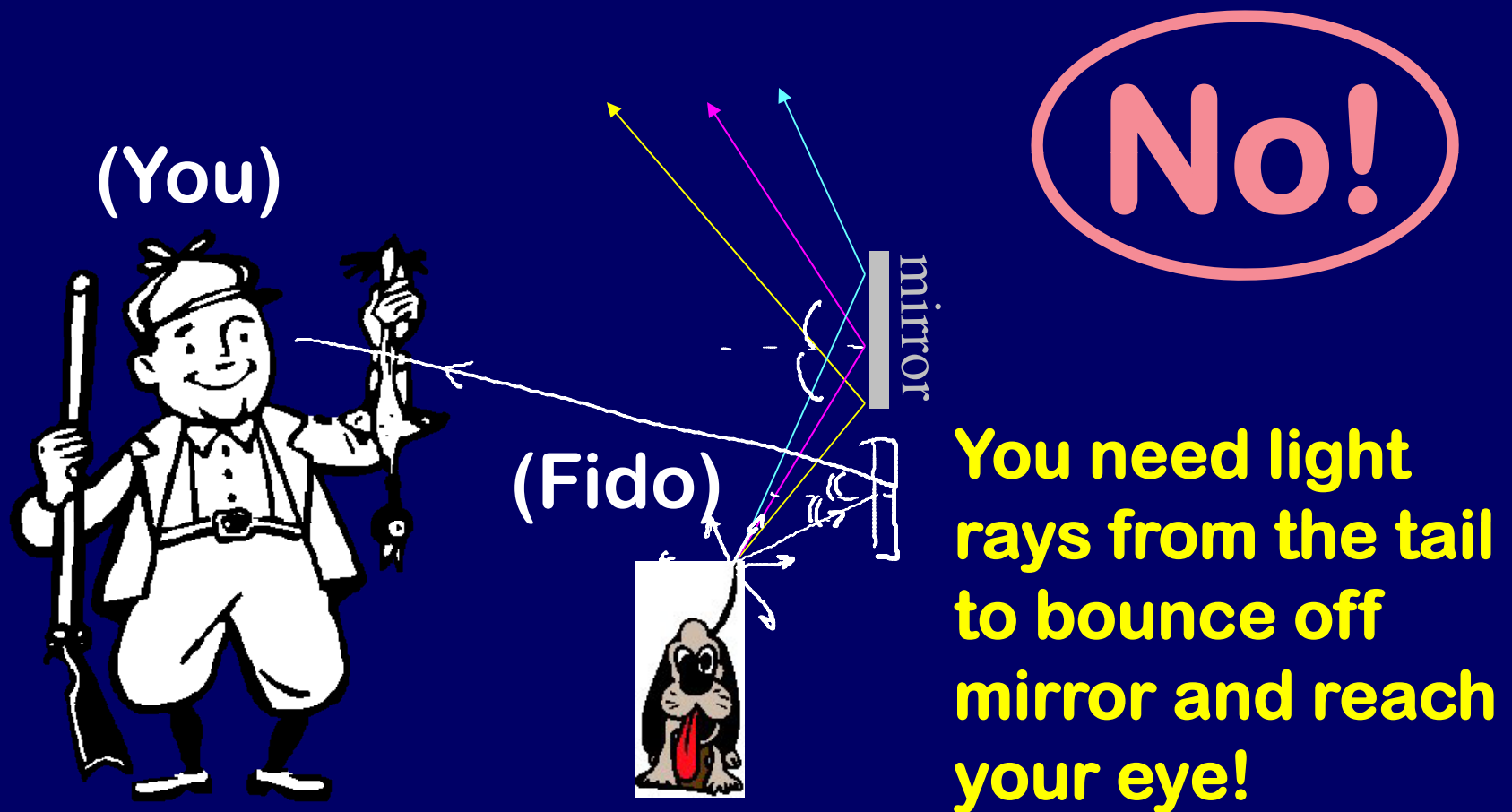
Why do ambulances have  
“AMBULANCE”  
written backwards?

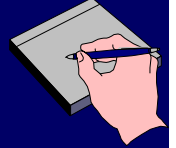
So you can read it in  
your rear-view mirror!



# Checkpoint 2.1

Can you see Fido's tail in mirror?

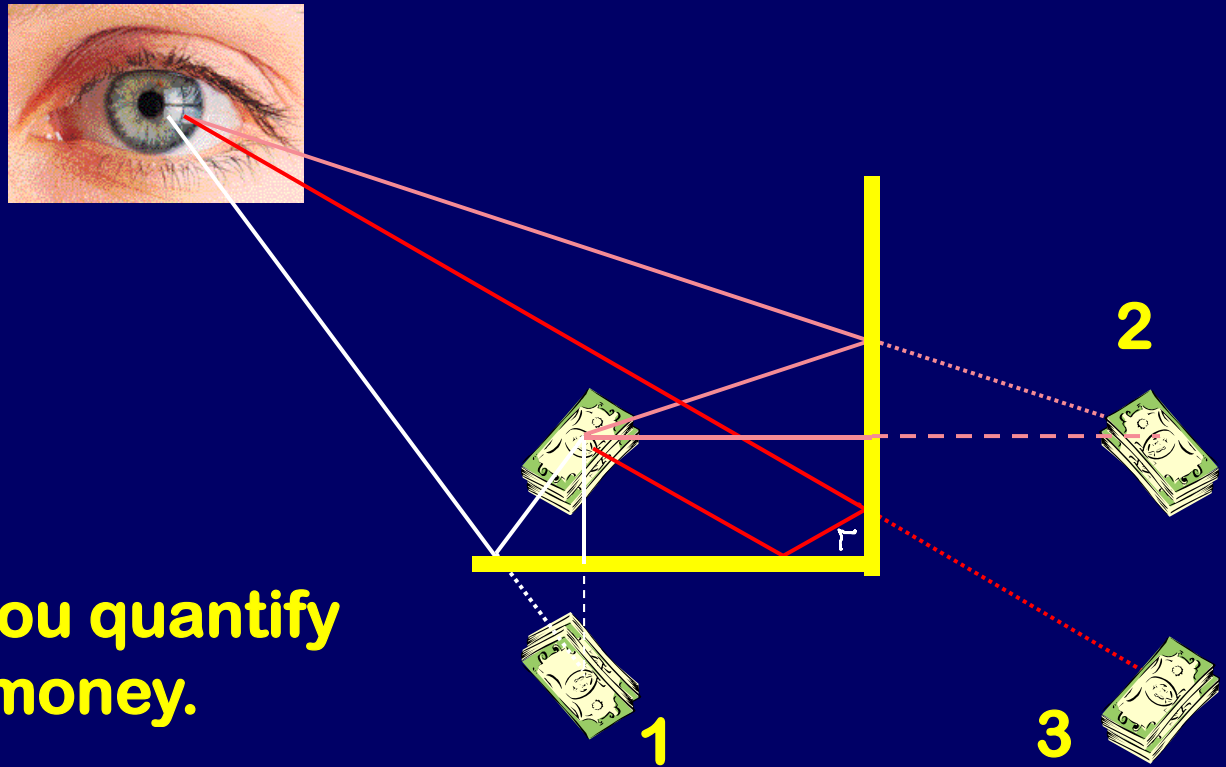




# ACT/Two Mirrors

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

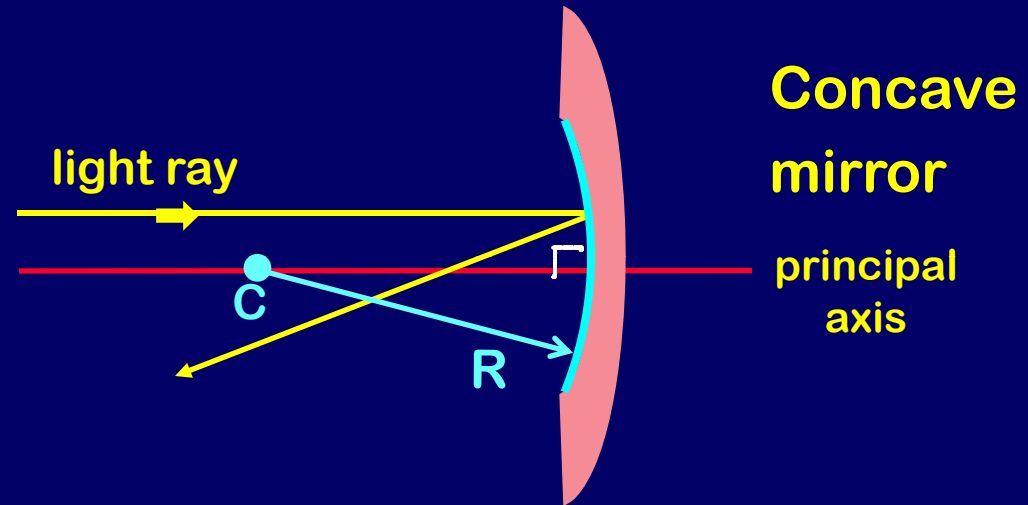
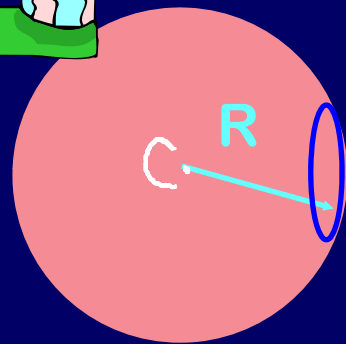
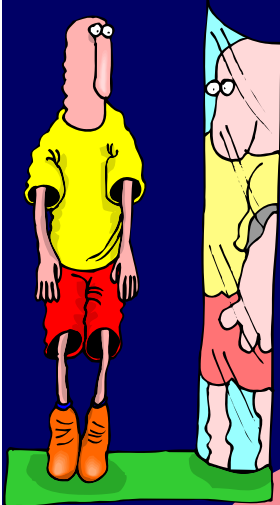
- a. 1
- b. 2
- c. 3**
- d. 4
- e. 5



Homework lets you quantify positions of the money.

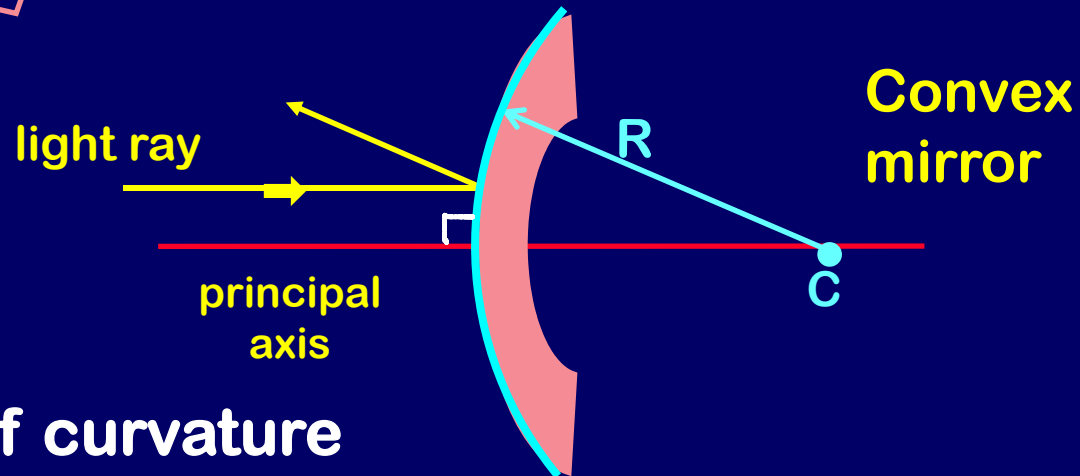
# Curved mirrors

A Spherical Mirror: section of a sphere.



Concave mirror

principal axis



Convex mirror

principal axis

**C = Center of curvature**

# Checkpoint 2.1

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?



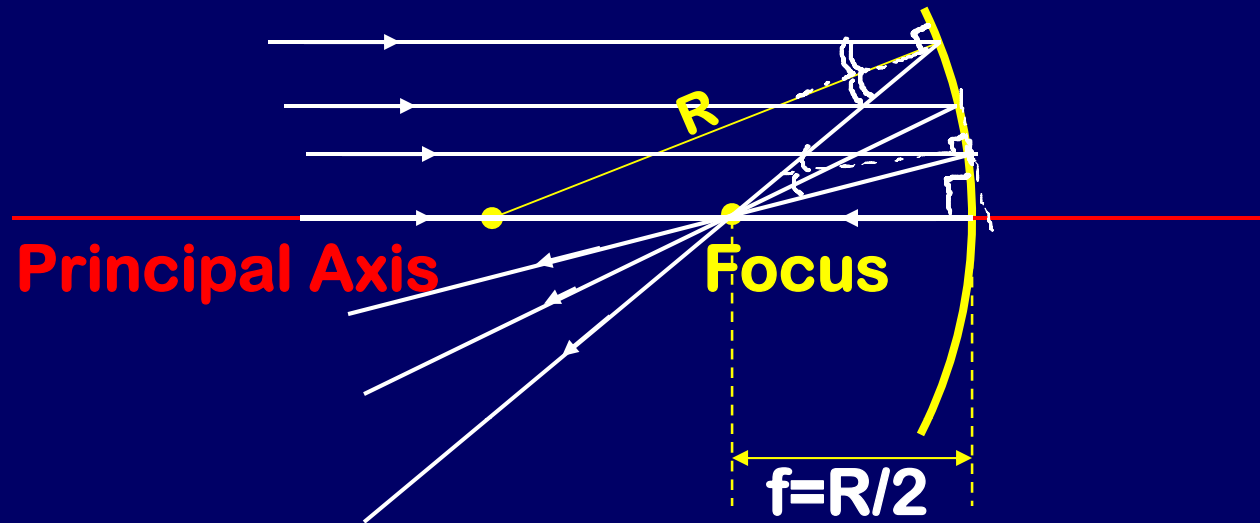
15% (1) concave

63% (2) convex

22% (3) flat

# Concave Mirror

$$\theta_i = \theta_r$$



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).

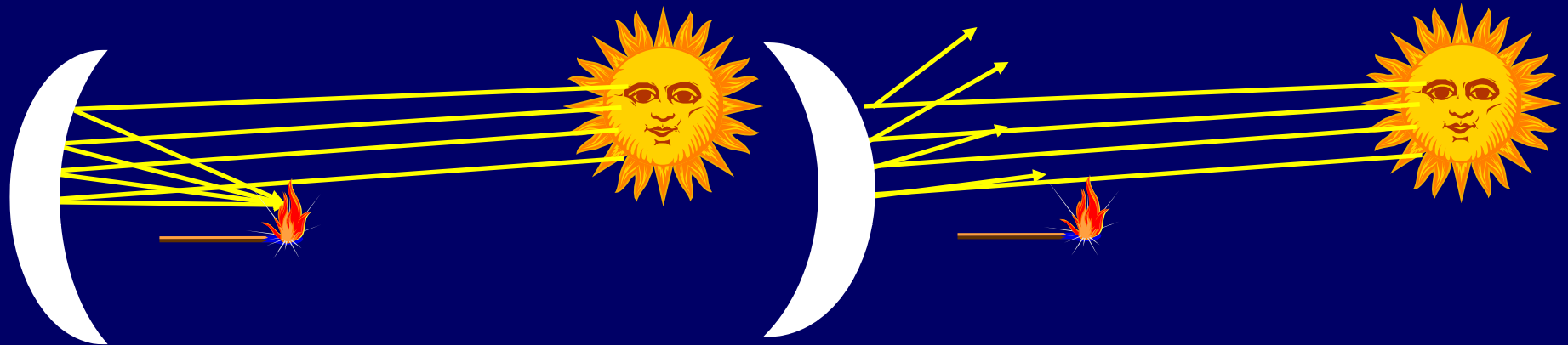
The distance from F to the center of the mirror is called the “Focal Length” (f).

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



# ACT

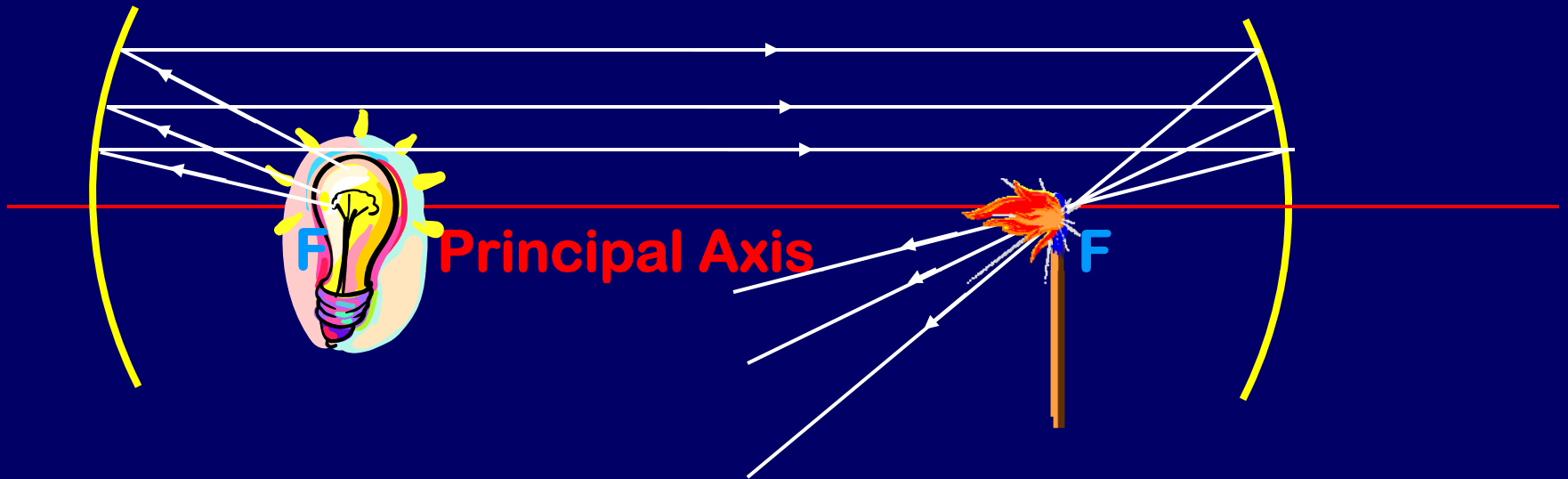
A concave mirror can be used to start a fire.



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

- A. farther than the focal length
- B. closer than the focal length
- C. at the focal length

# Concave Mirror

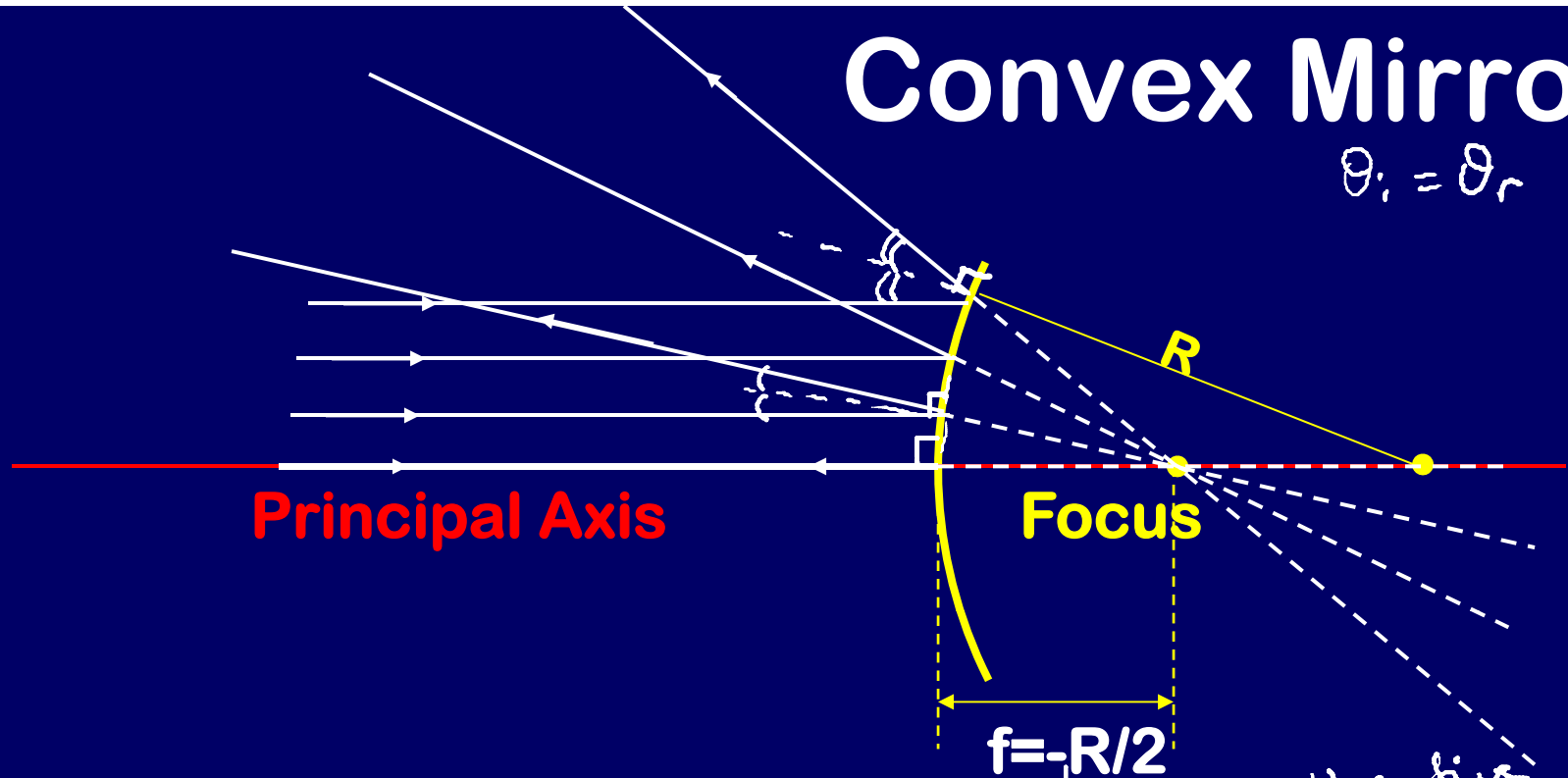


**Rays traveling through focus before hitting mirror are reflected parallel to **Principal Axis**.**

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

# Convex Mirror

$$\theta_i = \theta_r$$



Rays are bent away from the principal axis.

Negative  
= behind  
mirror

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).

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

See You Wednesday.