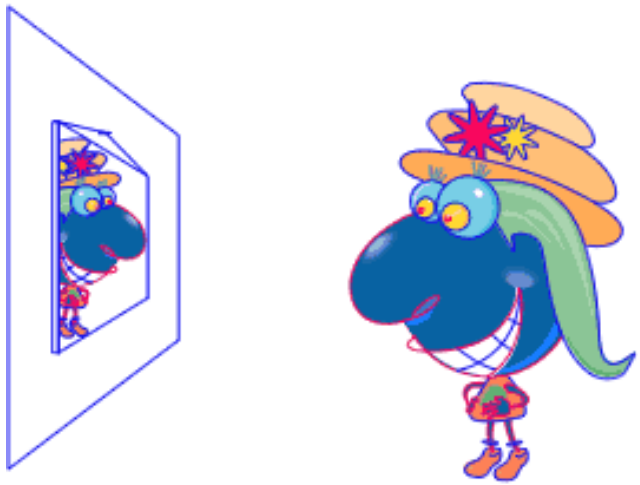
Science 8
Unit 2: OPTICS

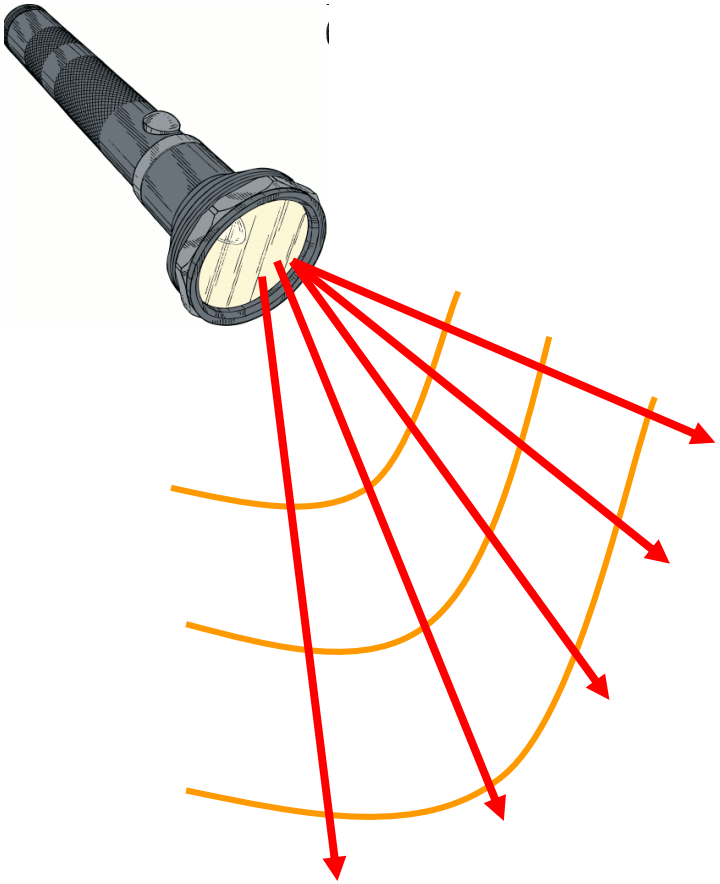
Topic 6: Ray Model Of Light



"Your eyesight's fine. You just aren't paying attention."

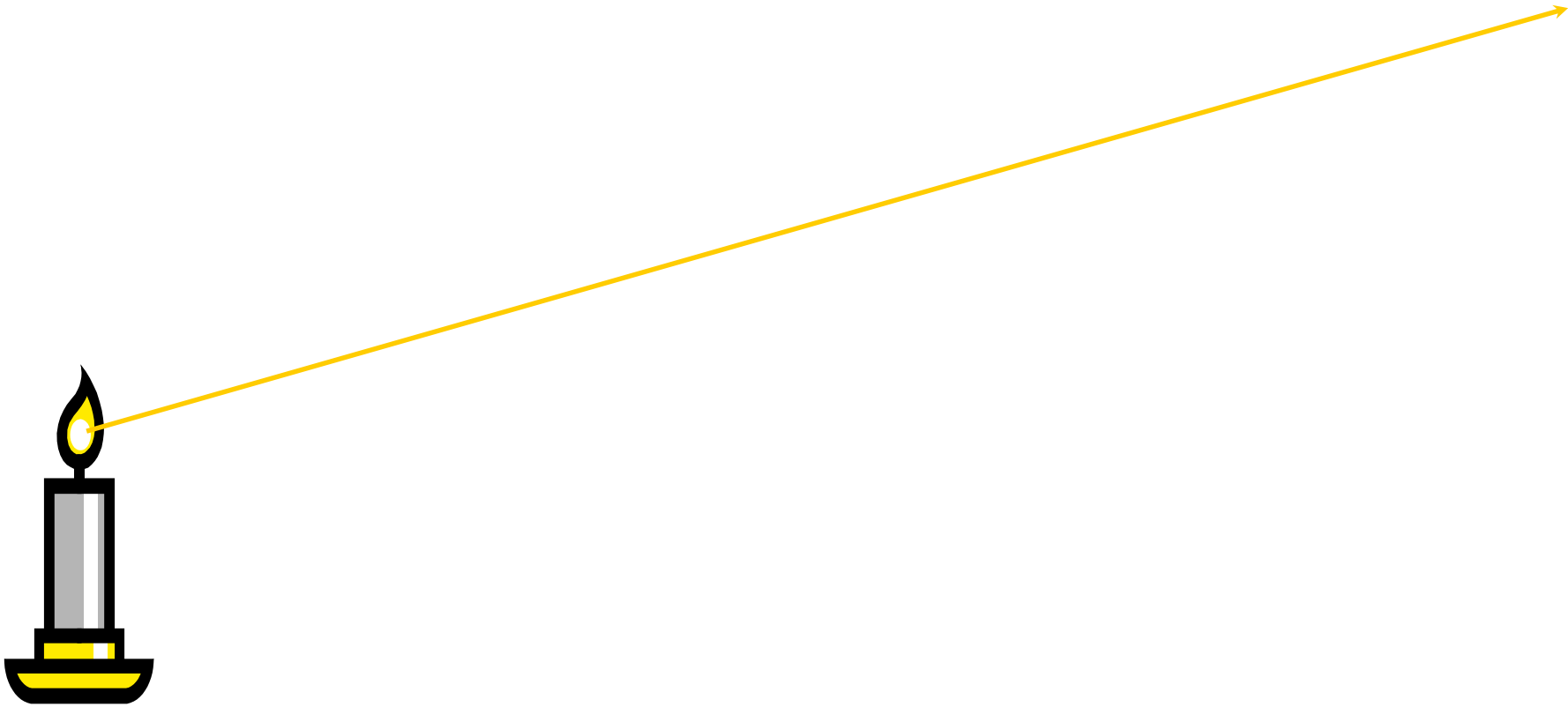
The Ray Model of Light

Some properties of light are best described by considering light as a wave.

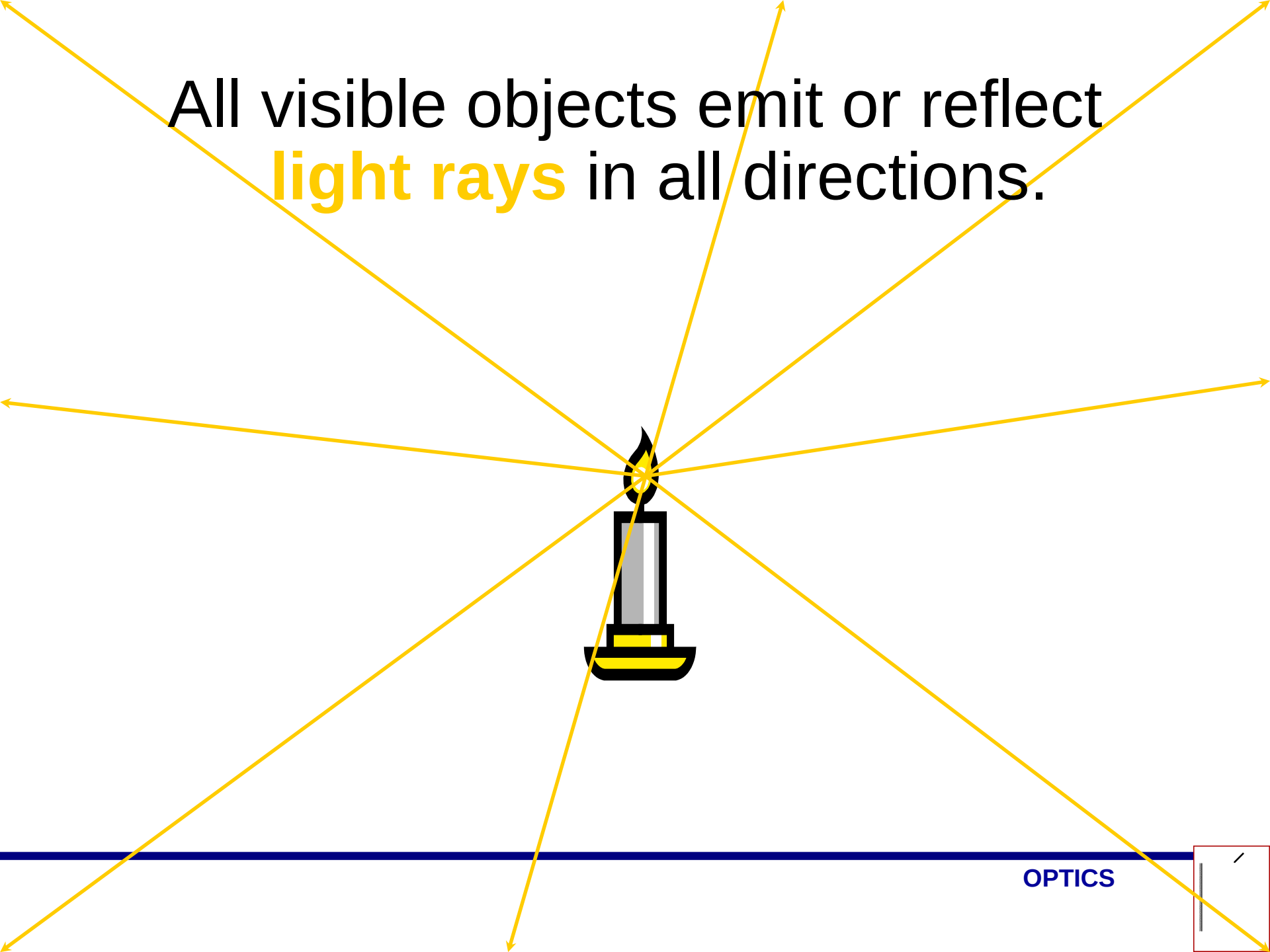


The ray model of light uses a straight line with an arrowhead, or ray, to show the direction the light wave is traveling

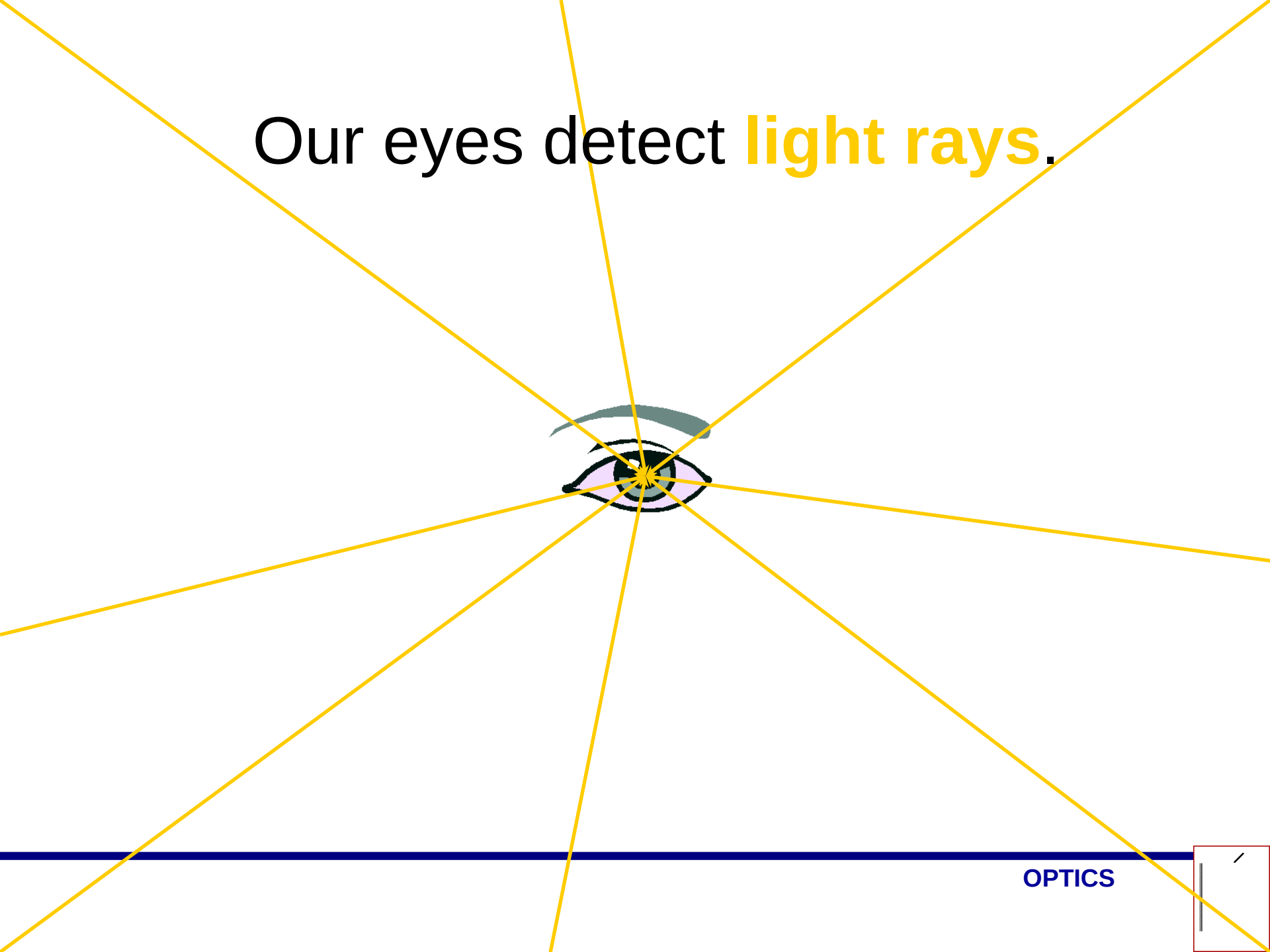
A **ray of light** is an extremely narrow beam of light.



All visible objects emit or reflect **light rays** in all directions.



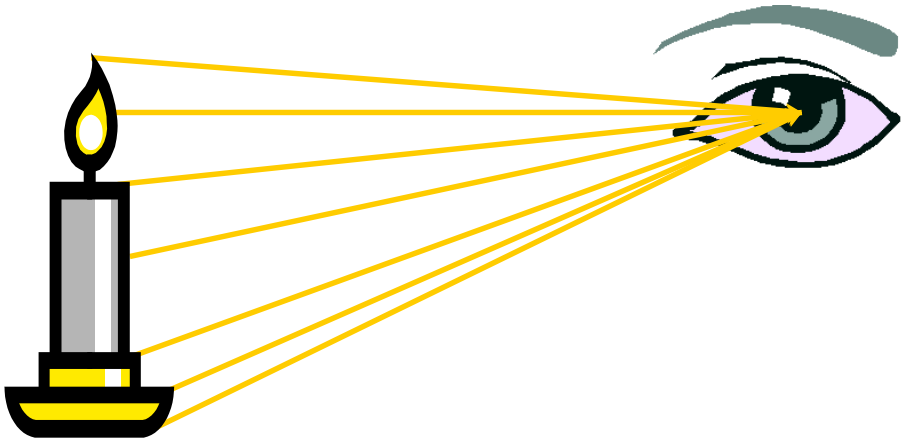
Our eyes detect **light rays**.



We see images when

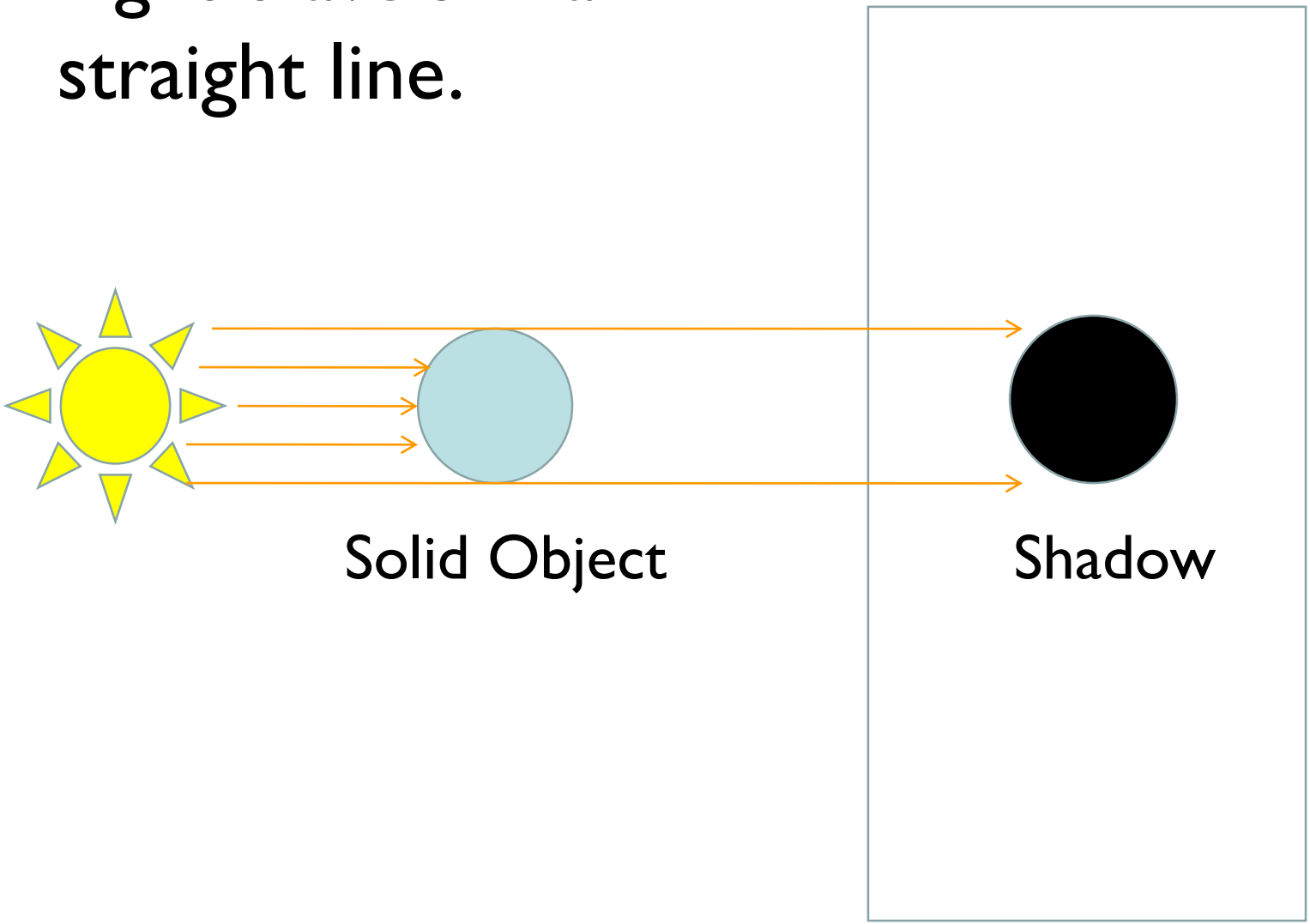
light rays

converge in our eyes.



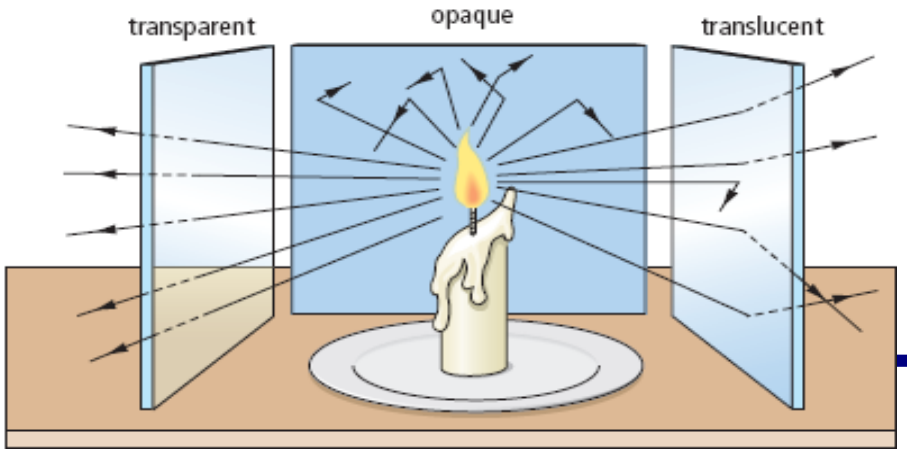
Rectilinear Propagation

Light travels in a straight line.



1) Ray Model explains how light passes through different materials

- Different materials can either transmit, absorb, or reflect light.
- **Transparent** materials allows light to pass through freely.
- **Translucent** materials lets most light through but scatters the light leaving.
- **Opaque** materials prevent light from passing through.



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Which of the following is:

Translucent **Transparent** **Opaque**

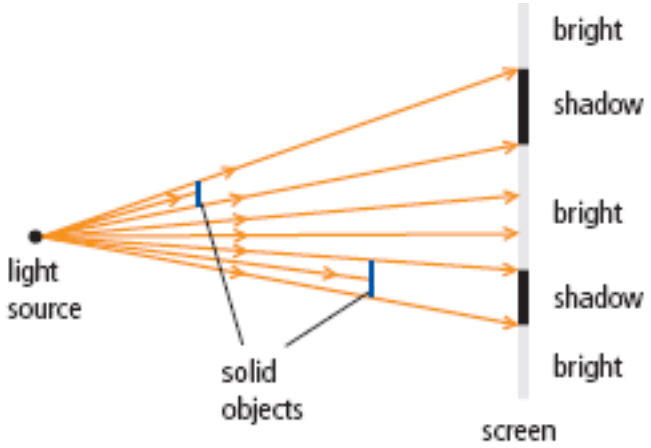
Tin Foil

Plastic Wrap

Wax Paper

2) Ray Model explains Shadows

- A shadow is created when an opaque object absorbs light rays.



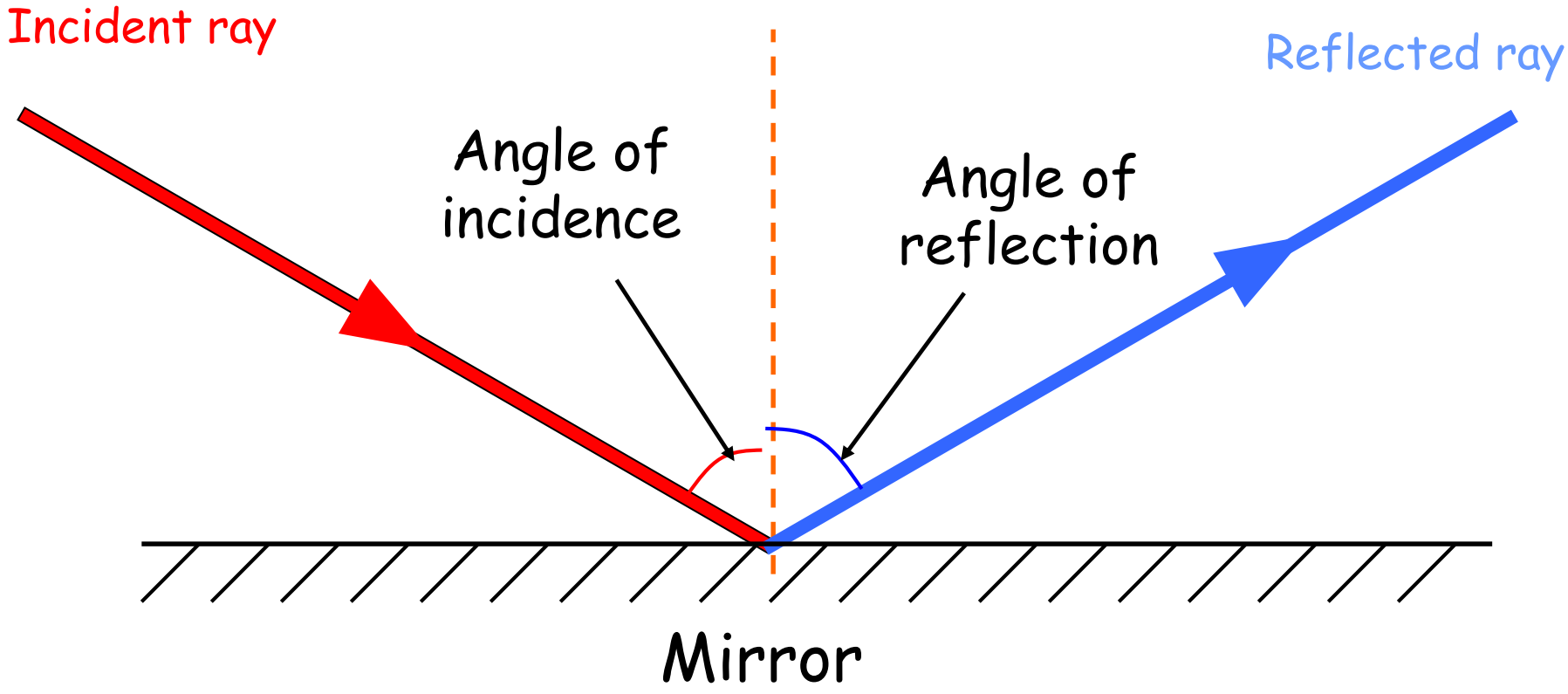
- Shadows demonstrate that light travels in straight lines.

- A ray diagram shows how the distance from the light source affects the size of the shadow an object makes.

The farther an object is from a source of light, the smaller its shadow will be.

3) Ray Model explains how light reflects off a mirror.

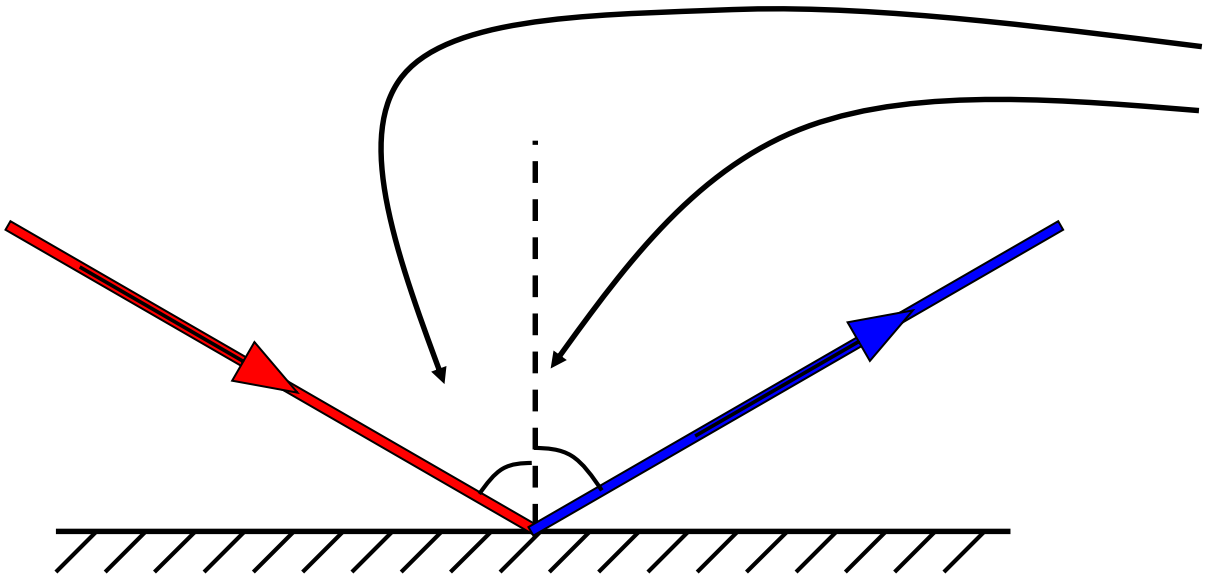
- **Reflection** is when light bounces off of an object.
  - » To act like a mirror, the surface must be smooth.



The Law of Reflection

Angle of incidence = Angle of reflection

In other words, light gets reflected from a surface at _____ _____ angle it hits it.



The same !!!

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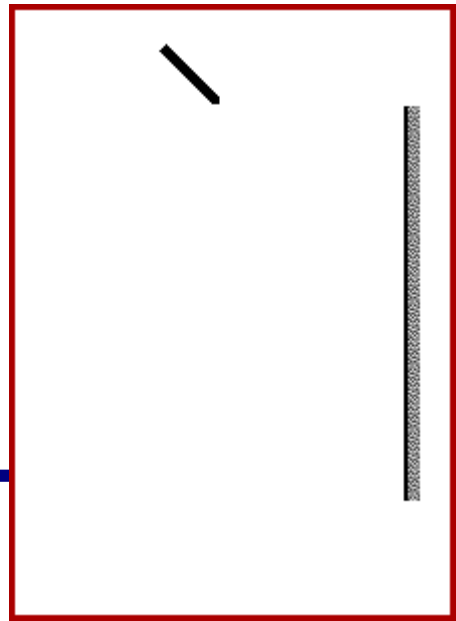
Incident ray: the incoming light ray

Reflected ray: the ray that bounces off the barrier

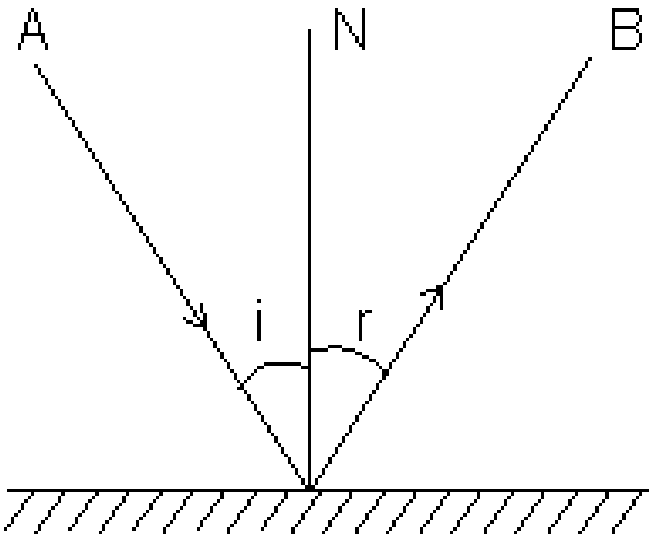
Normal: An imaginary line that is perpendicular to the barrier.

Angle of incidence: The angle formed by the incident ray and the normal.

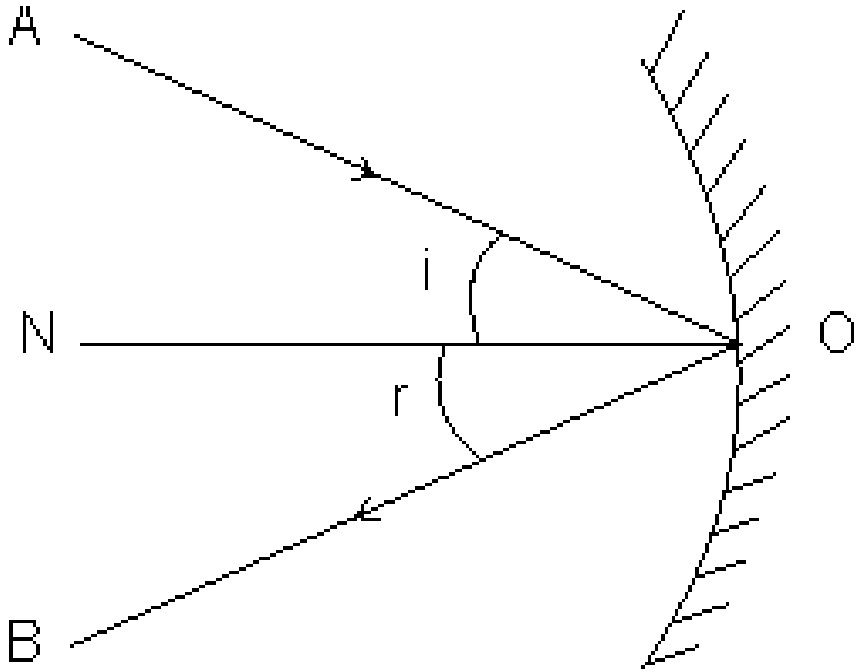
Angle of reflection:
The angle formed by the reflected ray and the normal.



Reflection



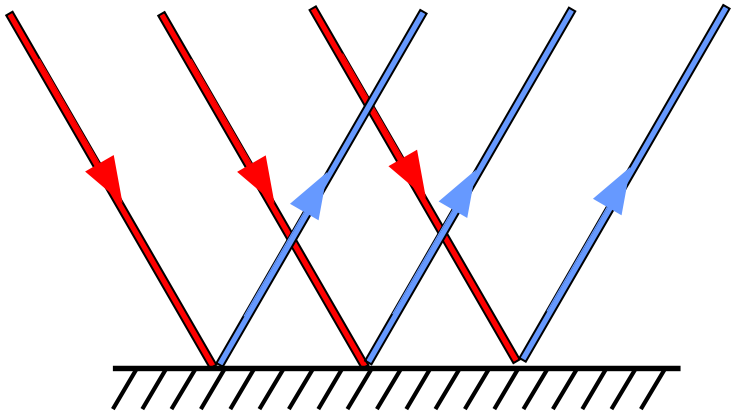
Plane Mirror



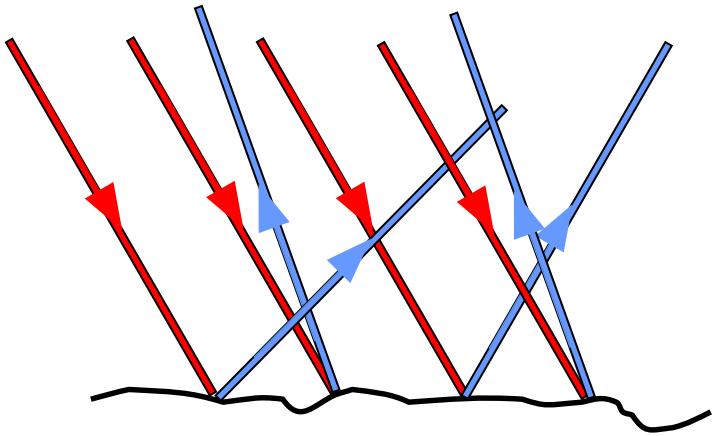
Concave Mirror

Specular vs. Diffuse Reflection

- Smooth, shiny surfaces have a *Specular Reflection*:



Rough, dull surfaces have a *diffuse* reflection.



Diffuse reflection is when light is scattered in different directions

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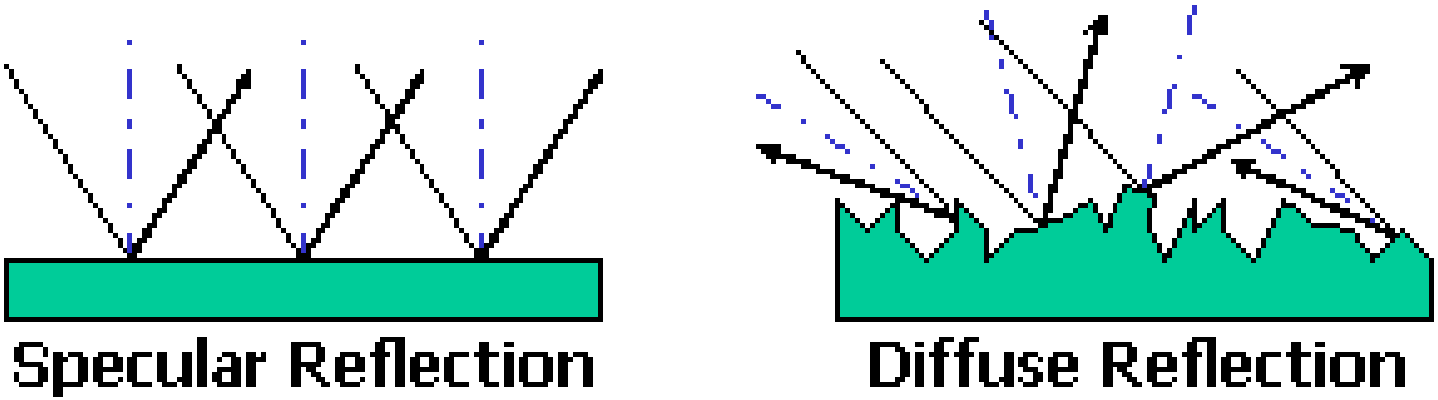
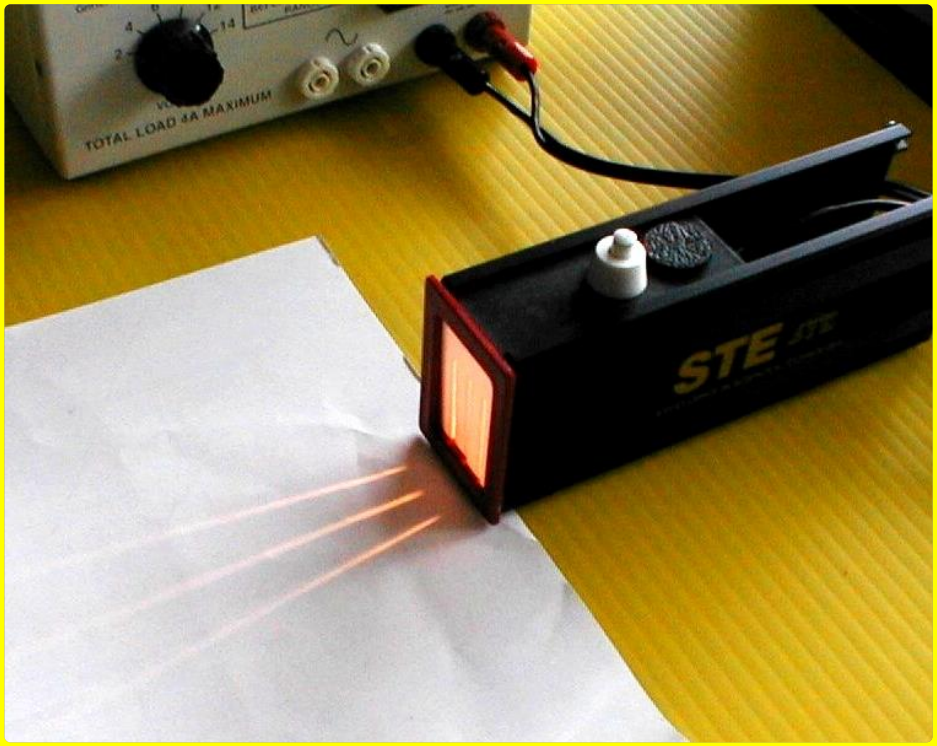
Specular vs. Diffuse Reflection



Applications of Specular and Diffuse Reflection:

- Countertop surfaces
- Furniture or car wax
- Glazed vs, unglazed ceramics
- Matte vs. Glossy finish on photographs or in paint



Determining the Laws of Reflection

Using a Ray Box

CORE LAB
ACTIVITY 5-2 B
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"DEMONSTRATING THE LAWS OF REFLECTION"

Student Work

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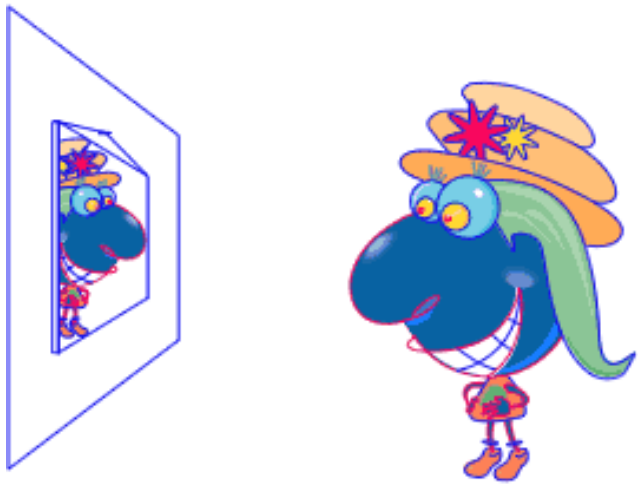
#1, #2

Science 8
Unit 2: OPTICS

Topic 7: REFLECTION IN A PLANE MIRROR



Using Mirrors to Form Images

- All mirrors reflect light according to the law of reflection.

- A flat smooth mirror is called a plane mirror.
  - The mirror on the wall, in your bathroom, is probably a plane mirror.

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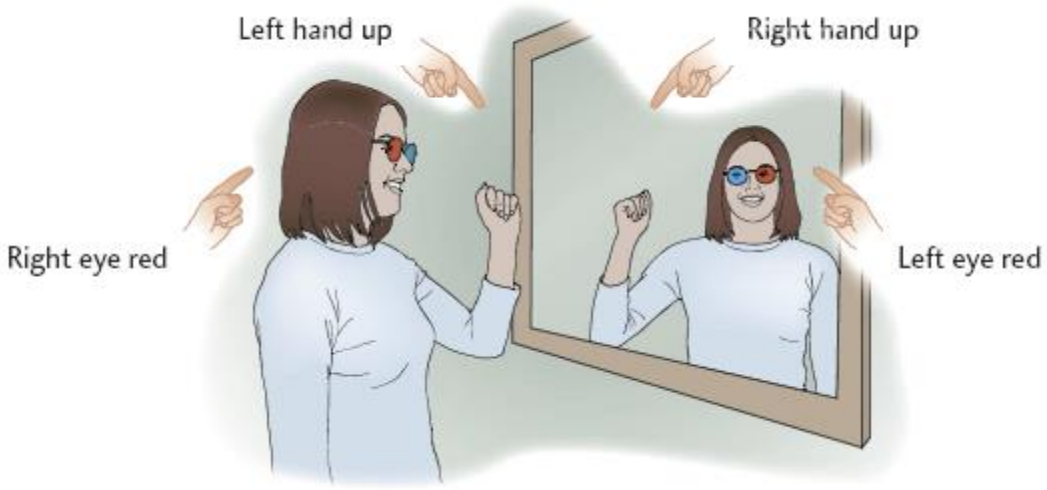
Plane Mirrors

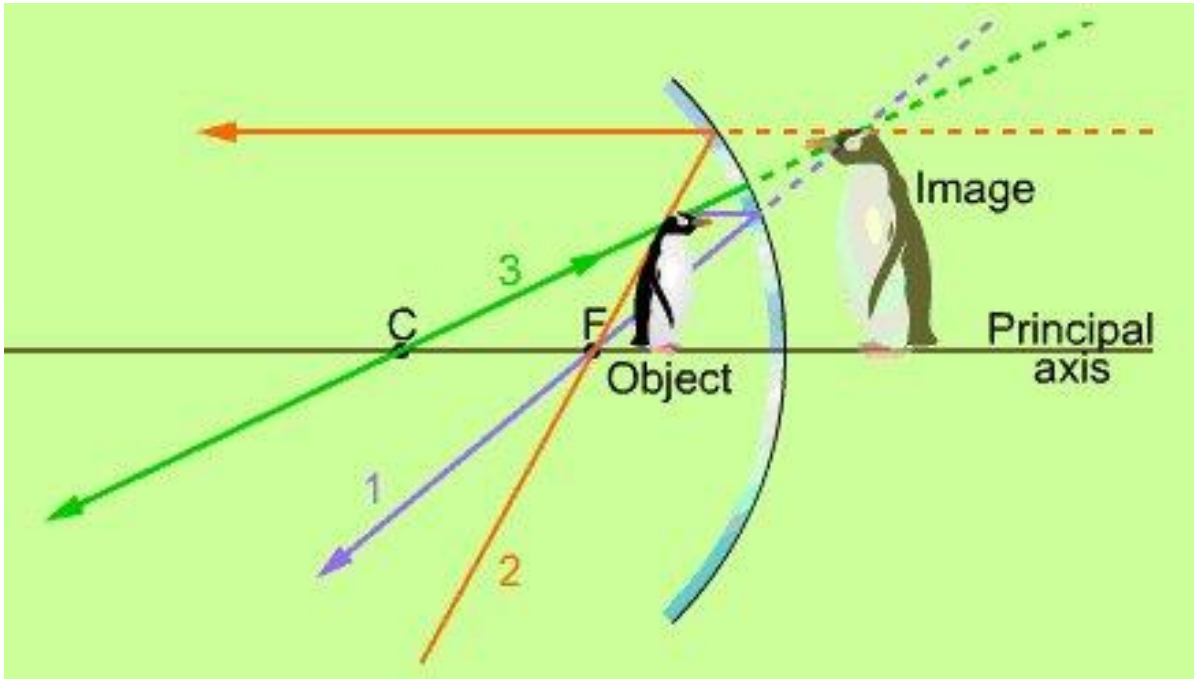
A flat, smooth mirror

- Reflection is responsible for producing virtual images, which are images that cannot be captured on a screen.

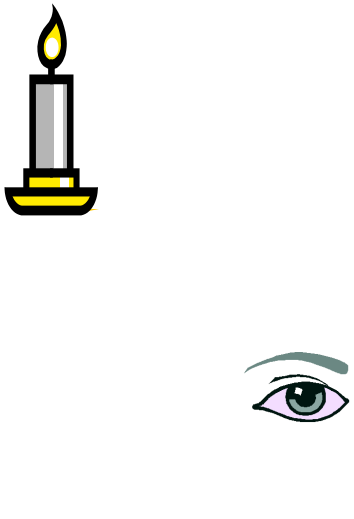


Virtual Image:

- Formed when the reflected rays are extended
- Located behind the mirror

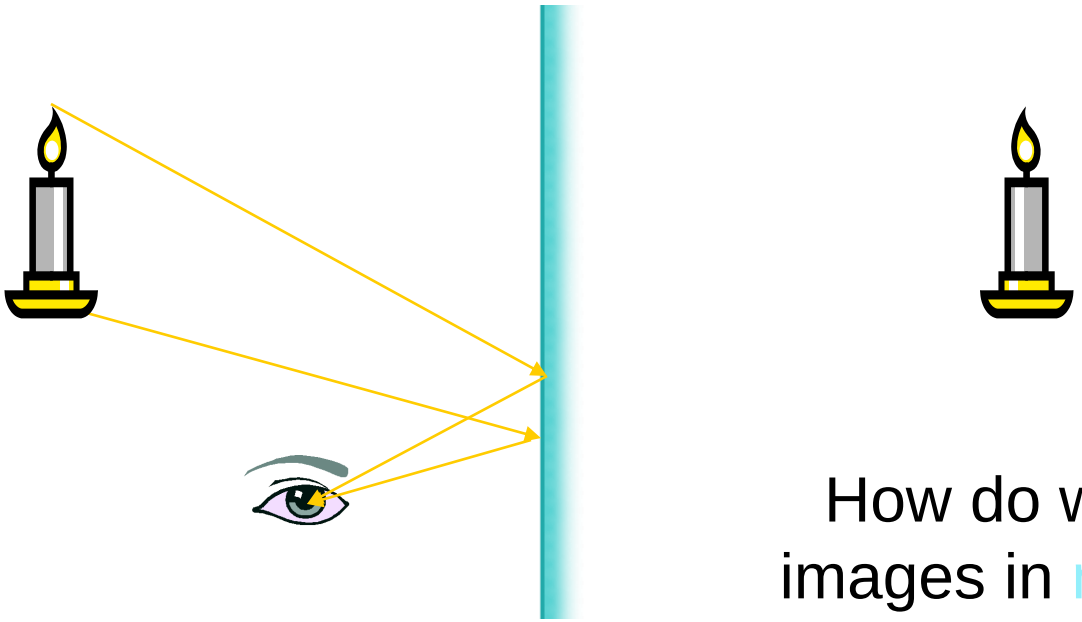


Plane Mirrors
(flat mirrors)



How do we see images in mirrors?

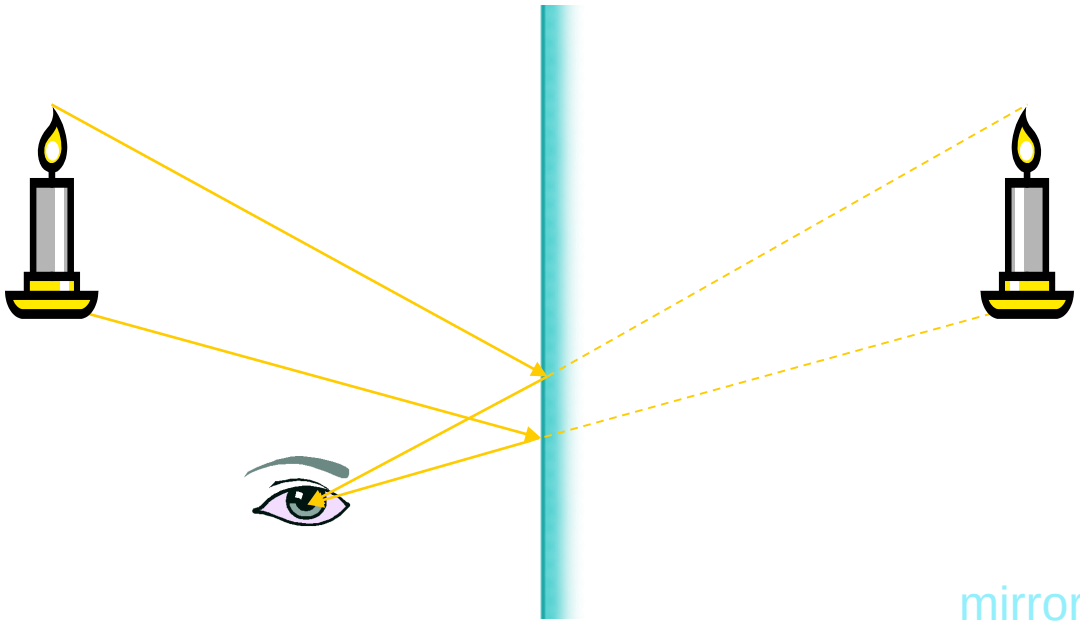
Plane Mirrors
(flat mirrors)



How do we see images in mirrors

Light reflected off the mirror converges to form an image in the eye.

Plane Mirrors
(flat mirrors)



Light reflected off the mirror converges to form an image in the eye.

The eye perceives light rays as if they came through the mirror

Imaginary light rays extended behind mirrors

Plane Mirrors
(flat mirrors)

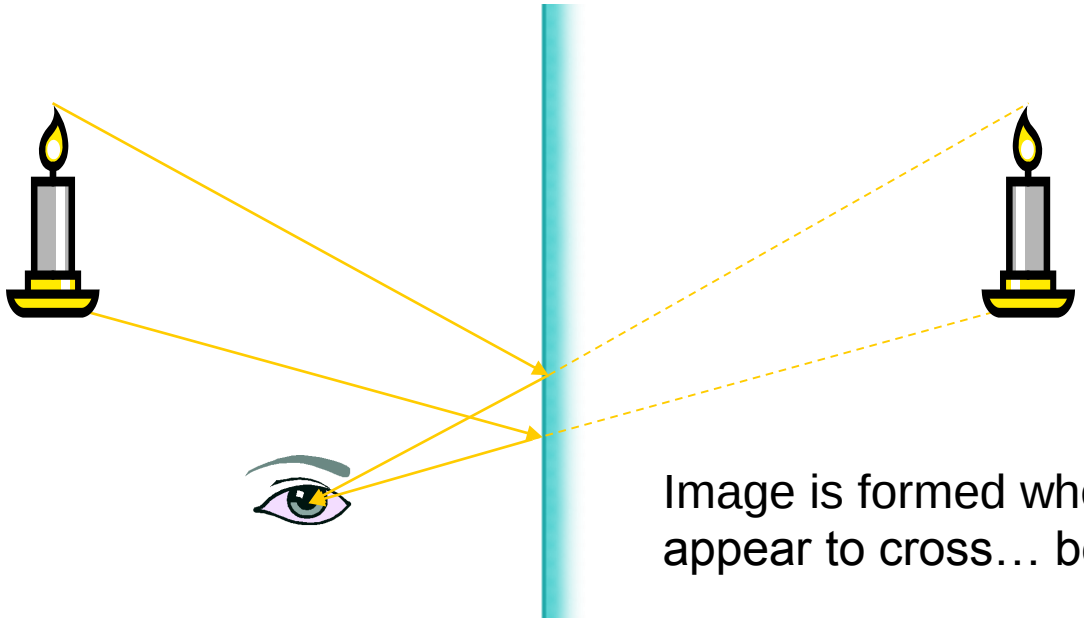


Image is formed where reflected rays appear to cross… behind the mirror!

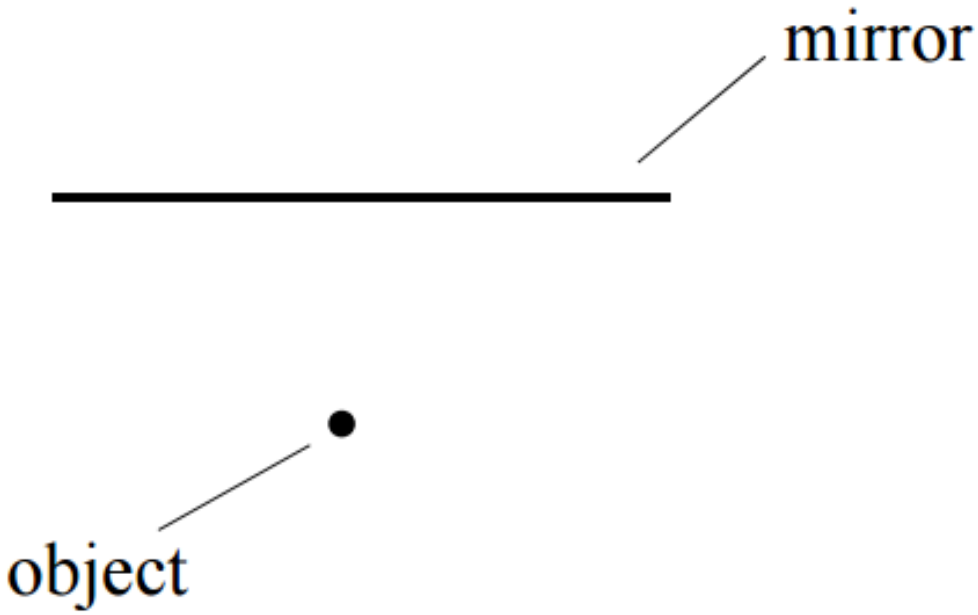
mirrors

Imaginary light rays extended behind mirrors are called sight lines.

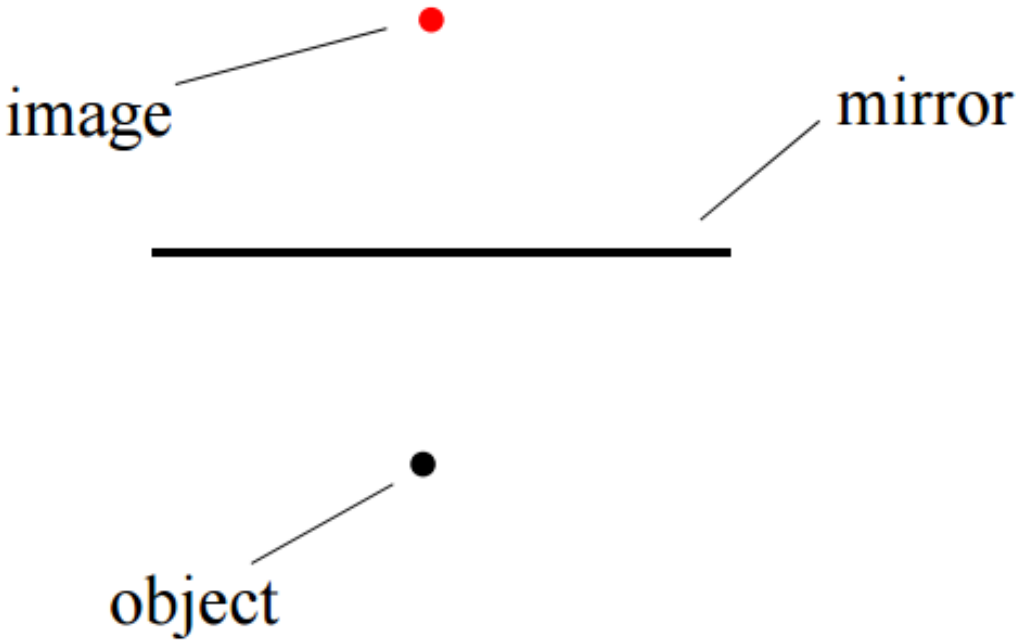
The image is virtual since it is formed by imaginary sight lines, not real light rays.

Ray Diagrams

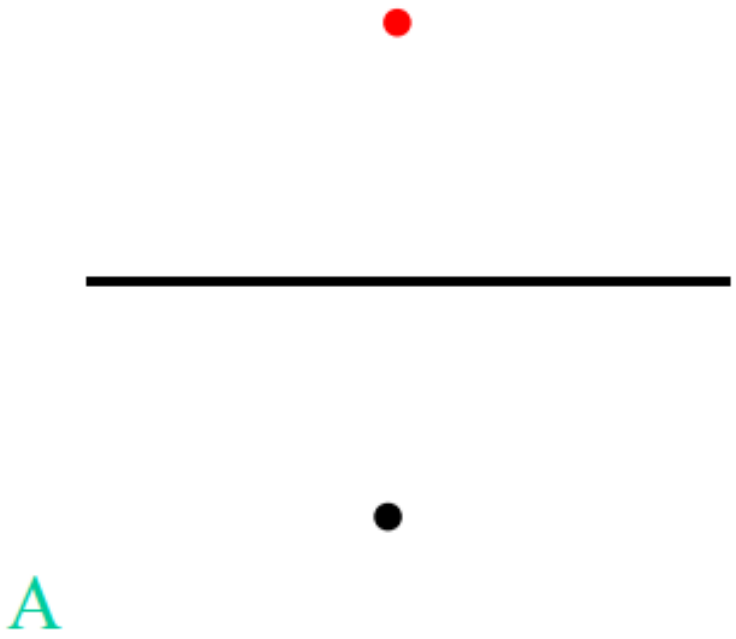
Let's draw a plane mirror and place an object.



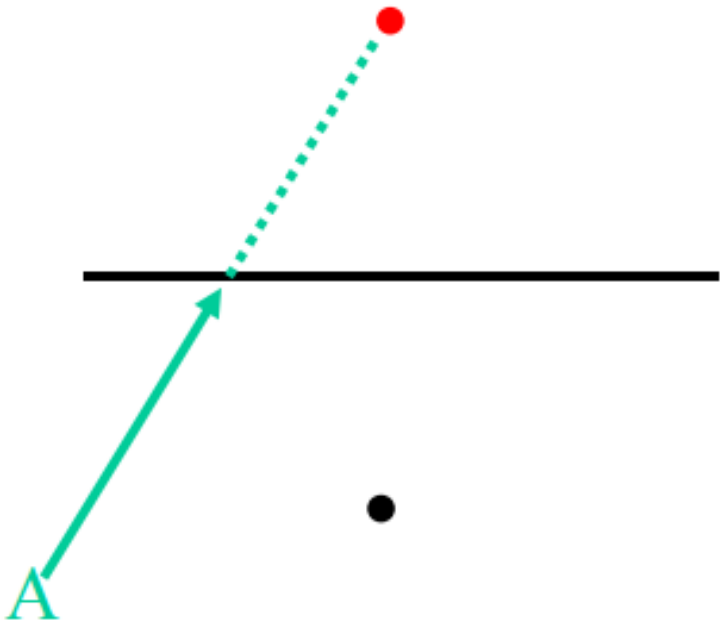
Let’s use the distance of the object equals the distance of the image



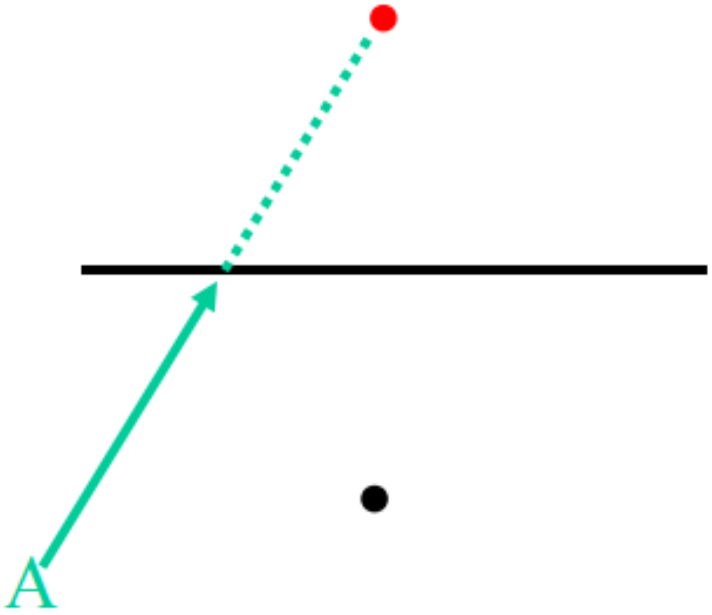
Let’s put a person at position A and let’s see if they can see the image from that position



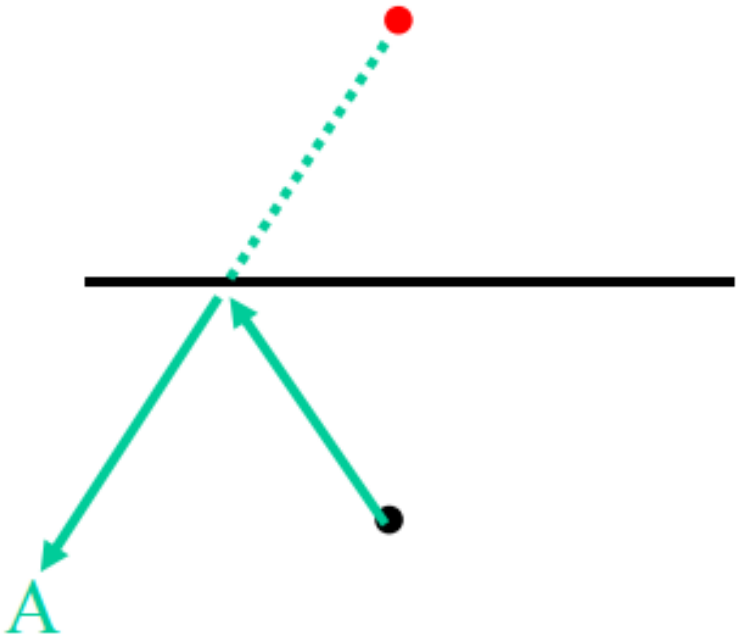
If you want to see something, you have to look at it.



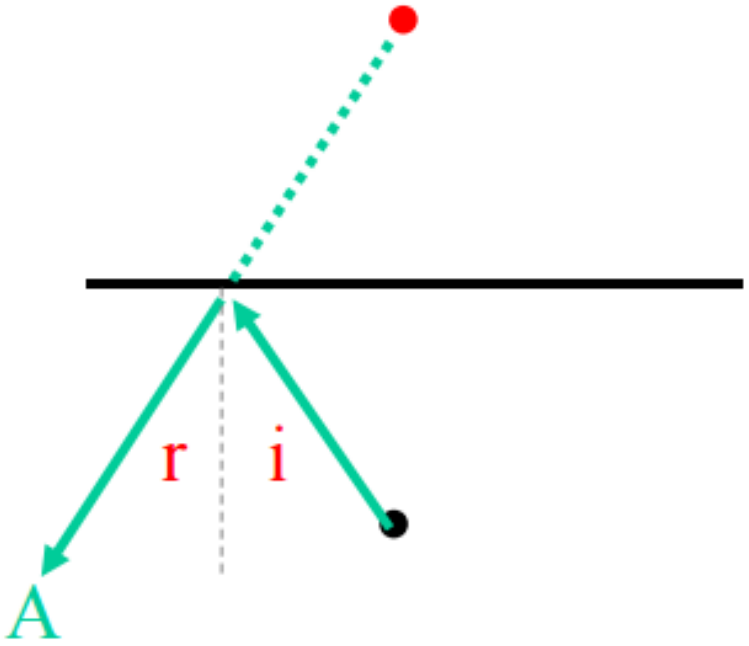
We know at position A the person can see it because the sight line crosses the mirror.



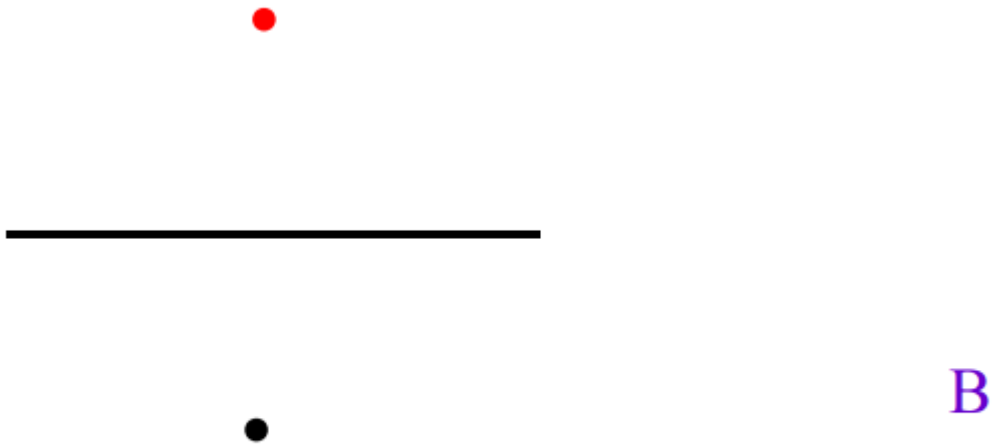
For you to see something, light has to go from the object to your eye



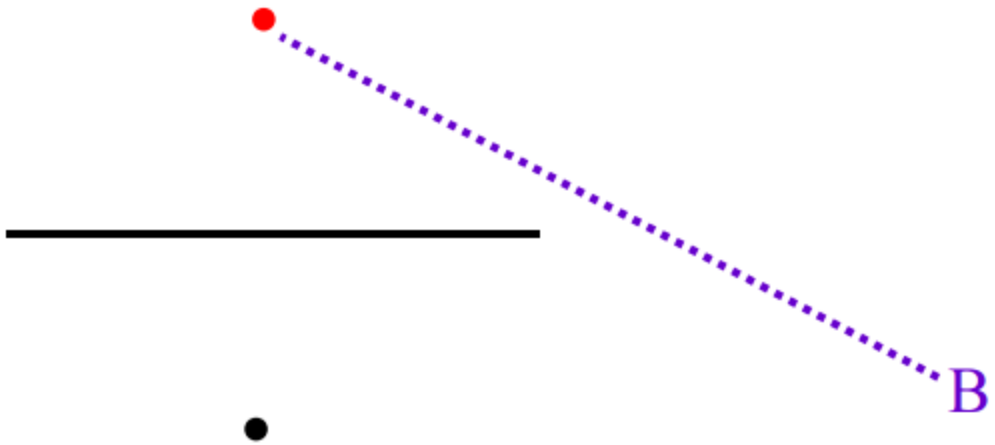
If you drop a normal and measure the angles, they will be equal, the incident angle is equal to angle of reflection



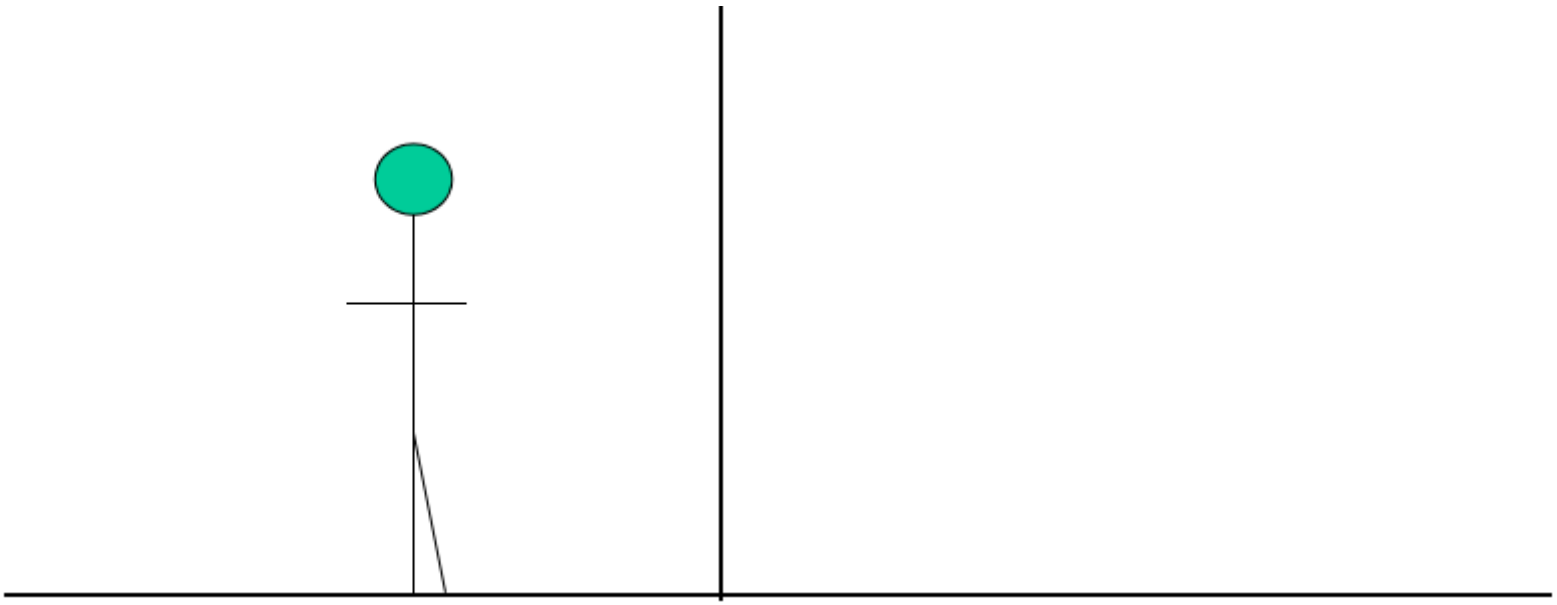
What if we put person B at this location. Can they see the image?



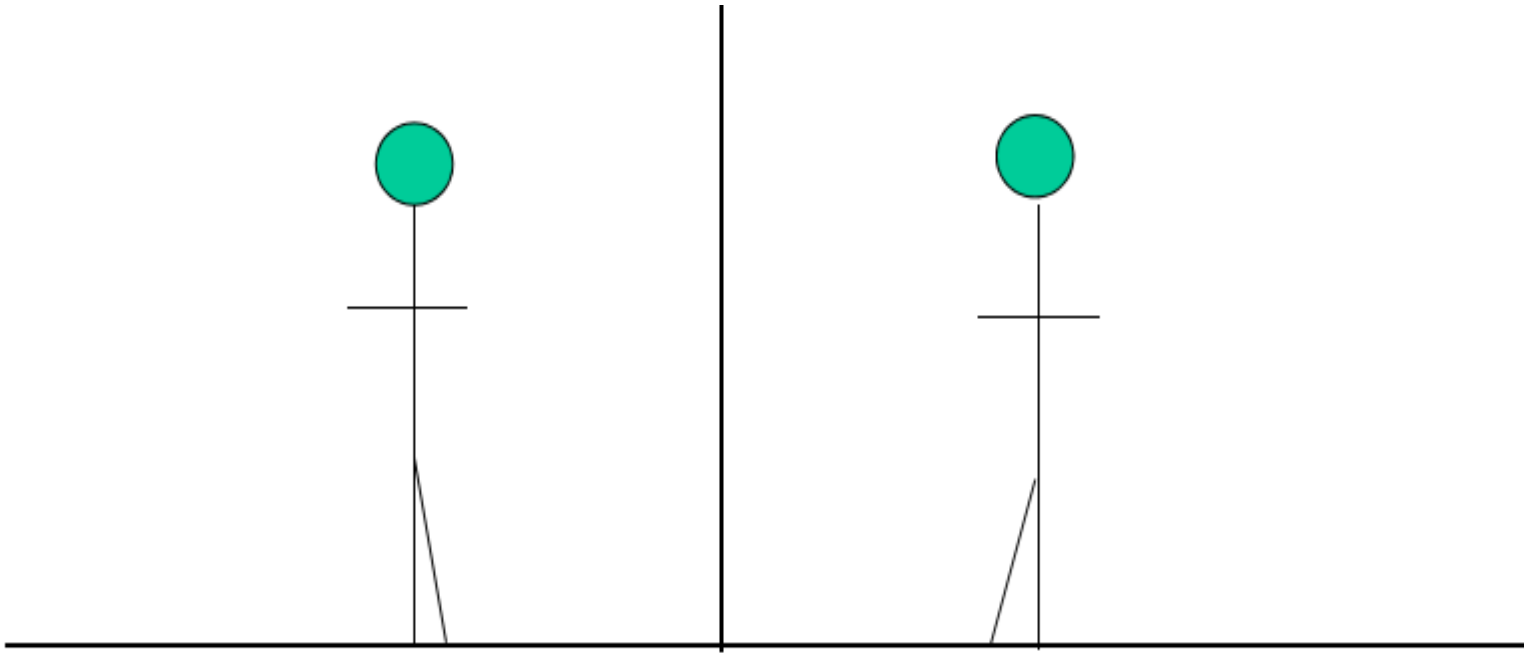
The answer is **NO** because the sight line does not cross the mirror



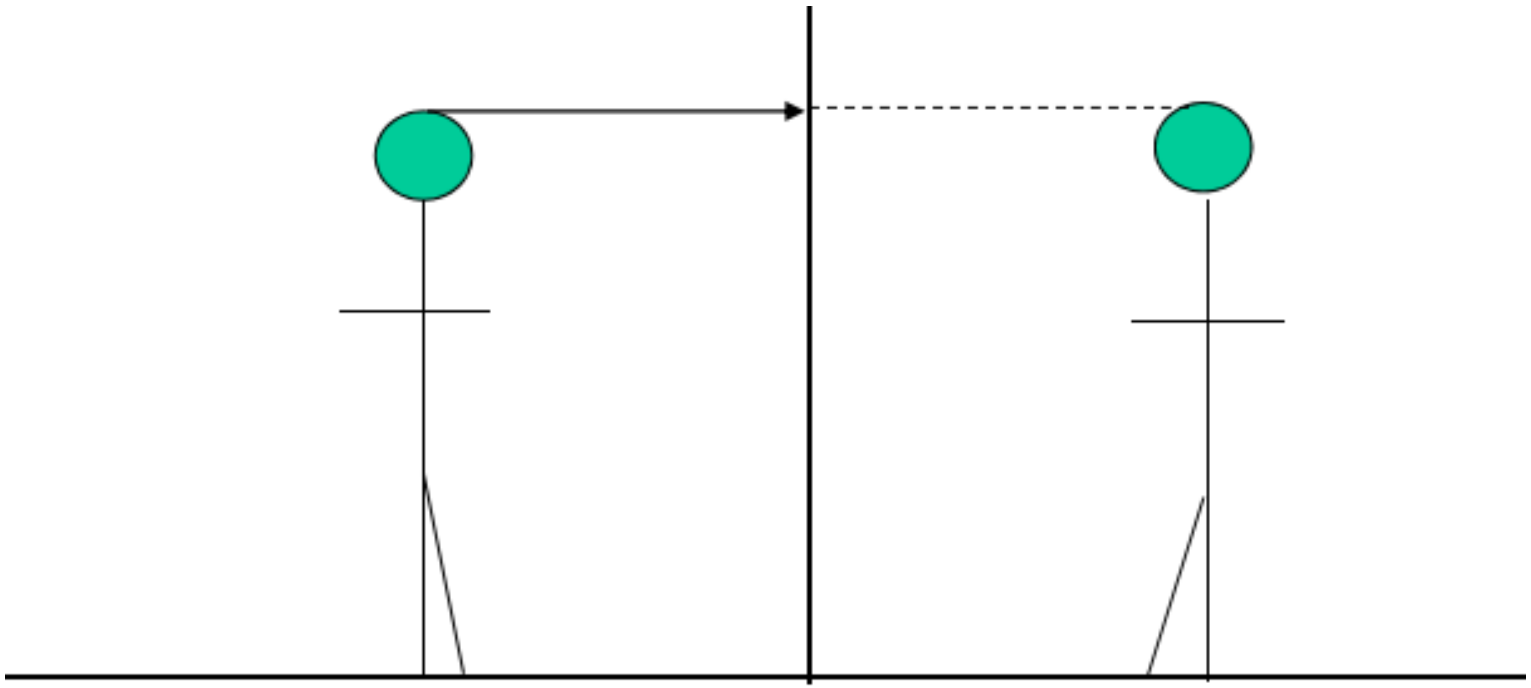
How much mirror do you need to see yourself?



Let’s use the distance of the object equals the distance of the image



Look at your head



Look at your feet

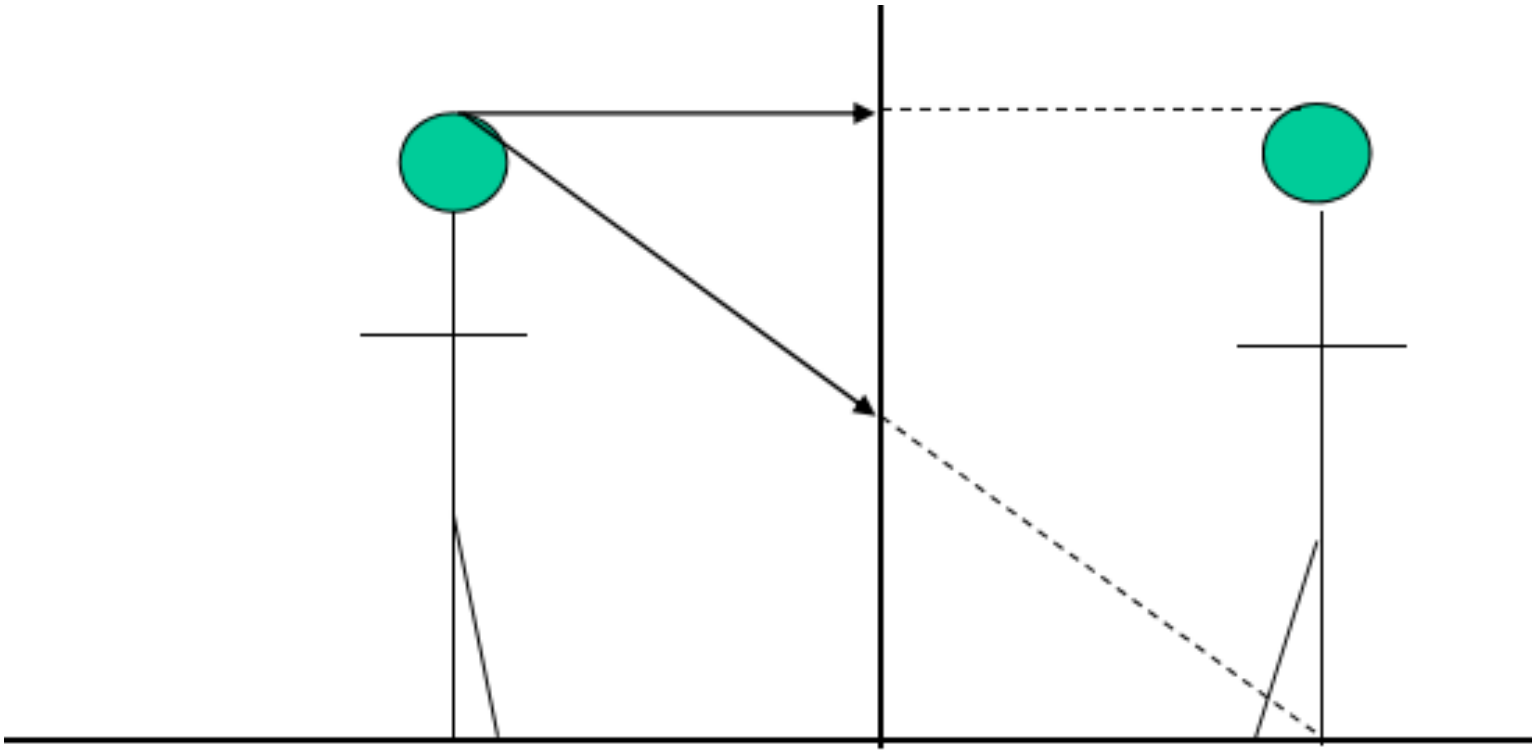
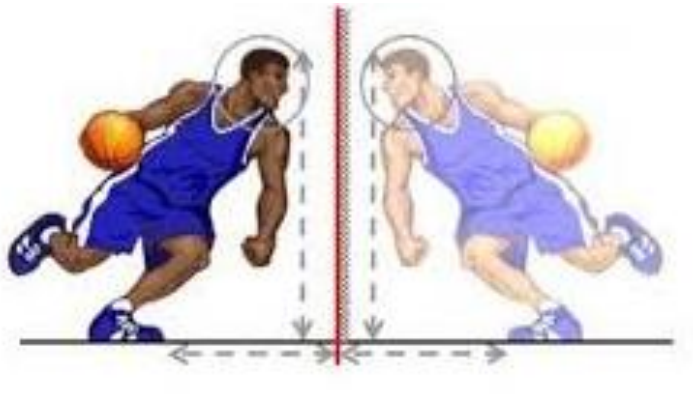


Image Properties

- **S** – size (Larger or Smaller than object)
- **P** – position (Closer or Further away from mirror or optical centre)
- **O** – orientation (upright or inverted)
- **T** – type (Real or Virtual)



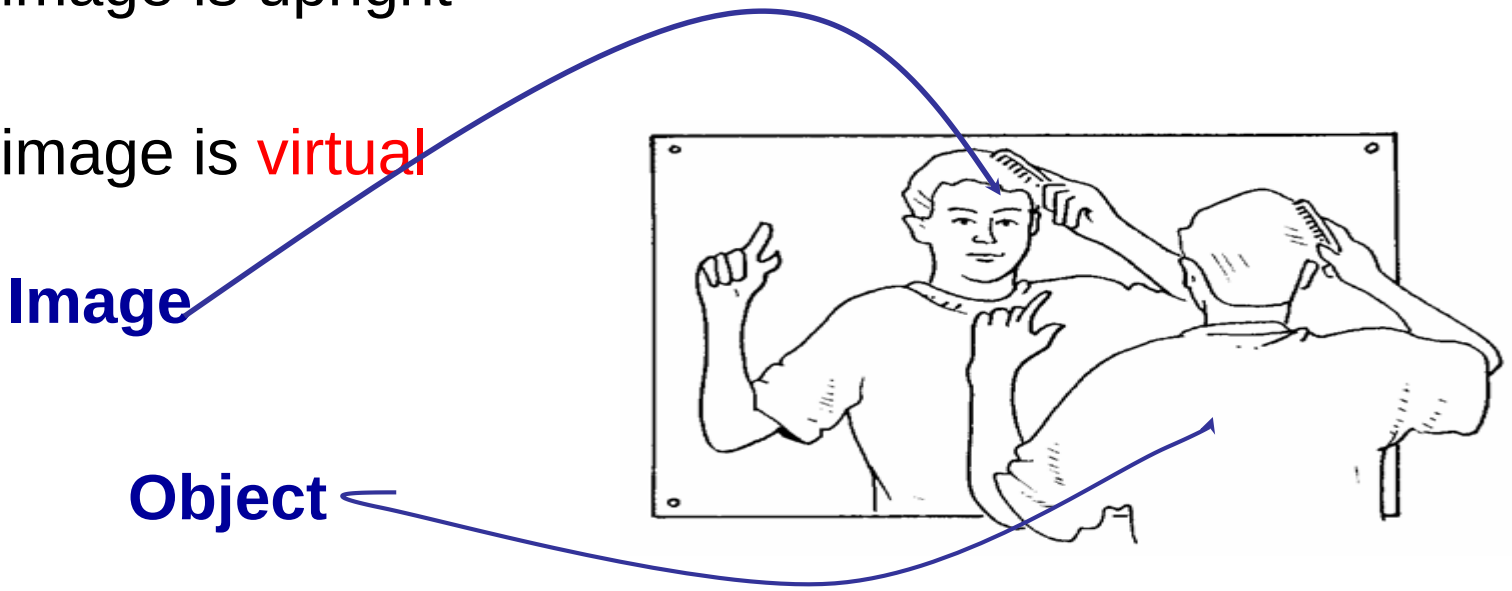
Characteristics of images using plane mirrors:

1. Image size is equal to object size

2. Image distance is equal to object distance

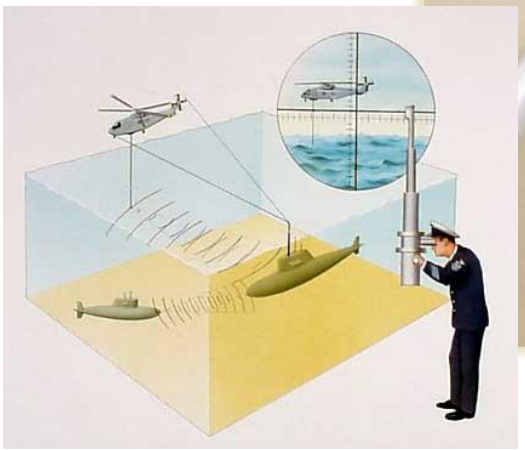
3. The image is upright

4. The image is virtual



Examples of plane mirrors:

- Bathroom mirrors
- Rear view mirrors
- Dentist mirror for looking at teeth
- Periscopes



Student Work

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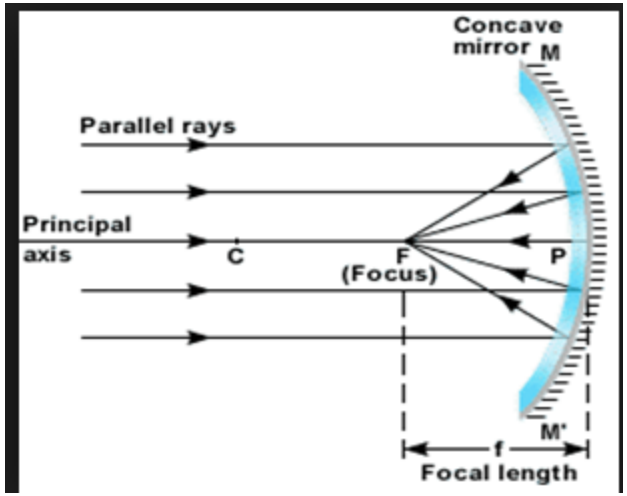
Science 8
Unit 2: OPTICS

Topic 8: CURVED MIRRORS PART 1
CONCAVE MIRRORS



Curved Mirrors

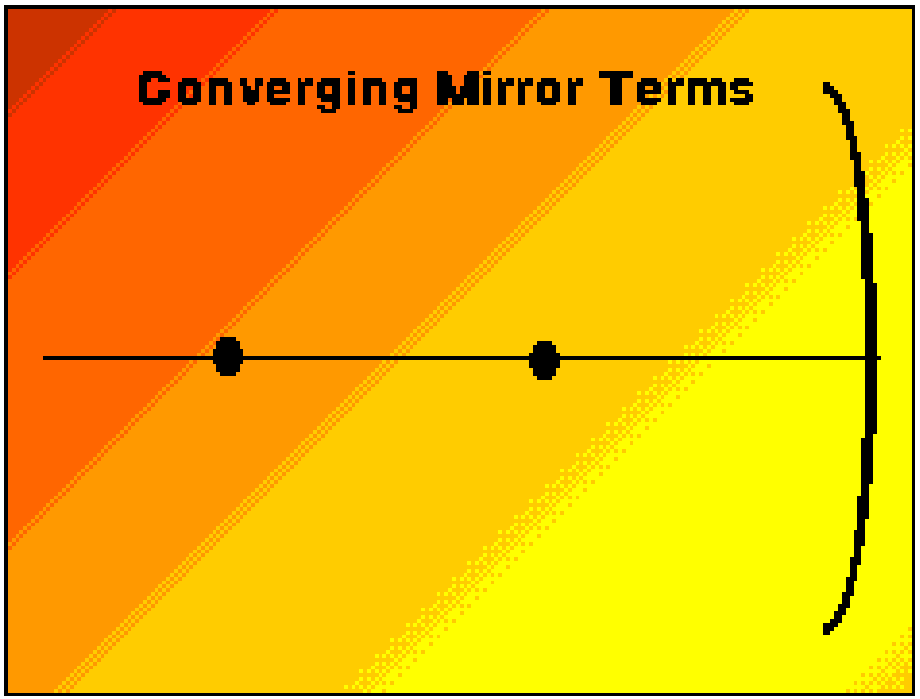
- Plane mirrors are very common, but they are not the only type. Curved mirrors have many applications too. There are two types of curved mirrors:

Concave Mirror

Convex Mirror

1. Concave Mirrors

Concave Mirror refers to a reflective surface that curves inwards. Also, called a converging mirror.

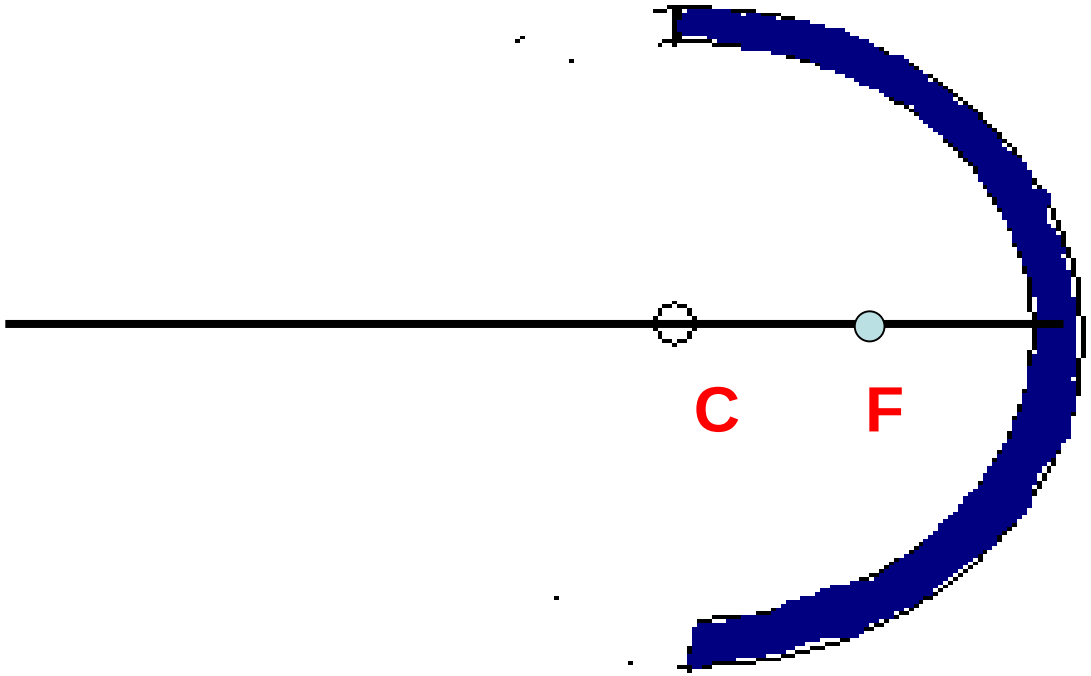


The advantage of a concave mirror is that it helps focus the light to a focal point,

Examples of concave mirrors:

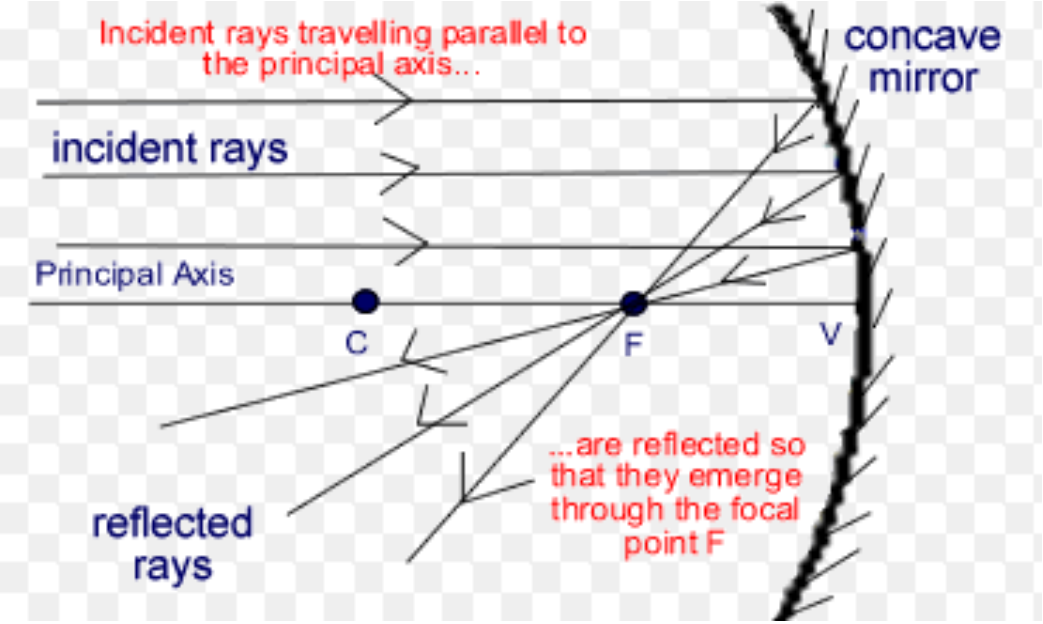
- Inside a metal spoon
- Spotlights
- Overhead projectors
- Flashlights
- Car headlights
- Lighthouses
- Satellite dishes

DEFINITIONS



Centre of curvature (C) is the imaginary center of the circle.

Principal Axis : line passing through the center of curvature and attaching to the mirror in the exact center of the mirror.



Vertex: where the principal axis meets the mirror.

Focal Point: mid way between the mirror and the centre of curvature.

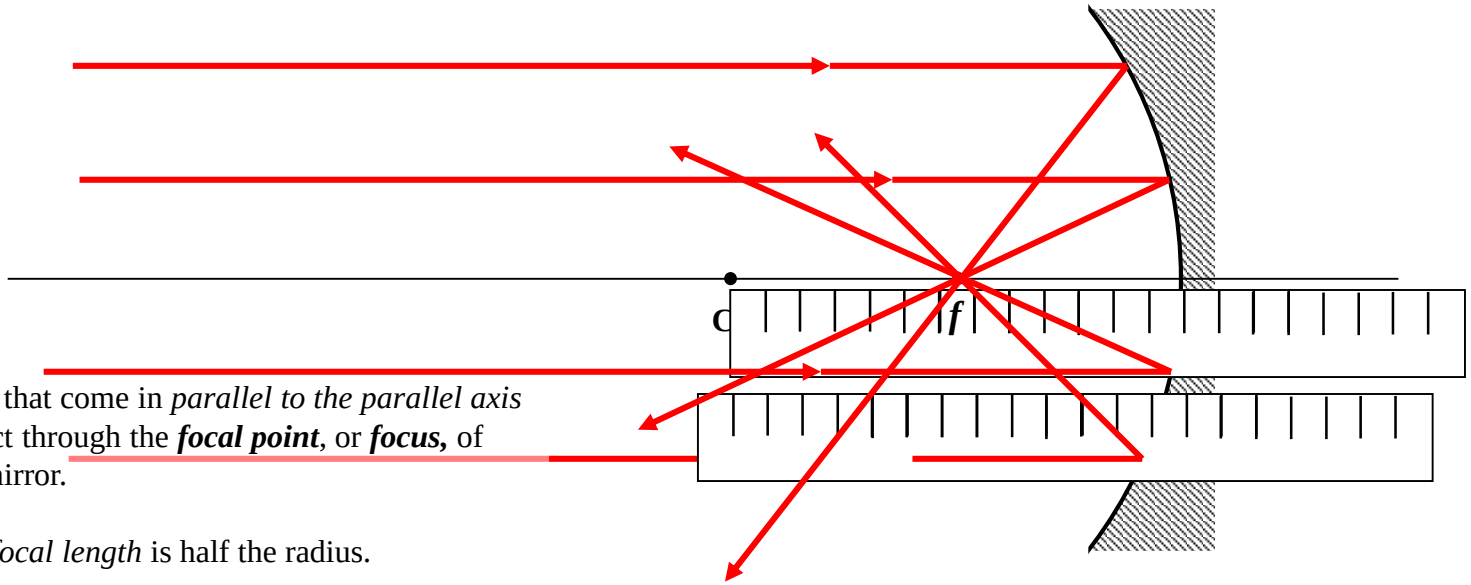
$$\left(f = \frac{1}{2} C \right)$$

When parallel light rays are shone along the principal axis, the reflected rays converge and cross at the focal point.

CORE LAB ACTIVITY

RAY DIAGRAMS USING CONCAVE MIRRORS

To find how an image is going to look in a mirror we use a ray diagram

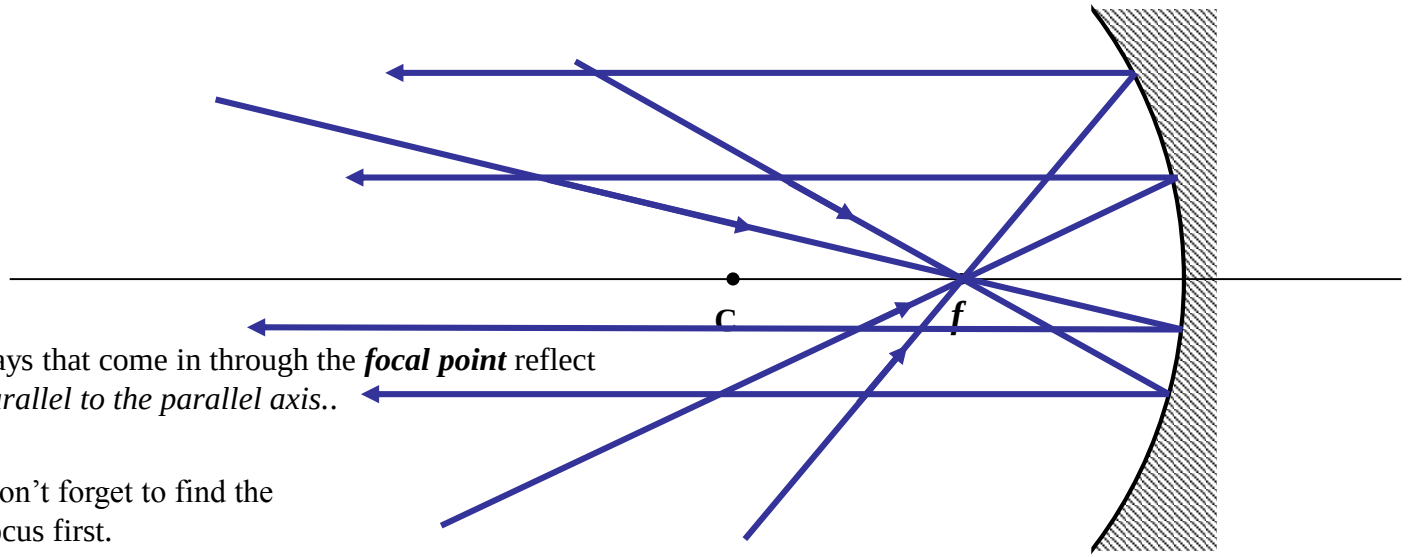


Rays that come in *parallel to the parallel axis* reflect through the ***focal point***, or ***focus,*** of the mirror.

The *focal length* is half the radius.

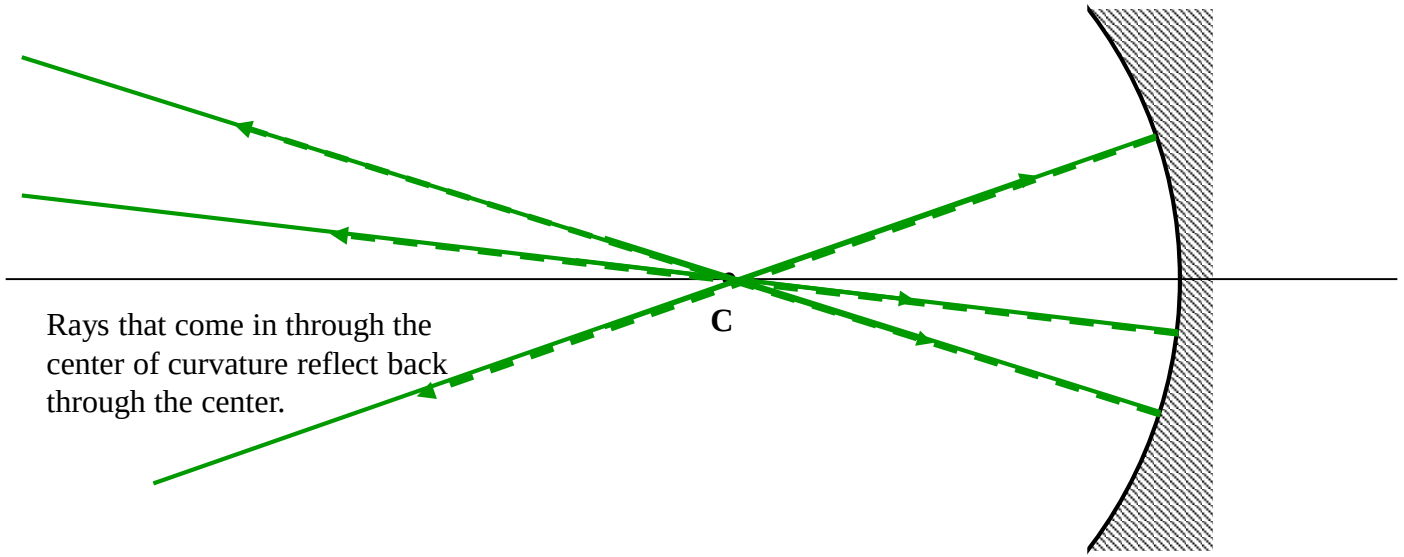
Find the *focal point first.*

Now you can draw parallel rays reflecting through the focus..



Rays that come in through the ***focal point*** reflect *parallel to the parallel axis..*

Don’t forget to find the focus first.



Rays that come in through the center of curvature reflect back through the center.

Type 1: Concave- Beyond Centre of Curvature

We find the image of an object in front of the mirror by using the three rays.

First, the parallel ray.

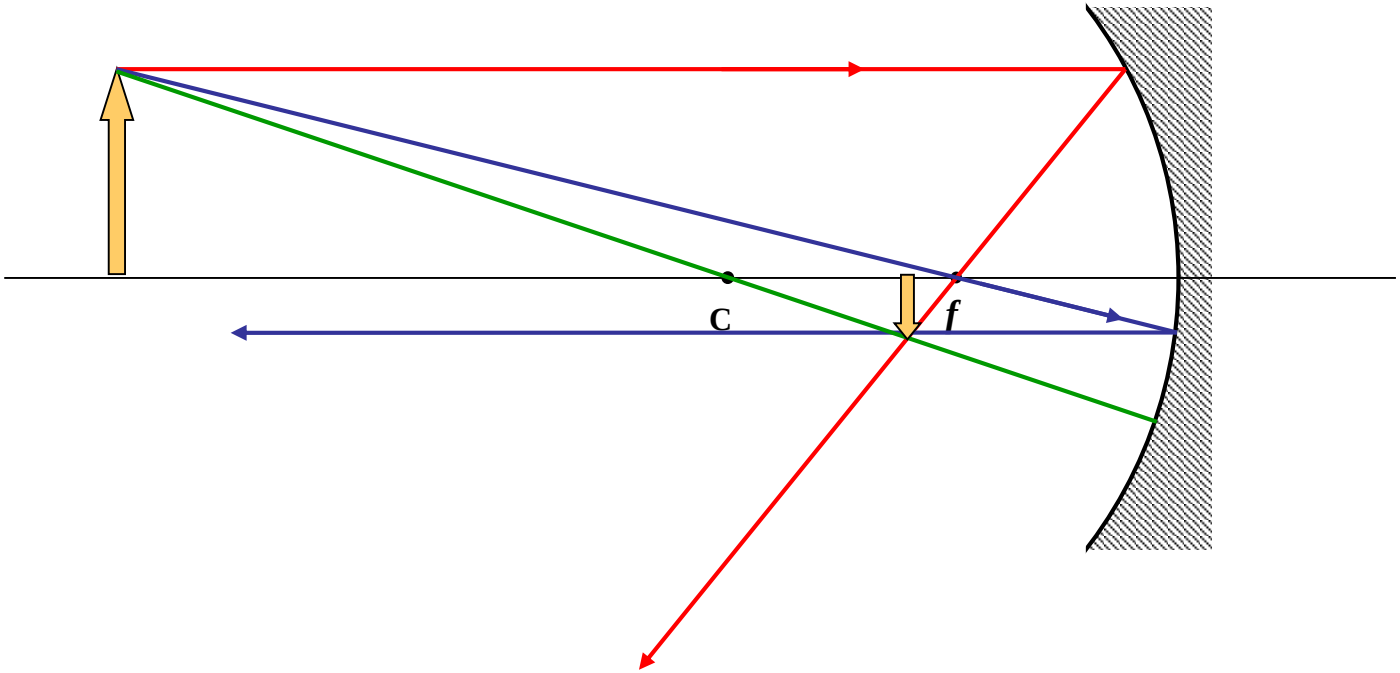
Then the ray thru the focus.

Then the ray thru the center.

The image will appear where these three reflected rays meet.

On the next sheet, you will get a chance to try to find the images.

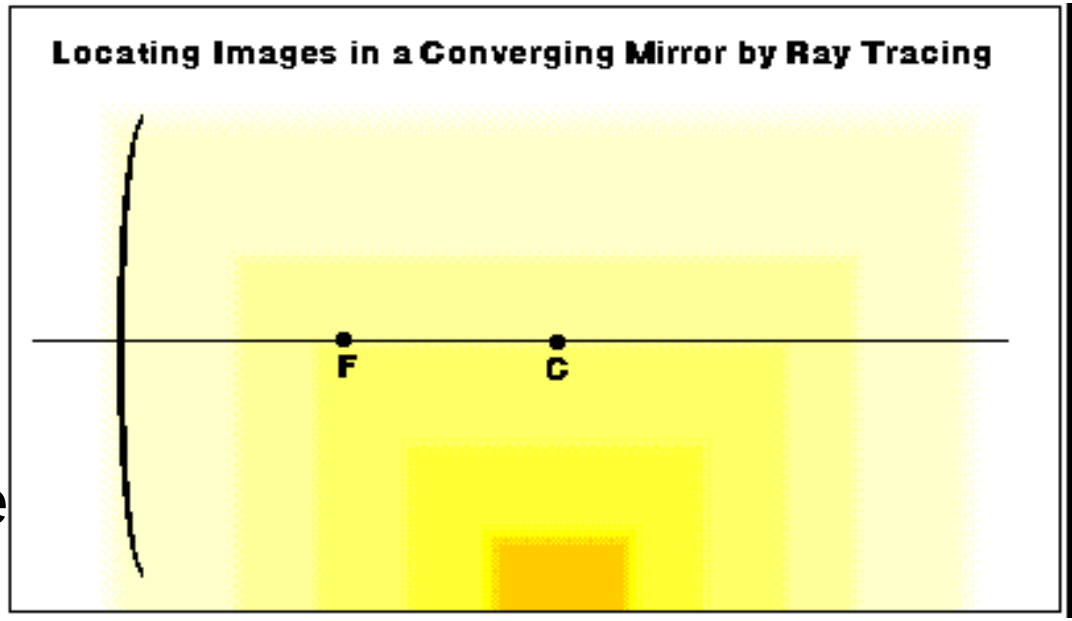
We'll do the first together.



•Image is Real (placed on a screen)

•Image is inverted (upside down)

•Image is smaller than obje



•Image is located between the

center of curvature and focal point

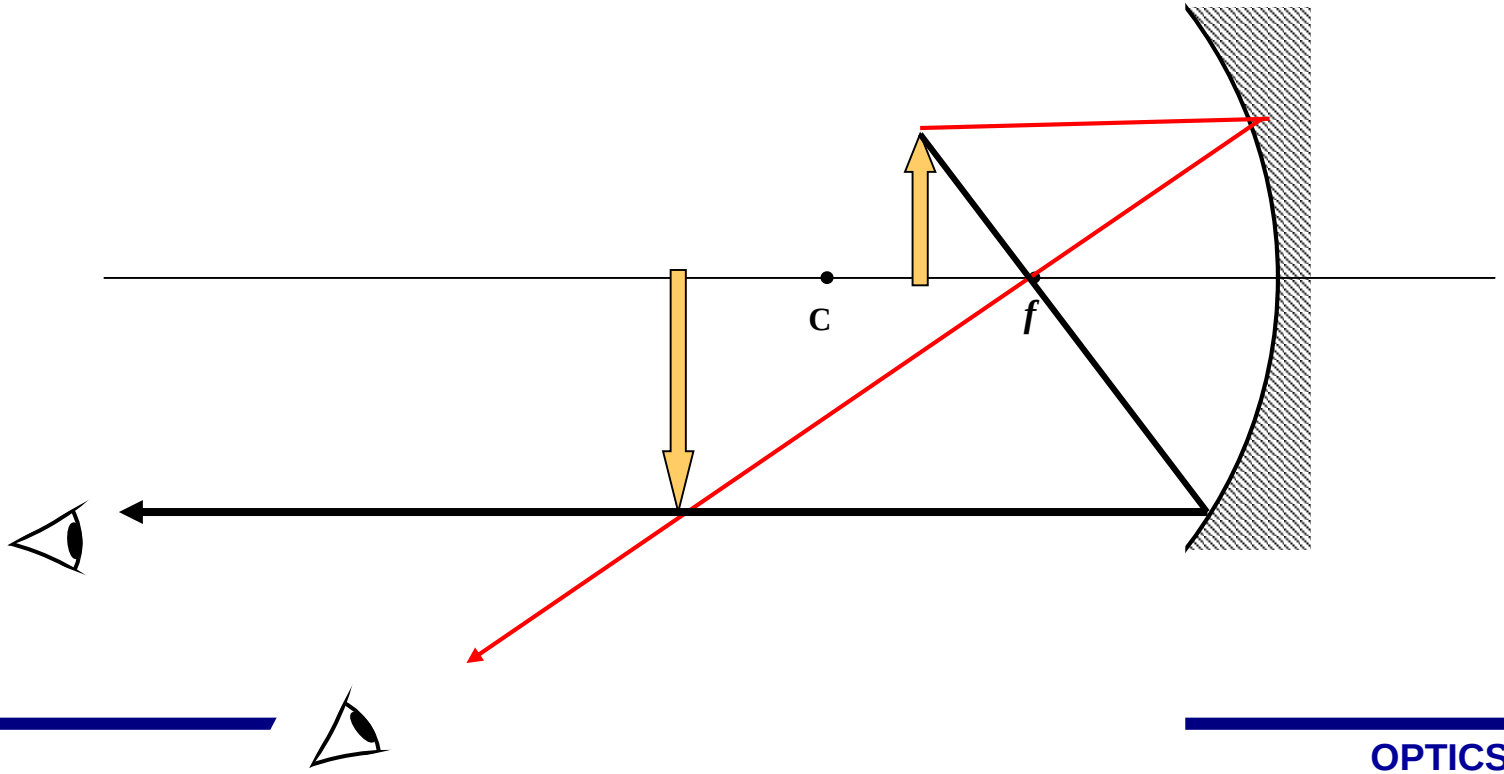
Type 2: Between the Focal Point and Centre of Curvature

Try this one before going on.

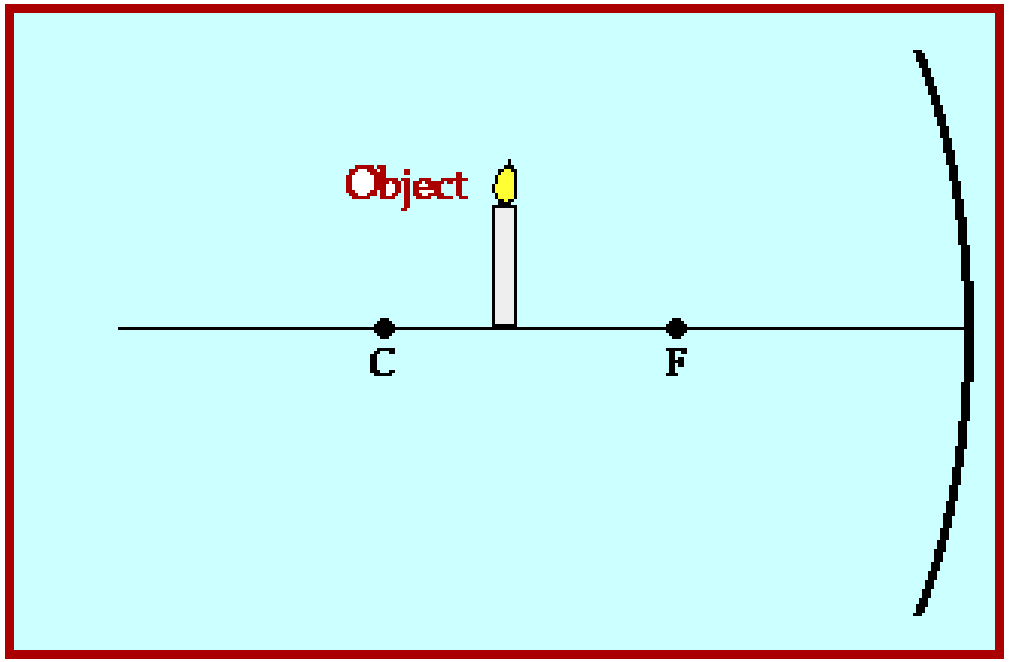
Even though the reflected rays don't converge in front of the mirror, we see the image along those rays.

We trace the rays back and see they converge behind the mirror. That is where the image appears.

This is the same for all objects at a distance less than the focal length.



- Image is real
- Image is inverted
- Image is larger
- Image is beyond C



You Try: Concave-Object at the Centre of Curvature

Try this one before going on.

Notice how an object placed at the center of curvature has an image directly below it.

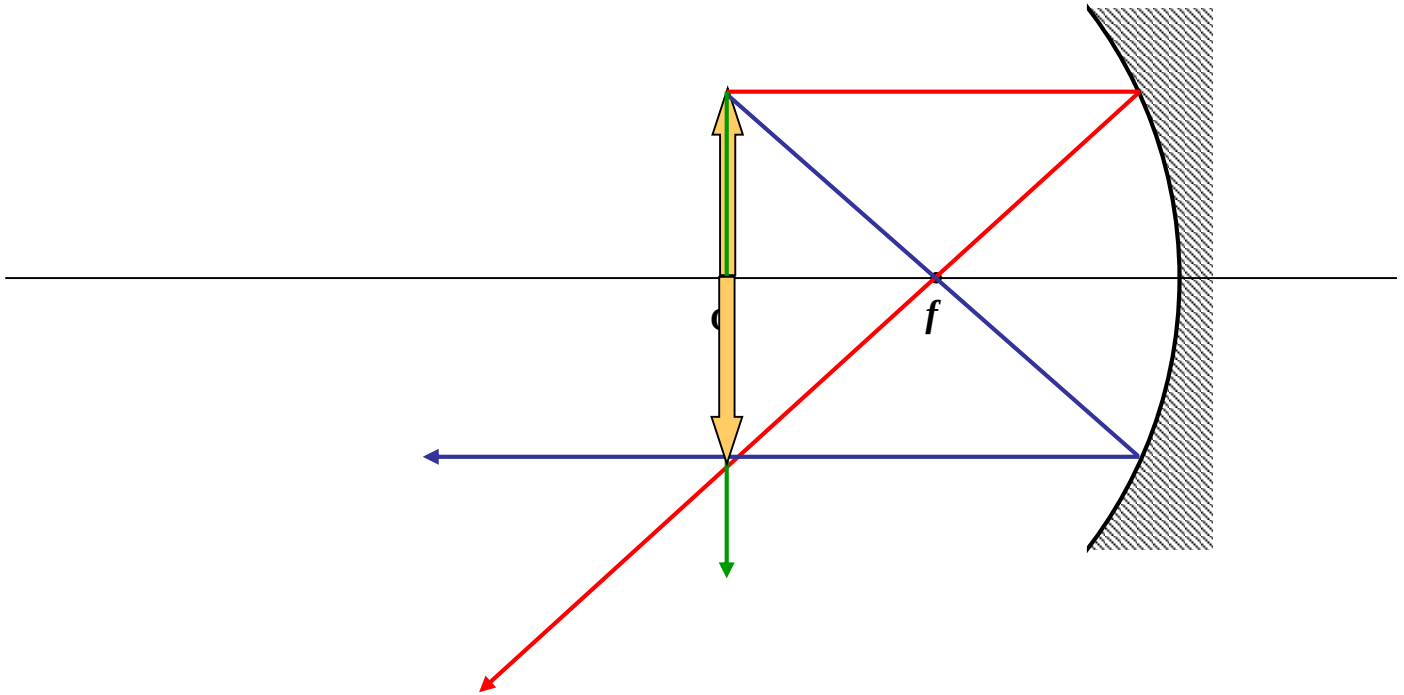


Image is real

Image is inverted

Image is the same size

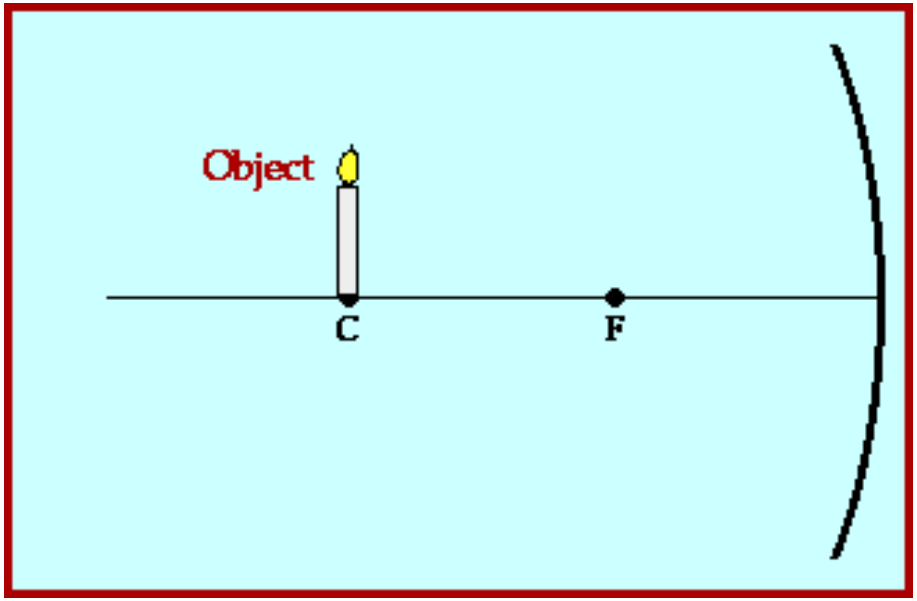


Image will also be located at the center of curvature

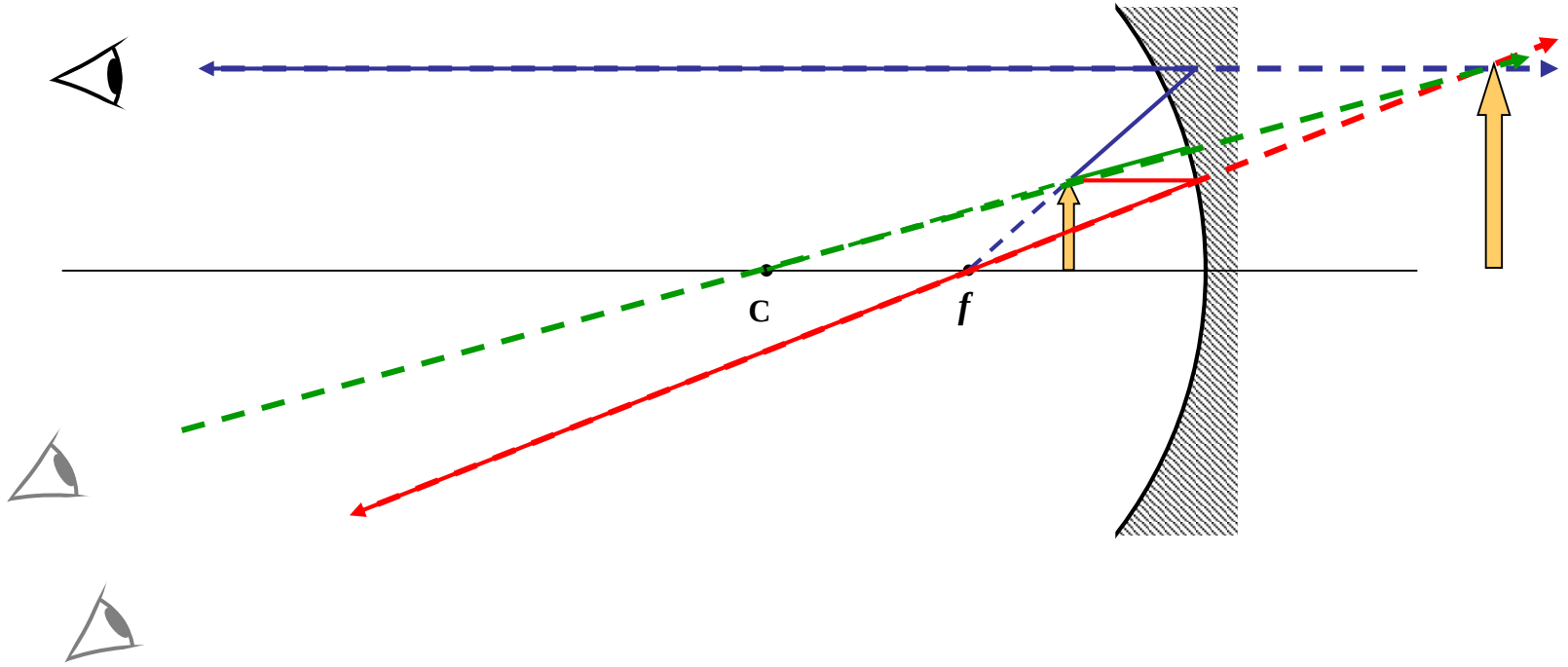
Type 3: Concave- Inside Focal Point

Try this one before going on.

Even though the reflected rays don't converge in front of the mirror, we see the image along those rays.

We trace the rays back and see they converge behind the mirror. That is where the image appears.

This is the same for all objects at a distance less than the focal length.



- Image is Behind the mirror
- Image is Virtual
- Image is Erect
- Image is enlarged

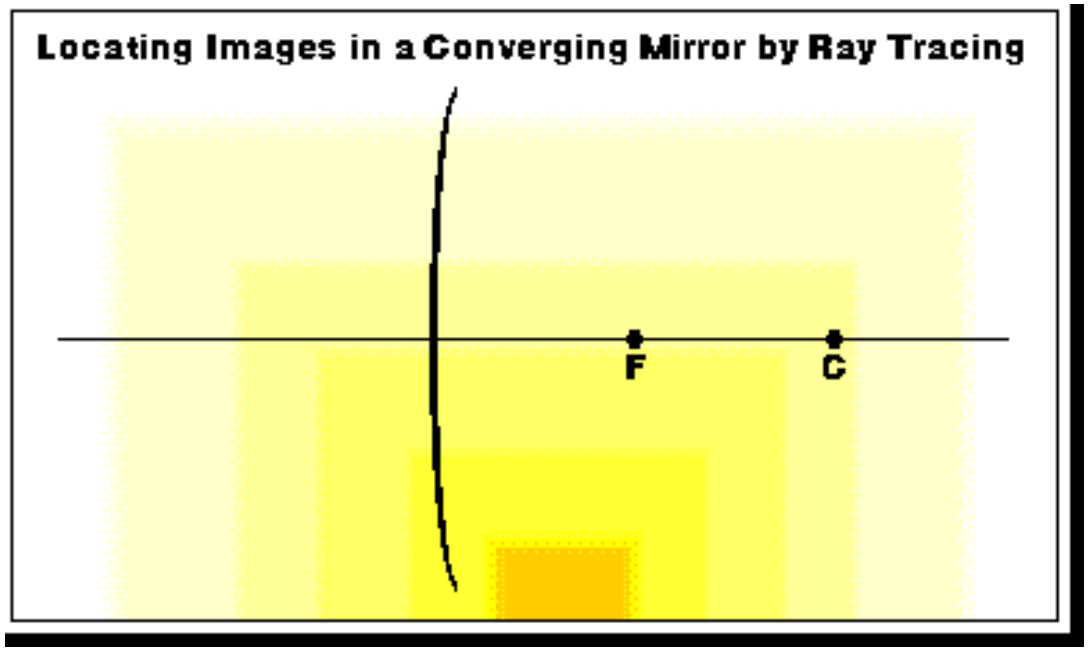
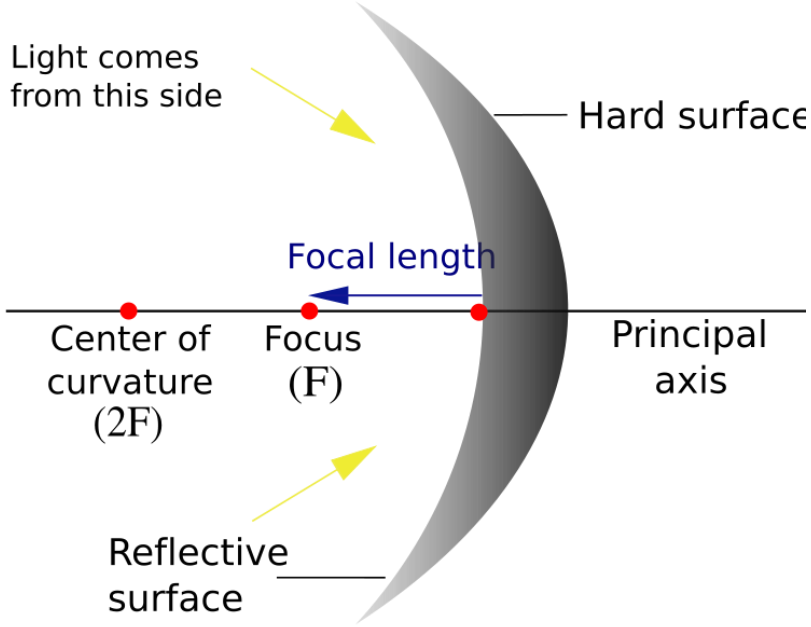


Image Properties

- **S** – size (Larger or Smaller than object)
- **P** – position (Closer or Further away from mirror or optical centre)
- **O** – orientation (upright or inverted)
- **T** – type (Real or Virtual)
  - Qualitative vs. Quantitative Description

Summary-

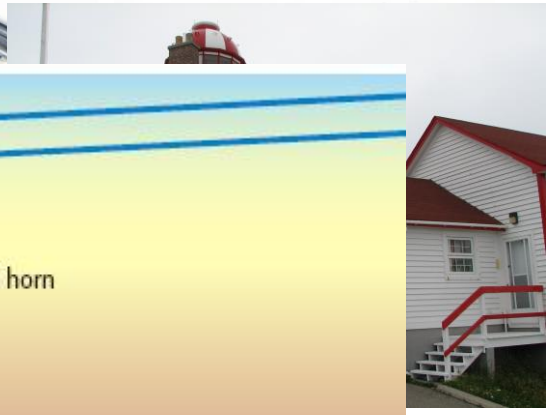
Concave Mirrors



Position of object	Position of Image	Erect/Inverted	Real / Virtual	Size of Image
Beyond C	Between C and F	Inverted	Real	Smaller
Between C and F	Beyond C	Inverted	Real	Larger
Inside F	Behind the mirror	Erect	Virtual	larger
At C	at C	Inverted	Real	Same size

Examples of concave mirrors:

- Inside a metal spoon
- Spotlights
- Overhead projectors
- Flashlights
- Car headlights
- Lighthouses
- Satellite dishes



Student Work

- **Page 202**

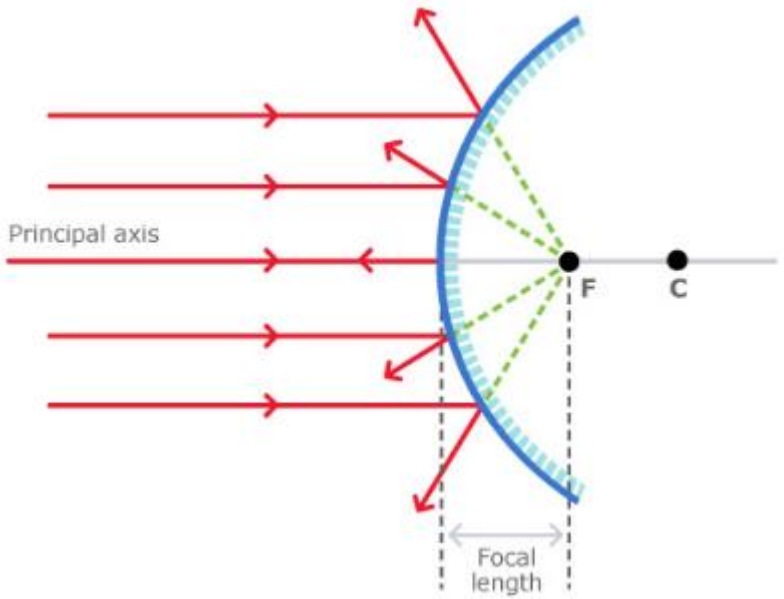
#1, #2, #3, #4

Page 195

#3, #$

Science 8
Unit 2: OPTICS

Topic 9: CURVED MIRRORS PART 2
CONVEX MIRRORS



Examples of convex mirrors:

- Safety mirrors at the front of a bus

- Mirrors in Stores

- Disco balls

3. Convex Mirrors

- Curved outward like the outside of a bowl.

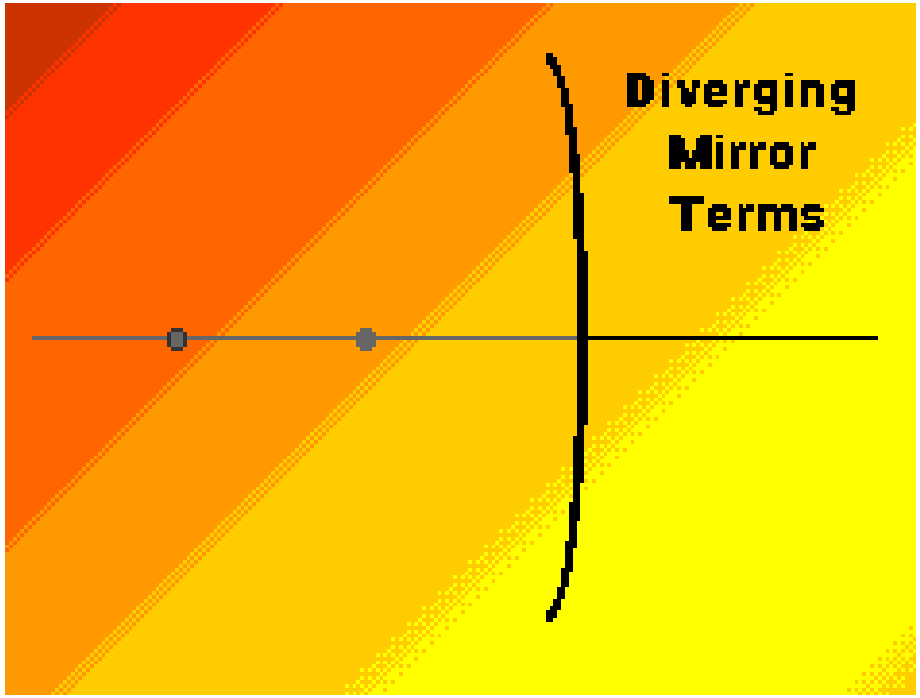


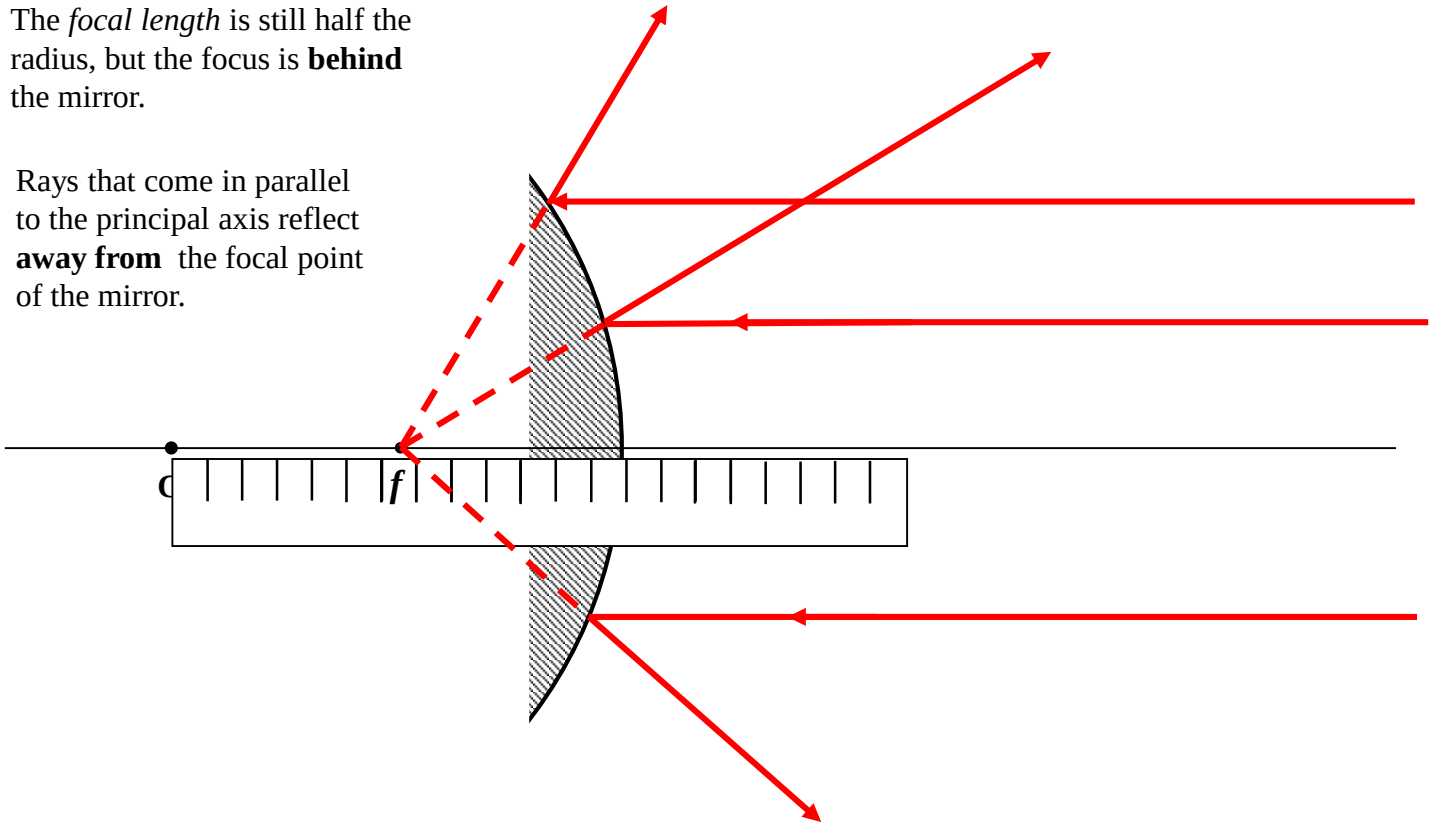
Image in a convex mirror is always virtual

The three rays are similar to the concave mirrors.

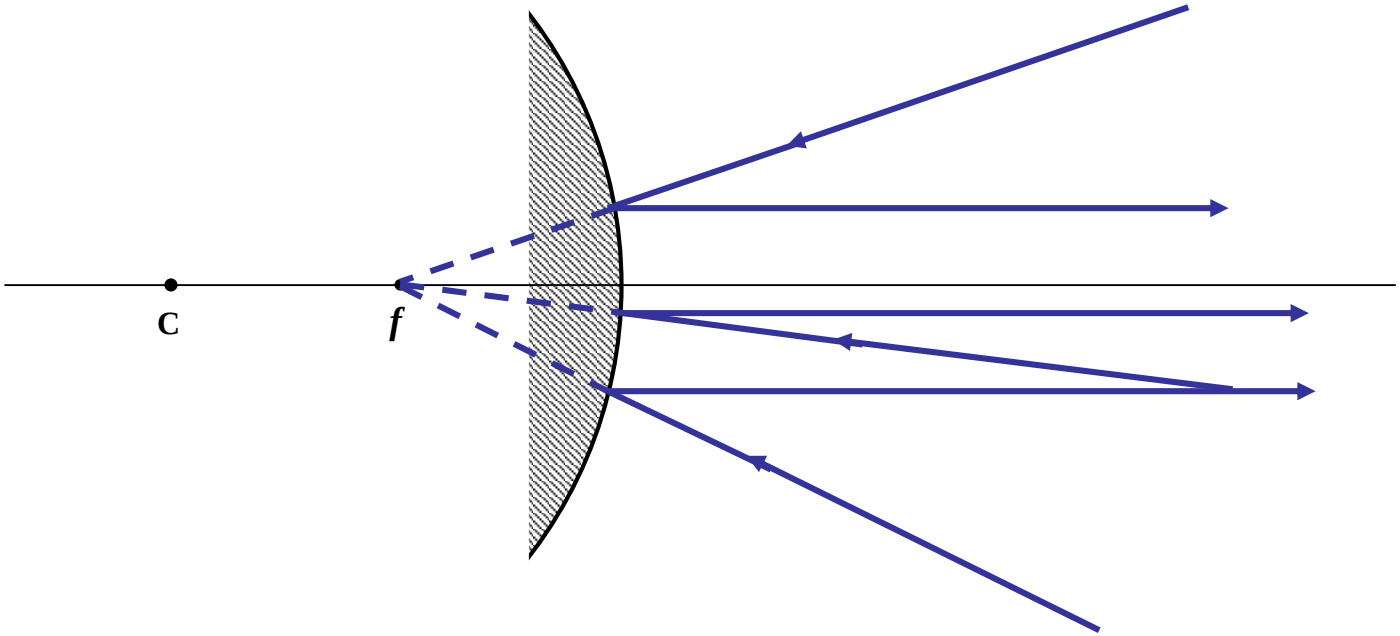
Now we'll learn about Convex or Diverging Mirrors

The *focal length* is still half the radius, but the focus is **behind** the mirror.

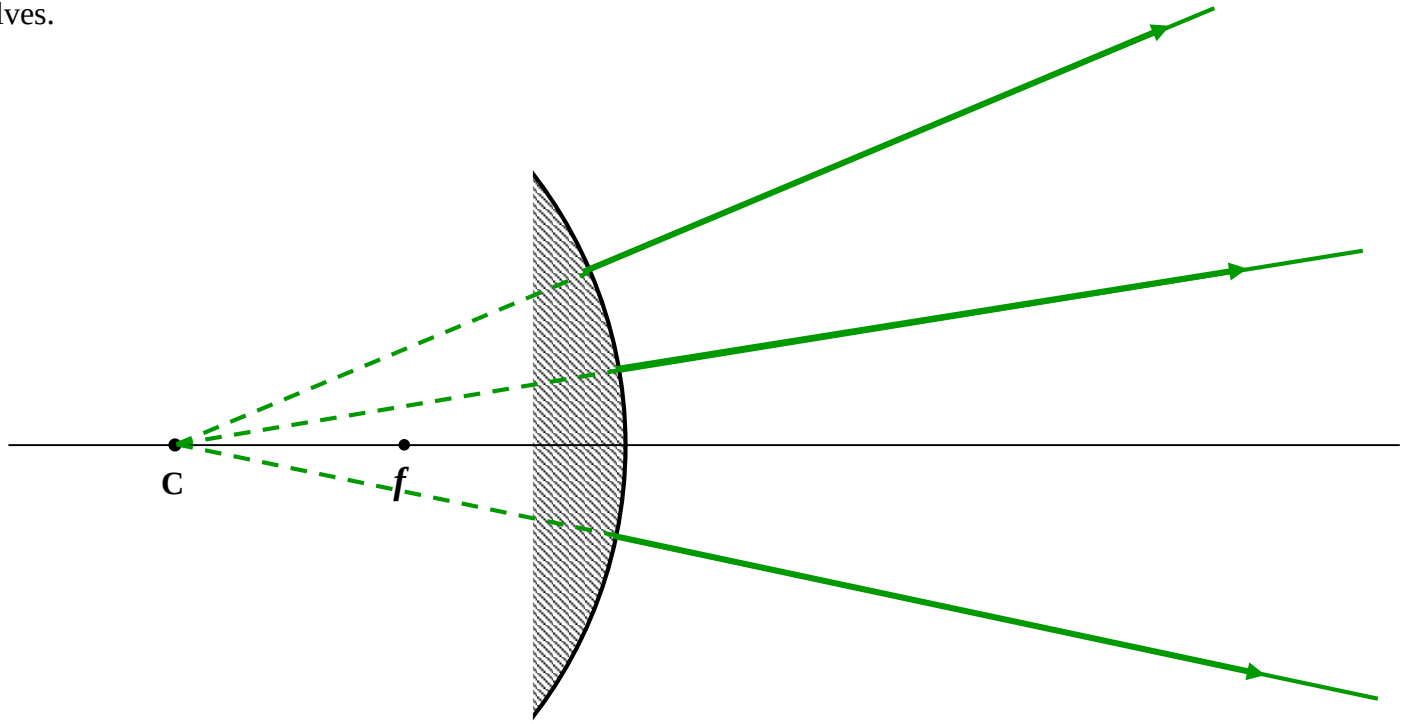
Rays that come in parallel to the principal axis reflect **away from** the focal point of the mirror.



Rays that come in ***toward*** the ***focal point*** reflect *parallel to the optical axis..*



Rays that come in ***toward*** the center of curvature reflect back on themselves.



We find the image of an object in front of the mirror by using the three rays.

First, the parallel ray.

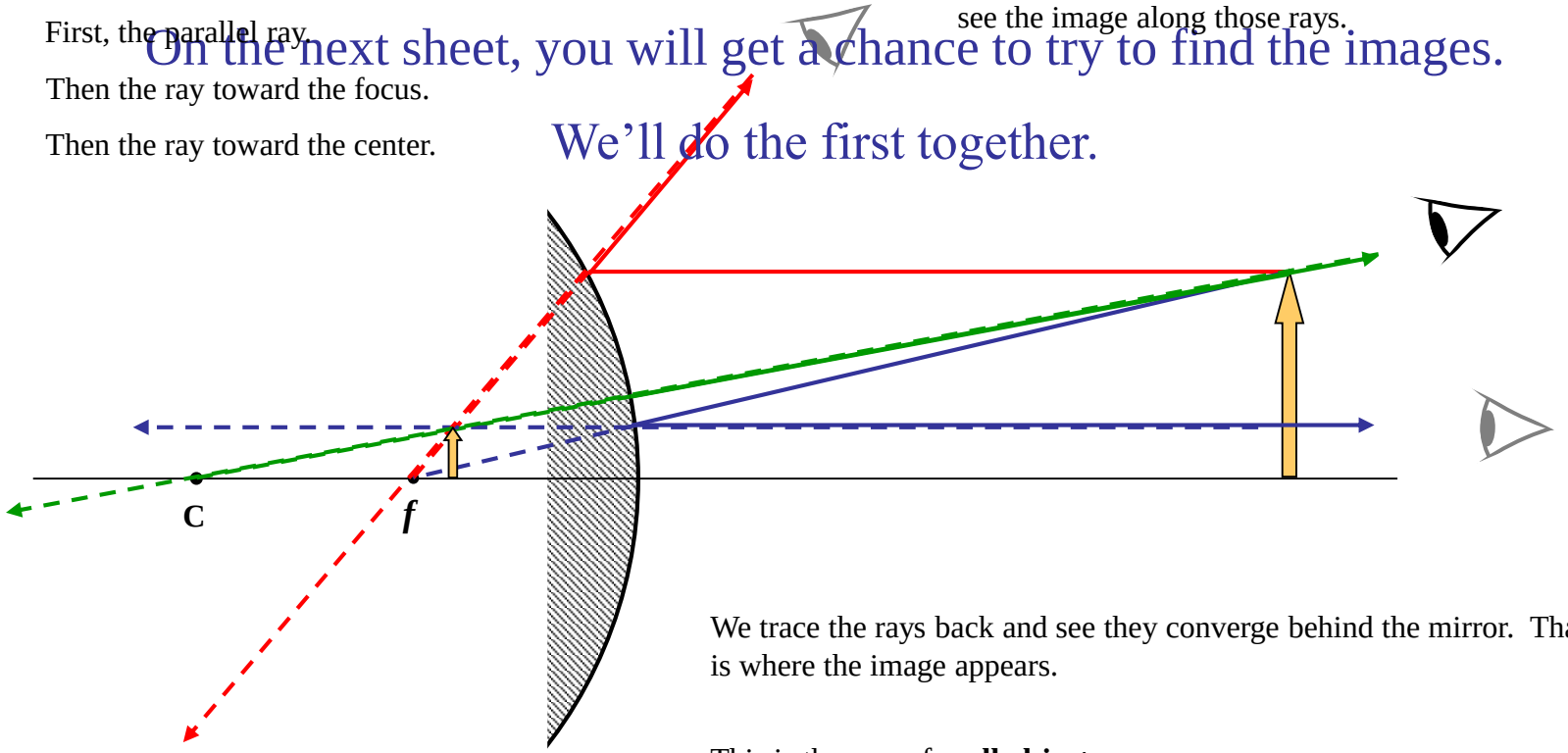
Then the ray toward the focus.

Then the ray toward the center.

Even though the reflected rays don't converge in front of the mirror, we see the image along those rays.

On the next sheet, you will get a chance to try to find the images.

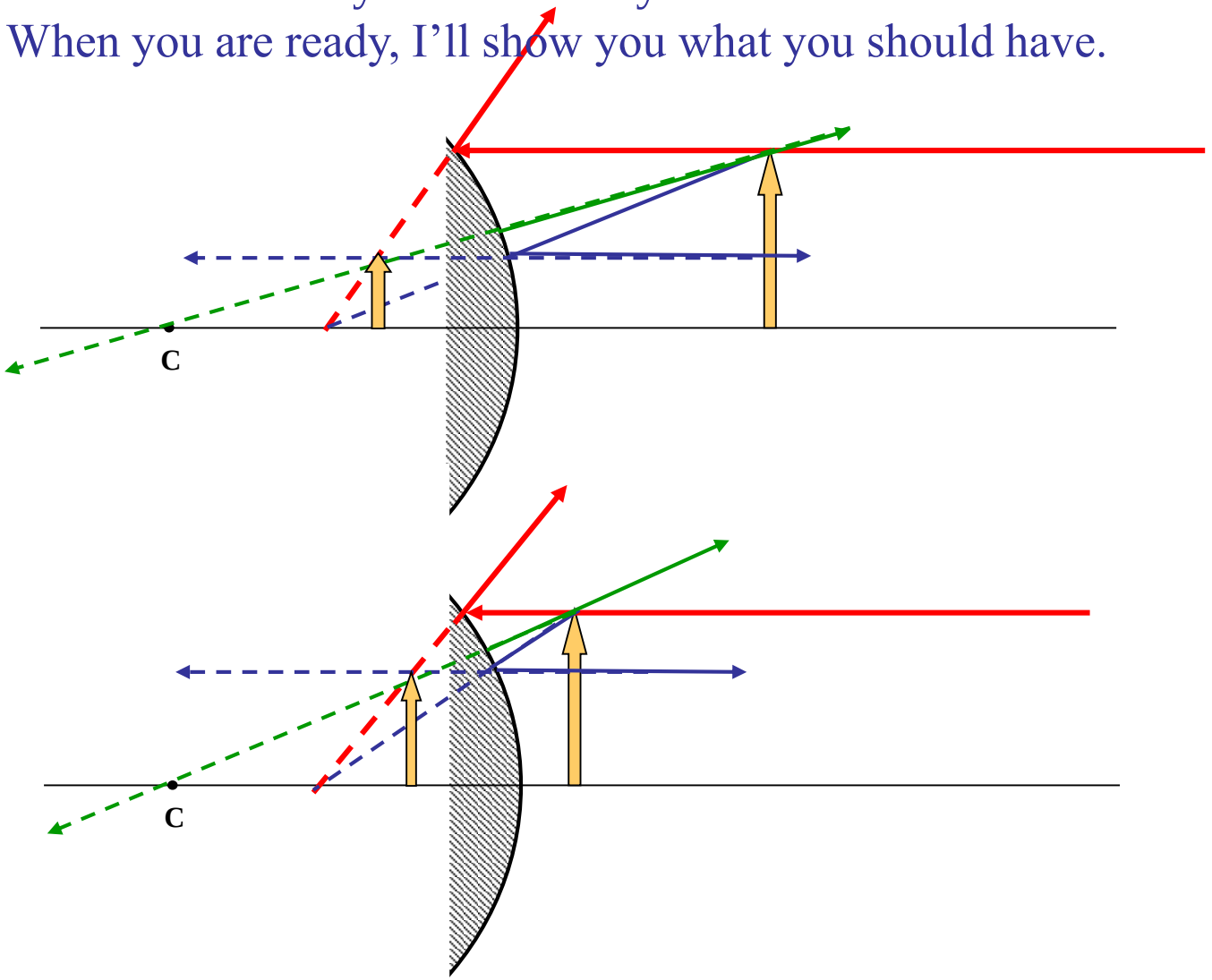
We'll do the first together.



We trace the rays back and see they converge behind the mirror. That is where the image appears.

This is the same for **all objects.**

Try the next two yourself.
When you are ready, I'll show you what you should have.



CORE LAB ACTIVITY

RAY DIAGRAMS USING CONVEX MIRRORS

Characteristics of images using convex mirrors:

1. The image is smaller than the object.

2. The image distance is smaller than the object distance.

3. The image is upright.

4. The image is virtual.

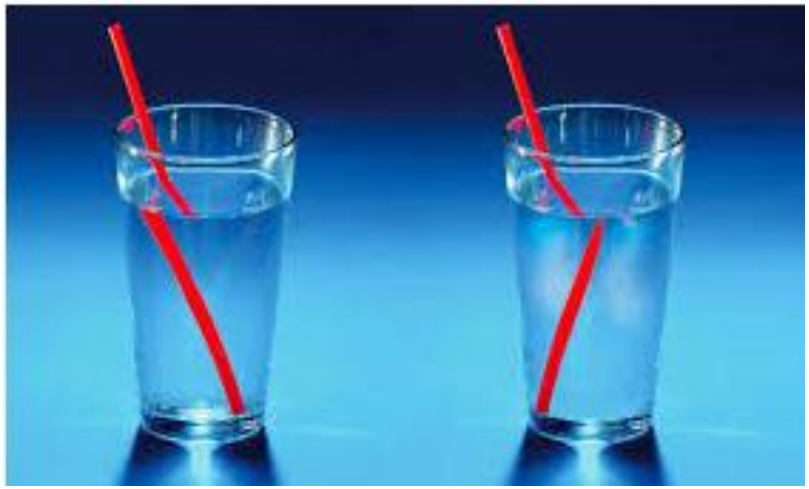
Ray Diagrams for Curved Mirrors

- Hopefully you can now use ray diagrams to find the images in mirrors.
- If you worked along on the handouts, you can find a copy of what yours should look like at:

RayMHOA.doc

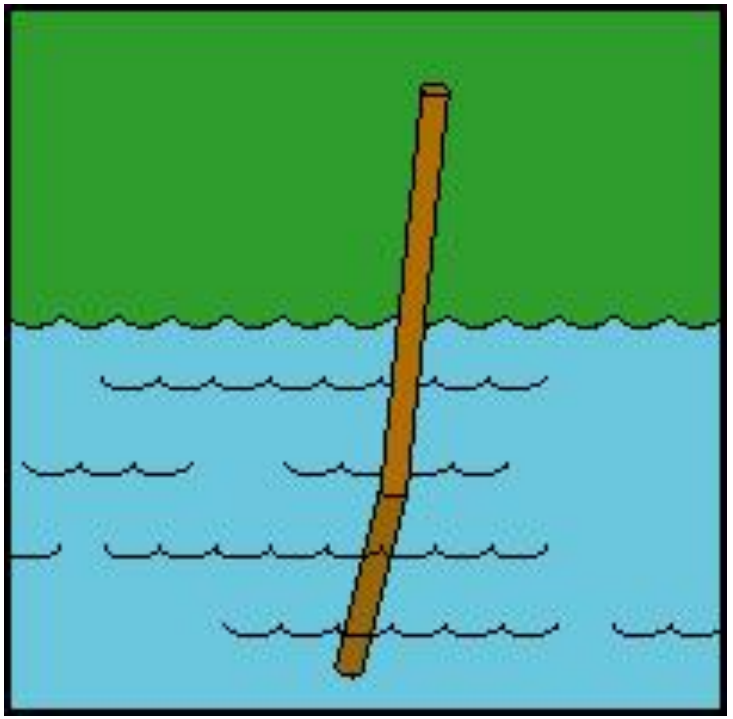
Science 8
Unit 2: OPTICS

Topic 10: REFRACTION



Refraction...

Refraction refers to the bending of a wave when it travel from one medium to another.

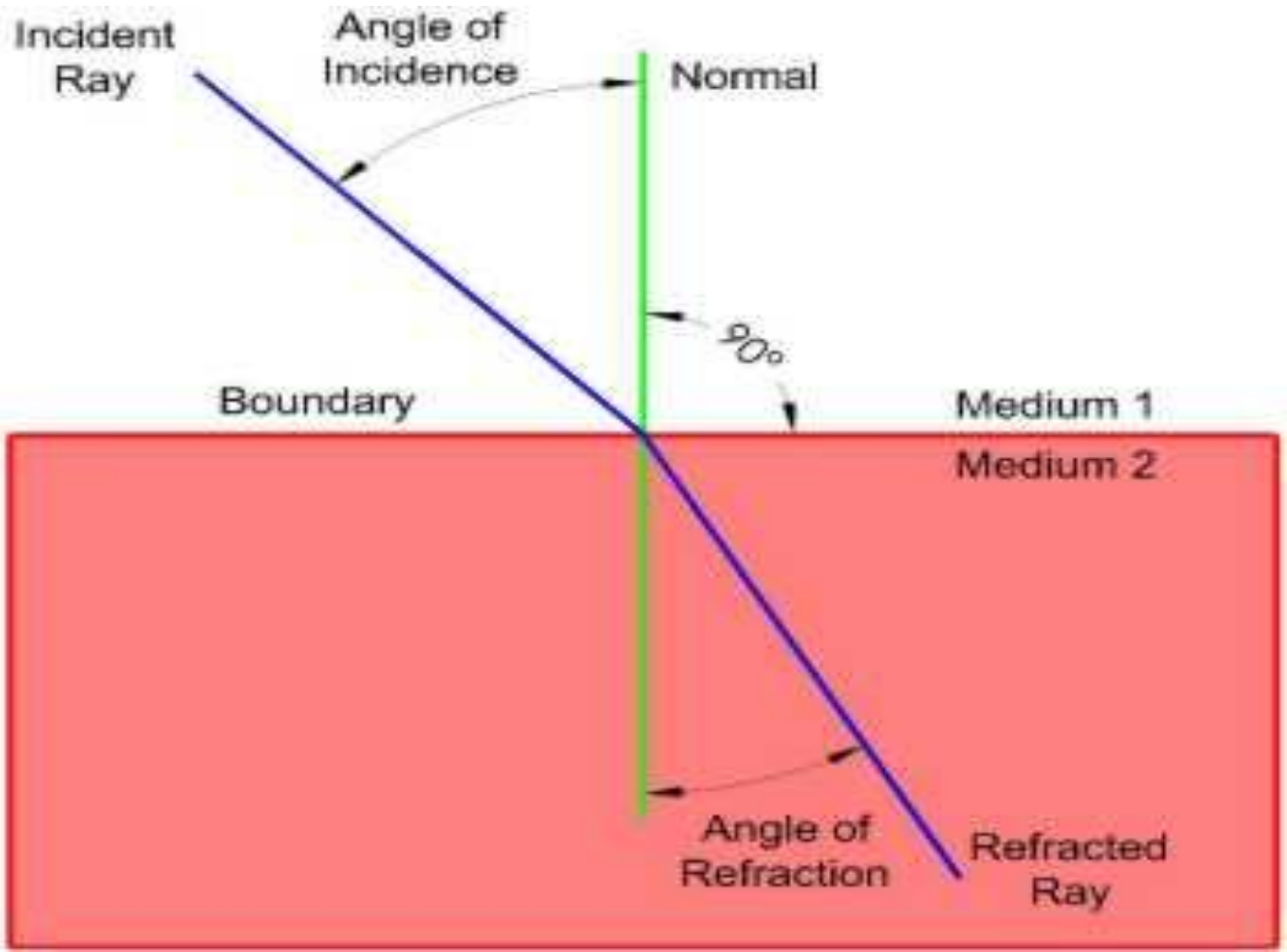


Refracted ray:

- is in the second medium travelling in a different direction than the incident ray.

Angle of refraction:

- The angle between the normal and the refracted ray.

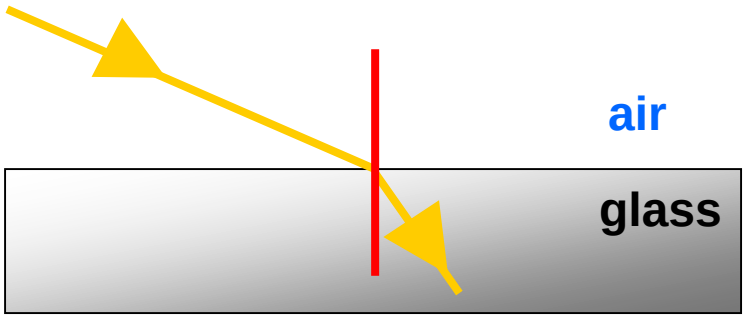


Why is light refracted?

The speed of light depends on the material through which the light is travelling.

When light enters a different material (e.g. from air into glass), the speed of light changes.

This causes the light to bend or **refract**.

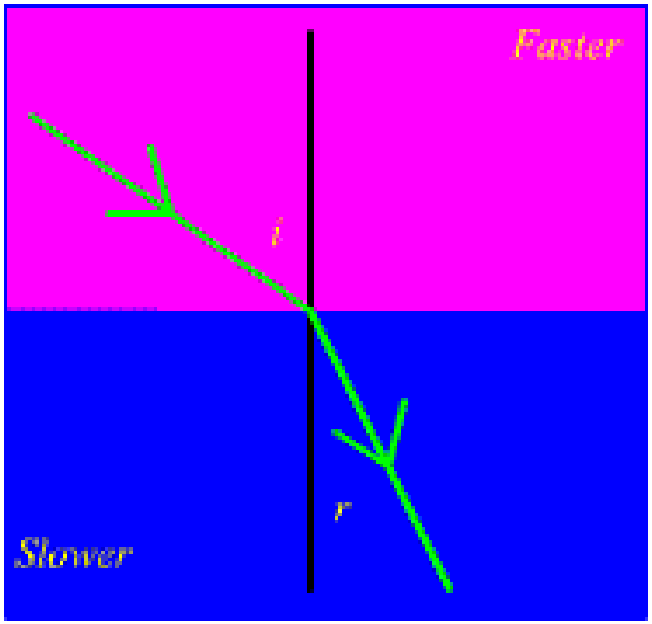


The speed of light is affected by the density of the material through which it is travelling.
When light enters a more dense medium (from air into glass), its speed decreases and this is why refraction occurs.

What happens…

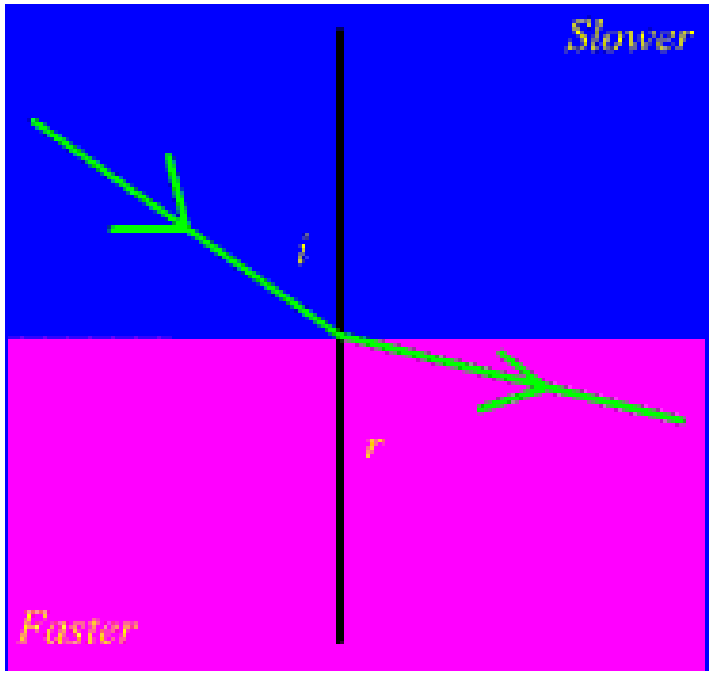
As light travels from a less dense medium to a more dense medium (ie. Slows down)?

The ray bends towards the normal.



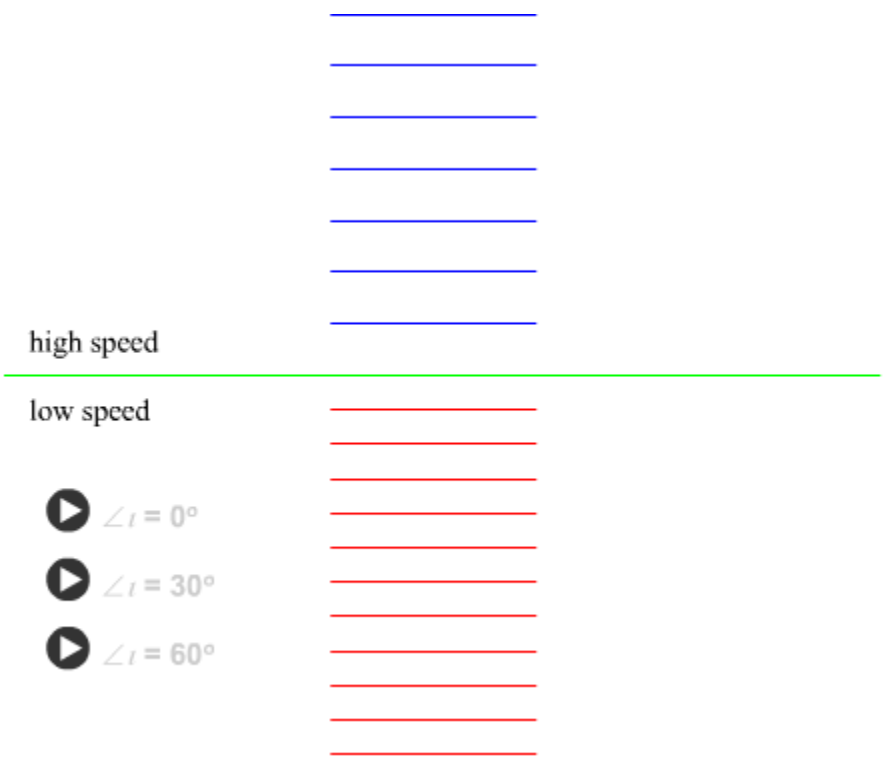
As light travels from a more dense medium to a less dense medium (ie. Speeds up)?

The ray bends away from the normal.



REFRACTION OF WAVES

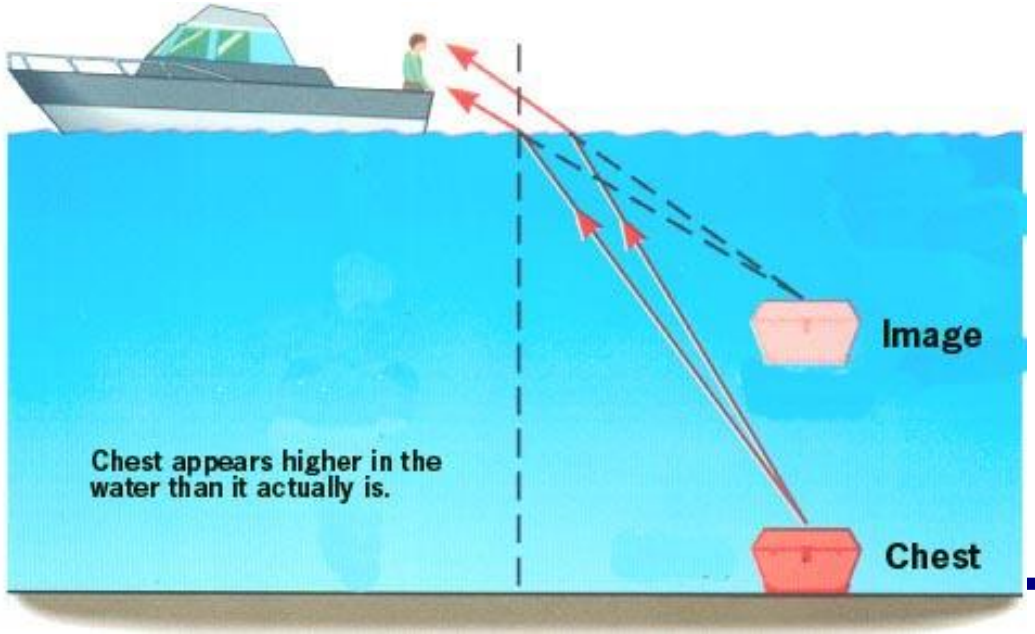
A wave doesn't just *stop* when it reaches the end of the medium. Notice both the speed and the wavelength decrease. It is also observed to change directions as it crosses the boundary separating the mediums. This bending of the path of light is known as refraction.



Why is the object not where you think it is?

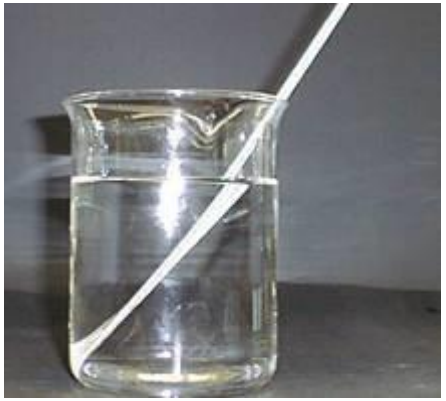
If the light travels through two different media before it reaches your eyes, it does not travel in a straight line.

The object is not where your brain thinks it is.



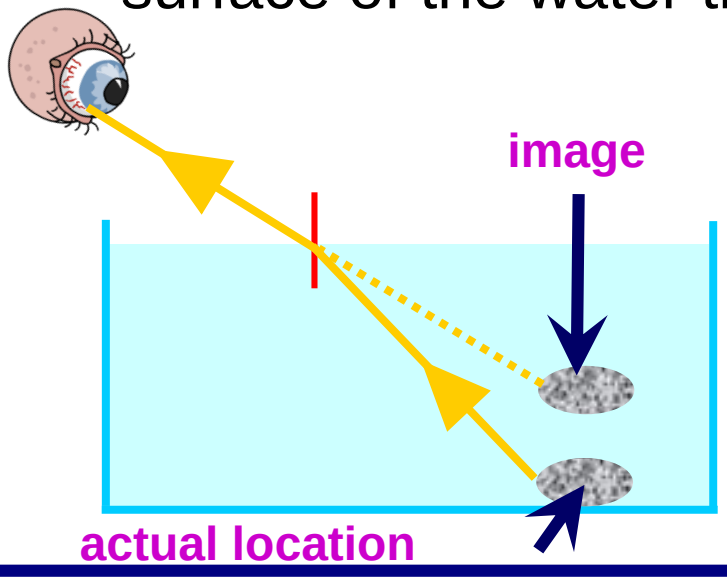
Effects of Refraction

Refraction causes visual effects such as this ruler appearing to be bent.



This happens because light from the part of the ruler in the water is refracted as it travels from the water into the air.

How does refraction make this stone look closer to the surface of the water than it really is?



Light rays from the stone are refracted as they leave the water.

The brain assumes that these rays have travelled in straight lines and is fooled into forming an image where it thinks the light rays came from.

Effects of Refraction – Seeing Fish In Water

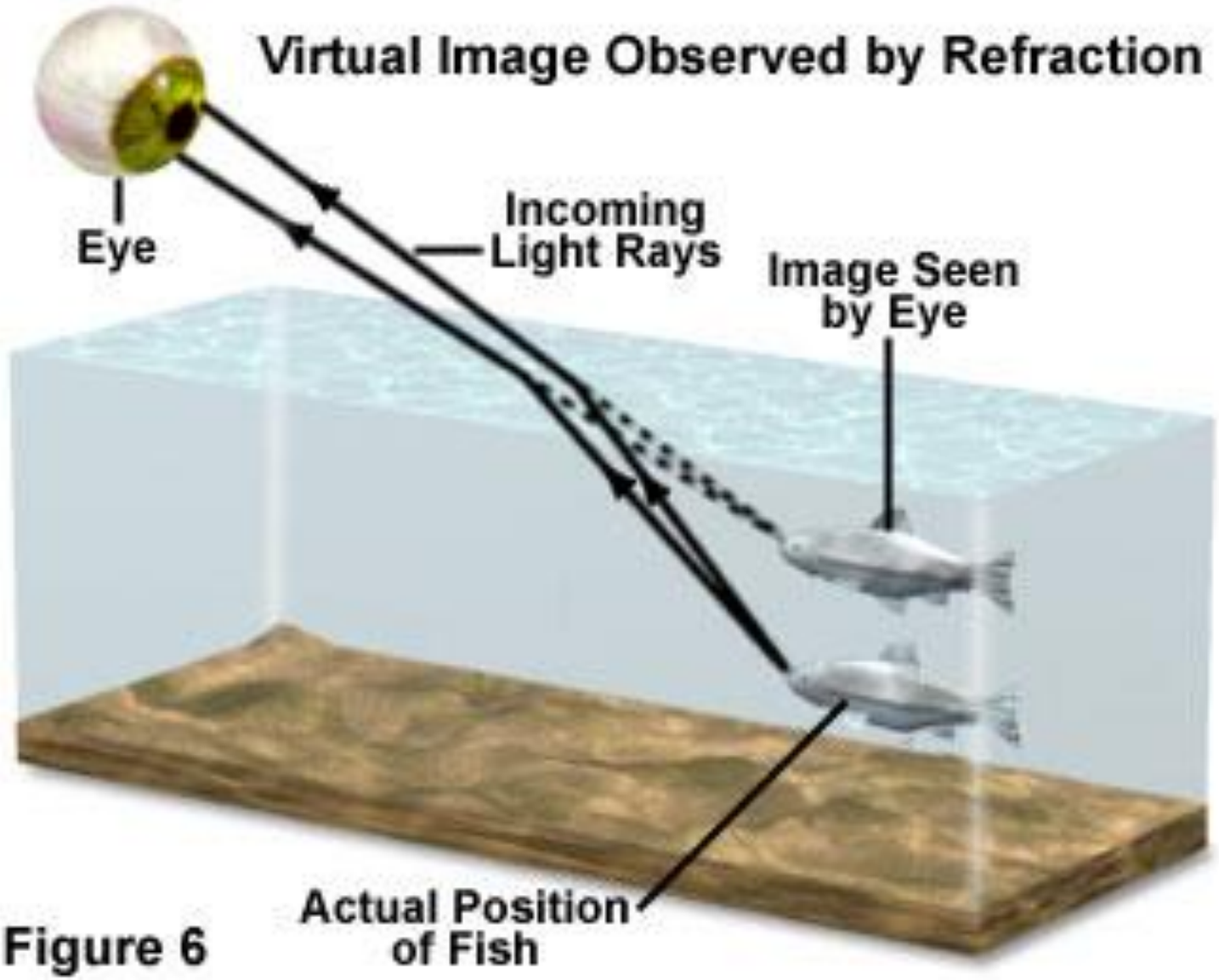


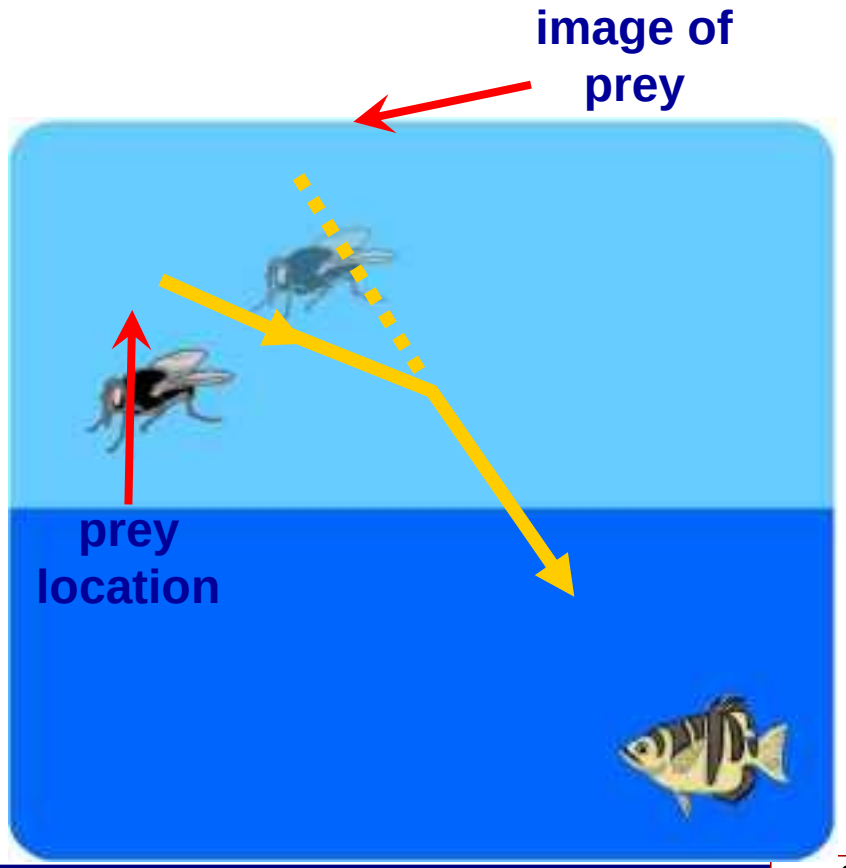
Figure 6

Effects of refraction – the Archer fish

The Archer fish is a predator that shoots jets of water at insects near the surface of the water, e.g. on a leaf.

The Archer fish allows for the refraction of light at the surface of the water when aiming at its prey.

The fish does not aim at the refracted image it sees but at a location where it knows the prey to be.



CORE LAB ACTIVITY 5-1D

"FOLLOW THAT REFRACTED RAY!"