SCIENCE AND TECHNOLOGY CLASS

AS PER THE ONTARIO CURRICULUM,
GRADES 1–8: SCIENCE AND TECHNOLOGY

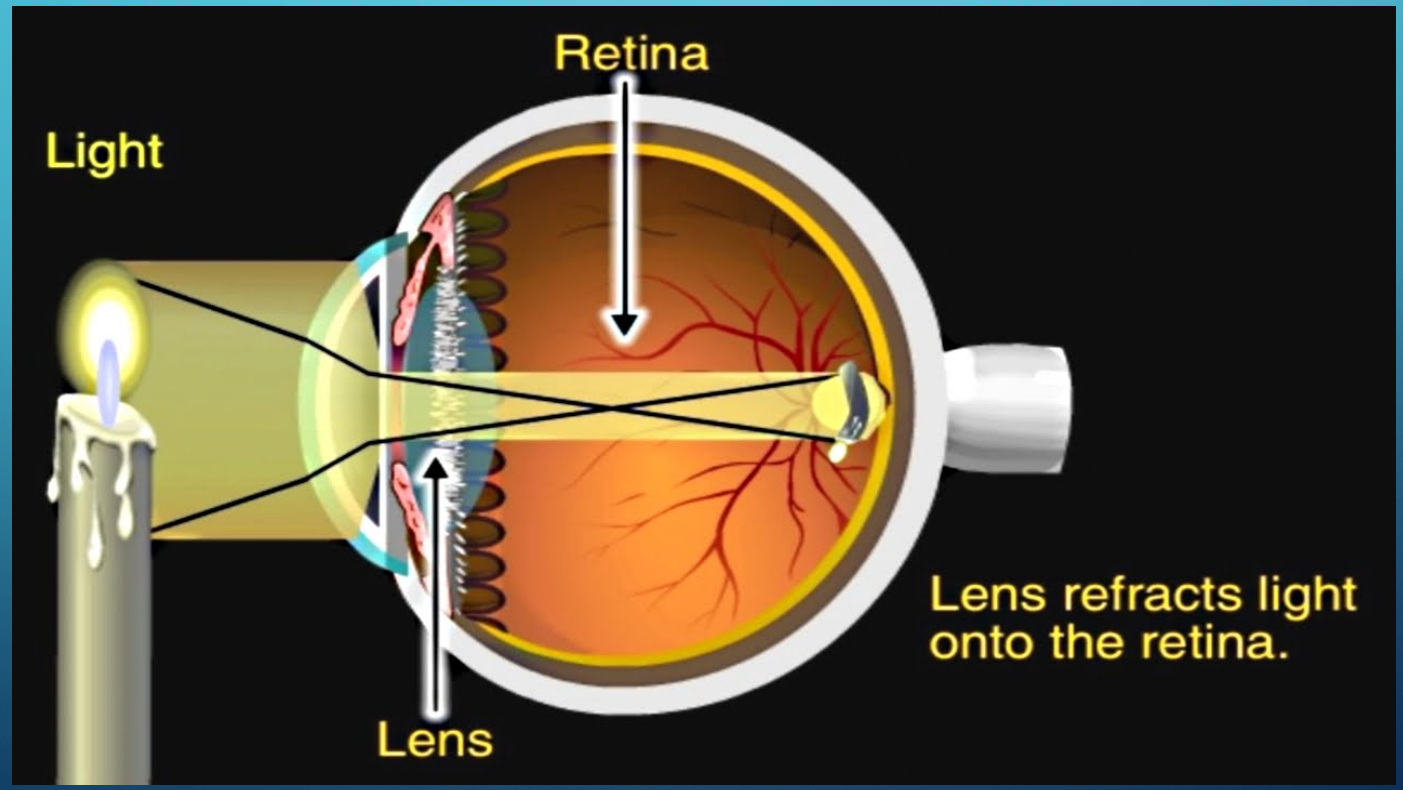
OPTICS

BY PROFESSOR B. KRIGER

SEEING THE LIGHT

VISIBLE LIGHT IS THE LIGHT

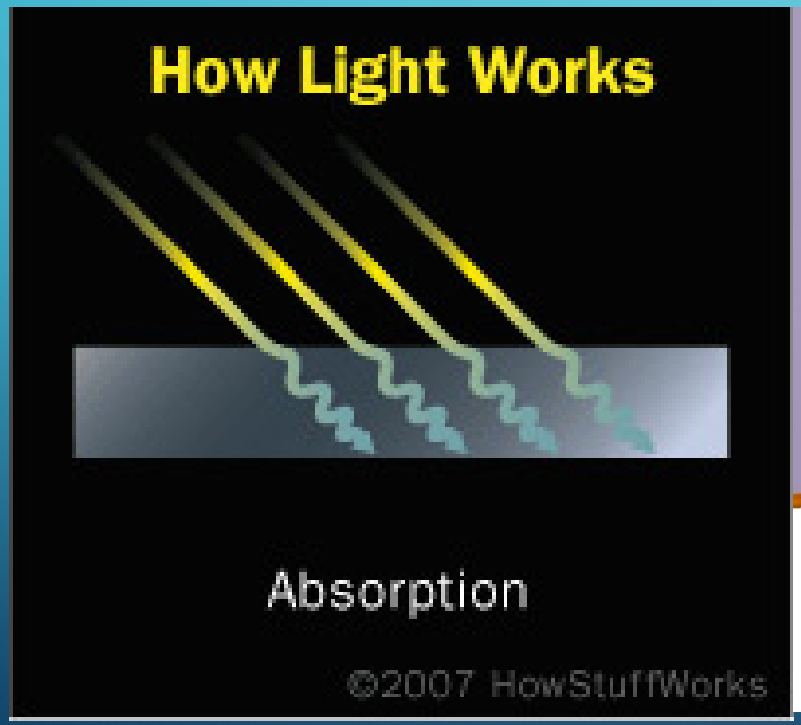
THAT HUMANS CAN SEE.

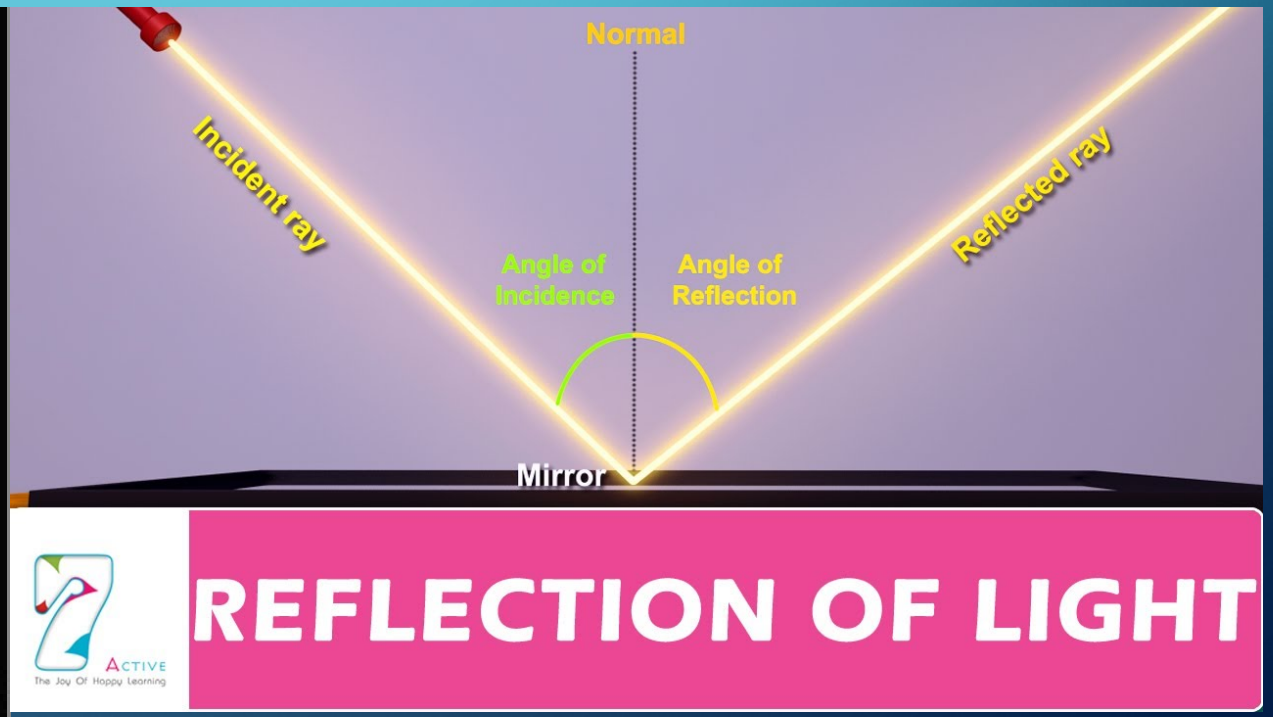


SEEING THE LIGHT

YOU SEE THE LIGHT THAT

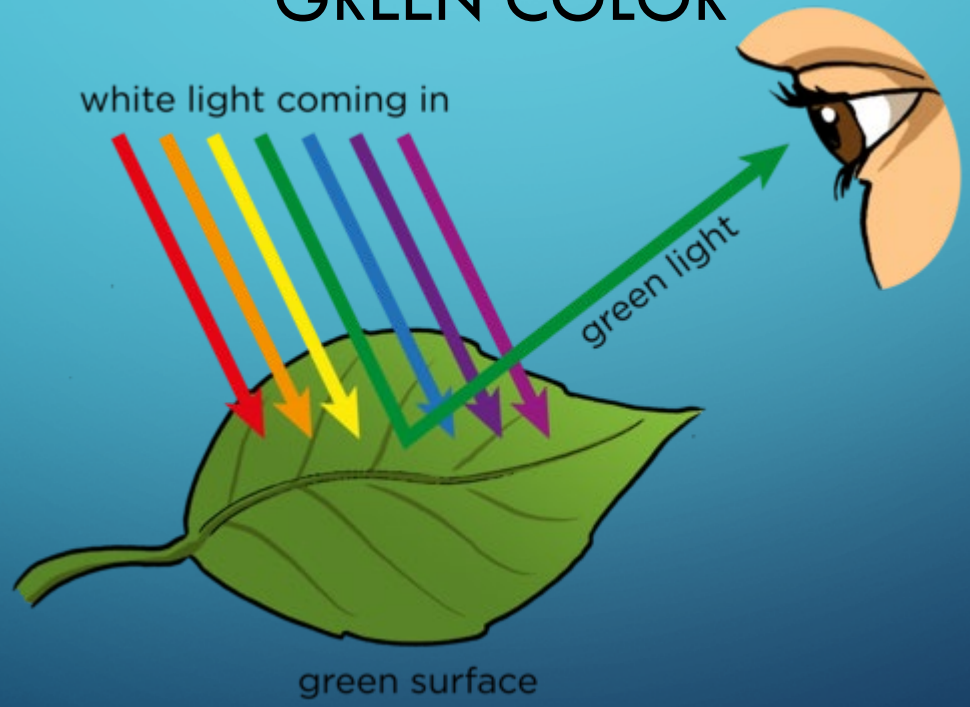
IS REFLECTED AND NOT ABSORBED BY OBJECTS.



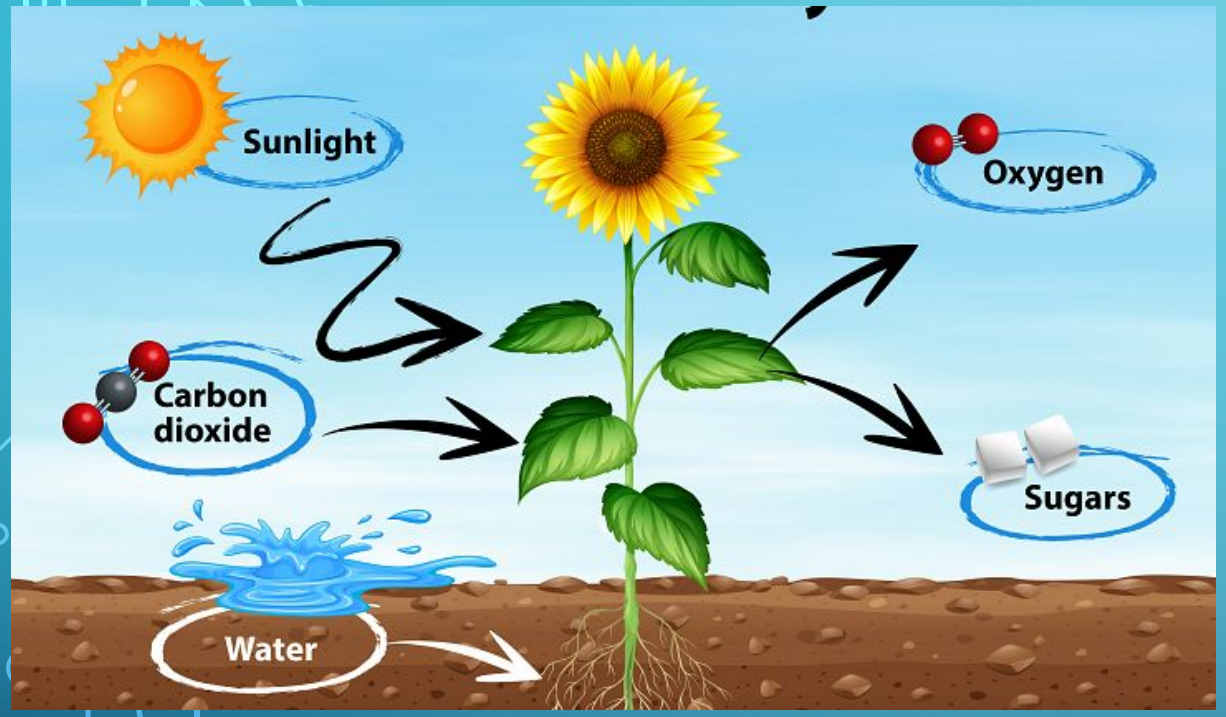


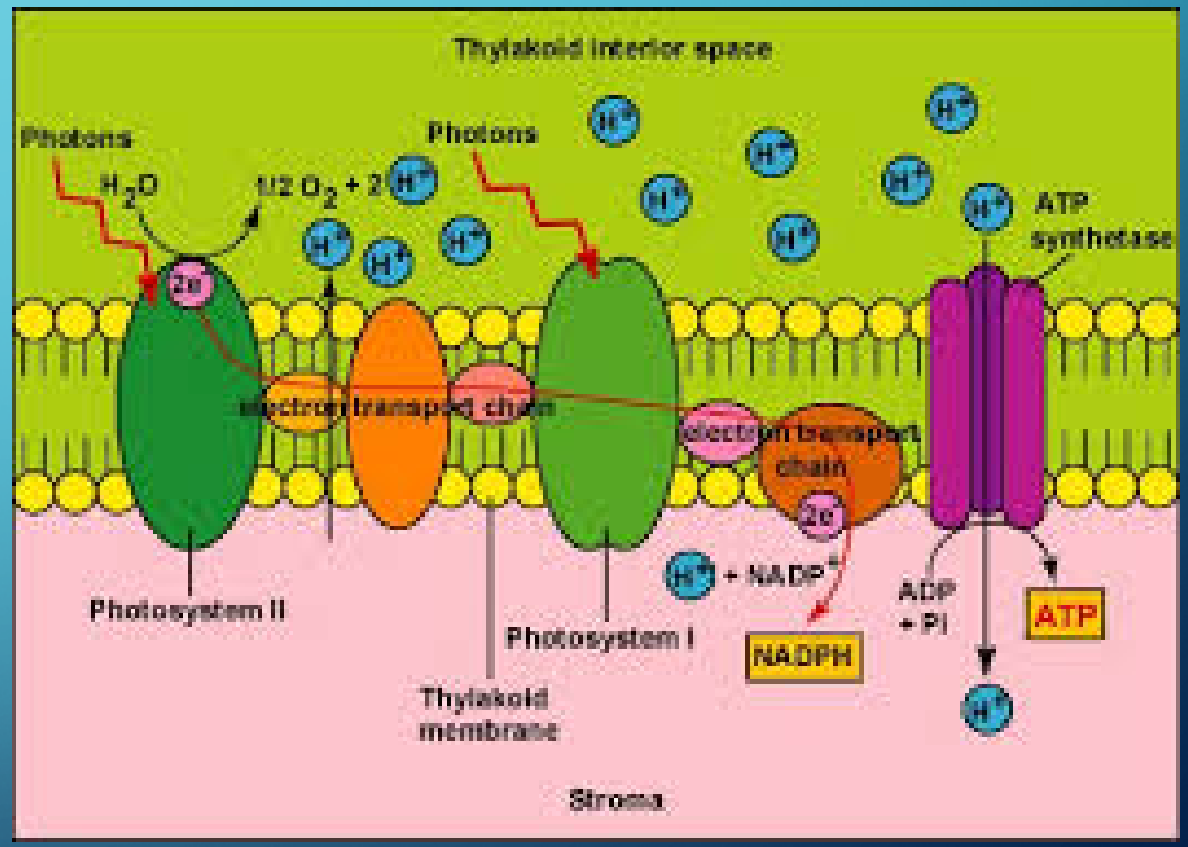
SEEING THE LIGHT

GREEN PLANTS ARE GREEN BECAUSE THEY ABSORB ALL OF THE COLORS OF THE VISIBLE SPECTRUM EXCEPT THE GREEN COLOR



PHOTOSYNTESIS

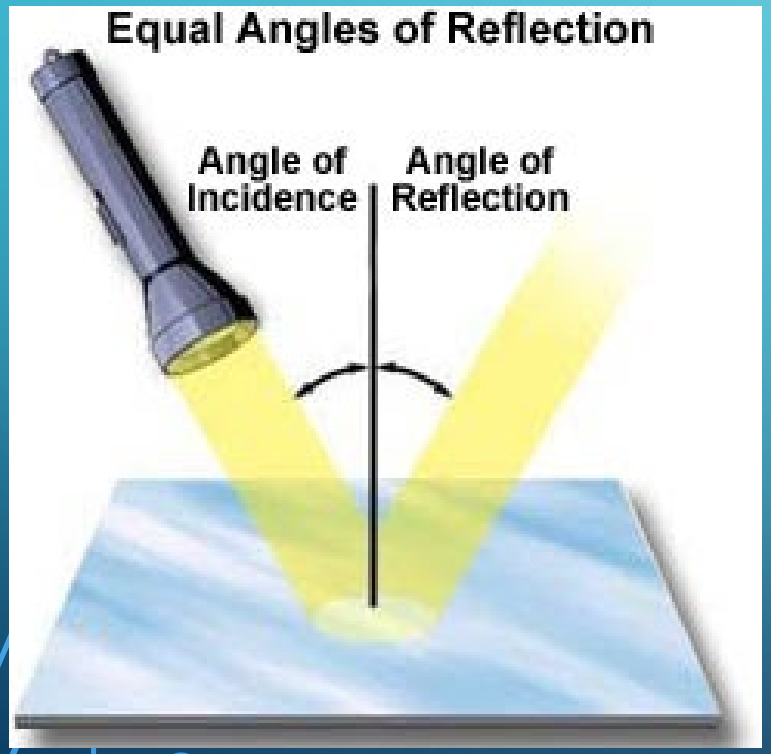




SEEING THE LIGHT

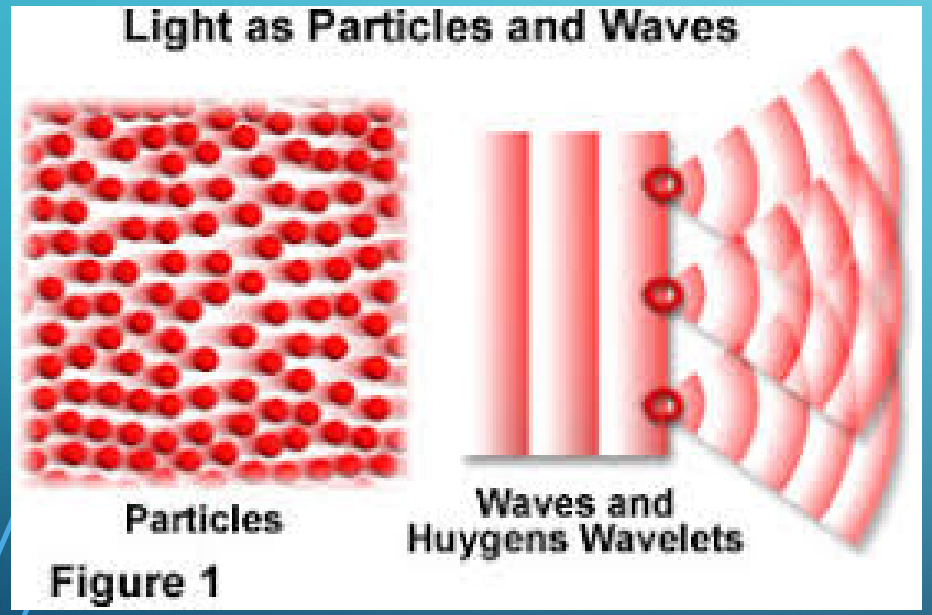
MIRRORS REFLECT ALL

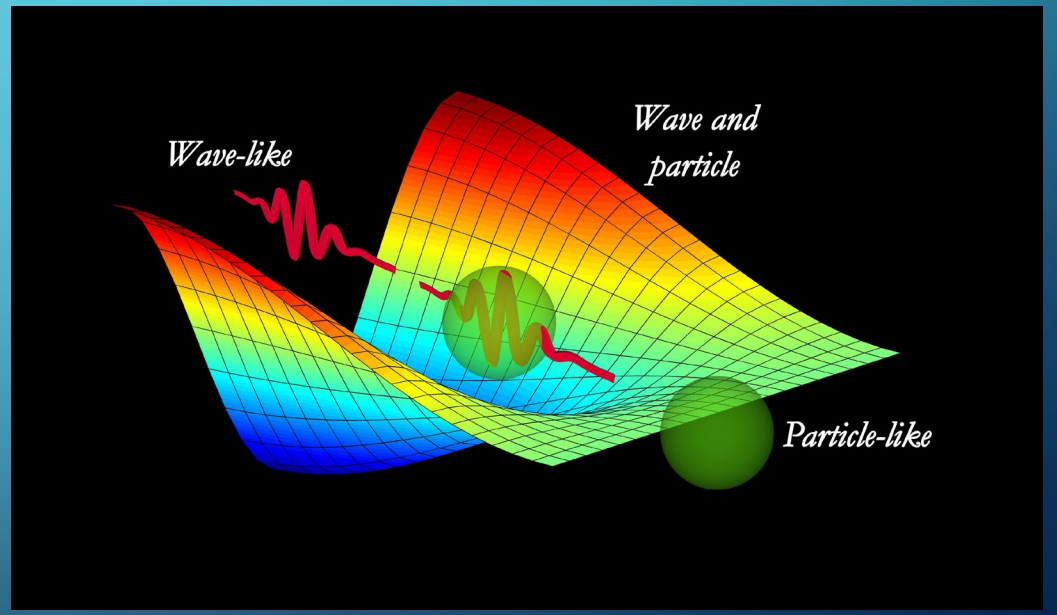
OF THE COLORS OF VISIBLE LIGHT.



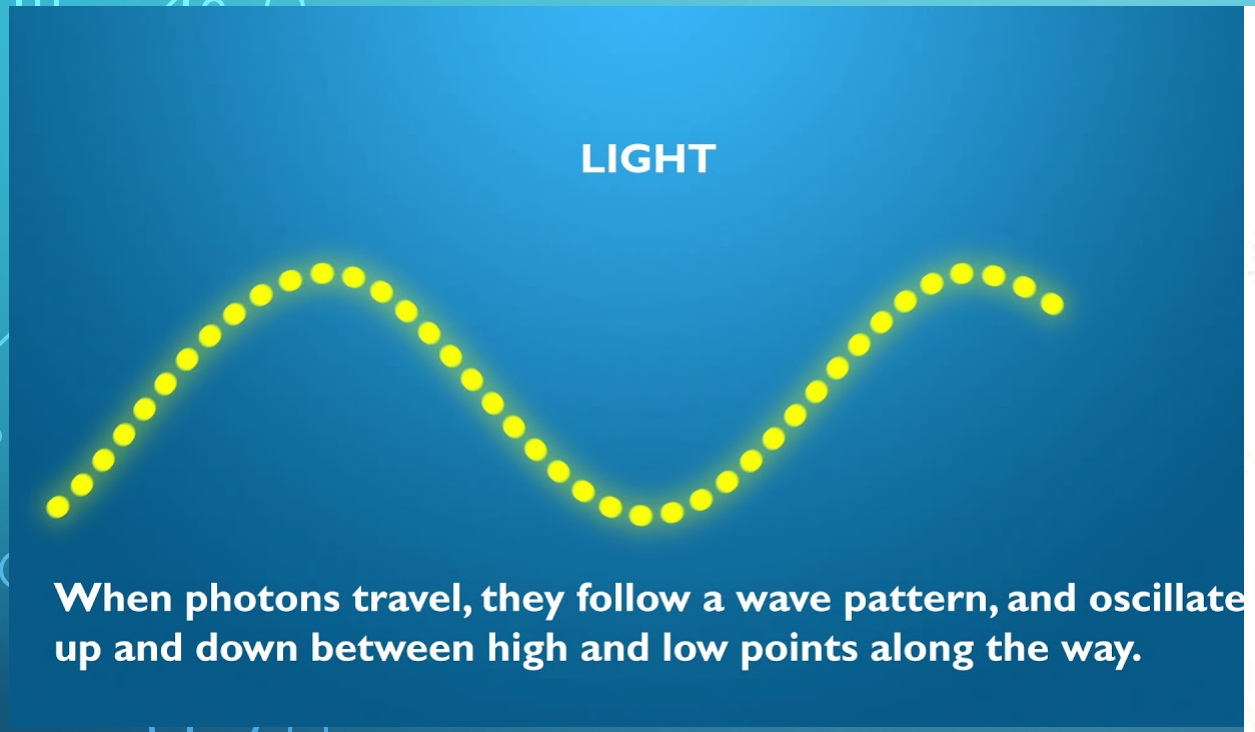
WHAT IS LIGHT

LIGHT IS ELECTROMAGNETIC PARTICLE AND THE WAVE

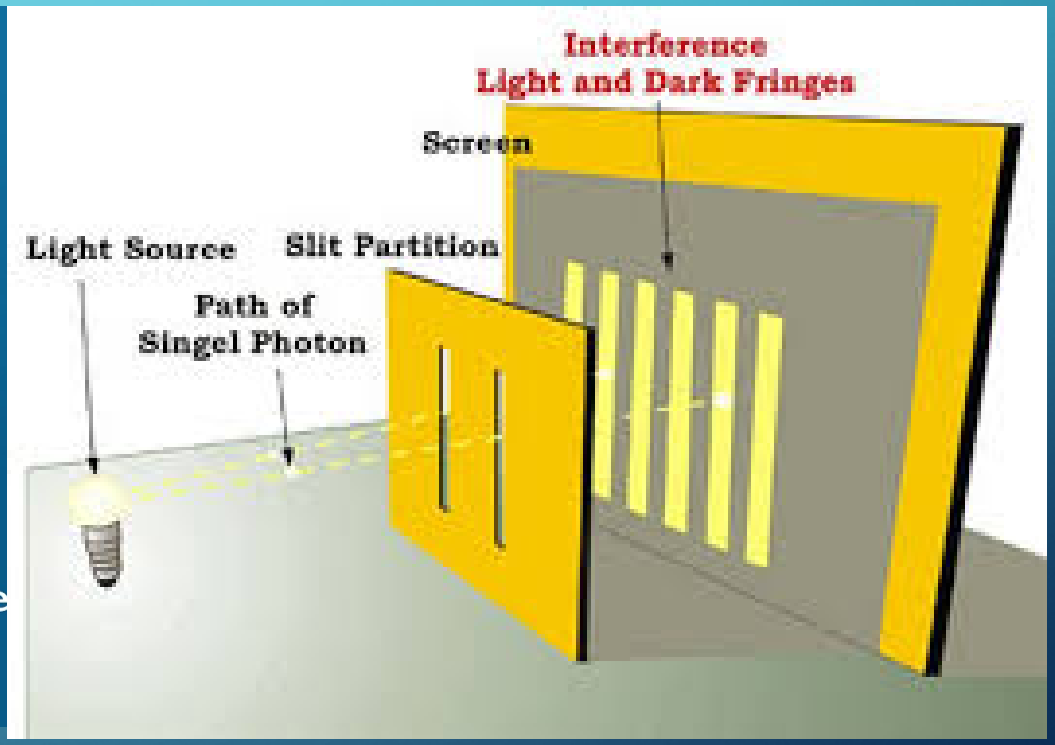




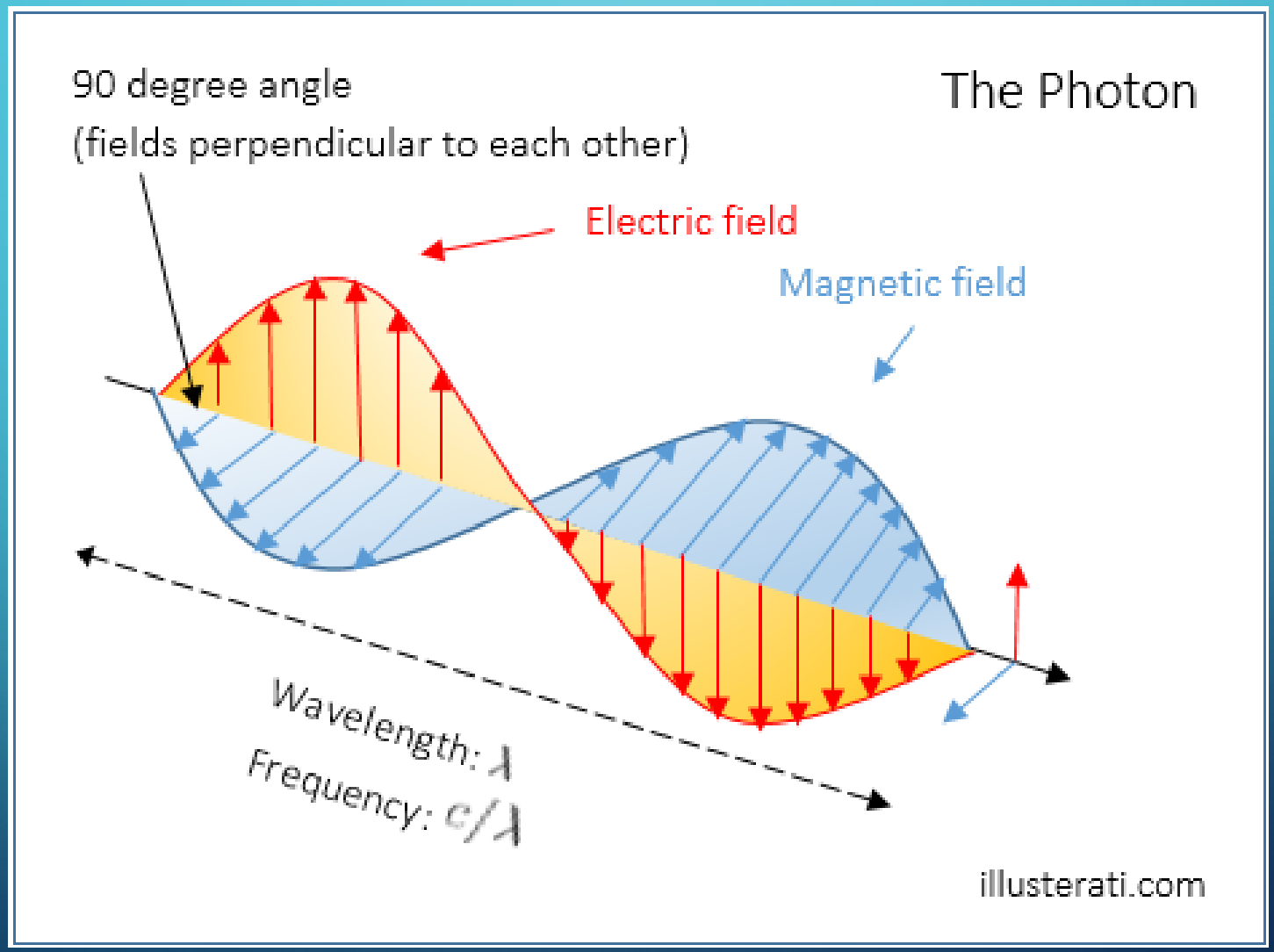
WHAT IS LIGHT



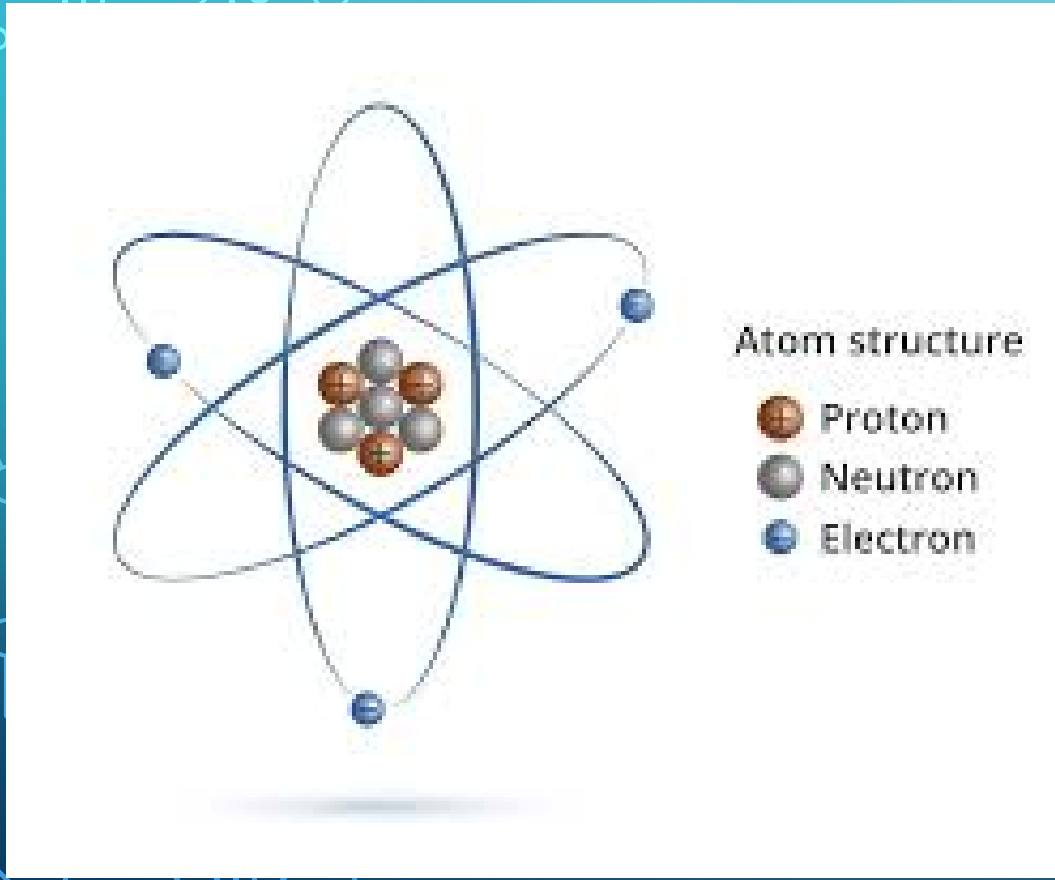
When photons travel, they follow a wave pattern, and oscillate up and down between high and low points along the way.

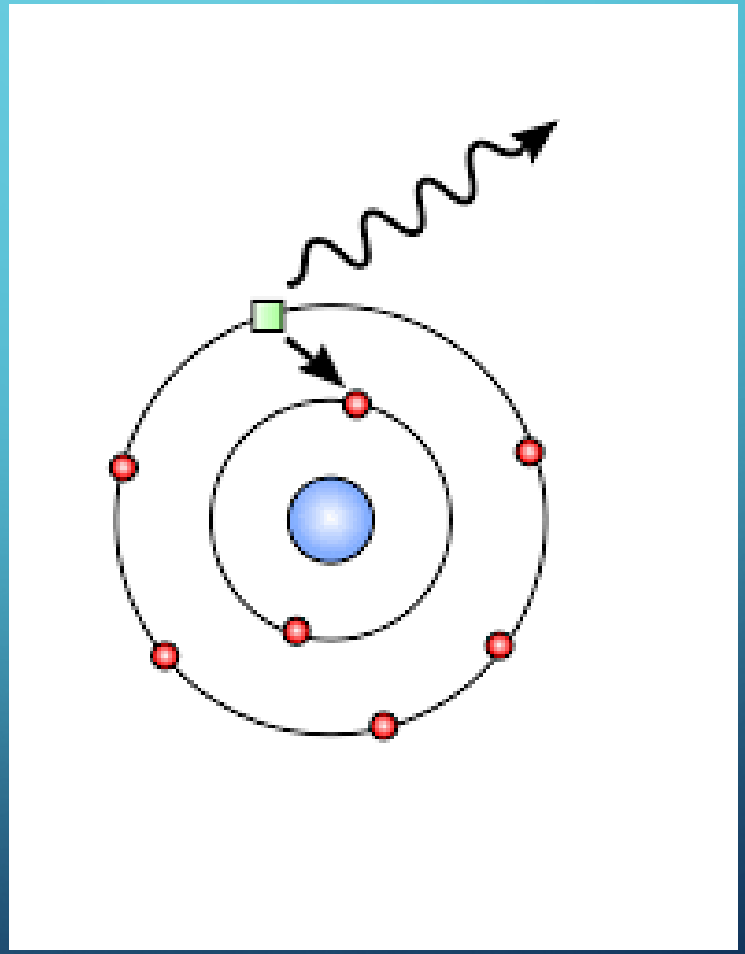


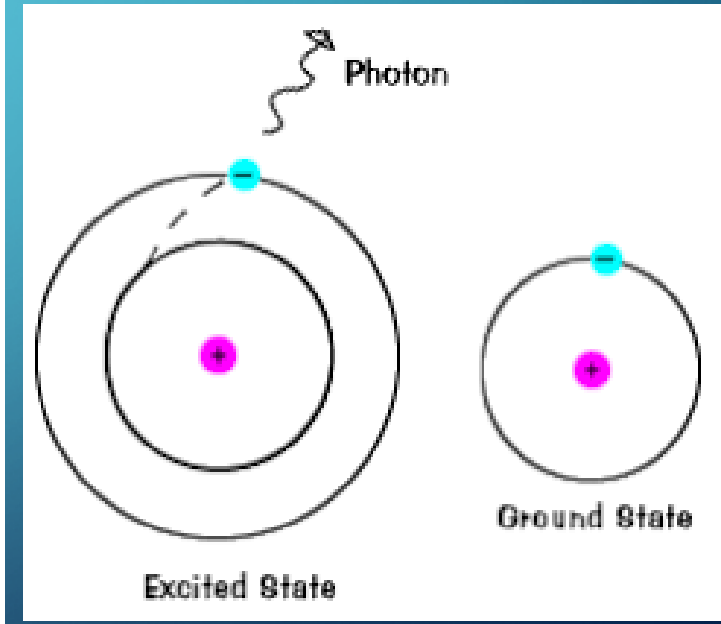
WHAT IS LIGHT



WHAT HAPPENS WHEN LIGHT HITS THE ATOM







SPEED OF LIGHT

Light travels VERY FAST – around 300,000 kilometres per second.

At this speed it can go around the world 8 times in one second.

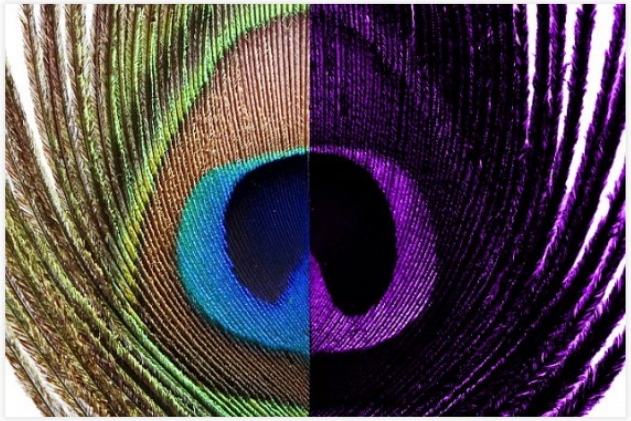
SEEING THE LIGHT DIFFERENTLY

WHEN YOU ARE LEARNING ABOUT VISIBLE LIGHT YOU SHOULD REMEMBER WE MEAN VISIBLE TO HUMANS.

ANIMALS AND OTHER LIVING BEINGS CAN SEE LIGHT DIFFERENTLY

SEEING THE LIGHT DIFFERENTLY

#1 What Birds See:



Humans (left) Peacock (right)

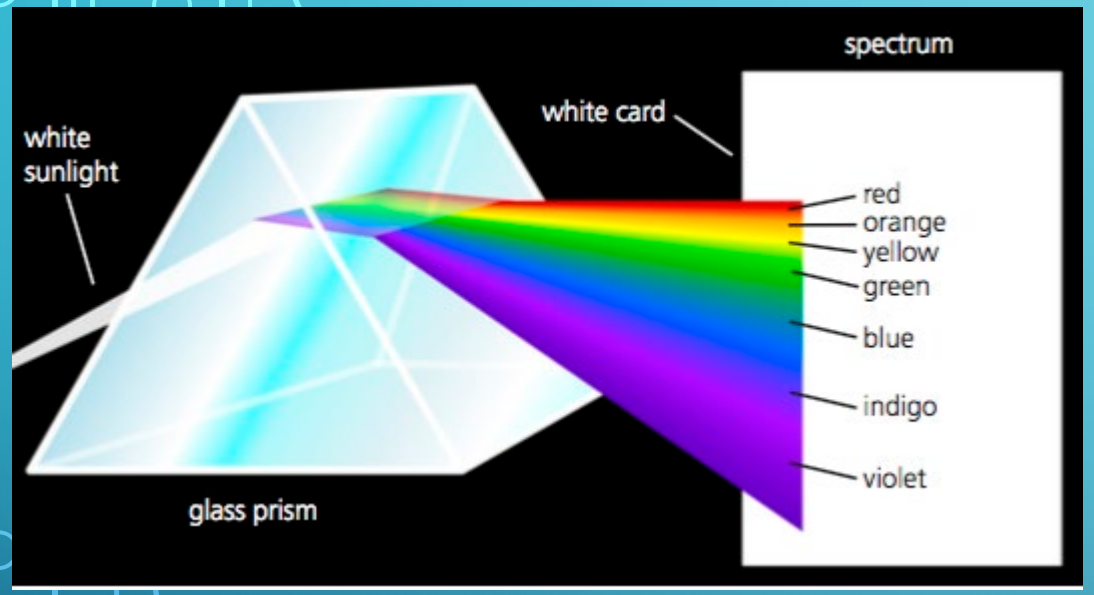
#2 What Dogs See:

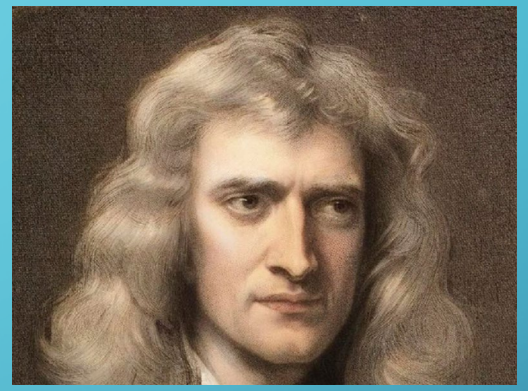
Humans (left) Dogs (right)

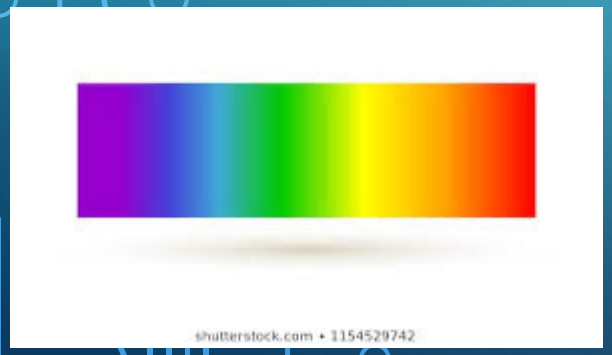
#4 What Snakes See:

Snakes (left) Humans (right)

SEEING A RAINBOW!!!!



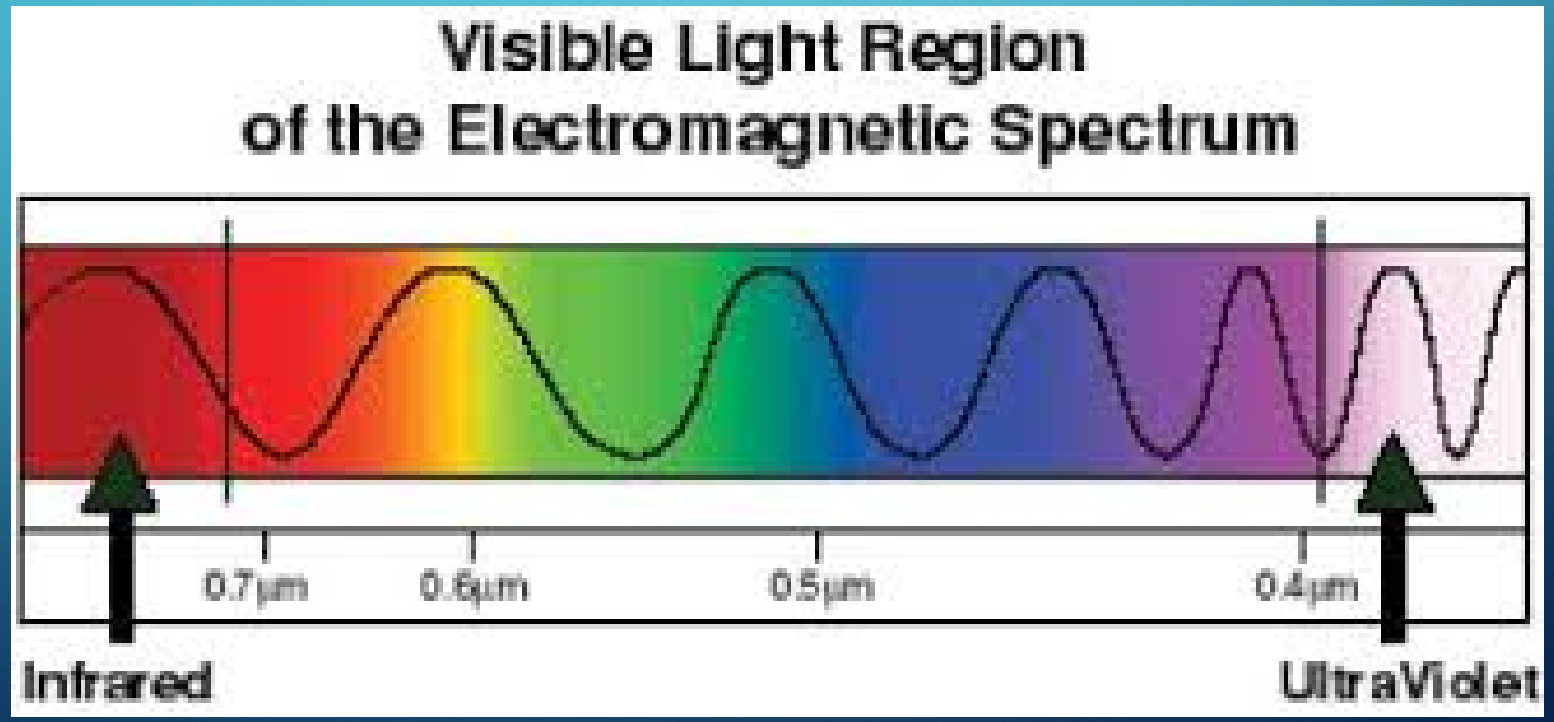




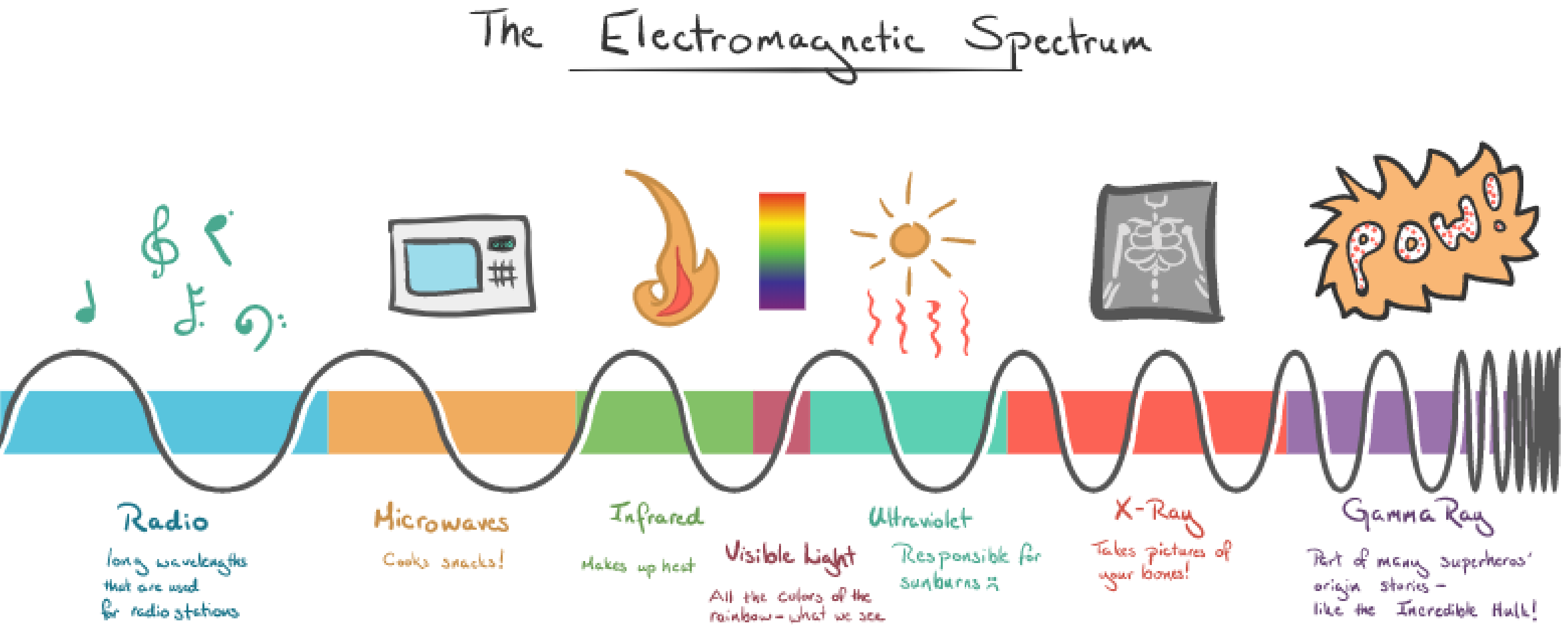
THE HISTORY OF SPECTROSCOPY BEGAN WITH ISAAC NEWTON'S OPTICS EXPERIMENTS (1666–1672). NEWTON APPLIED THE WORD "SPECTRUM" TO DESCRIBE THE RAINBOW OF COLORS THAT COMBINE TO FORM WHITE LIGHT AND THAT ARE REVEALED WHEN THE WHITE LIGHT IS PASSED THROUGH A PRISM.

VISIBLE SPECTRUM

R (RED) - O (ORANGE) - Y (YELLOW) - G (GREEN) - B (BLUE) - I (INDIGO) - V (VIOLET). NOT ONLY ARE THOSE THE COLORS WE CAN SEE AS HUMANS, BUT THEY ARE ALSO IN THE RIGHT ORDER. RED HAS THE LONGEST WAVELENGTH AND VIOLET HAS THE SHORTEST. YOU COULD ALSO SAY THAT RED IS THE LEAST ENERGETIC AND VIOLET IS THE MOST ENERGETIC OF THE VISIBLE SPECTRUM.



FULL SPECTRUM OF ELECTROMAGNETIC WAVES



ELECTROMAGNETIC RADIATION

Scientists also call light electromagnetic radiation. Visible light is only one small portion of a family of waves called electromagnetic (EM) radiation. The entire spectrum of these EM waves includes radio waves, which have very long wavelengths and both gamma rays and cosmic rays, which are at the other end of the spectrum and have very small wavelengths. Visible light is near the middle of the spectrum.

FULL SPECTRUM OF LIGHT

INFRARED (NVISIBLE) - R (RED) - O (ORANGE) - Y (YELLOW) - G (GREEN) - B (BLUE) - I (INDIGO) - V (VIOLET) – ULTRAVIOLET (INVISIBLE)

MEMORIZE THIS PHRASES INVENTED BY PROFESSOR KRIGER. THEY INDICATE THE ORDER WITHIN THE FULL SPECTRUM OF LIGHT:

IS RED ORANGE YUMMY?

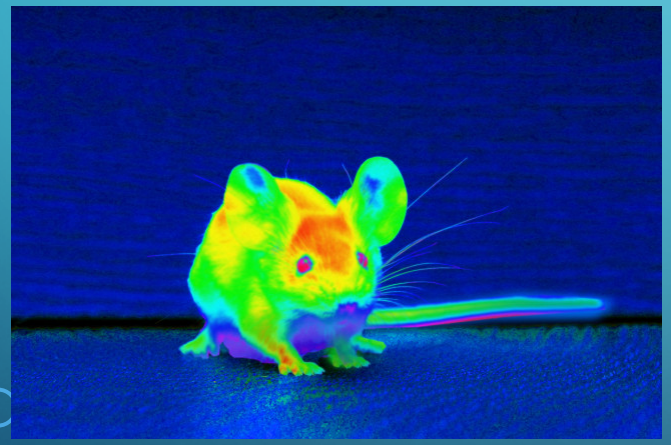
GREEN BANANA IS VERY UGLY!

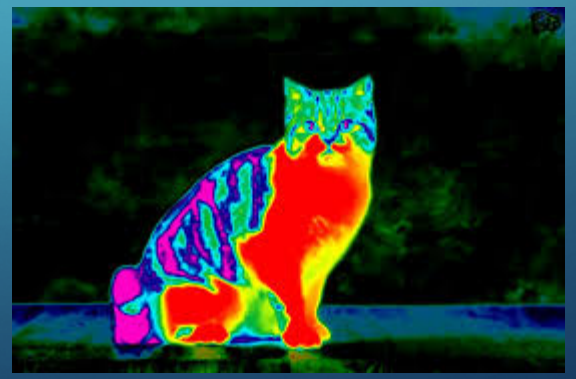
INFRARED LIGHT

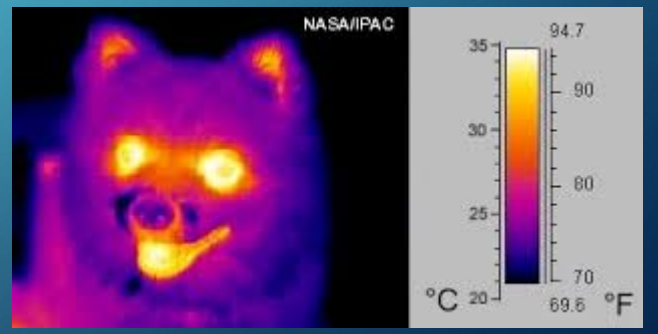
PEOPLE DO NOT SEE INFRARED LIGHT;

THEY SENSE **INFRARED** AS HEAT.

IT CAN BE USED TO SEE IN THE DARK – NIGHT VISION EQUIPMENT



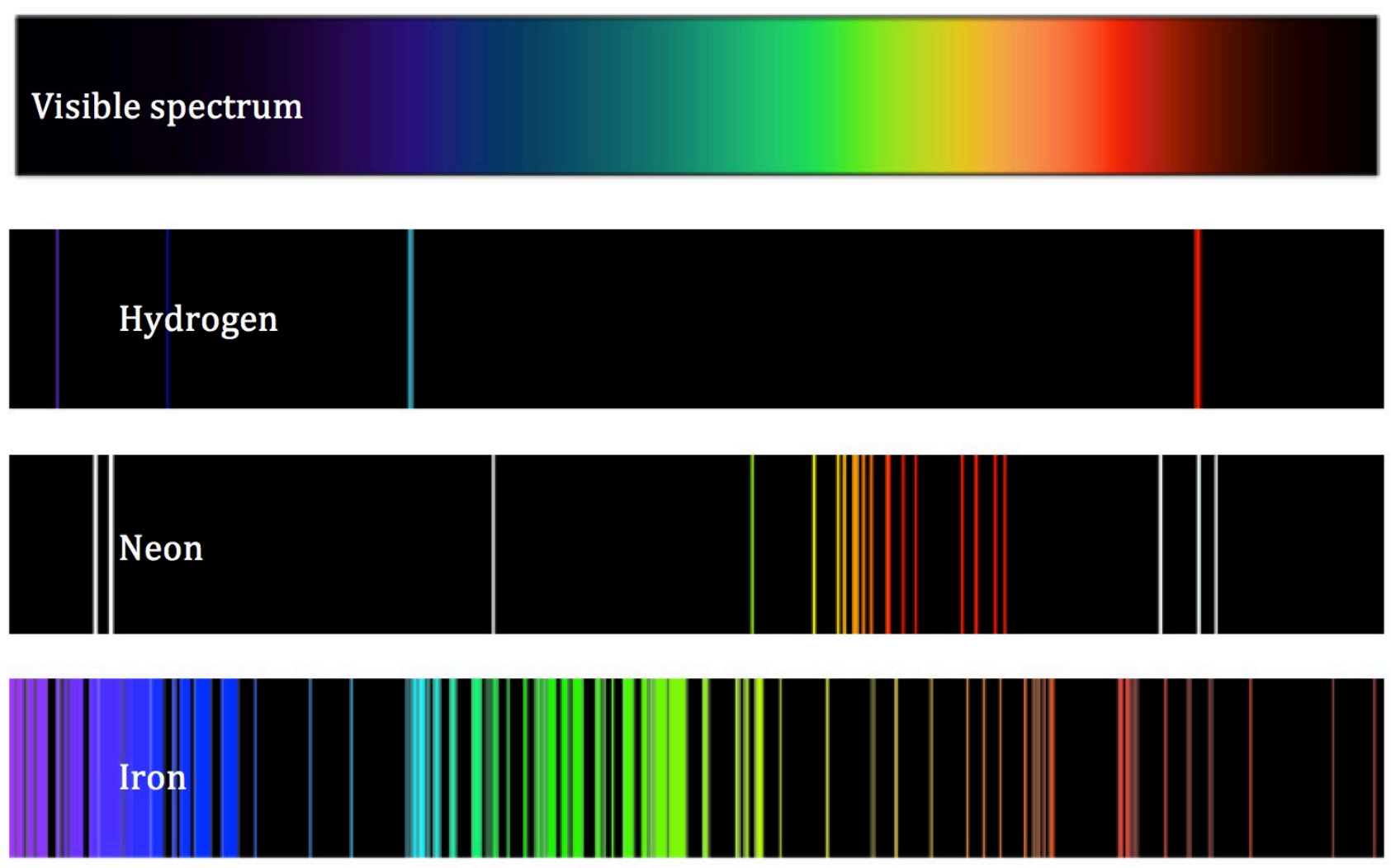


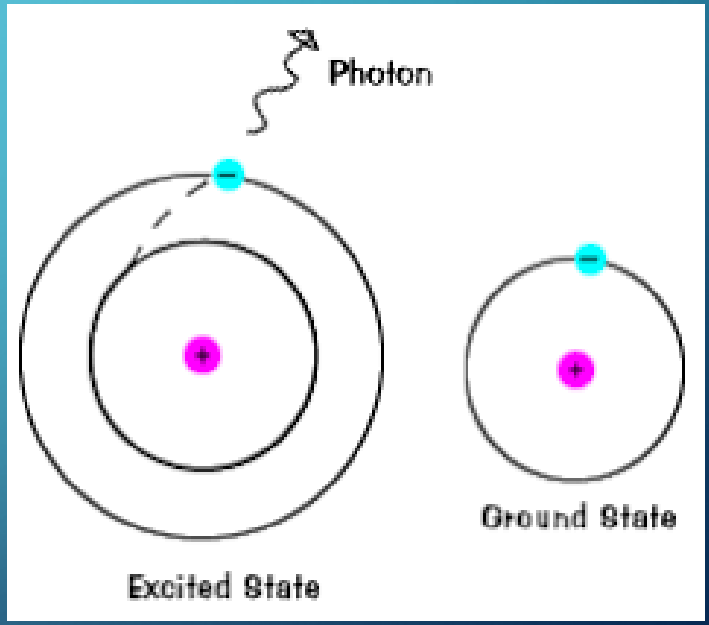


ULTRAVIOLET LIGHT

ULTRAVIOLET RADIATION (UV) IS JUST BEYOND THE VIOLET END OF THE VISIBLE SPECTRUM. UV LIGHT IS GIVEN OFF BY THE SUN AND ABSORBED BY OZONE IN THE ATMOSPHERE. ULTRAVIOLET LIGHT CAN ALSO MUTATE CELLS IN YOUR SKIN AND GIVE YOU SKIN CANCER.

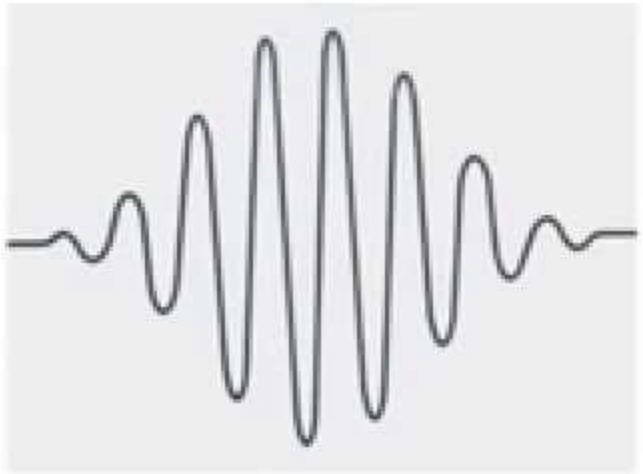
SPECTRAL ANALYSIS





What is a photon?

A photon is a discrete *quantum,* or packet, of electromagnetic energy.
The energy of a photon is proportional to its frequency.

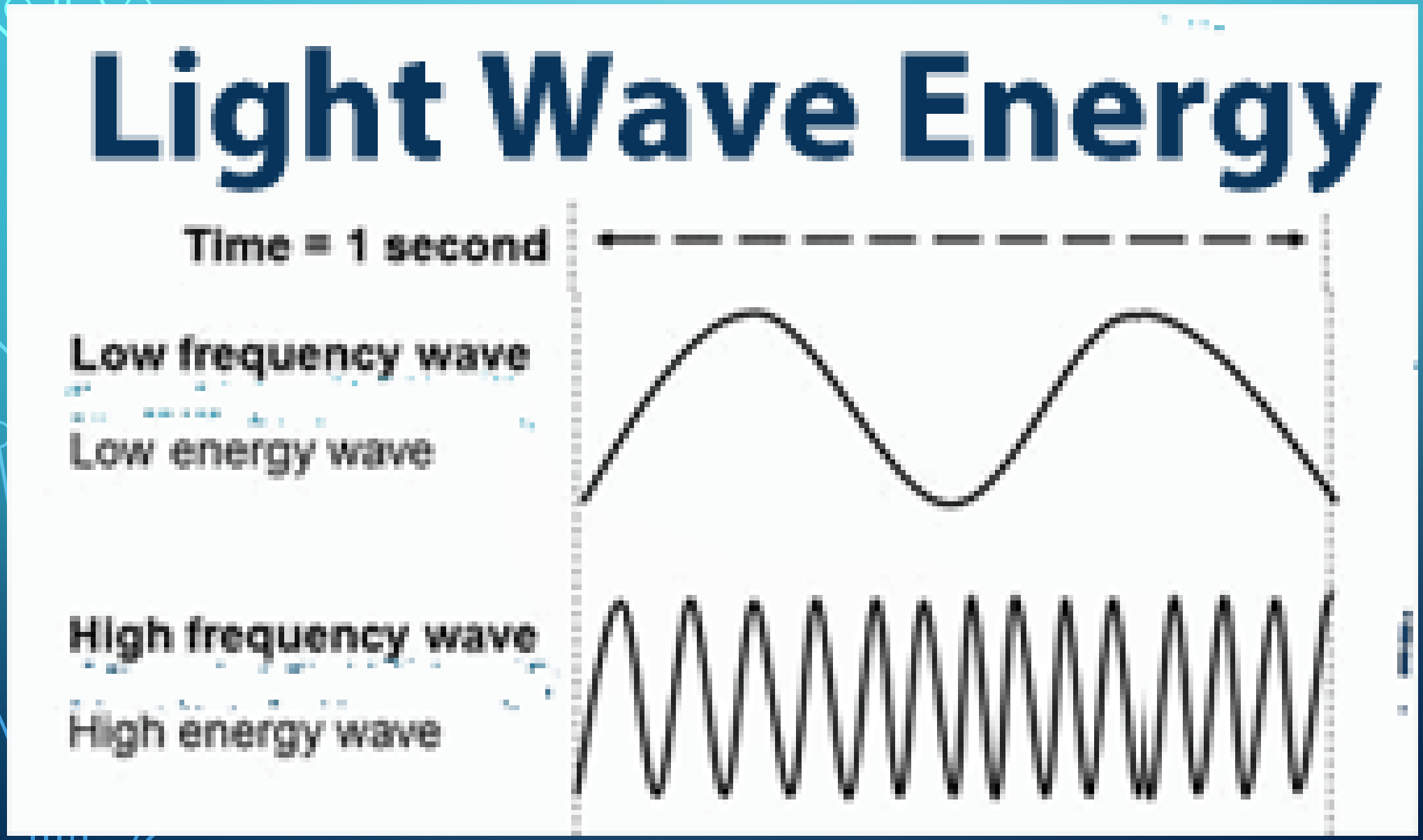


Einstein proposed that EM radiation could be modelled as these discrete quanta in 1905, while formulating an alternative explanation of Planck's theory of radiation from black bodies.

LIGHT IS PURE ENERGY

THE KEY THING TO REMEMBER IS THAT LIGHT AND EM RADIATION CARRY **ENERGY**. THE **QUANTUM THEORY** SUGGESTS THAT LIGHT CONSISTS OF VERY SMALL BUNDLES OF ENERGY/PARTICLES; IT'S JUST THAT SIMPLE. SCIENTISTS CALL THOSE SMALL PARTICLES PHOTONS, AND THE WAVELENGTH DETERMINES THE ENERGY AND TYPE OF EM RADIATION, AND THE NUMBER OF PHOTONS TELLS YOU HOW MUCH RADIATION THERE IS. A LOT OF PHOTONS GIVE A BRIGHTER, MORE INTENSE TYPE OF LIGHT. FEWER PHOTONS GIVE A VERY DIM AND LESS INTENSE LIGHT. WHEN YOU USE THE DIMMER SWITCH ON THE WALL, YOU ARE DECREASING THE NUMBER OF PHOTONS SENT FROM THE LIGHT BULB. THE TYPE OF LIGHT IS THE SAME WHILE THE AMOUNT HAS CHANGED.

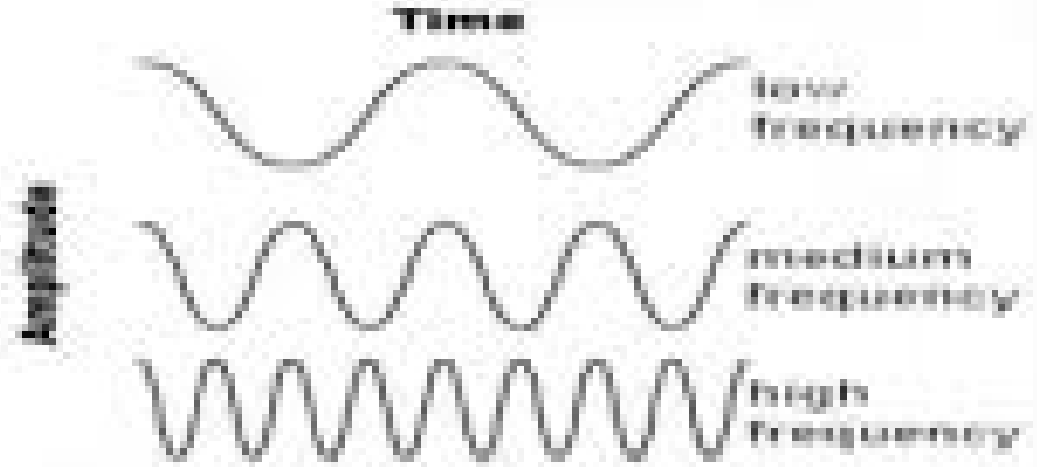
LIGHT IS PURE ENERGY

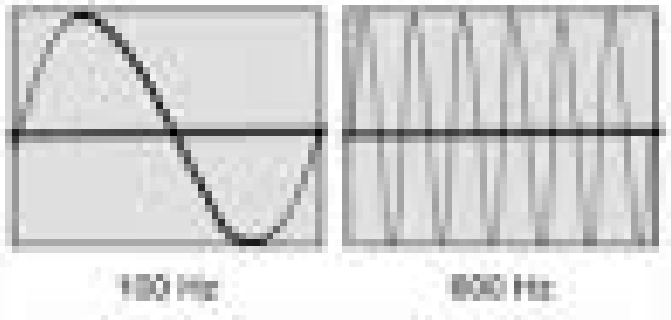


LIGHT IS PURE ENERGY

Frequency (Hertz / Hz)

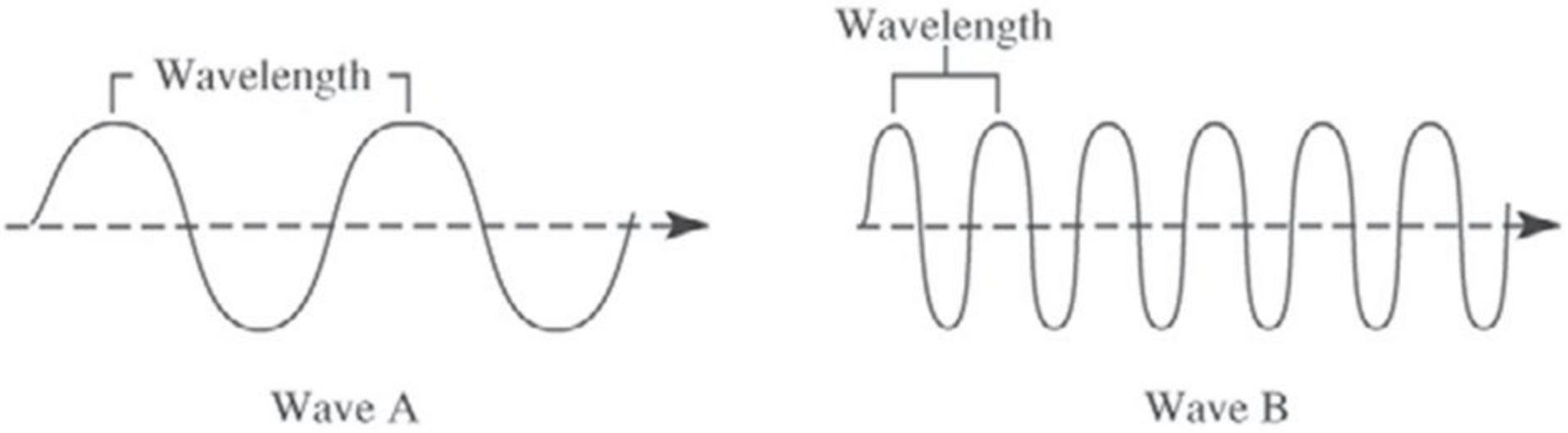
- higher frequency = more energy



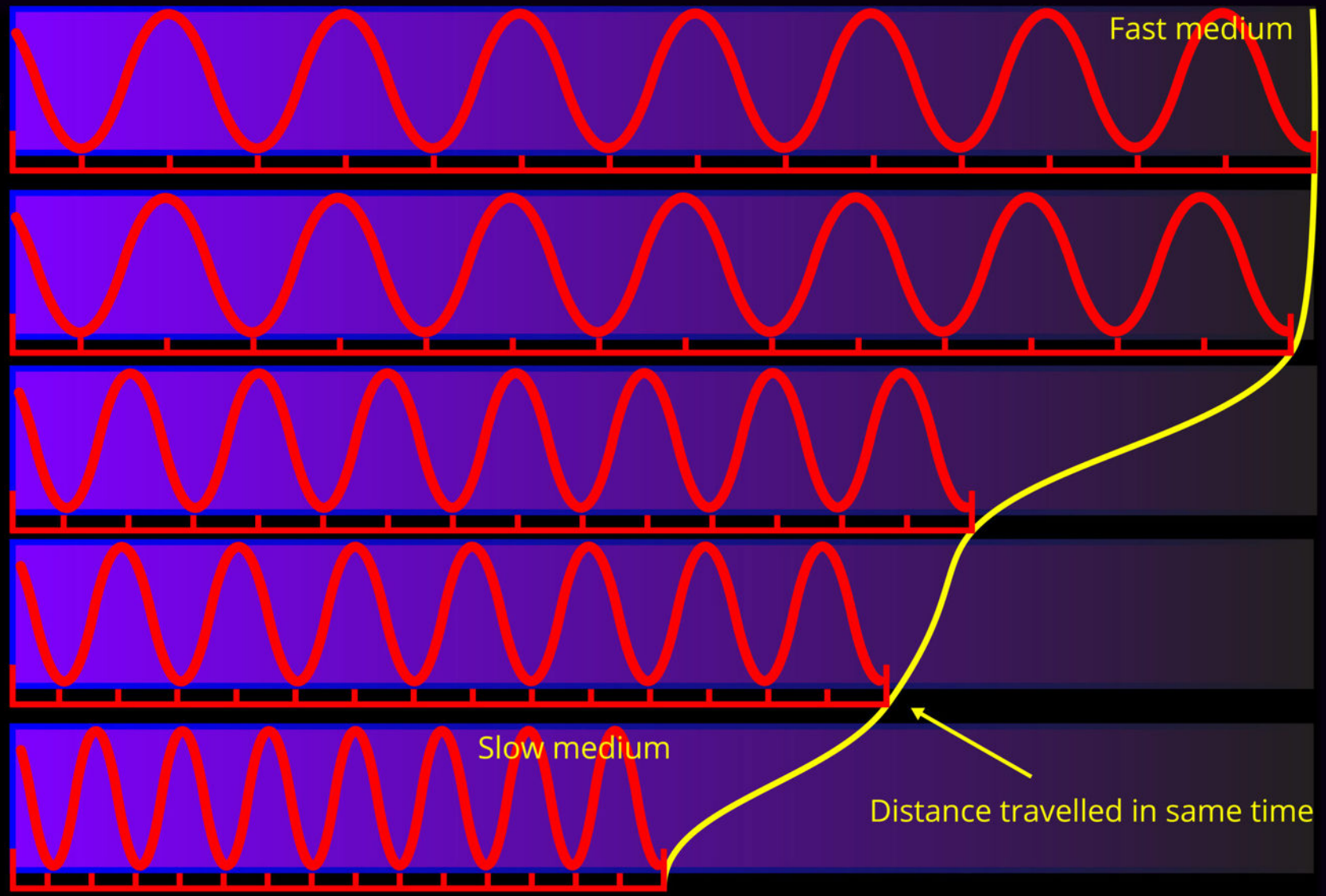


Which wave has the higher energy per photon?

A. Wave A
B. Wave B

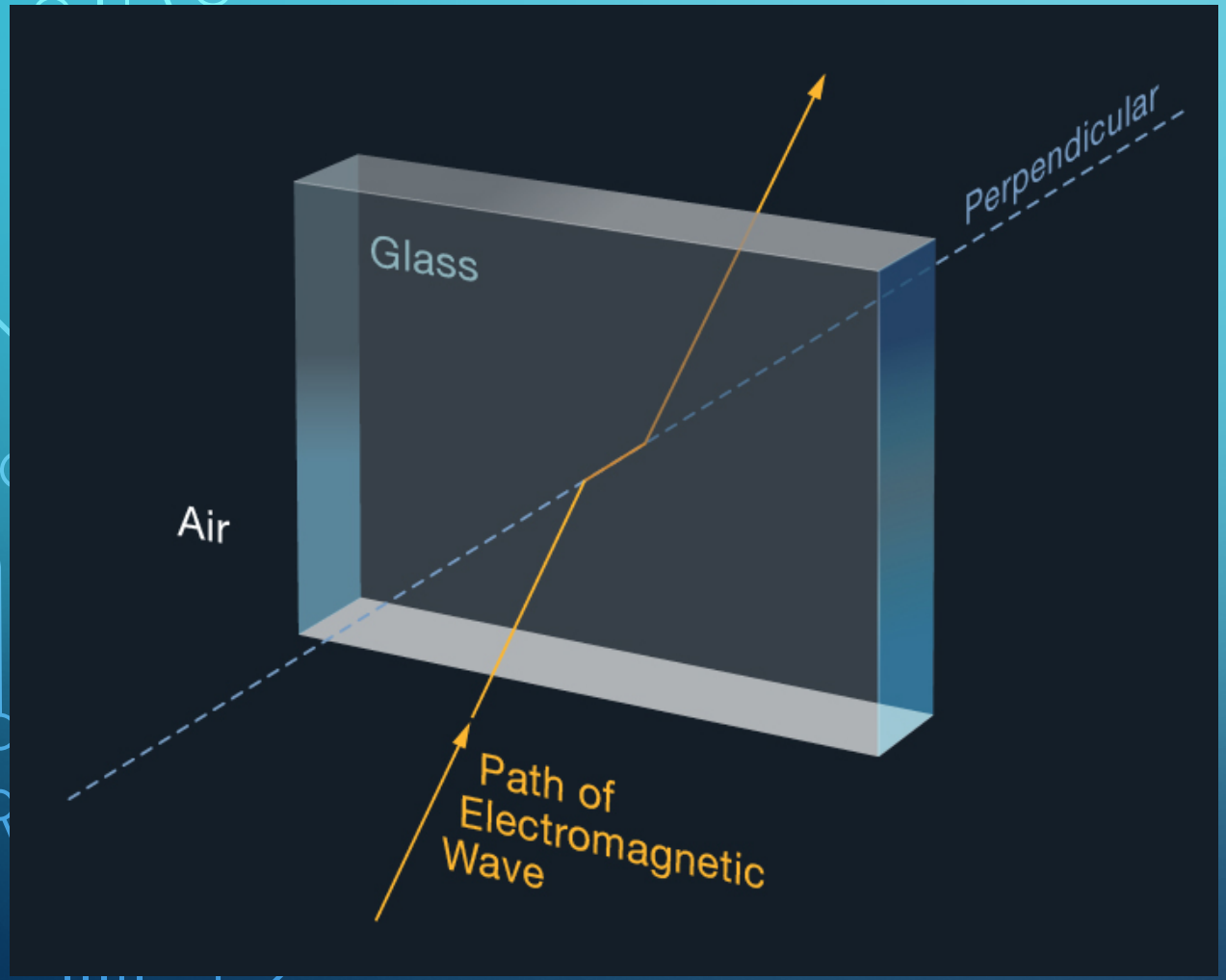


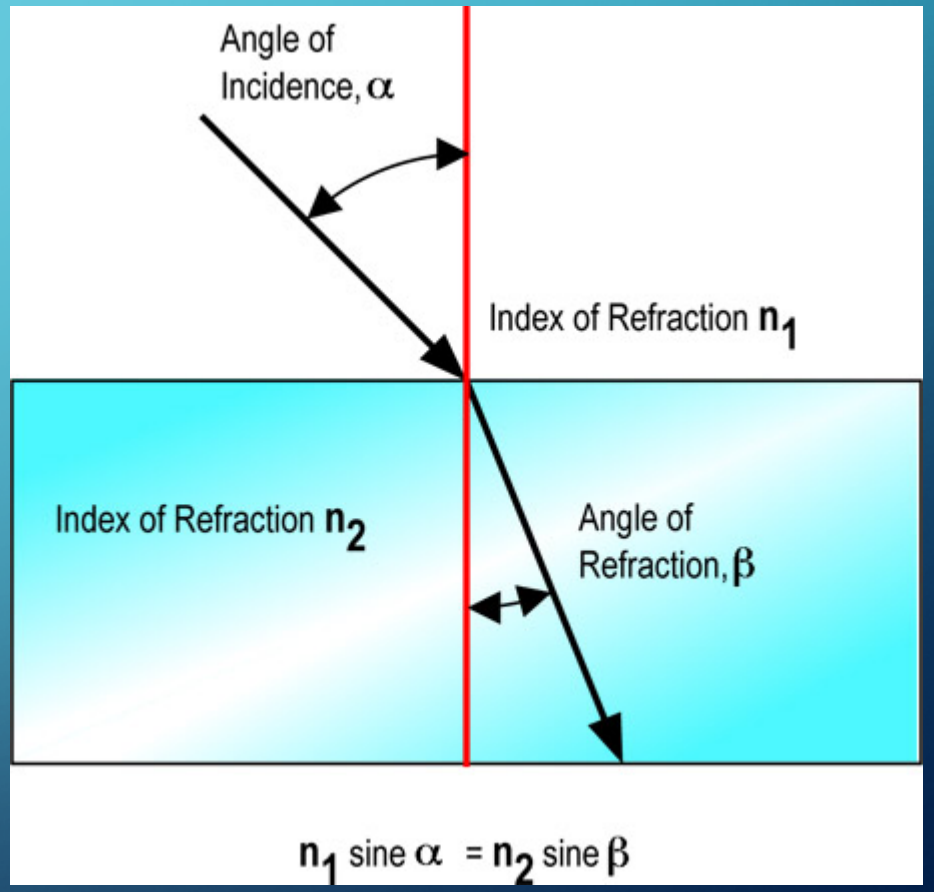
Wavelength and Speed of Light in Different Media



Wavelength and speed change as light travels through different transparent media
Frequency and so colour are unchanged

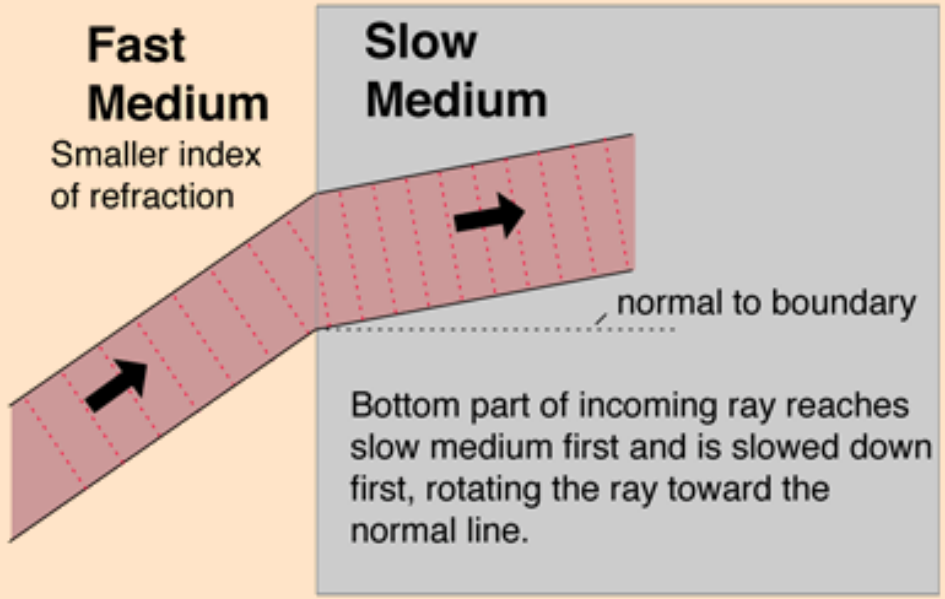
REFRACTION


Glass
Perpendicular
Air
Path of Electromagnetic Wave


Angle of Incidence, α
Index of Refraction n_1
Index of Refraction n_2
Angle of Refraction, β
$n_1 \sin \alpha = n_2 \sin \beta$

REFRACTION

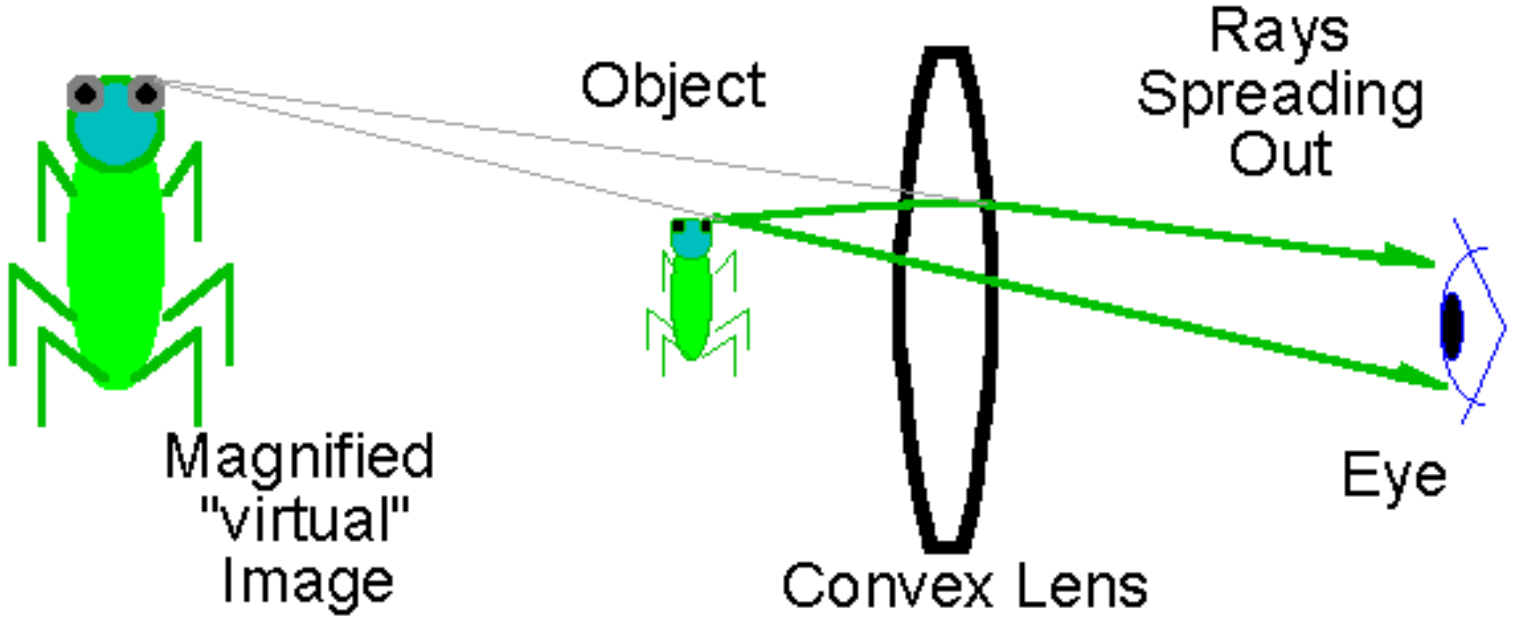
Refraction is responsible for image formation by lenses and the eye.



$$n = \frac{c}{v}$$

n = *index of refraction*; c = *velocity of light in vacuum*; v = *velocity of light in the medium*

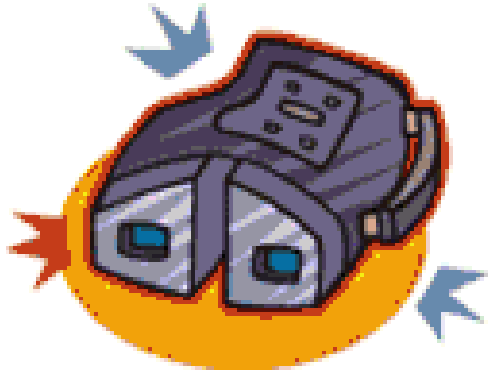
MAGNIFYING



If a convex lens is held near an object, the object looks bigger because the lens bends the light rays inward. The eyes trace the light rays back in straight lines and see a "virtual" image that is magnified.
(Description from *Light* by David Burnie)

USE OF THE LENSES

a. Telescope



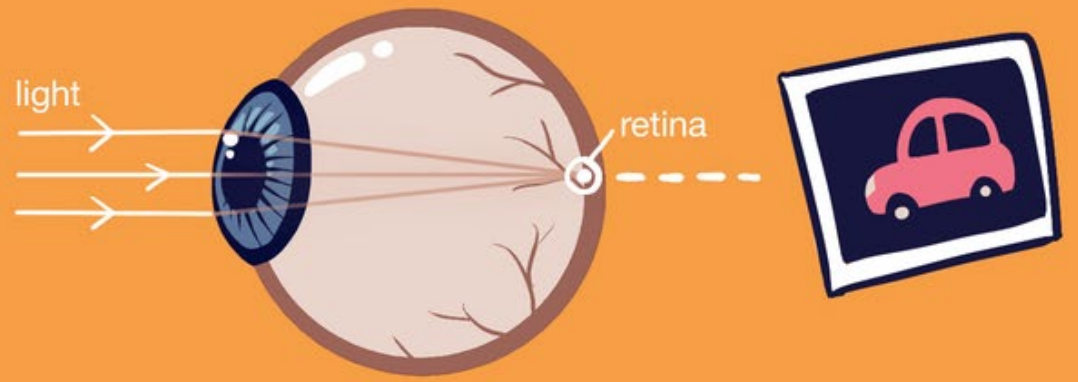
b. Night vision goggles

c. Camera

d. Projector

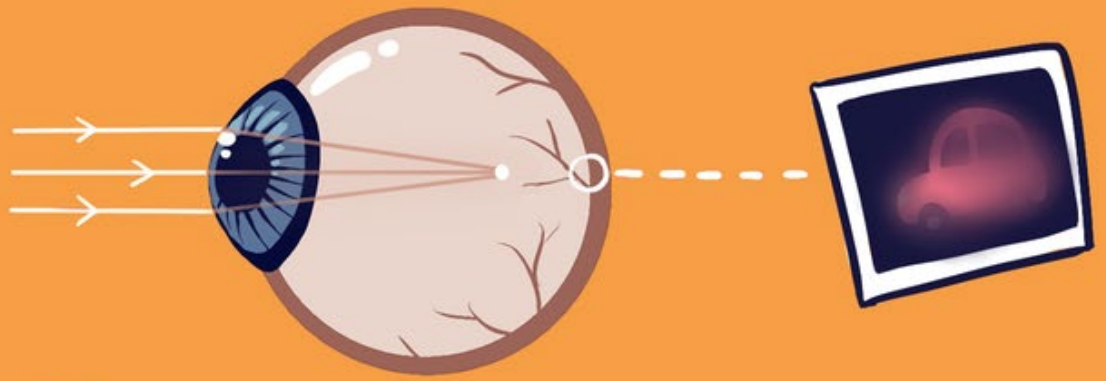
e. Glasses

f. Microscope



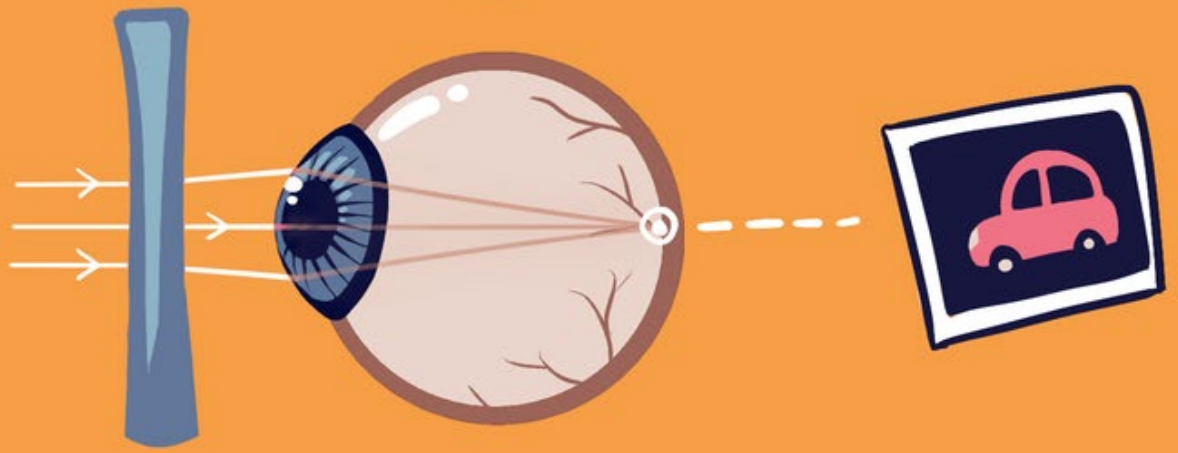
Light is focusing correctly onto the retina, so we see things clearly.

✓



Light is not focusing correctly onto the retina, so things appear blurry.

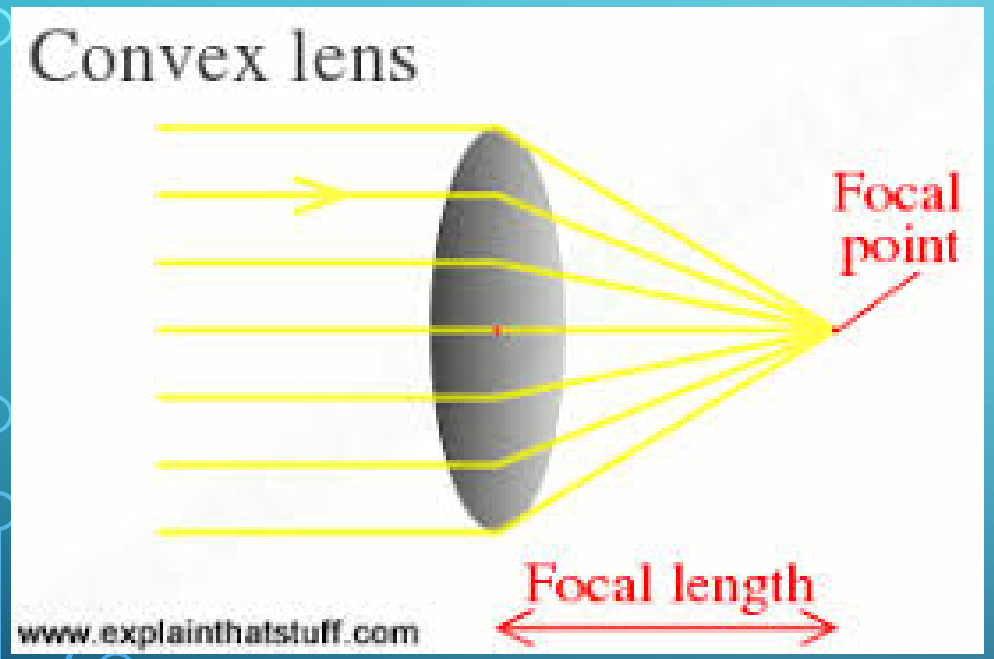
✗

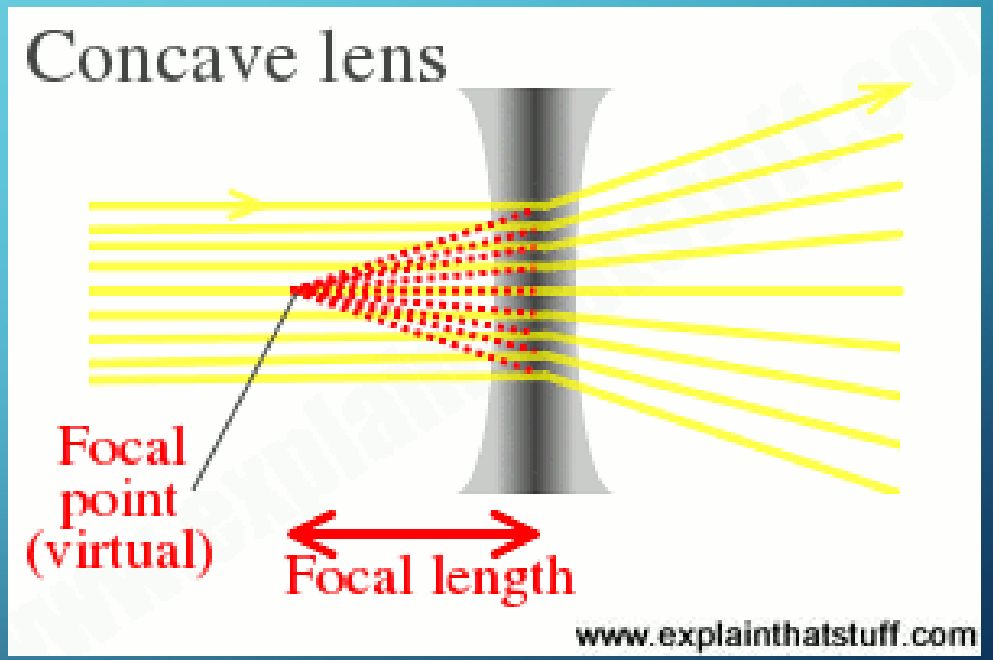


Glasses help to focus light to the correct place so that we can see clearly.

✓

LENSES BEND LIGHT IN USEFUL WAYS.

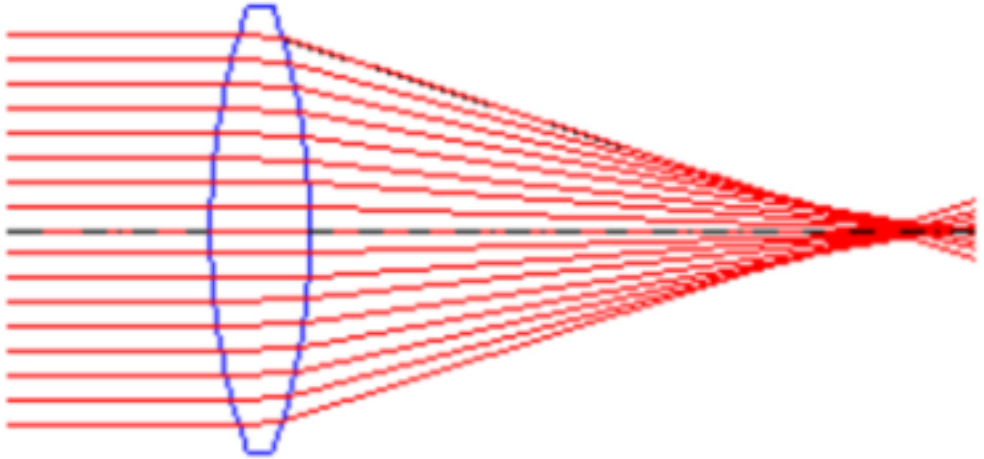




There are TWO basic simple lens types

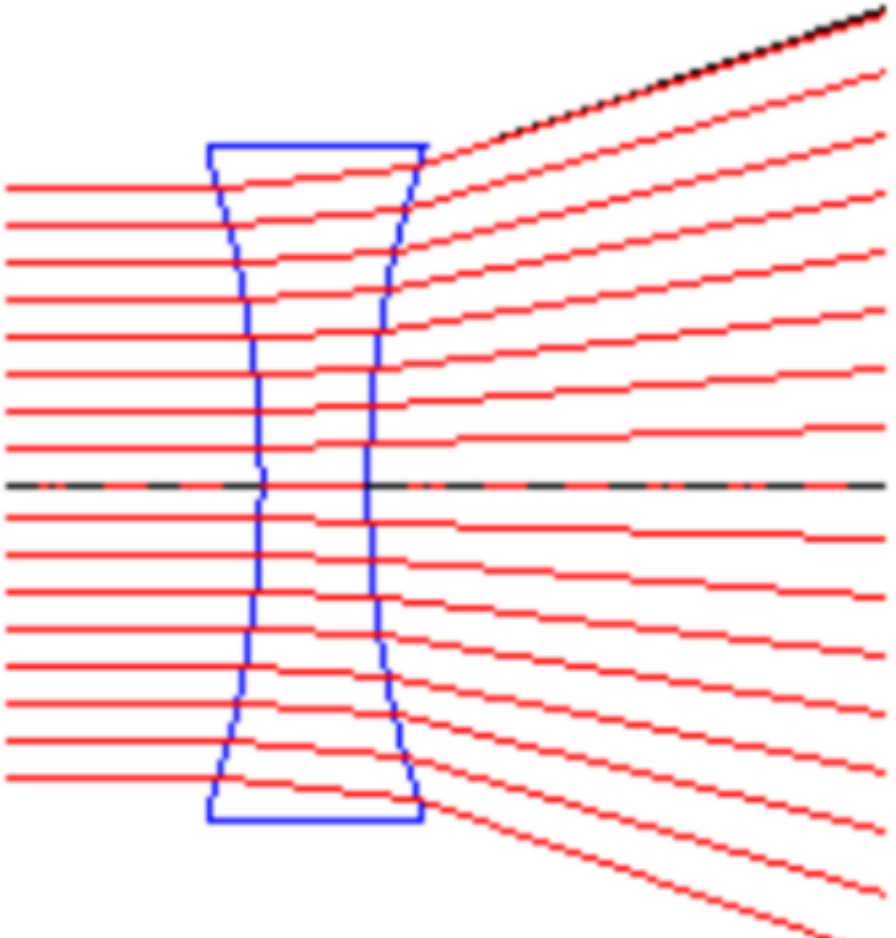
What is a convex lens?

CONVEX or POSITIVE lenses will CONVERGE or FOCUS light and can form an IMAGE

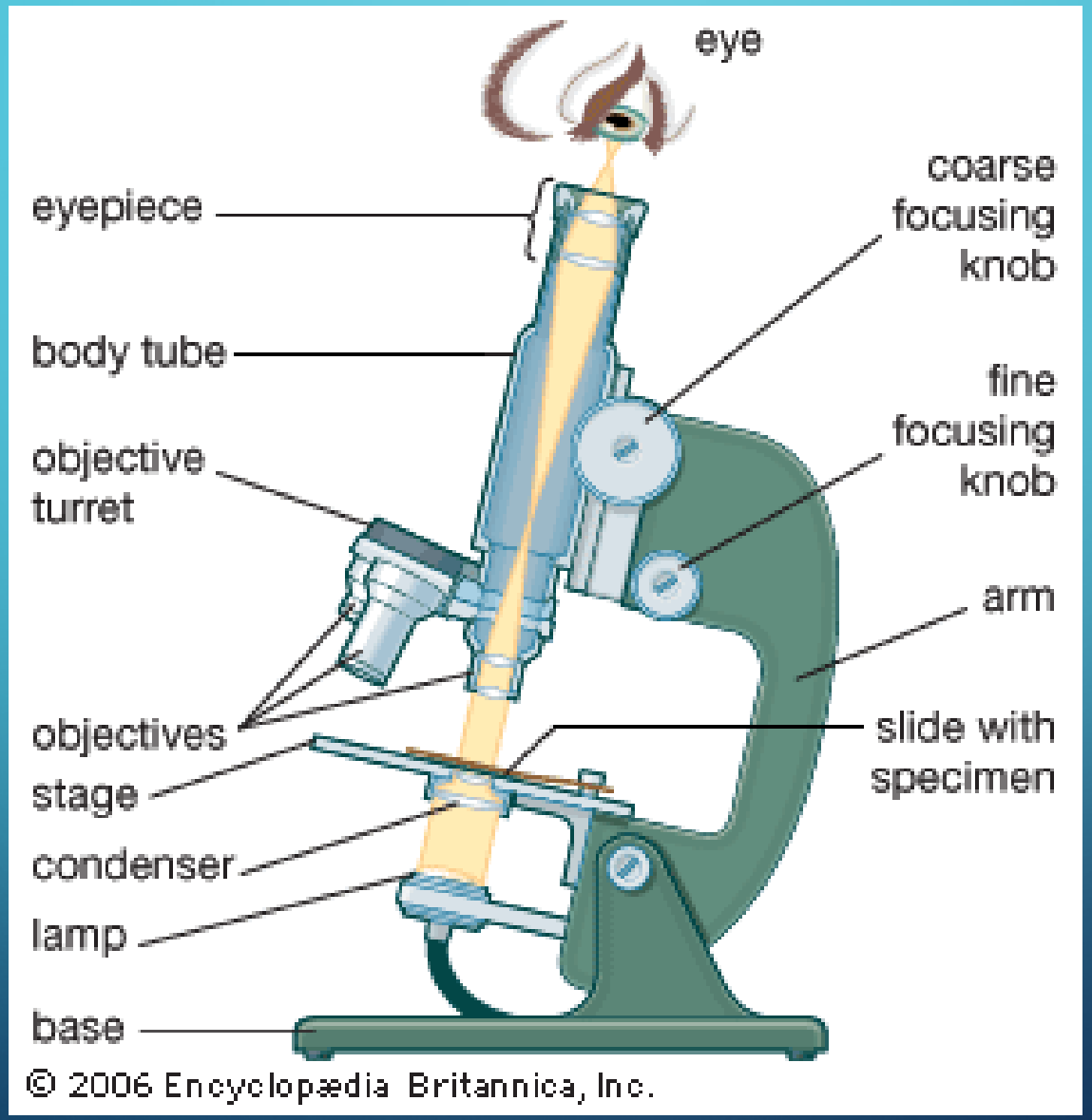


What is a concave lens?

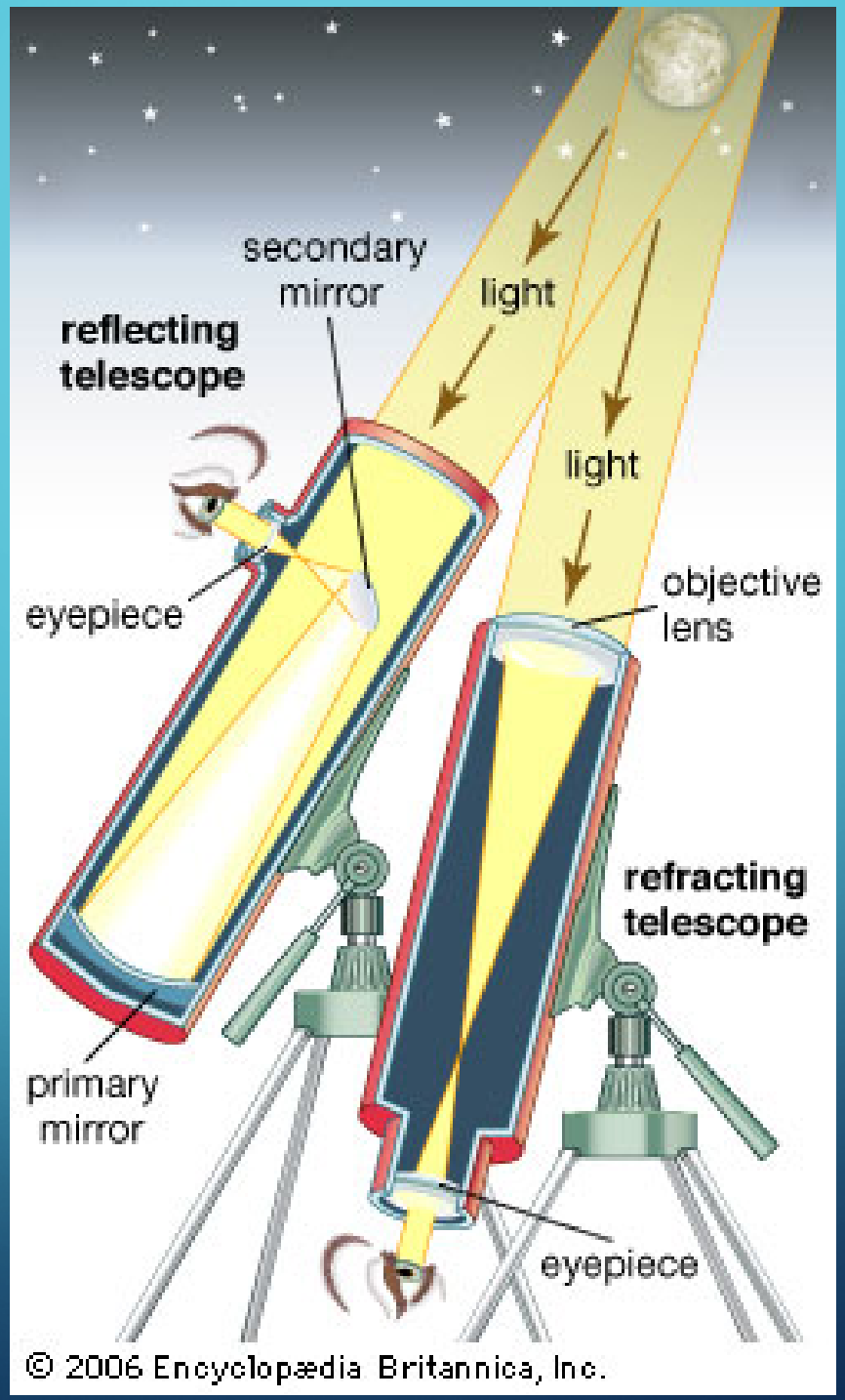
CONCAVE or NEGATIVE lenses will DIVERGE (spread out) light rays



OPTICAL MICROSCOPE EXPLAINED



TELESCOPES EXPLAINED



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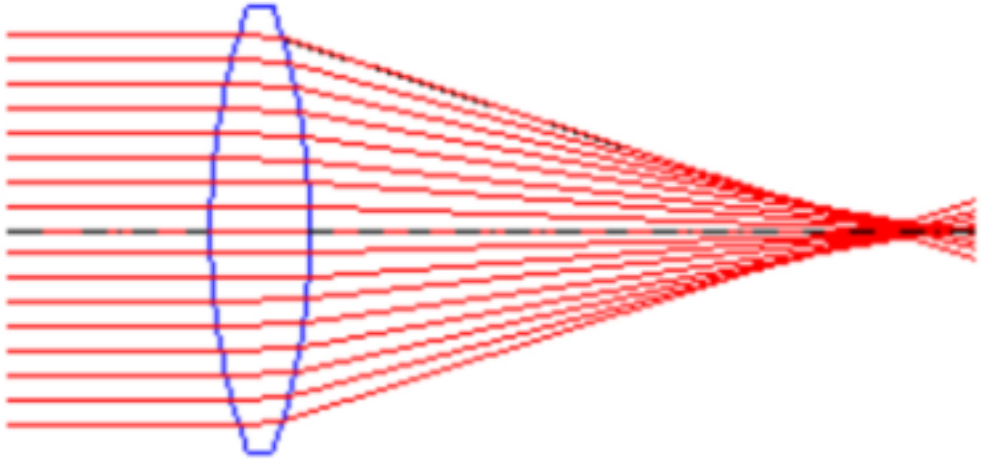
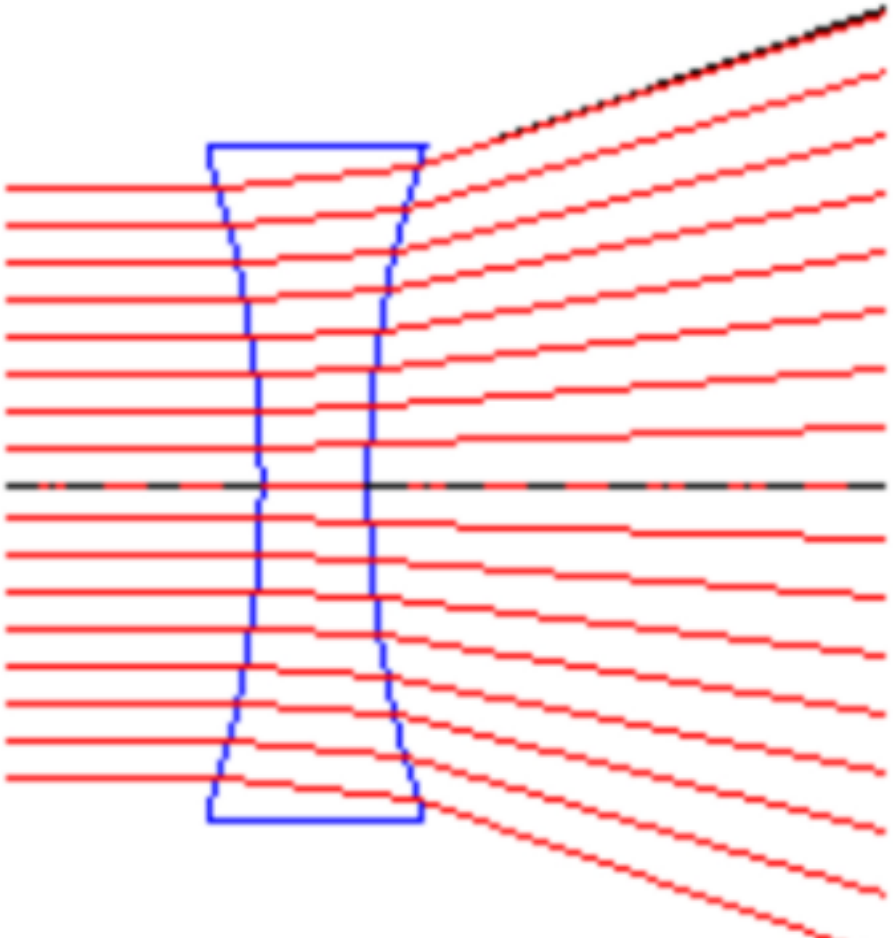


What is a concave lens?

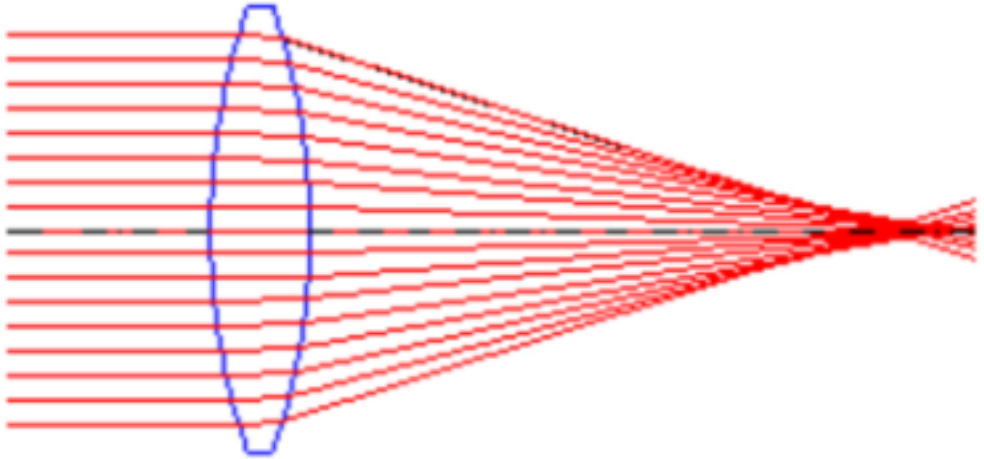
CONCAVE or NEGATIVE lenses will DIVERGE (spread out) light rays



There are TWO basic simple lens types

What is a convex lens?

CONVEX or POSITIVE lenses will CONVERGE or FOCUS light and can form an IMAGE



What is a concave lens?

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