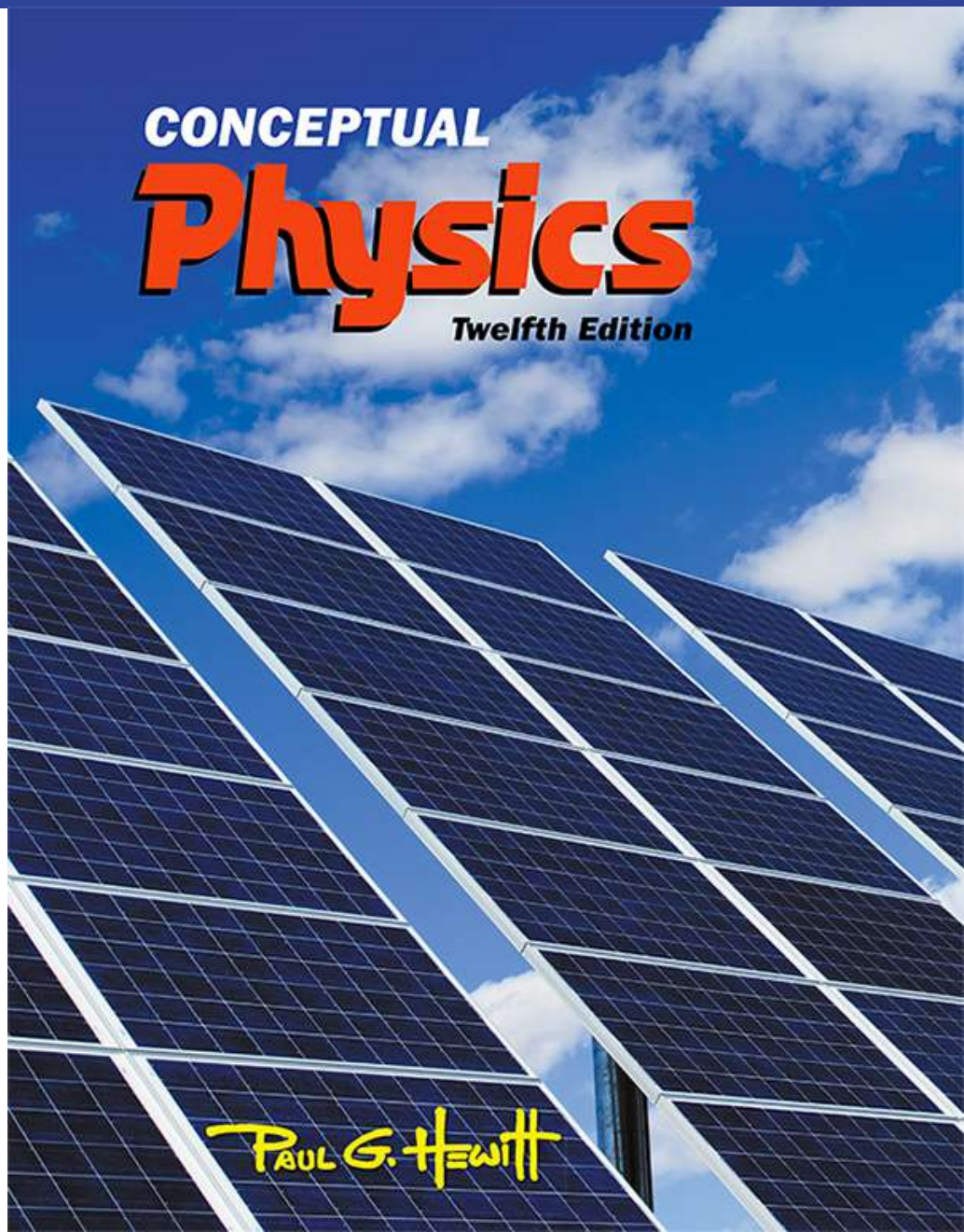
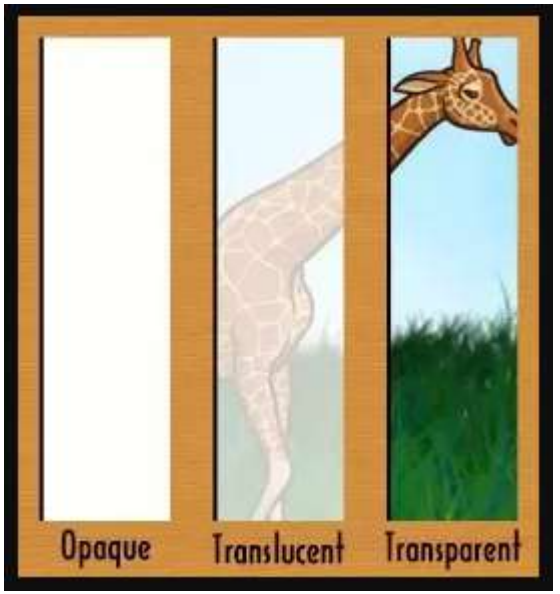
Lecture Outline

Chapter 26: Properties of Light



Opaque Materials

- Most things around us are **opaque**—they absorb light without re-emitting it.
  - Books, desks, chairs, and people are opaque.



- Vibrations given by light to their atoms and molecules are turned into random kinetic energy—into internal energy.
  - These materials become slightly warmer.

Classwork: answer now. turn in later.

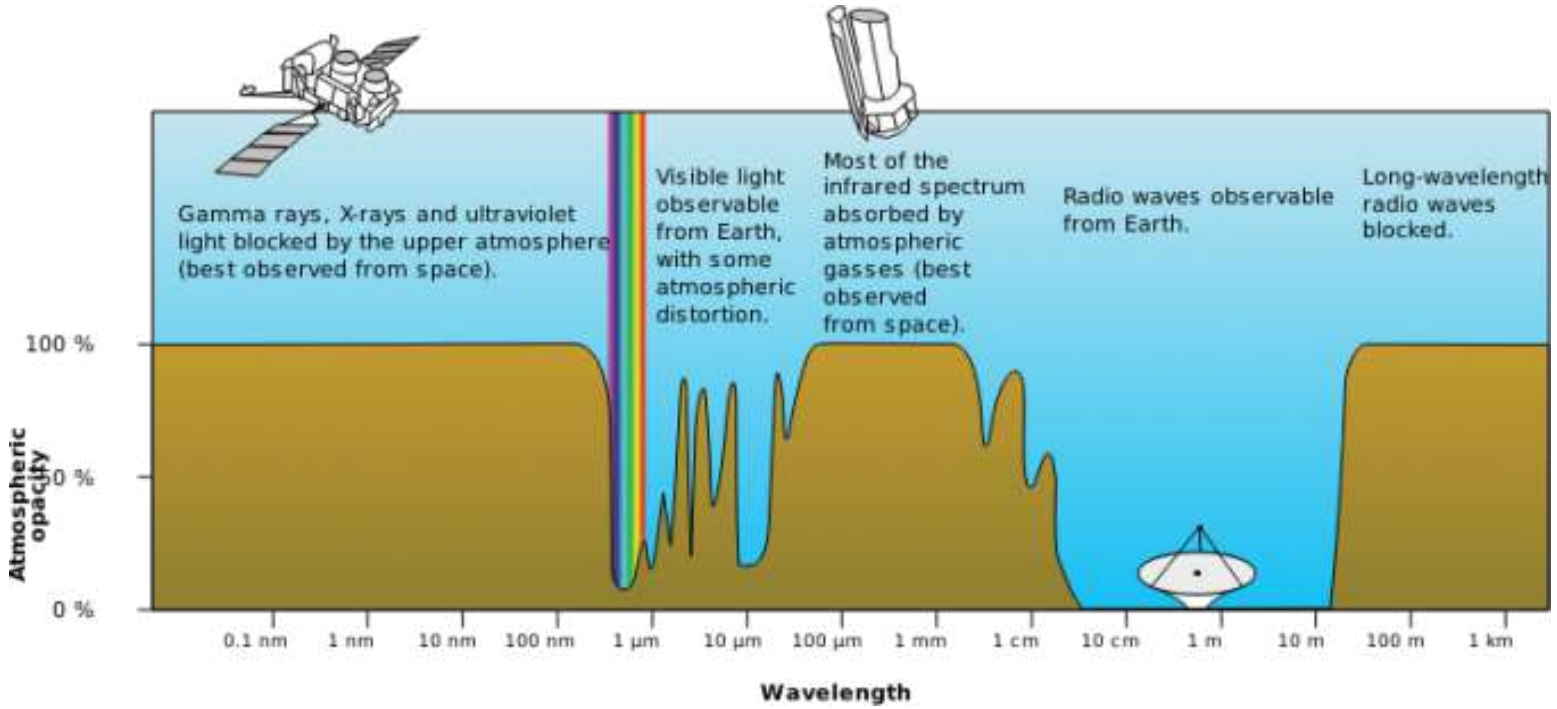
23. Why do opaque materials become warmer when light shines on them?

Opaque Materials, Continued

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

Classwork: answer now. turn in later.

24. Why are metals shiny?



Our atmosphere is *transparent* to:

visible light and many radio waves,

and some IR & microwave

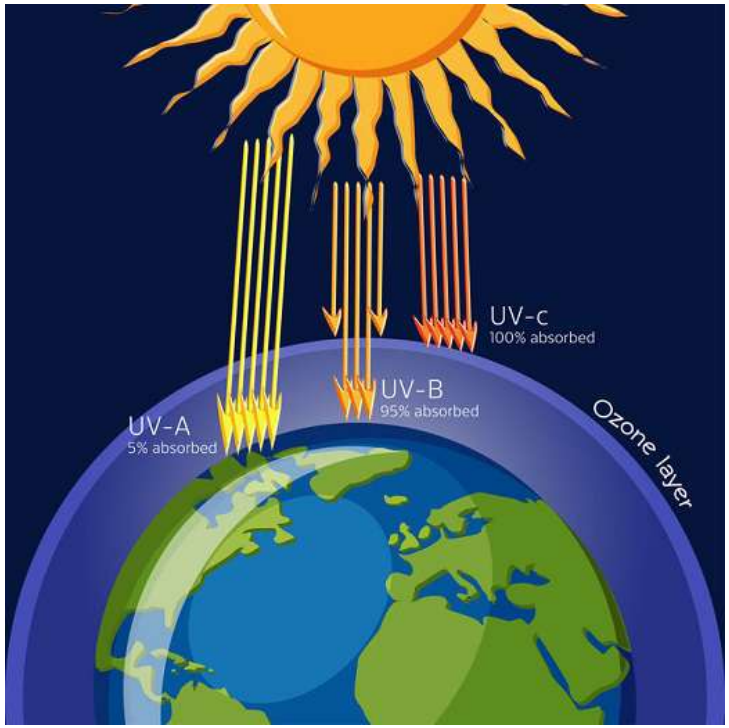
These are called “windows.”

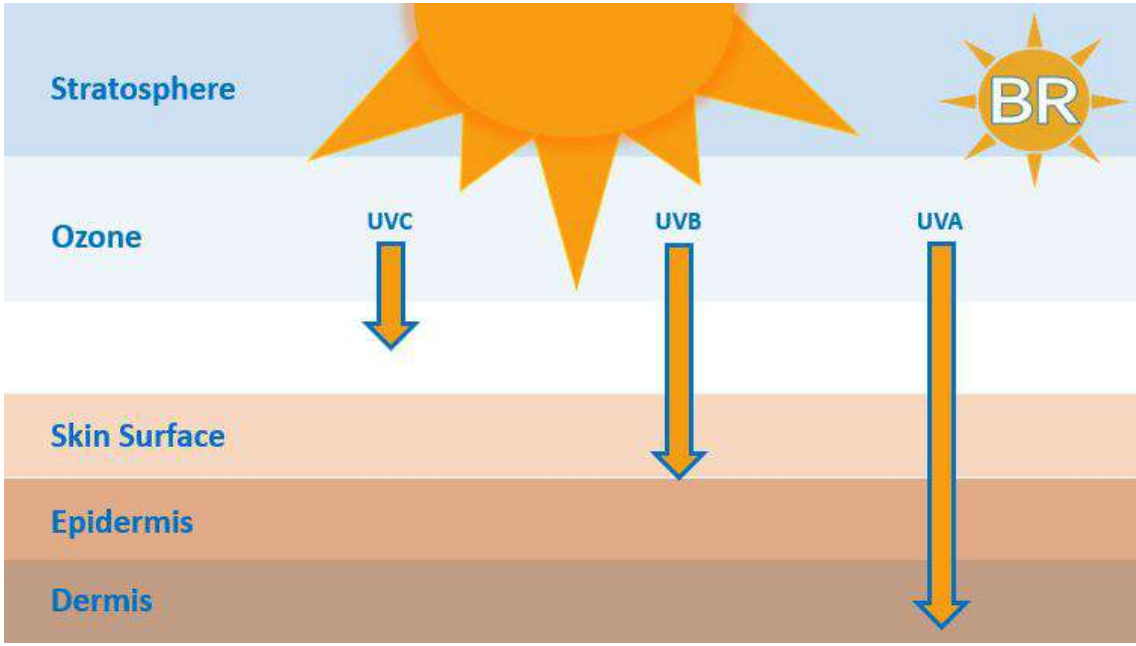
It is *opaque* to gamma rays, x-rays and most UV

UV is a complicated story:

Lower frequency UV is absorbed.

Clouds pass some UV: sunburn on a cloudy day

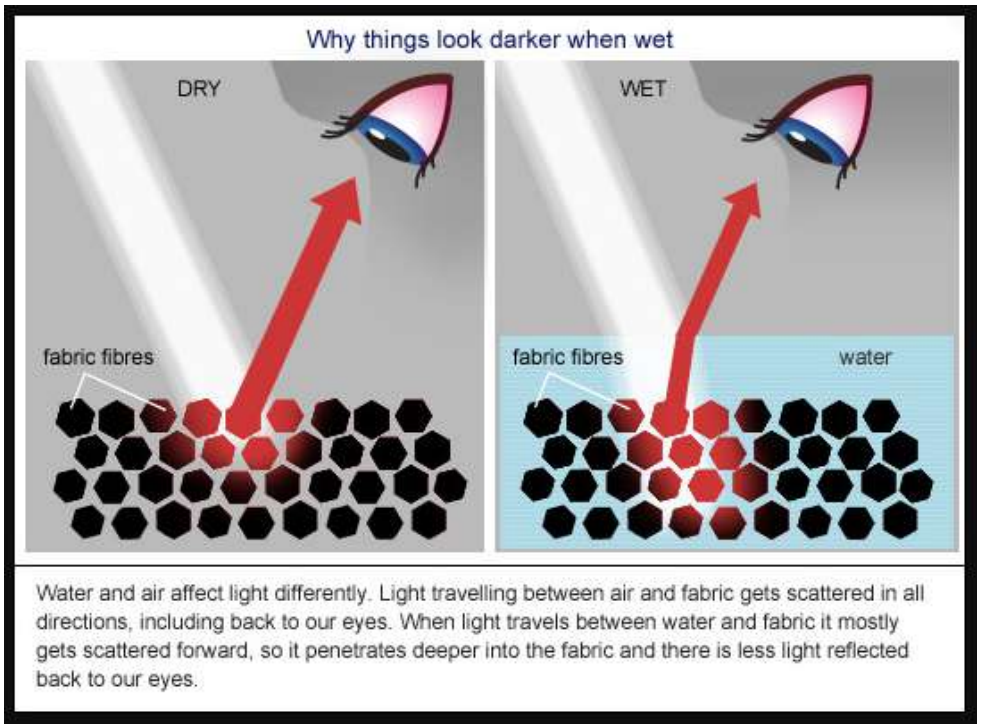




UV travels more deeply into lighter skin.

Getting a tan protects you.

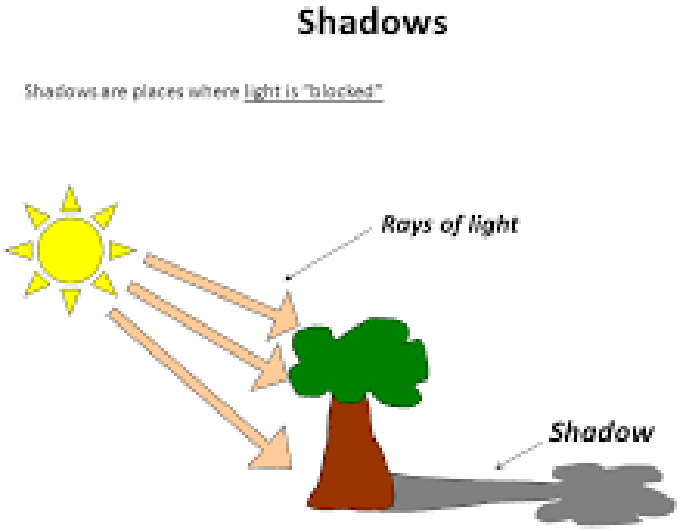
- Light incident on
  - dry surfaces bounces directly to your eye.
  - wet surfaces bounces inside the transparent wet region, absorbing energy with each bounce, and reaches your eye darker than from a dry surface.

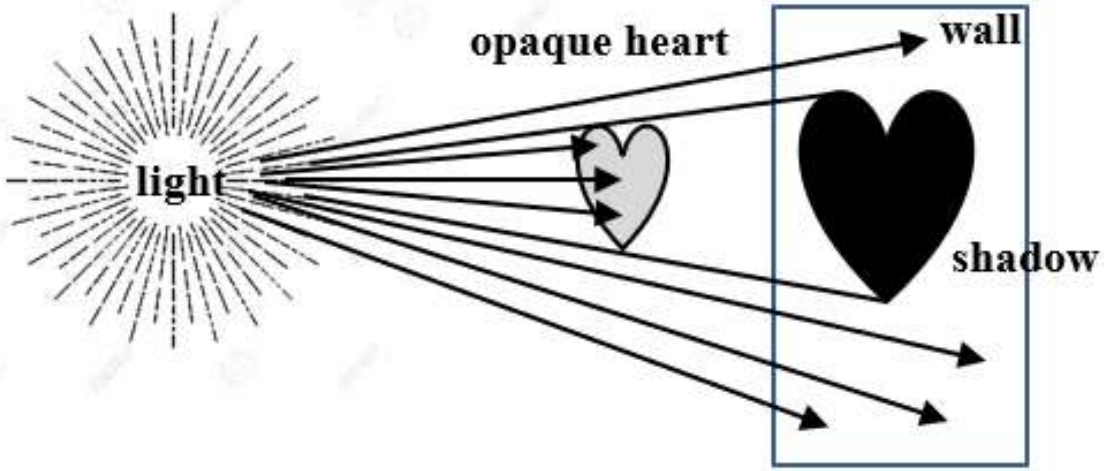


Classwork: answer now. turn in later.

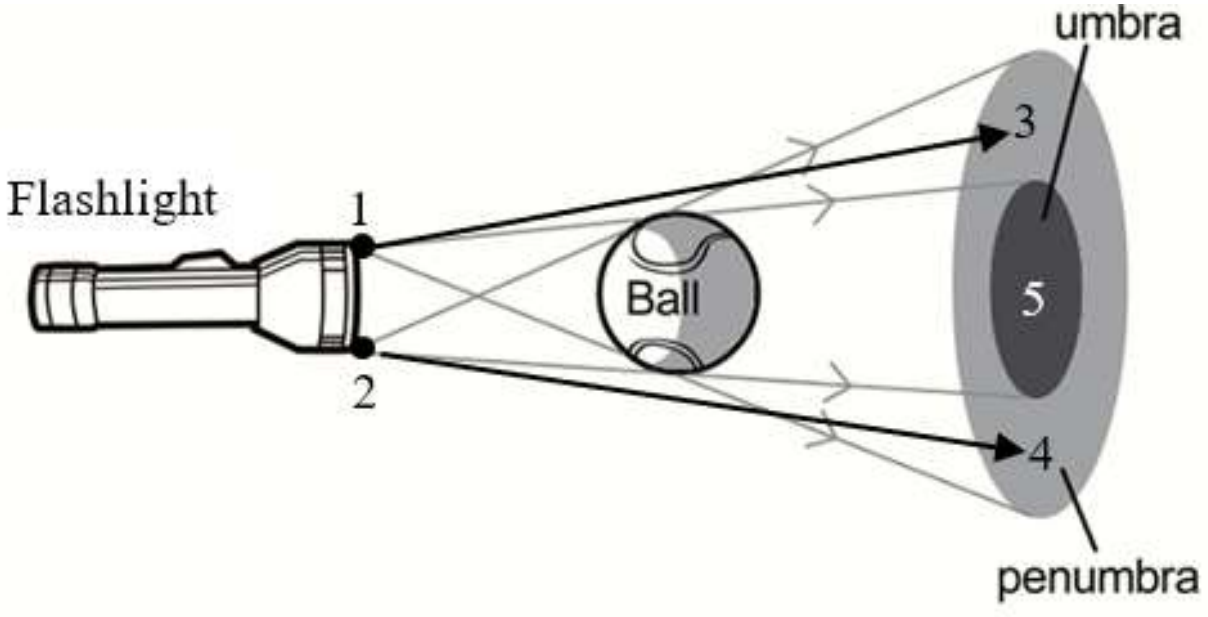
25. Why do wet objects normally look darker than the same objects when dry?

- Shadows
  - A thin beam of light is often called a *ray*.
  - When we stand in the sunlight, some of the light is stopped while other rays continue in a straight-line path.
  - We cast a **shadow**—a region where light rays do not reach.





- Either a large, far-away light source or a small, nearby light source will produce a sharp shadow.
- A large, nearby light source produces a somewhat blurry shadow.



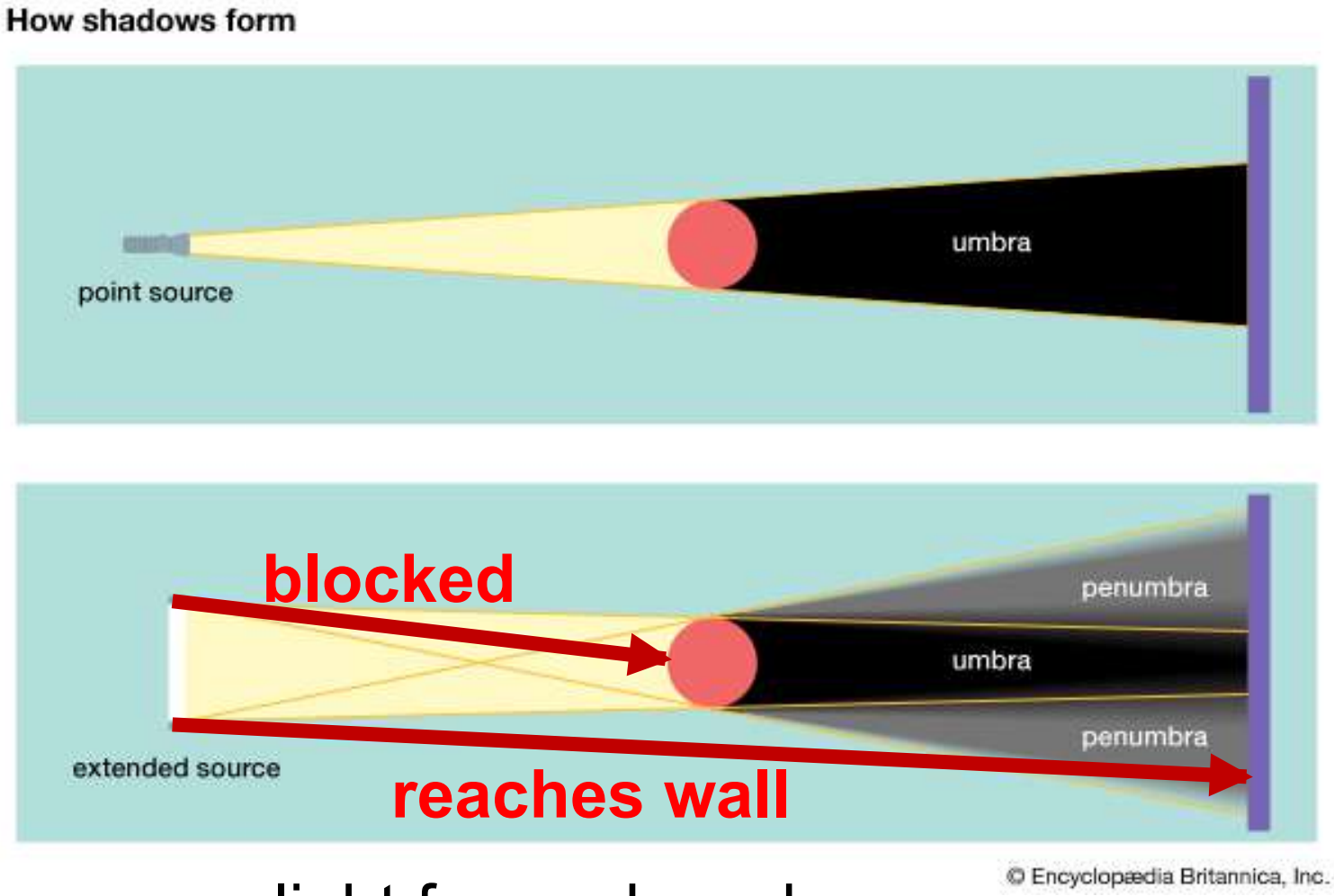
= total shadow

No light reaches point 5

= partial shadow

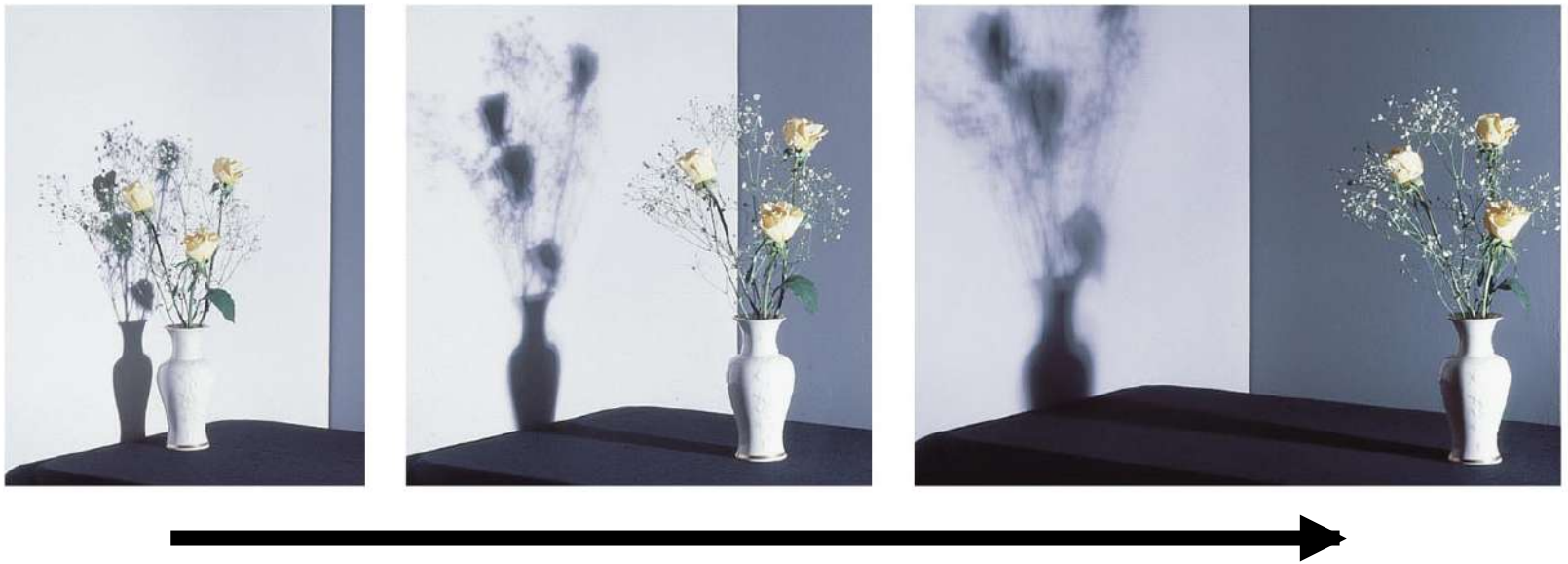
Some, not all light reaches 3 and 4

Point (small) source vs. a broad source:



- light from a broad source is only partially blocked.

- Umbra = total shadow because no light reaches there
- = dark part on the inside
- Penumbra = partial shadow,
- = some light reaches there and “fills it in”
- = lighter part around the edges of an umbra

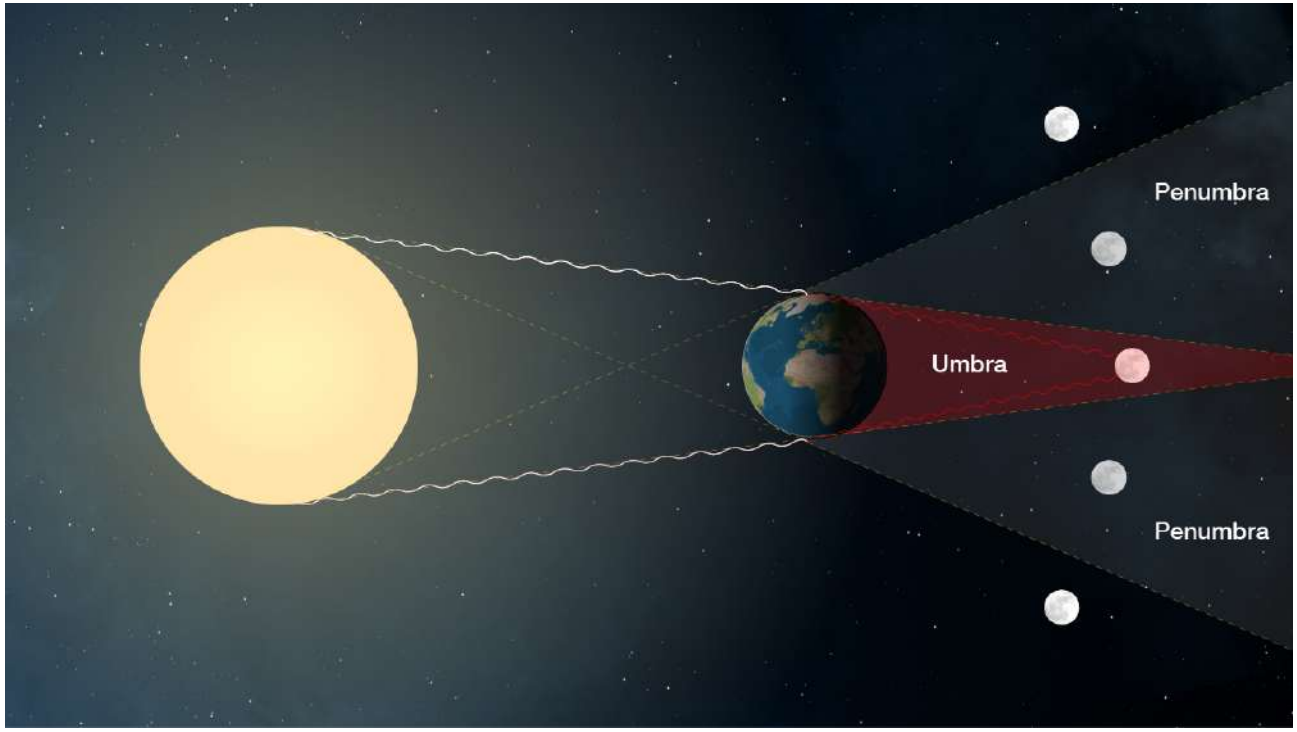


As the vase is moved towards light source, the penumbra grows.

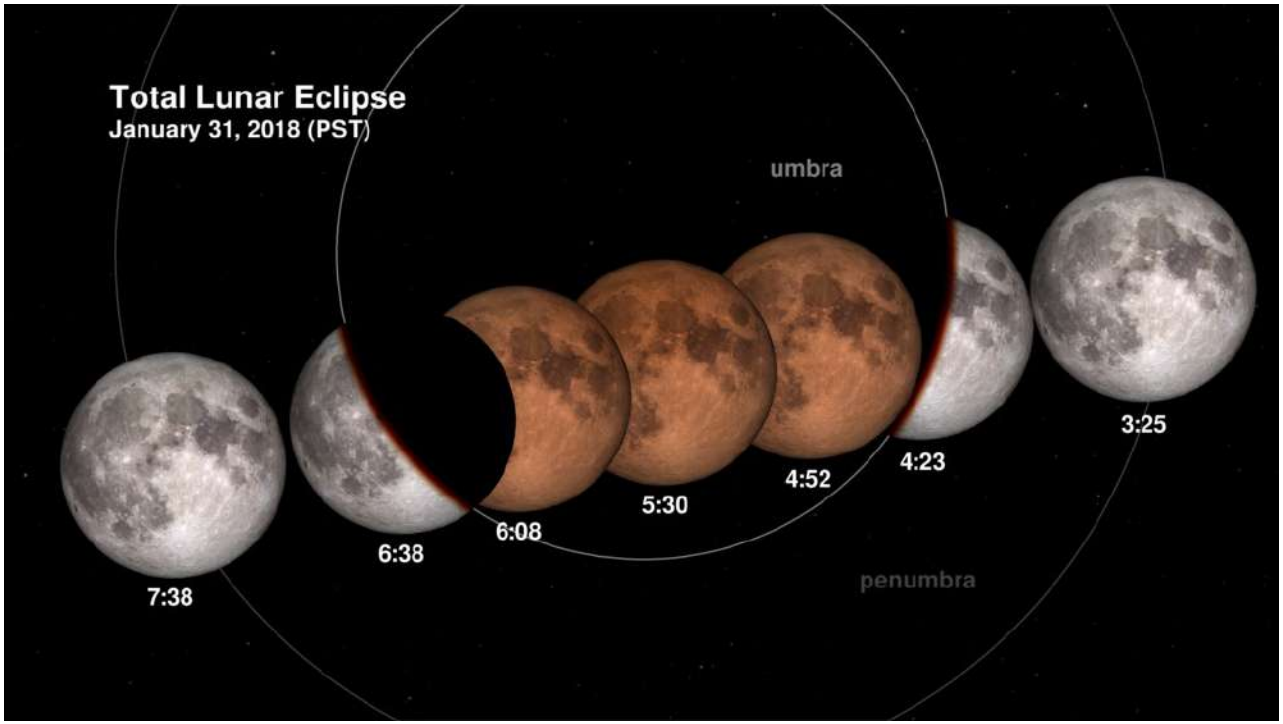
Classwork: answer now. turn in later.

26. Distinguish between an umbra and a penumbra.

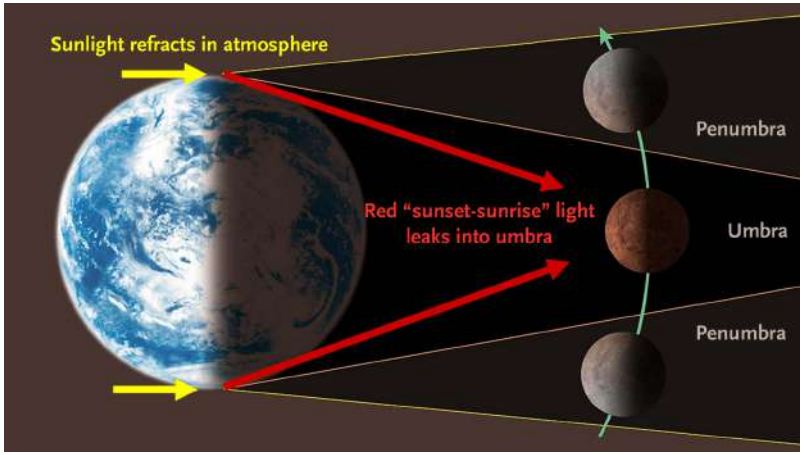
- In a **lunar eclipse,** Moon passes into the shadow of Earth.
- Can only occur at full moon.
- Seen from the entire night side of Earth.
- Difficult to notice when still in the penumbra because so much light from the Sun reaches it.
- Completely safe to view: You are seeing reflected light.



The curved shadow of Earth proves that Earth is round.



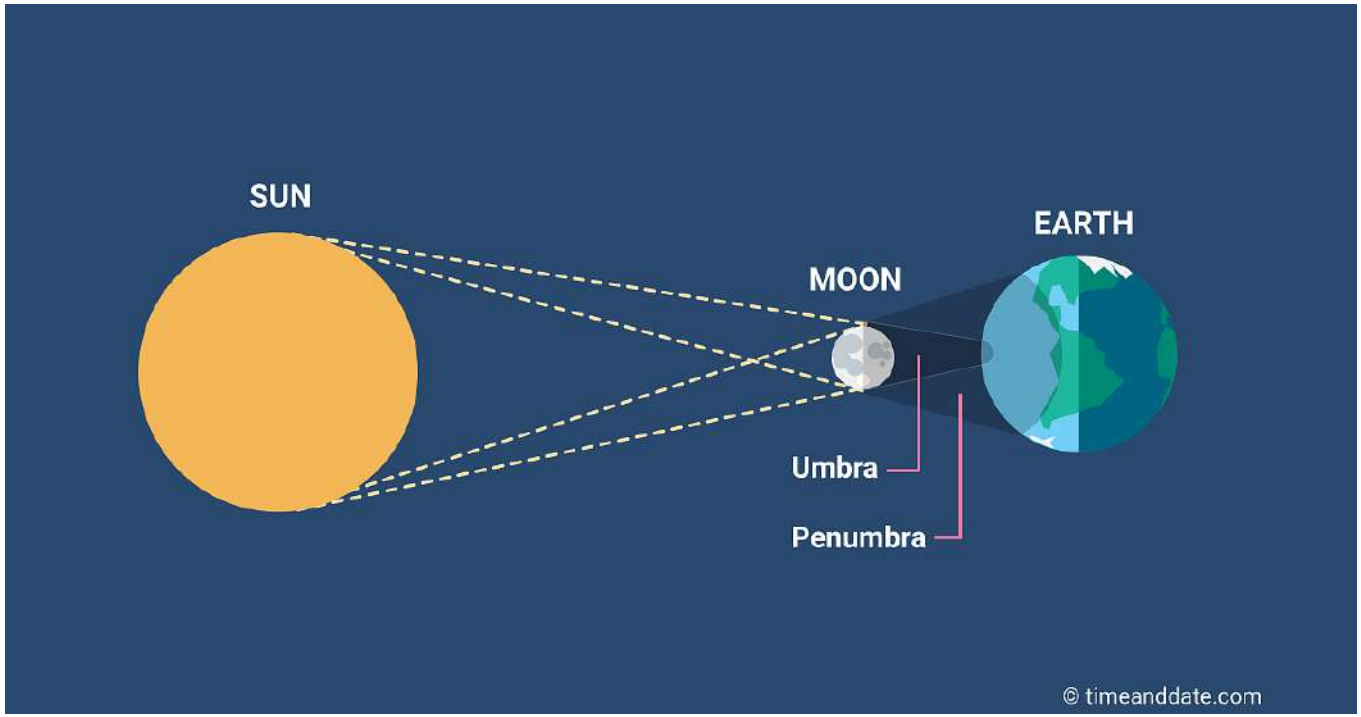
A total lunar eclipse appears red because red light bends through Earth's atmosphere.



In a **solar eclipse,** because of the large size of the Sun, the rays taper to provide an umbra (total eclipse) and a surrounding penumbra (partial eclipse).

Can only occur at a new Moon.

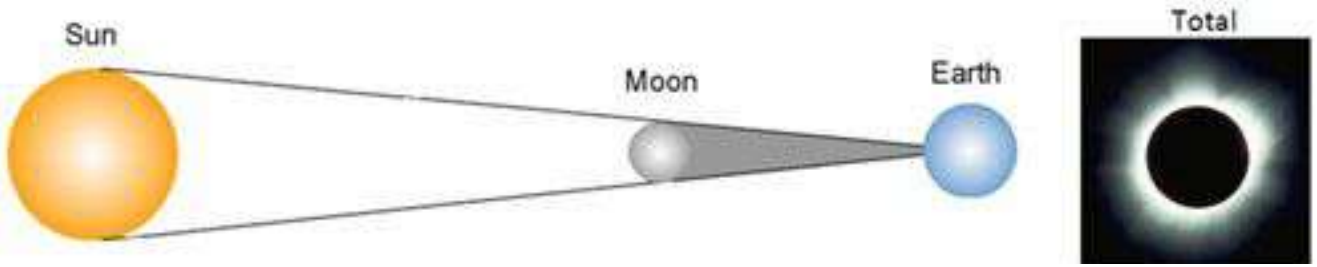
Dangerous to view unless it is a total solar eclipse.



Types of solar eclipses

Depends on how far away the Moon and Sun are.

Total can only be seen by a small area on Earth.



Total solar eclipses:

Diamond ring effect:

Light shining through a mountain valley.

The *corona* (crown) of the Sun is the faint outmost atmosphere. Usually the light of the Sun makes it impossible to see.

Last American total solar eclipse:

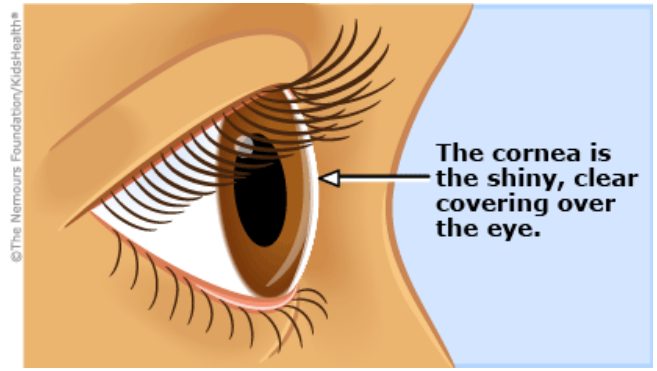
Next one:

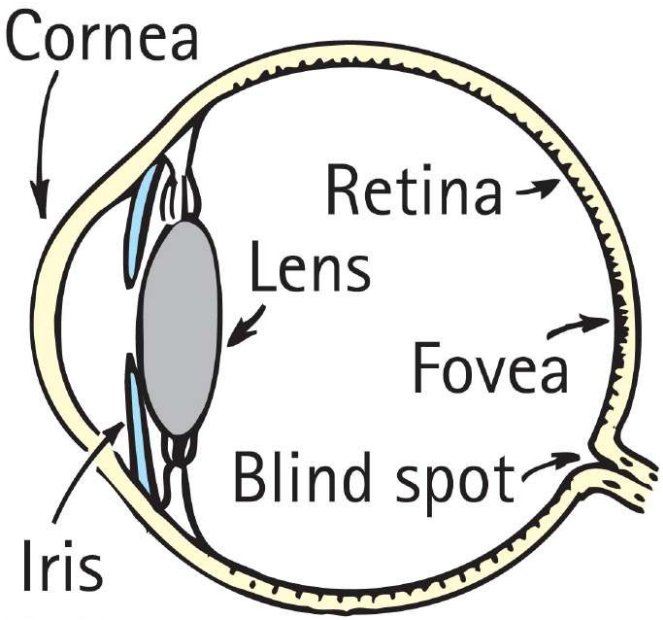
Classwork: answer now. turn in later.

27. Do Earth and the Moon always cast shadows? What do we call the occurrence where one passes within the shadow of the other?

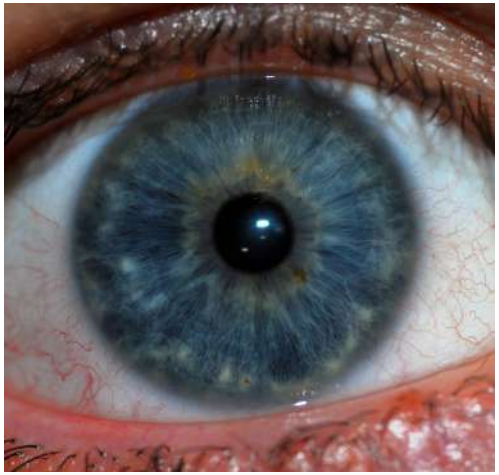
The Eye

As light enters the eye, it moves through the transparent cover called the *cornea*



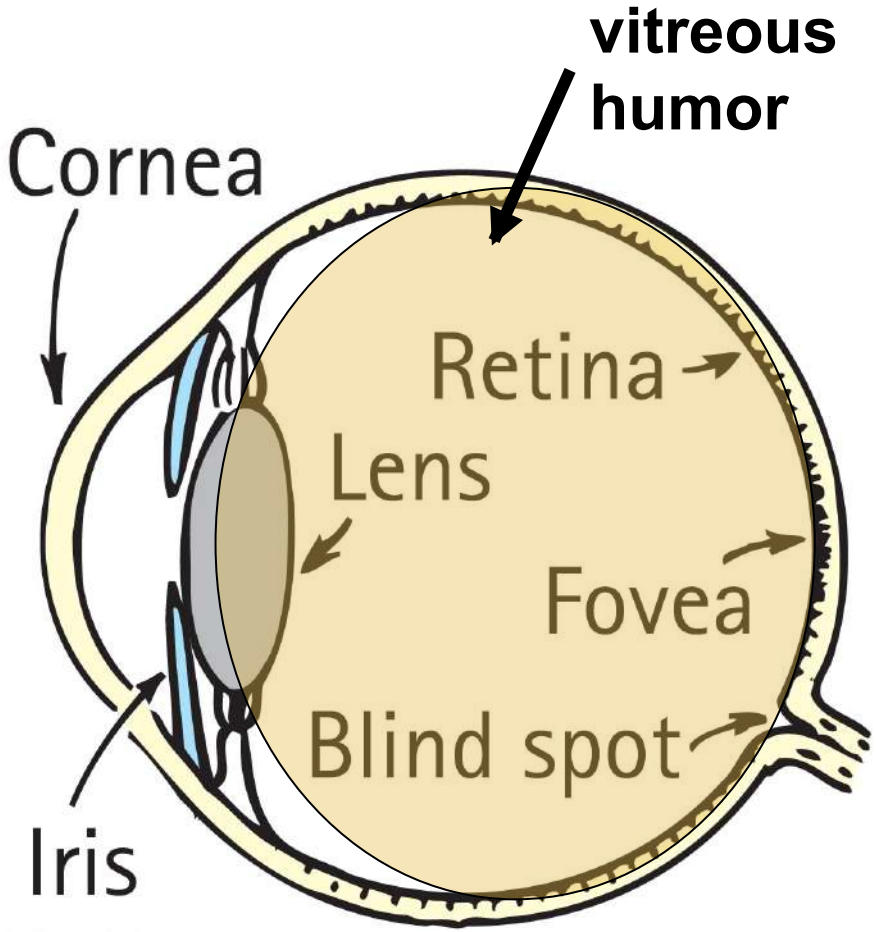


The cornea does about 70% of the necessary bending of the light before it passes through the *pupil*, an opening in the *iris* (colored part of the eye)



Seeing Light – The Eye, Continued

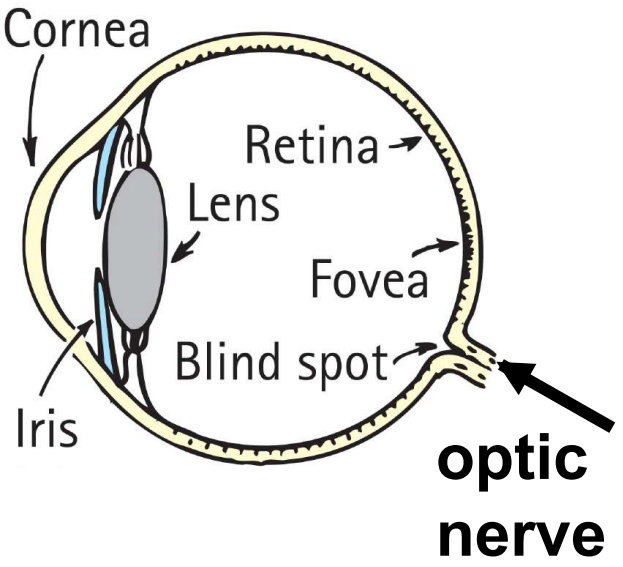
- The opening is called the *pupil*.
- The light then reaches the *crystalline lens,* which fine-tunes the focusing of light that passes through a gelatinous fluid called *vitreous humor*.
- Light then passes to the *retina,* which covers the back two-thirds of the eye and is responsible for the wide field of vision that we experience.



For clear vision, light must focus directly on the *retina*.

The retina is not uniform.

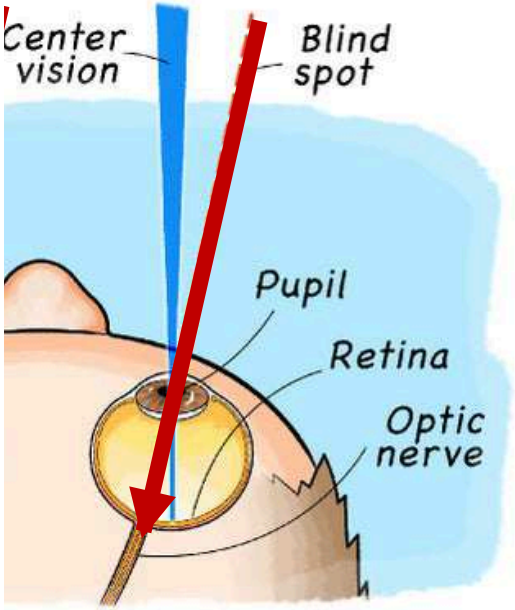
- In the middle is the *macula,* and a small depression.
- in the center is the *fovea,* the region of most distinct vision.



- Behind the retina is the *optic nerve,* which transmits signals from the photoreceptor cells to the brain.
- There is also a spot in the retina where optic nerves are connected; this is the *blind spot*.

Blind spot

The blind spot is not usually noticed because light reaches both eyes at the same time.



See page 496:

Cover your left eye.

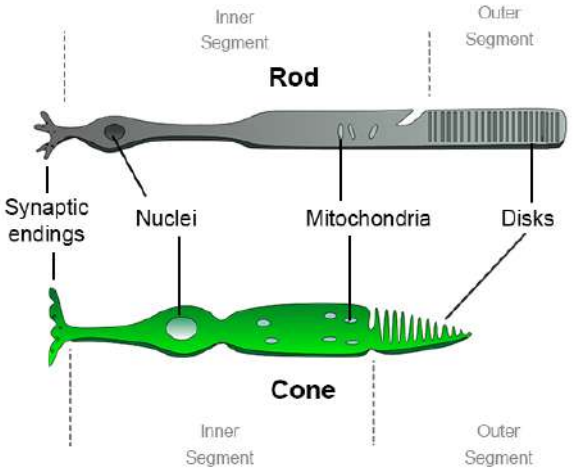
Hold book at arm's length.

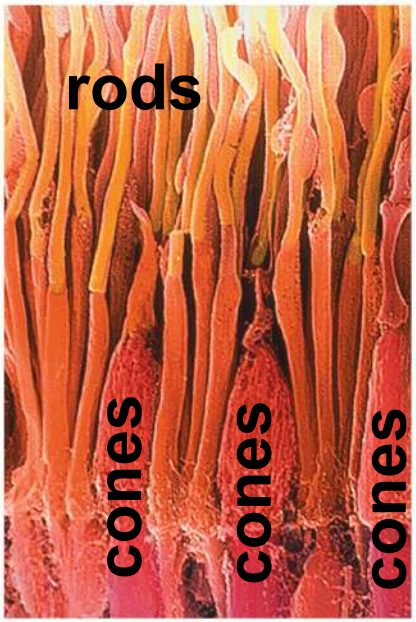
Focus on dot as you bring book closer.

The X will disappear!

● ✖

- The retina is composed of tiny antennae that resonate to the incoming light.
- Rods handle vision in **low light.**
  - They predominate toward the periphery of the retina.
- Cones handle color vision and detail in **brighter light.**
  - They are denser toward the fovea (center of retina)
  - There are three types of cones, stimulated by low, intermediate and high frequencies of light.

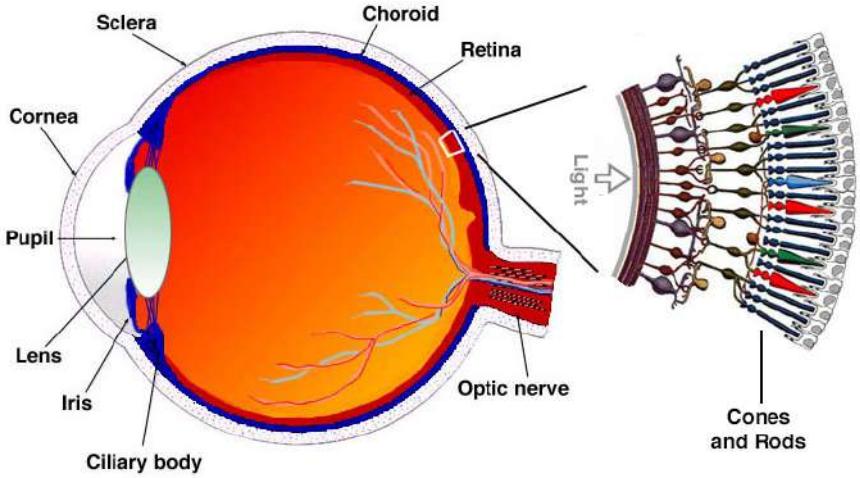


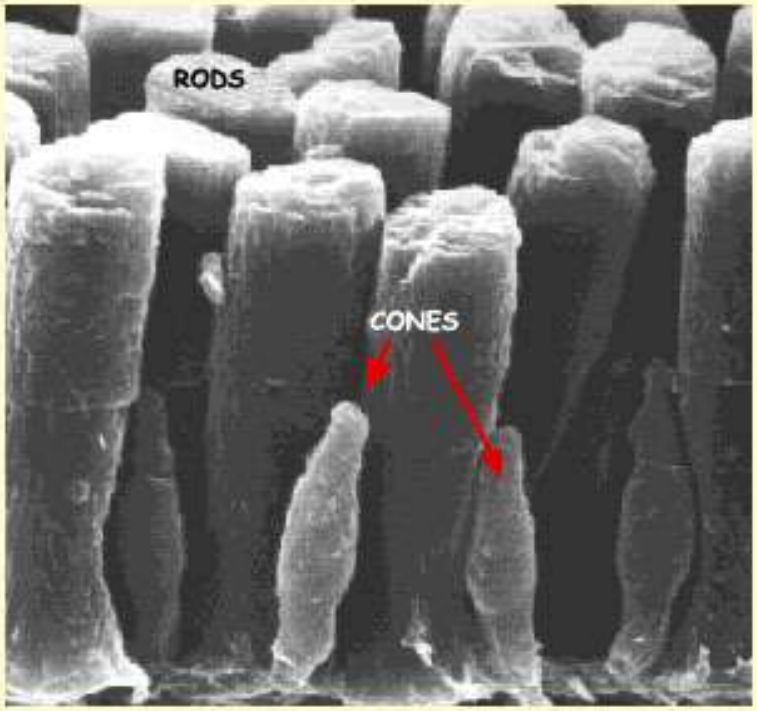


Classwork: answer now. turn in later.

28. How do the rods in the eye differ from the cones?

Rods and Cones





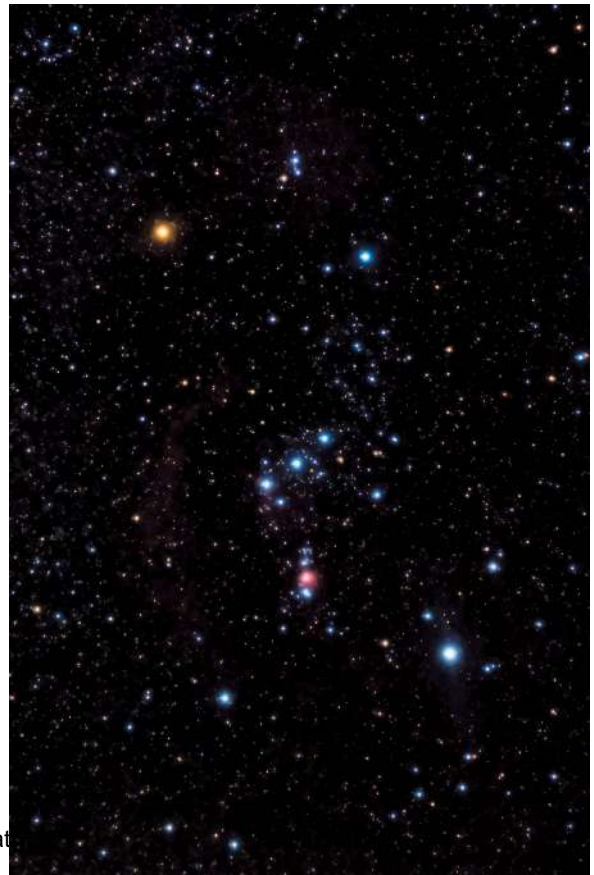
rods: grey

3 cones: low f (red)

middle f (yellow)

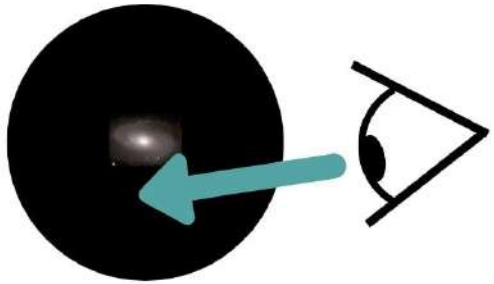
high f (blue)

Stars are usually seen as white because the light is not bright enough to activate the color-sensitive cones.



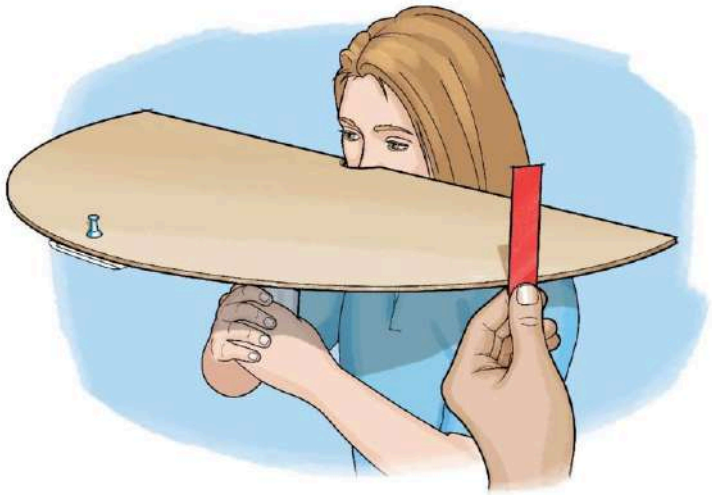
Averted vision:

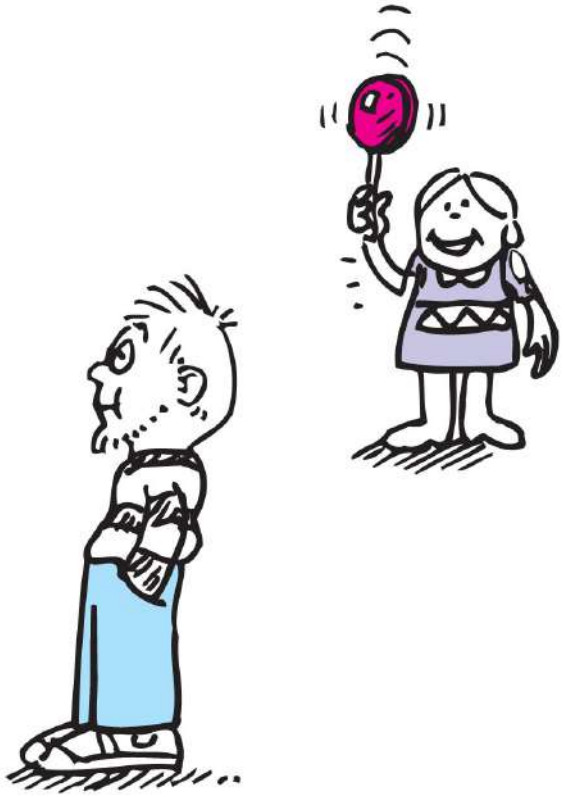
To see faint stars, astronomers learn to look at a star indirectly because then the light falls on the light-sensitive rods.



- Although our vision is poor from the corner of our eye (the periphery of the retina), we are sensitive to anything moving there—by evolution.

→ colors difficult to judge: The light falls on cones.





Classwork: answer now. turn in later.

29. When are objects on the periphery of your vision most noticeable?

Some brain functions occur in the eye:

The iris expands and contracts

to control the size of the pupil.

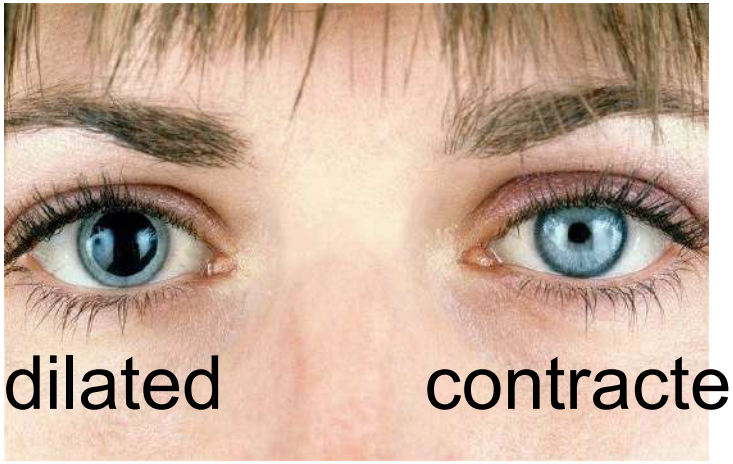
If you see, smell, taste or hear something that you…

….like → the pupils increase in size.

…don't like → the pupils contract.

She loves you...

She loves you not?



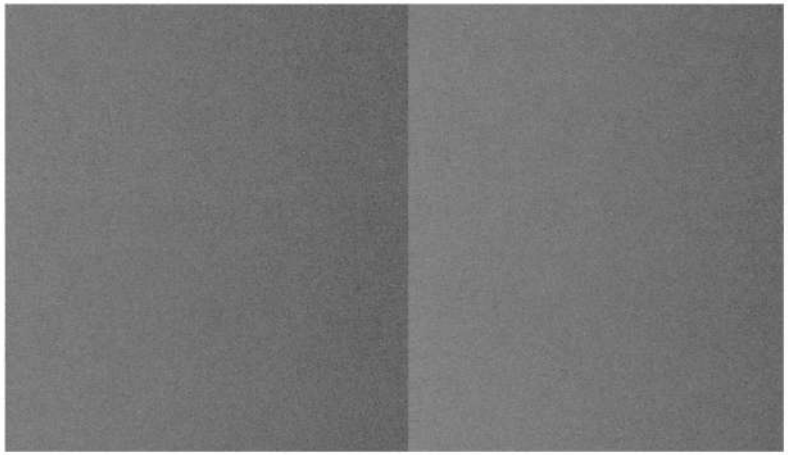
dilated contracted

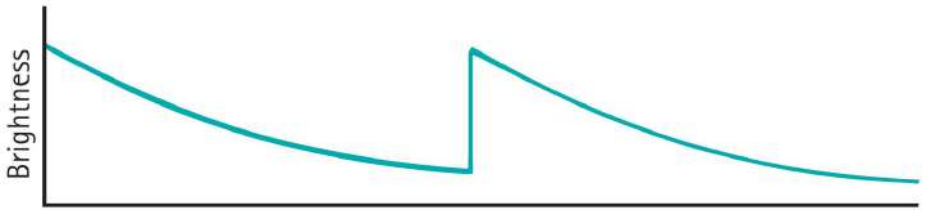
Classwork: answer now. turn in later.

30. What besides the amount of light affects the size of the pupil of the eye?

Seeing Light – The Eye, Continued-4

- The brightest light that the human eye can perceive without damage is some 500 million times brighter than the dimmest light that can be perceived.
- Lateral inhibition: We don't perceive the actual differences in brightness. The brightest places in our visual field are prevented from outshining the rest.





Seeing Light – The Eye, Continued-5

- The brightest light that the human eye can perceive without damage is some 500 million times brighter than the dimmest light that can be perceived.
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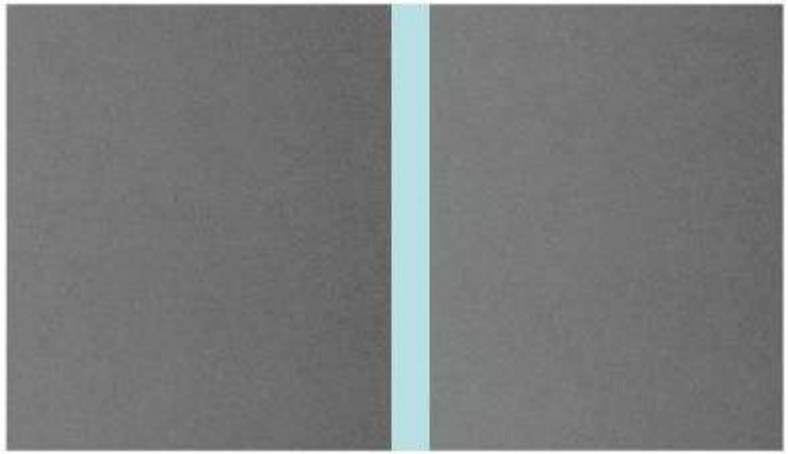
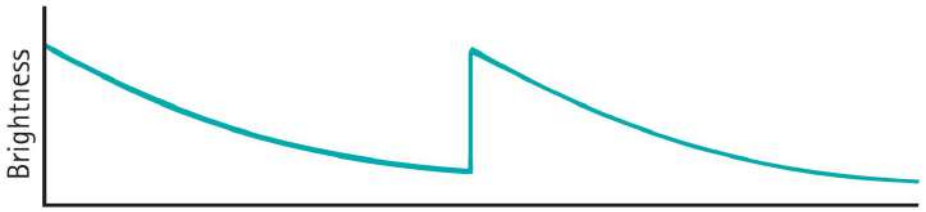
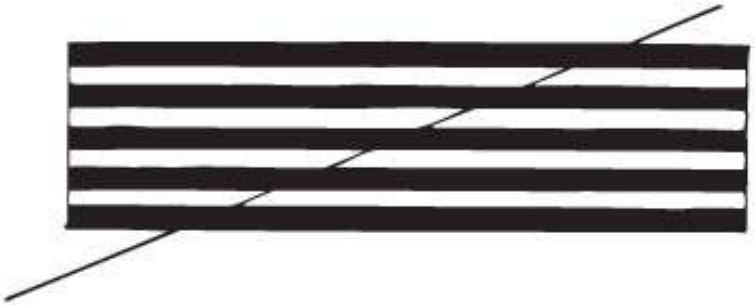


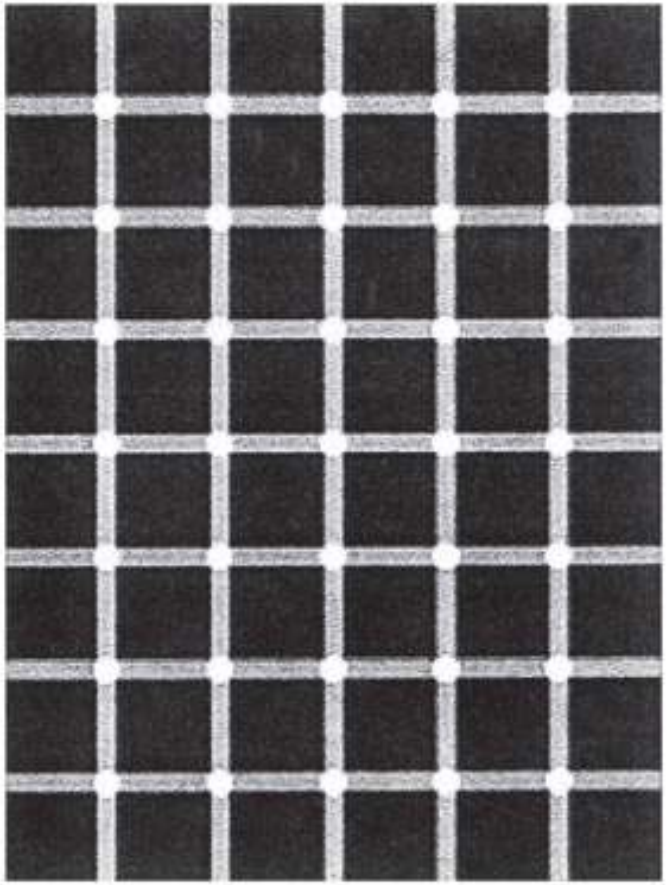


Seeing Light – The Eye, Continued-6



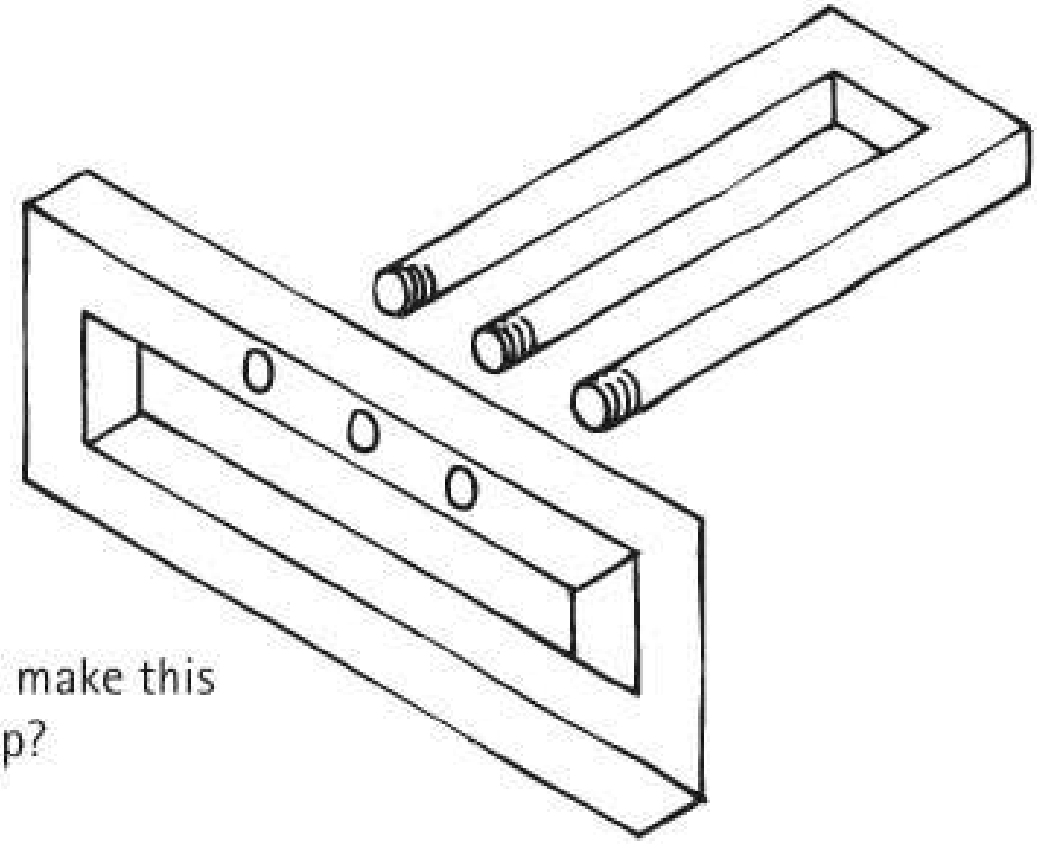
Is the slanted line really broken?

Seeing Light – The Eye, Continued-7



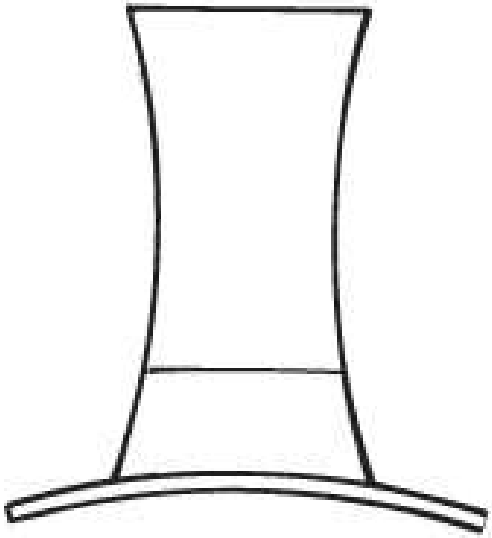
Can you count the black dots?

Seeing Light – The Eye, Continued-8



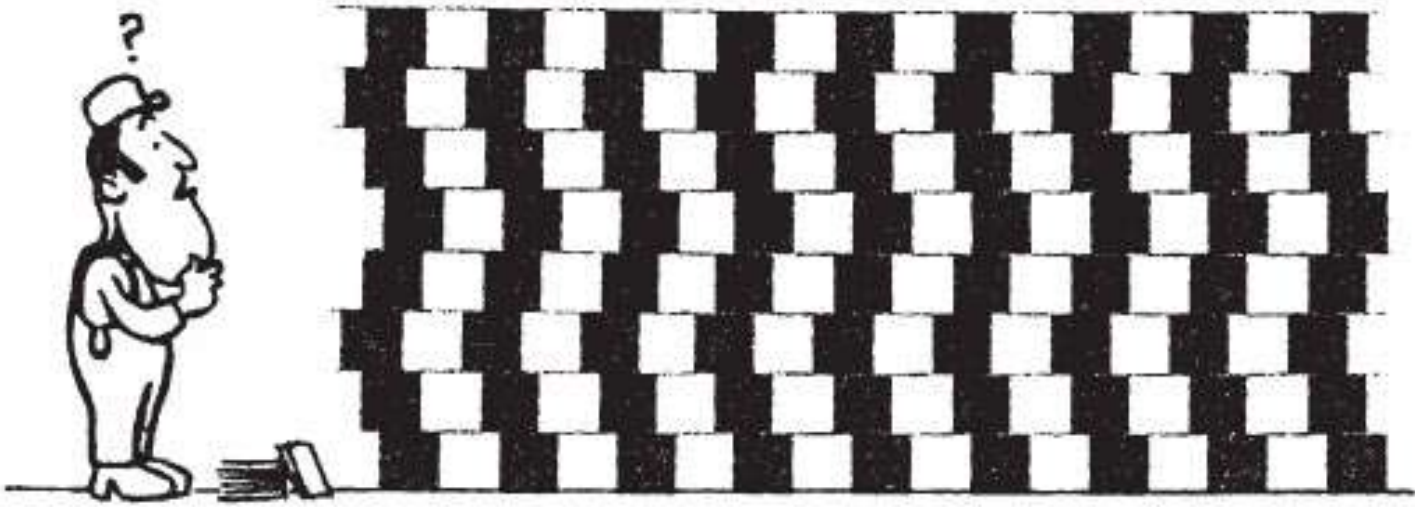
Could you make this in the shop?

Seeing Light – The Eye, Continued-9



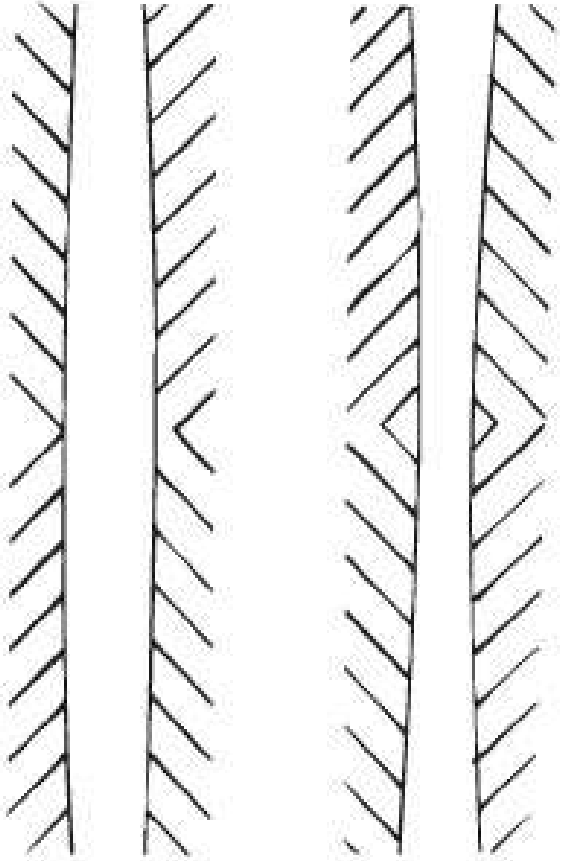
Is the hat taller than the brim is wide?

Seeing Light – The Eye, Continued-10



Are the rows of tiles really crooked?

Seeing Light – The Eye, Continued-11



Are the vertical lines parallel?

Dominant eye?

See page 501: # 32

Or try this: