********** LIGHT **********

I WHAT IS LIGHT?

A. Electromagnetic Wave:

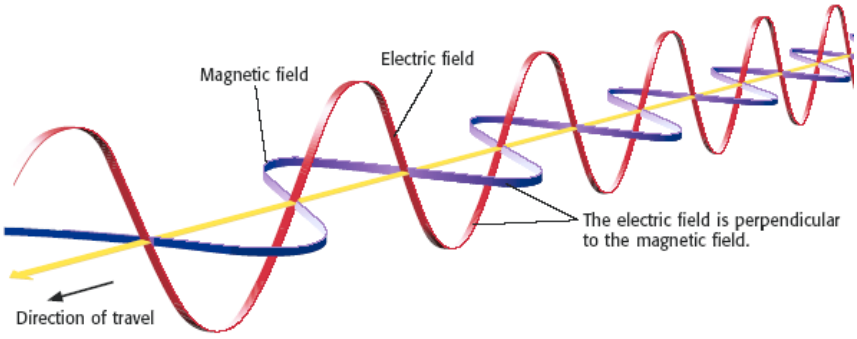
1. Can travel through empty space or matter.

2. Consists of changing electric and magnetic fields.

a) When a *charged* particle vibrates its electric field also vibrates.

b) That electric field creates a vibrating magnetic field.

c) When both the fields vibrate, an EM wave is produced.



3. The transfer of energy as electromagnetic waves is called radiation

B. Speed of Light:

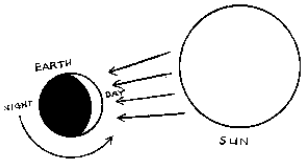
1. 186,000 miles / second

2. 300,000 km/ second or 300,000,000 m/s

3. Light could go around the earth 7.5 times in 1 second !

4. The sun is 93,000,000 miles from Earth.

a) It takes 8.3 minutes to get here.



II ELECTROMAGNETIC SPECTRUM:

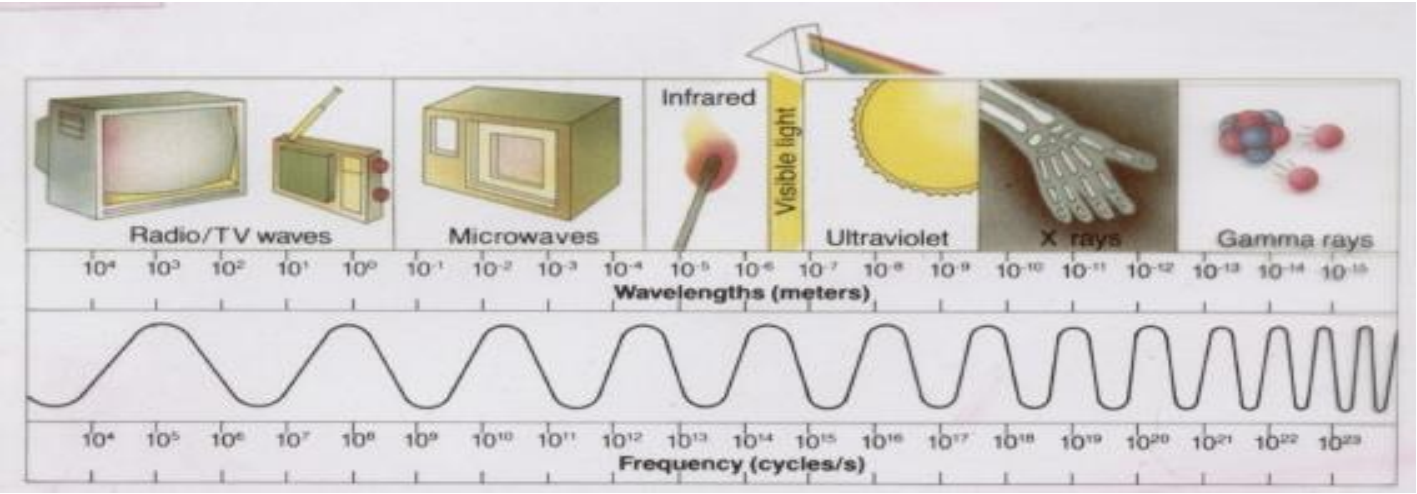
A. Speed of EM waves:

1. All EM waves travel at the same speed in a vacuum

2. They have different wavelengths and different frequencies.

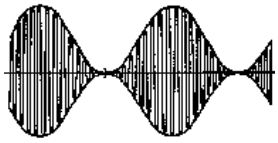
B. The Electromagnetic Spectrum:

1. It is divided into regions according to the wavelength



2. **Radio/TV waves**: (range from 1 millimeter to 100's of meters)

a) AM radio waves:



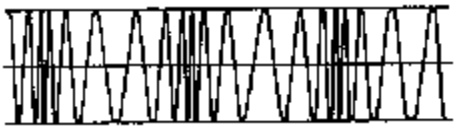
* AM stands for Amplitude Modulation

* 810 on the AM dial, receives signals at 810,000 Hz.

* have longer wavelengths than FM radio waves

* can bounce off the atmosphere & travel farther

b) FM radio waves:



* FM stands for Frequency Modulation

* 95.5 on the FM dial receives signals at 95500 Hz.

* less noise by electrical waves than AM stations

* music sounds better on FM stations

c) Television Signals: (carried by radio waves.)

* TV stations used shorter wavelengths and higher frequencies than radio stations.

* FM waves carry sound

* AM waves carry video

3. **Microwaves:** (range from 1 mm to 30 cm)

a) Uses: cell phones microwave ovens

b) Radar (Radio Detection And Ranging)

4. **Infrared Waves**: (range from 700 nanometers to 1 millimeter)

*1 nanometer = 0.000000001 m

a) Warm objects give off more infrared waves than cool ones.

b) Note: *Infra* means below

5. **Visible Light**: (range from 400 nanometers to 700 nanometers)

a) White light is all the colors combined.

b) Red: longest wavelength Violet: shortest wavelength

c) Red Orange Yellow Green

Blue Indigo Violet

6. **Ultraviolet Light:** (range from 60 nanometers to 400 nanometers)

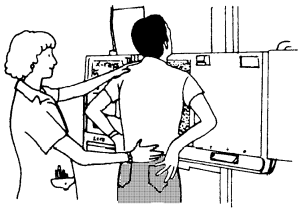
a) These waves have more energy than visible light.

b) Bad effects: skin cancer wrinkles eye damage

c) Good effects: kills bateria on food

helps skin produce Vitamin D

d) Remember: *Ultra* means beyond



7. **X rays:** (range from 0.001 nanometer to 60 nm)

a) Have enough energy to pass

through many materials.

b) Uses: medicine security

8. **Gamma rays**: (shorter than 0.1 nanometer !)

a) Can penetrate most materials very easily

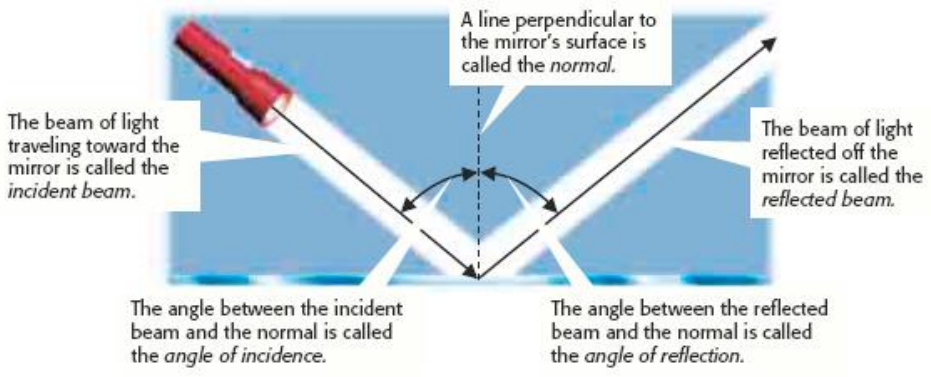
b) Can kill cancer cells, but also healthy cells.

III INTERACTIONS OF LIGHT WAVES:

A. REFLECTION:

1. Occurs when light waves bounce off an object.

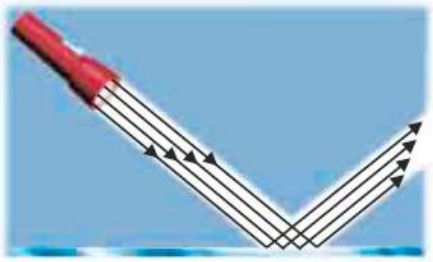
2. Law of Reflection:
   a) angle of incidence = angle of reflection



3. *Regular* reflection happens when…

   a) surfaces are smooth

   b) you can see an image



4. *Diffuse* reflection happens when…

   a) surfaces are rough

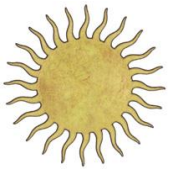
   b) Light is reflected at many different angles.

5. You see objects because they are…

   a) *Illuminated*: light reflects off of them

   b) *Luminous*: the object itself produces light





IV LIGHT AND COLOR:

A. Colors of Objects:

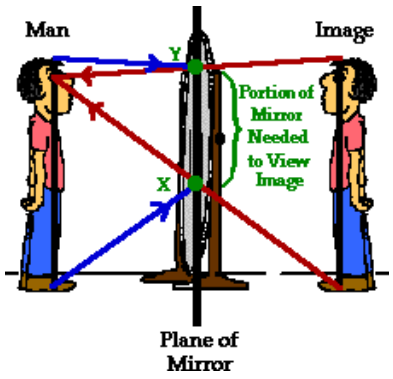
1. We see different wavelengths of light as different colors
   a) Long wavelengths are red Short ones are violet
2. A wave reflects off of an object & reaches our eyes.
3. This "light" is interpreted by the brain as color.
4. *Opaque* objects:
   a) When white light hits an opaque object, some colors are absorbed
   b) The only wavelengths that reach our eyes are the reflected ones.
   c) A red shirt reflects only red and absorbs the OYGBIV
   d) A green ball reflects only green and absorbs the others
   e) A white sail reflects all the colors
   f) A black dog absorbs all the colors
5. *Transparent* and *Translucent* objects:
   a) A blue bottle absorbs all the colors and only allows blue wavelength to pass through.

B. Mixing Colors :

1. Primary colors of light are: blue green red
   a) All these colors together make white
   b) This is called color addition.
2. Primary colors of paint are yellow cyan magneta
   a) When all three of these colors combine, you get black
   b) This is called color substraction.

V MIRRORS and REFLECTION:

A. Plane Mirrors:



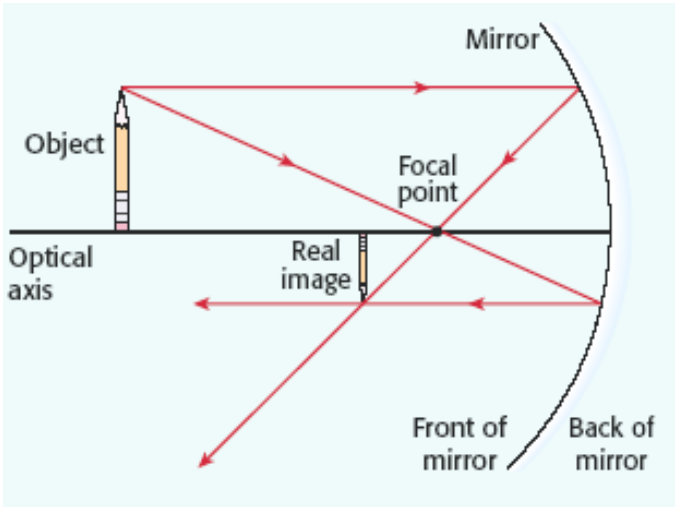
1. A mirror with a flat surface.
2. When you see the image in a plane mirror it is….

   reversed

   right side up

   same size, same distance from mirror
3. This image is a virtual image because light does not travel through it.

B. Concave Mirrors:



1. Curved inward
2. If the object is beyond.

   the focal point…..

   a) the image will be

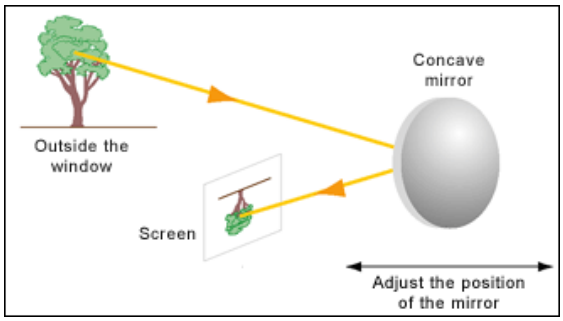
      upside down

      smaller

   b) This image is a real image…

      * light can pass through it.

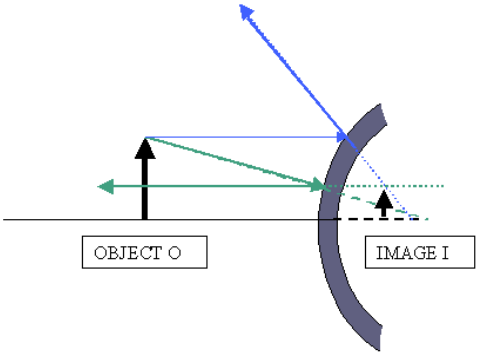
      *can be projected onto a screen



3. If a light source is placed at the focal point the light will be reflected out as a powerful beam…….. Used in headlights

   flashlights

C. Convex Mirrors:



1. Curved outward

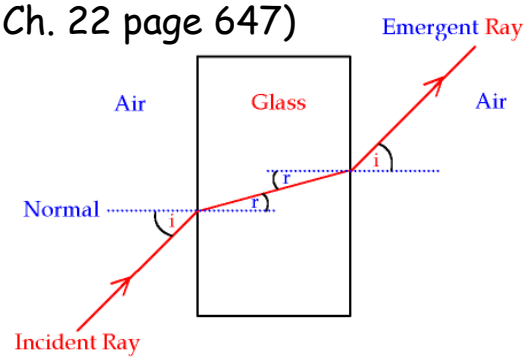
2. The image formed is

smaller

right side up and virtual

3. Uses: stores- security buses, hospitals

VI INTERACTIONS OF LIGHT WAVES (see Ch. 22 page 647)



A. REFRACTION:

1. The bending of a wave

as it passes at an angle

from one substance to another.

2. This happens because the speed of light depends on

the material that it is passing through.

3. The part of the wave that enters first begins

traveling at a different speed from the rest of the wave.

4. *Index of Refraction*: (how much the light bends)

a) the greater the change in light speed, the greater the index.

5. Refraction and Optical Illusions:

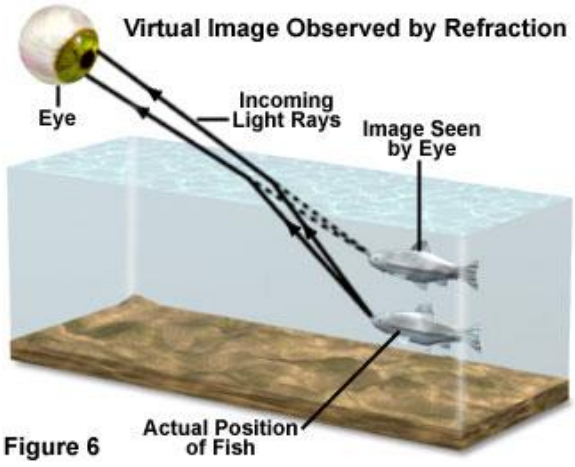
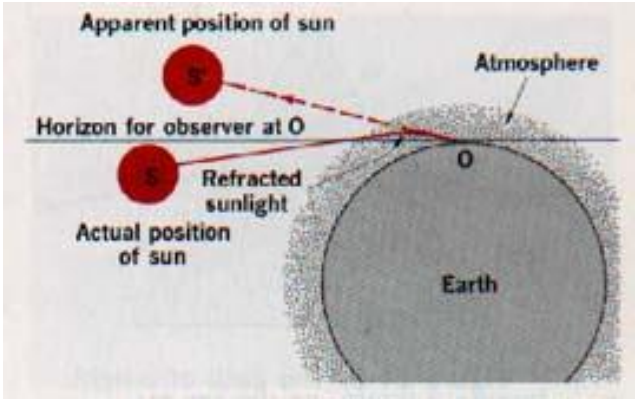


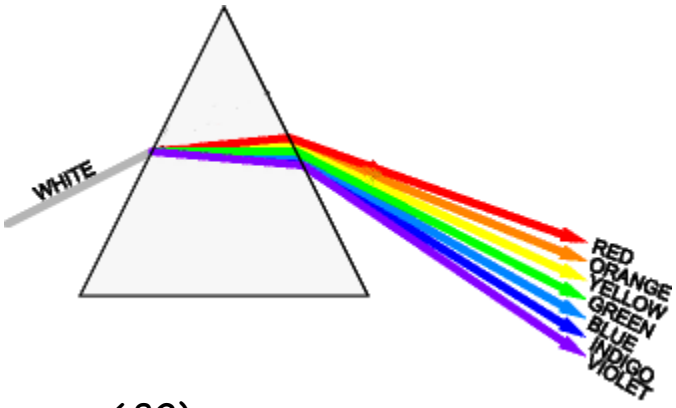
Figure 6



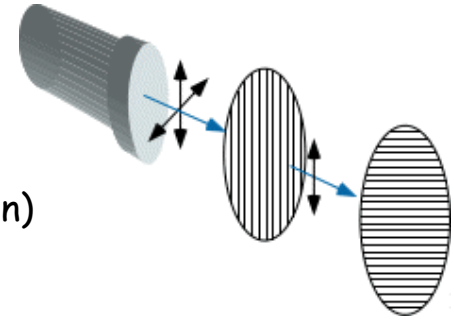
6. Refraction of White Light:

a) The shorterst wavelength bends the most (violet)

b) The longest wavelength bends the least (red)



C. POLARIZED LIGHT: (see Ch. 23 – page 682)



1. Light waves vibrate in all directions.

a) back and forth b) side to side

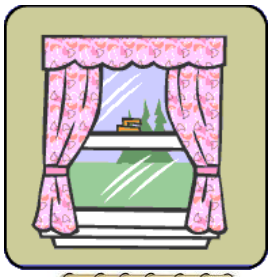
2. *Polarized* light vibrates in only one plane (direction)

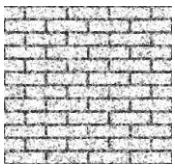
3. Light passes through a polarizing filter that has parallel slits.

4. Only the light waves that are vibrating in the same plane will pass through the filter.

5. Uses: a) sunglasses b) filters for cameras

D. LIGHT AND MATTER:





1. *Transparent*:

a) Light easily goes through it.

b) Examples: window glass water air

2. *Translucent*:

a) Allows light through it but scatters it.

b) Examples: shower curtain wax paper

3. *Opaque*:

a) Does not allow light to pass through it.

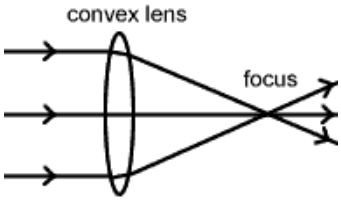
b) Examples: wood brick

VII LENSES: (A lens is a transparent object that refracts light)

A. Convex Lens:

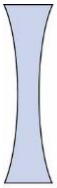
1. It is thicker in the middle than on the edges.
2. It forms an image that is.. (if the object is not close to the lens)

smaller upside down real



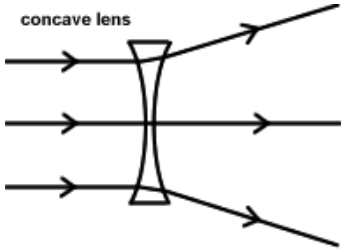
3. Used in eye glasses for farsighted people.
4. If the object is close to the lens, it can be used to magnify

B. Concave Lens:



1. It is thinner in the middle than at the edges.
2. It forms an image that is…..

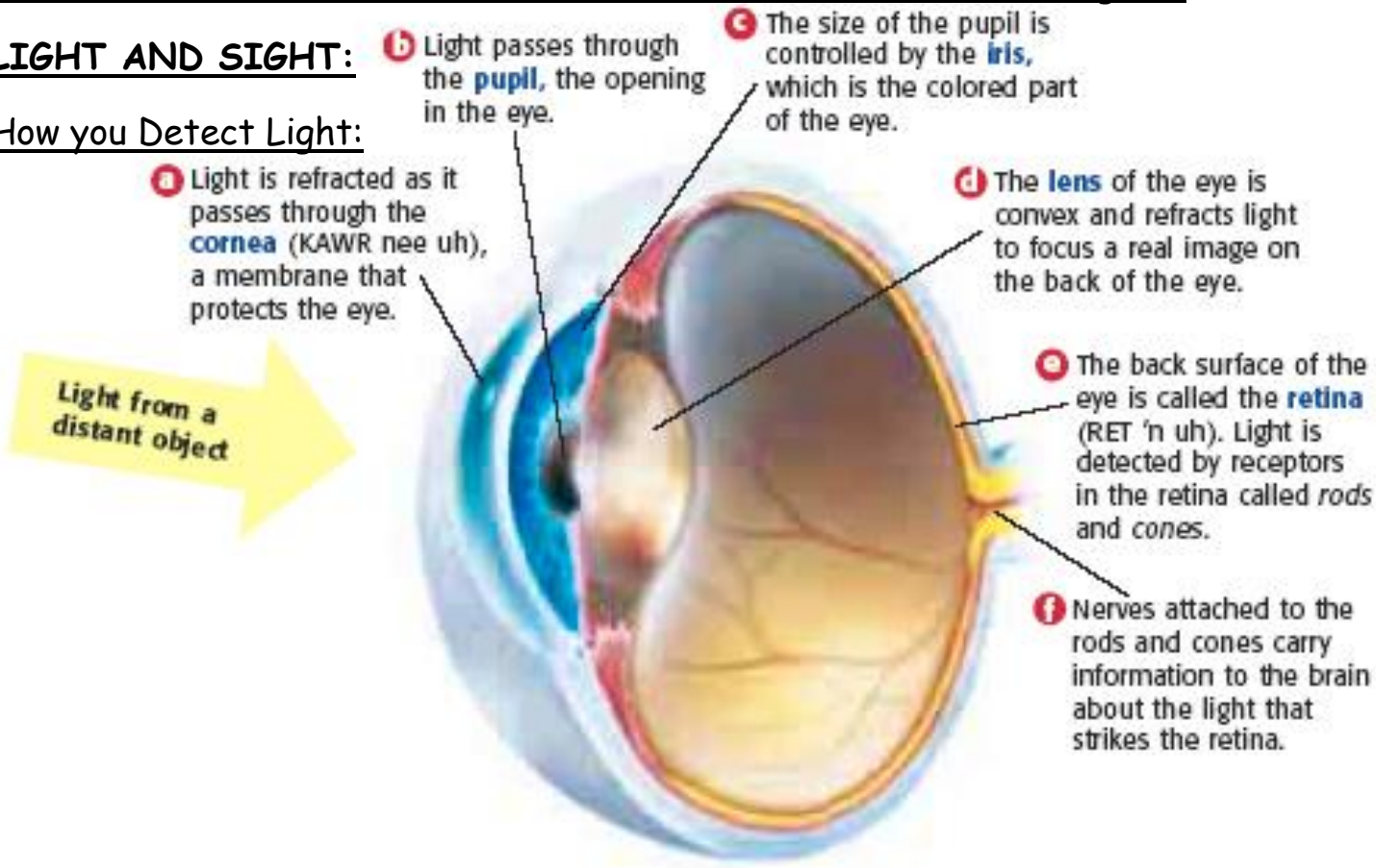
Right side up smaller virtual



3. Used in eye glasses for nearsighted people.

VII LIGHT AND SIGHT:

A. How you Detect Light:



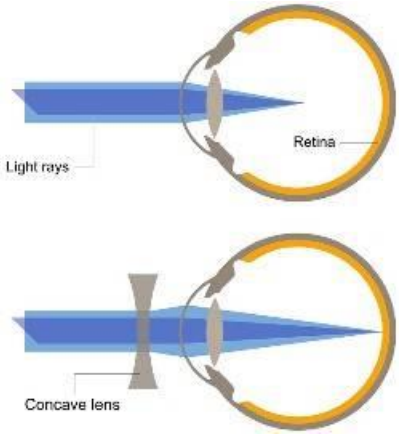
B Vision Problems:

1. Nearsightedness:

   a) When a person's eyeball is too long.

   b) Can only see objects clearly if near by.

   c) concave lens focuses image on retina.



2. Farsightedness:

   a) When a person's eyeball is too short

   b) Can only see objects clearly if far away

   c) convex lens focuses image on retina