

PHY132 Introduction to Physics II

Class 6 – **Outline:**

- Ch. 23, sections 23.1-23.5
- Reflection
- Refraction
- Total Internal Reflection
- Image Formation
- Colour and Dispersion



<http://physics.tutorvista.com/light/index-of-refraction.html>

Where to get help

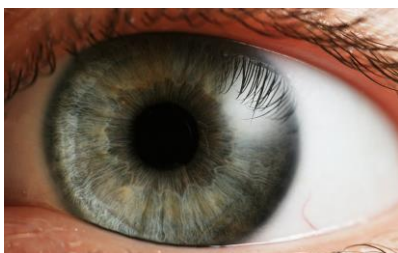
- **Your classmates:** go on Piazza.com, form a study group, hang out in MP125, etc
- **Your two graduate student TAs.** Learn their email address, office hours, and office location.
- **Me.** After class + MP121B office hours are T12, F10, email [Note I am away Friday Jan.23]
- **Professor Meyertholen**, MP129A office hours are M2, F11-12
- The Physics **Drop-In Centre** in MP125, back corner MTWR 12-3, F11-2
- **Academic Success Centre** in Koffler 1st floor, inside the Career Centre

Announcement

- Test 1 is Tuesday Jan. 27th from 6:00-7:30pm.
- Room To Be Announced
- If you have a conflict with the above time, the **alternate sitting** will be from 4:30-6:00pm on Tuesday Jan. 27th
 - To register, students should submit the Alternate Sitting Registration Form, available now in the PHY132S Portal course menu.
 - The location will be emailed no later than Jan. 26 to the people who have registered.
 - You have until Jan. 22 at 4:00pm to do it (the form will not be available after).

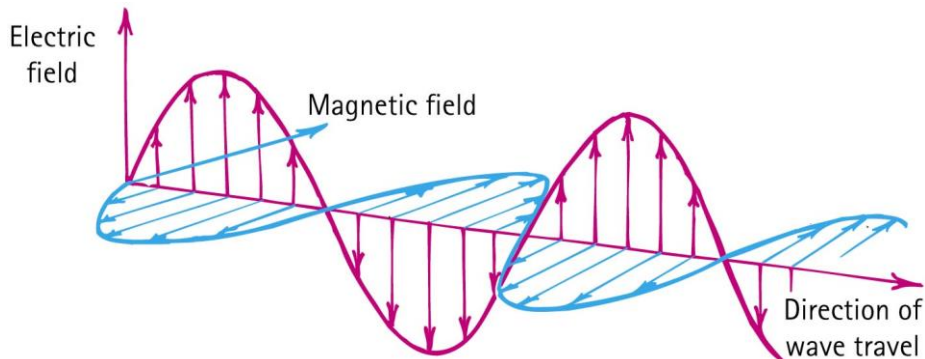
- What is light?

- Light is an electromagnetic wave – and is highly useful in our everyday life!



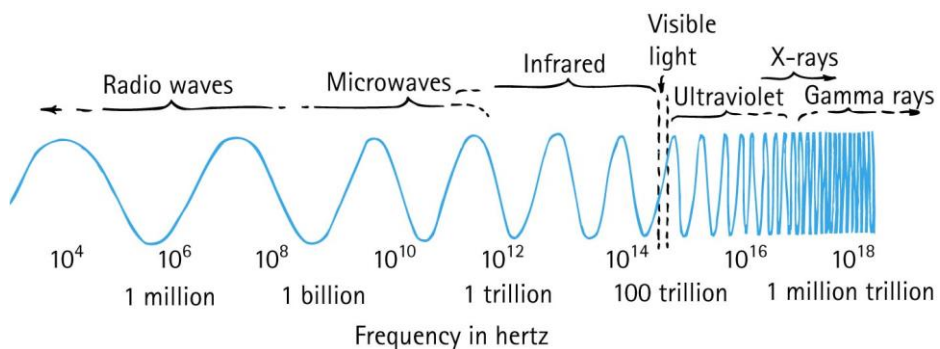
Electromagnetic Waves

The electric and magnetic fields of an electromagnetic wave are perpendicular to each other and to the direction of motion of the wave.



Electromagnetic Spectrum

- In a vacuum, all electromagnetic waves move at the same speed
- We classify electromagnetic waves according to their frequency (or wavelength)
- Light is one kind of electromagnetic wave



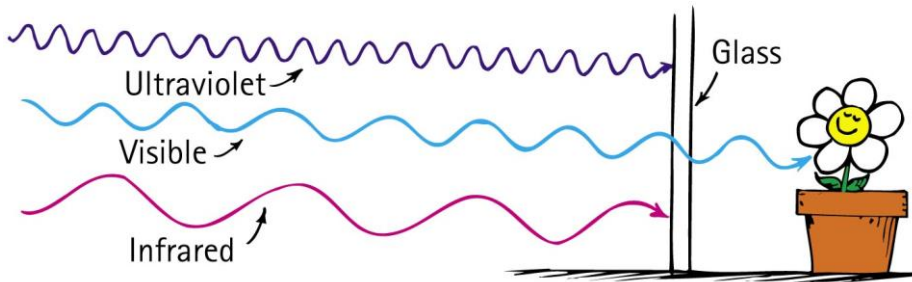
Electromagnetic Waves CHECK YOUR NEIGHBOUR

If a certain material is “transparent” (ie, not opaque), what does this mean?

- A. Electromagnetic waves of all frequencies can pass straight through it
- B. Electromagnetic waves of all frequencies are reflected from its surface
- C. Electromagnetic waves of all frequencies are absorbed throughout its volume
- D. Electromagnetic waves of a certain frequency can pass straight through it

Transparent Materials

Glass blocks both infrared and ultraviolet, but it is transparent to visible light.



Opaque Materials

- Most things around us are **opaque**—they absorb light without re-emitting it.
- Vibrations given by light to their atoms and molecules are turned into random kinetic energy—into internal energy.
- These materials become slightly warmer.



Opaque Materials

Metals

- Light shining on metal forces free electrons in the metal into vibrations that emit their own light as reflection.



Reflection
CHECK YOUR NEIGHBOUR

Which reflects more light, a white piece of paper or a black piece of paper?

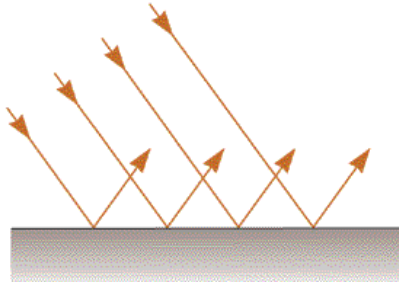
- A. Black
- B. White
- C. About the same

Reflection
CHECK YOUR NEIGHBOUR

Which reflects more light, a white piece of paper or a mirror?

- A. White Paper
- B. Mirror
- C. About the same

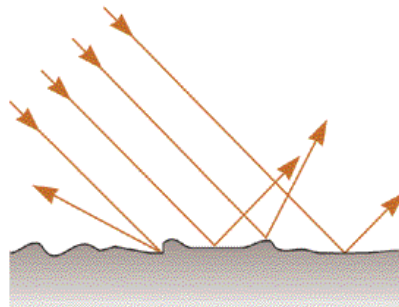
Specular Reflection



Mirrors

- The surface is *flat* at distance scales near or above the wavelength of light
- It looks “shiny”, and you can see images in it.

Diffuse Reflection

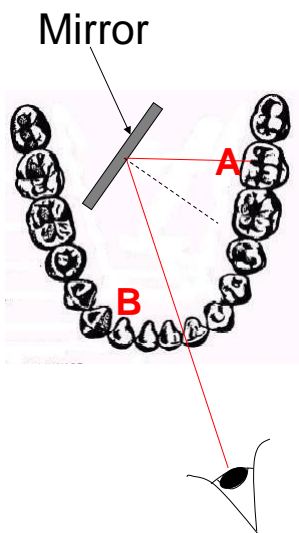
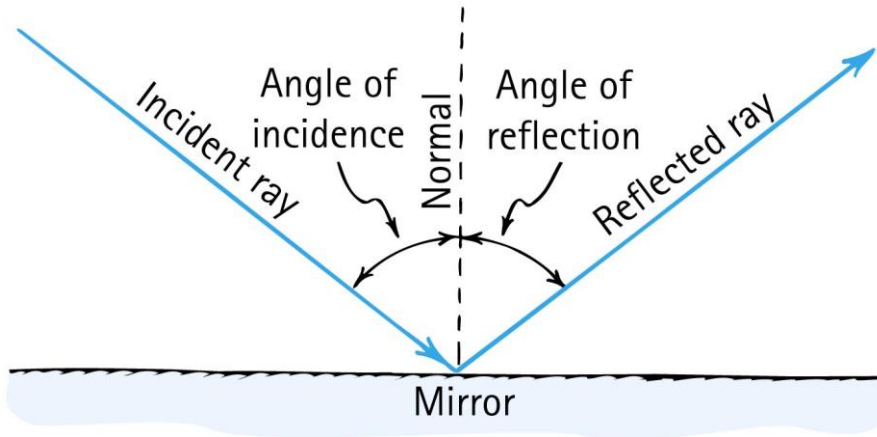


White Paper

- The surface is *rough* at distance scales near or above the wavelength of light
- Almost ***all*** surfaces reflect in this way!

Law of Specular Reflection

The angle of reflection equals the angle of incidence.

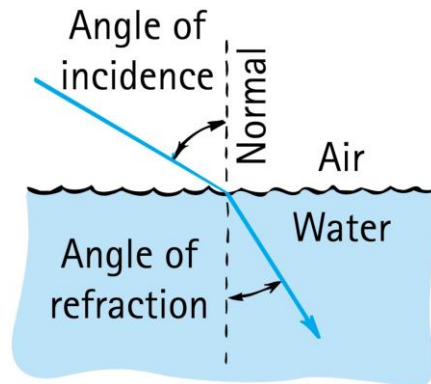


- A dentist uses a mirror to look at the back of a second molar (A).
- Next, she wishes to look at the back of a lateral incisor (B), which is 90° away.
- By what angle should she rotate her mirror?

- A. 90°
- B. 45°
- C. 180°

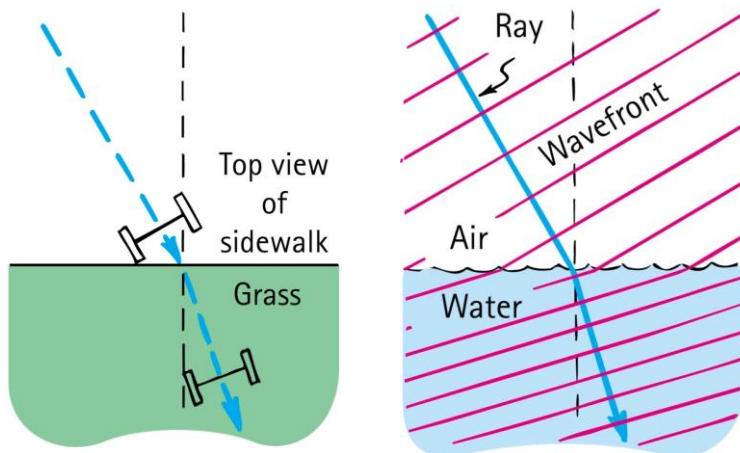
Refraction

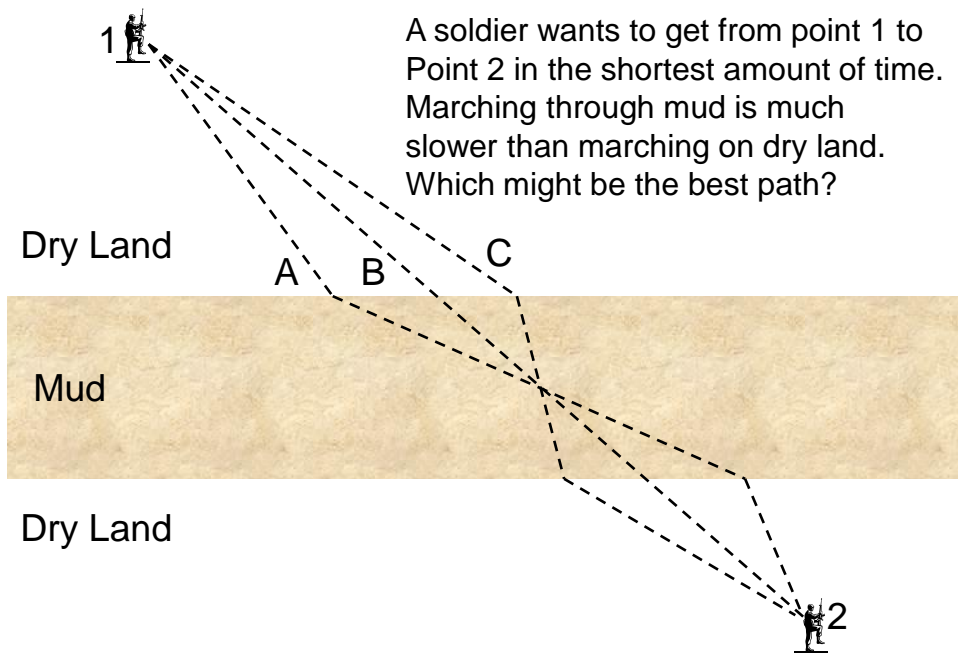
When light bends in going obliquely from one medium to another, we call this process refraction.



Cause of Refraction

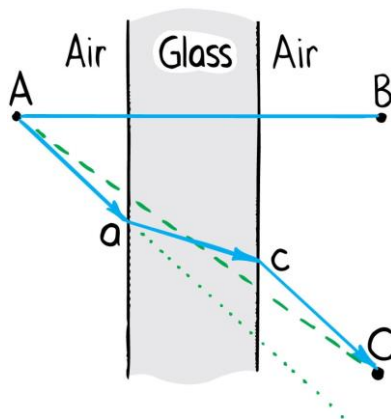
- Bending of light when it passes from one medium to another
- Caused by change in speed of light





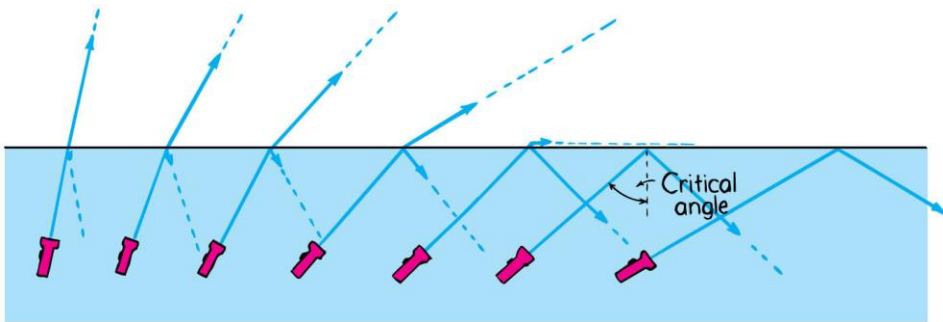
Refraction

Light travels slower in glass than in air, so it minimizes the time it spends in the glass.

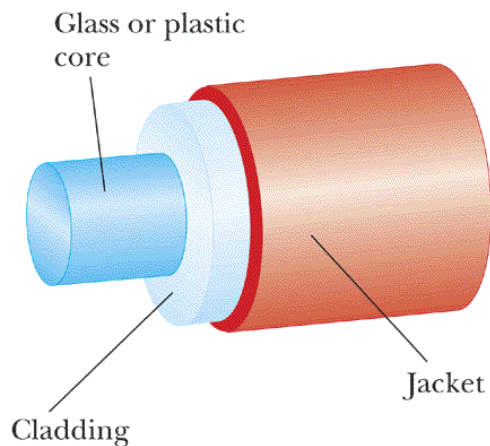


Total Internal Reflection

- Total reflection of light traveling within a medium that strikes the boundary of another medium at an angle at, or greater than, the critical angle



An Optical Fibre



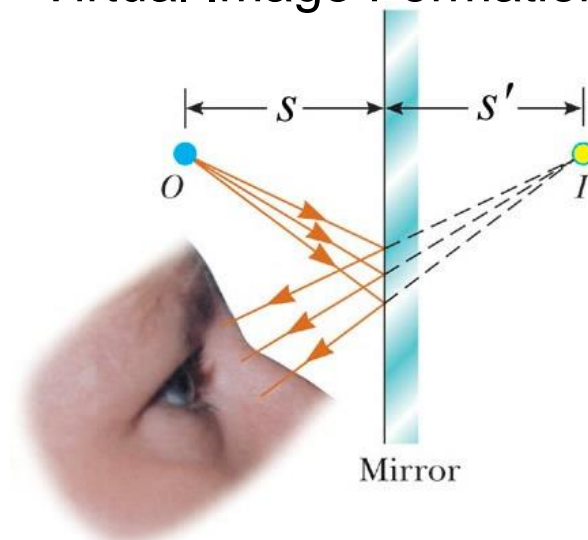
Speed of light in cladding is *higher* than speed of light in core.

Medical Fibrescopes



Video-laryngoscopy with a flexible fiberoptic laryngoscope

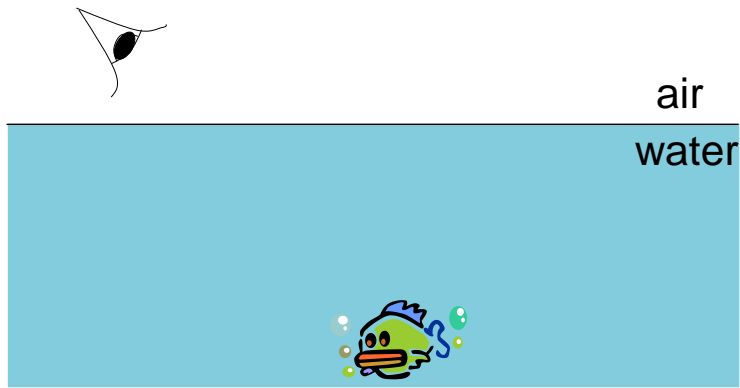
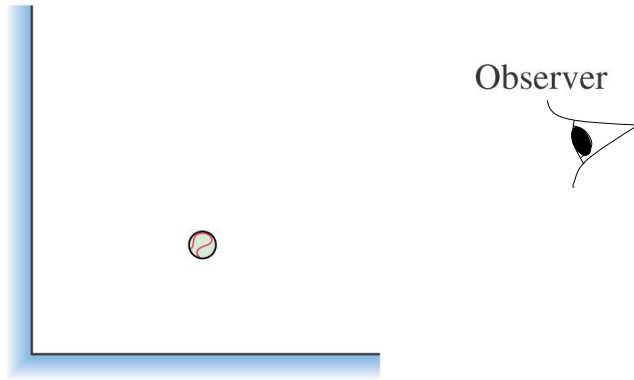
Virtual Image Formation



No light rays actually pass through or even near the image, so it is “virtual”.

Two plane mirrors form a right angle.
How many images of the ball can the
observer see in the mirrors?

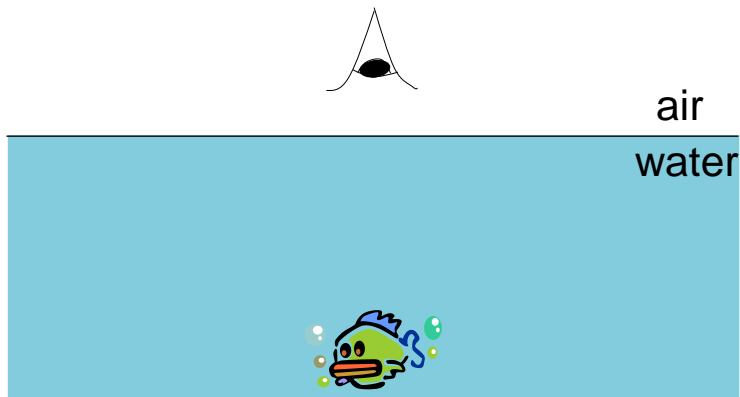
- A. 1
- B. 2
- C. 3
- D. 4



A fish swims below the surface of the water.

An observer sees the fish at:

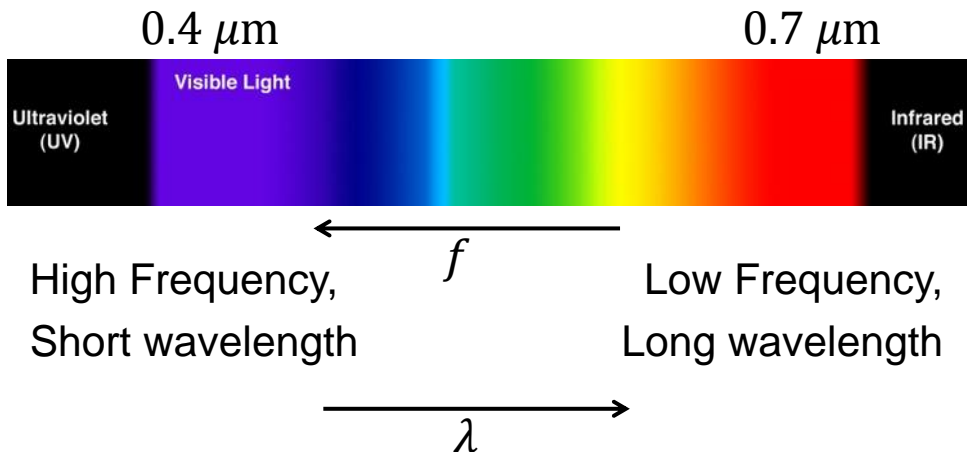
- A. a greater depth than it really is.
- B. its true depth.
- C. a smaller depth than it really is.



- A fish swims *directly* below the surface of the water. An observer sees the fish at:
- A. a greater depth than it really is.
 - B. its true depth.
 - C. a smaller depth than it really is.

Color

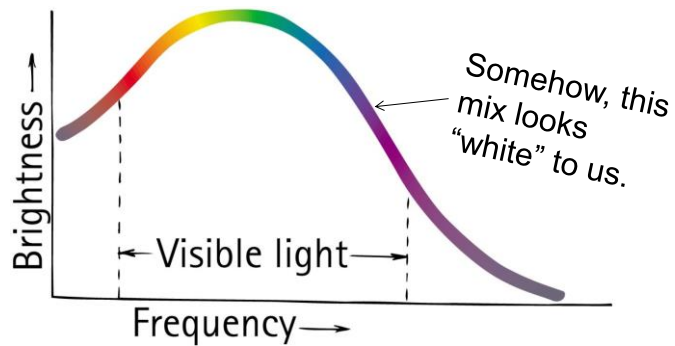
Color we see depends on frequency of light.



Mixing Colored Light

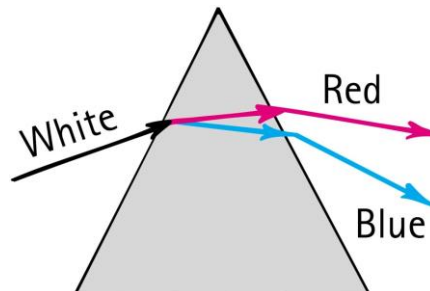


The spectrum of sunlight is a graph of brightness versus frequency.



Dispersion

- Process of separation of light into colors arranged by frequency

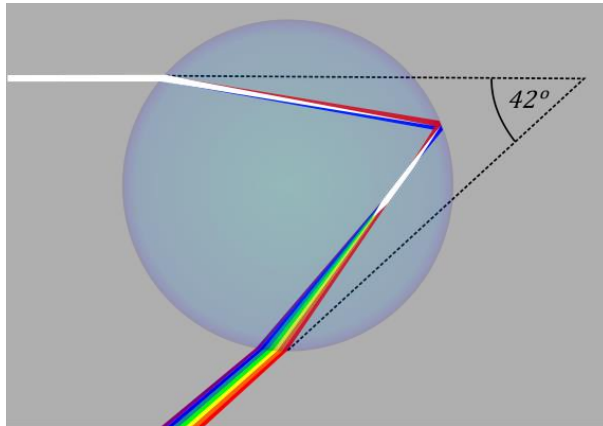


- Components of white light are dispersed in a prism (and in a diffraction grating).

Rainbows

Rainbows are a result of dispersion by many drops.

- Dispersion of light by a single drop



Rainbows

Radius of circle is about 41°

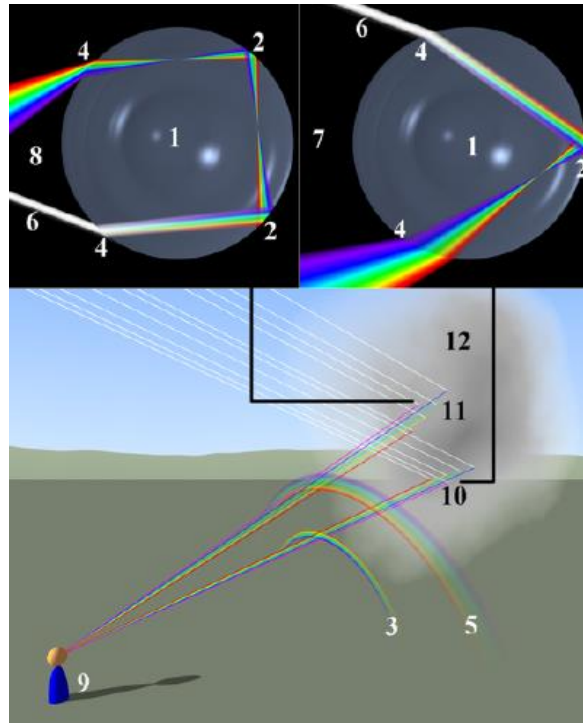
Antisun
(180° away from
actual sun)



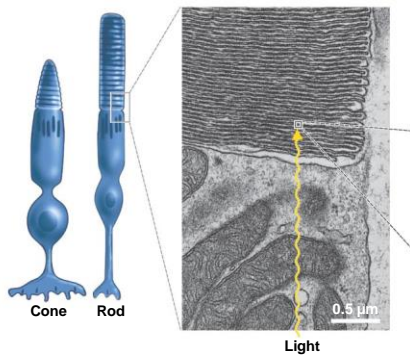
Image by Bitu Janzadah. ©2014. https://fbedn-sphotos-g-a.akamaihd.net/photos-akash2/s720x720/560575_10151053440411899_1380323186_n.jpg

Double-rainbow

The second rainbow has blue on the top, and a radius of about 53°



(a) Rods and cones contain stacks of membranes.



Slide courtesy of Ross Koning, Biology Department, Eastern Connecticut State University
<http://plantphys.info/sciencematters/vision.ppt>

Stare at the
dot on the
nose for 15
seconds.



What do you see on this blank white slide? Blink if needed!

This is called an “after image”
Does it move around as you move your gaze?

Before Class 7 on Monday

- Please read Knight Pgs. 670-686: Ch. 23, sections 23.6-23.8
- Don't forget Problem Set 2 due on Sunday night!
- Something to think about: What is the difference between a converging and diverging lens? Which type can be used to focus sunlight onto a piece of paper and burn a hole?

