



# General Wave Properties



# What is a wave?

- A wave is a periodic disturbance in a solid, liquid or gas as energy is transmitted.
- A wave is characterized by its wavelength, frequency, and amplitude
- Light waves don't require a medium
- Another name for light waves are Electromagnetic Waves

# Transverse

- Waves that travel perpendicular to the direction of motion
- Has crests and troughs
- Examples: Light, crowd waves, seismic s waves for earthquakes, Ocean waves & the waves created when you pluck an instrument.

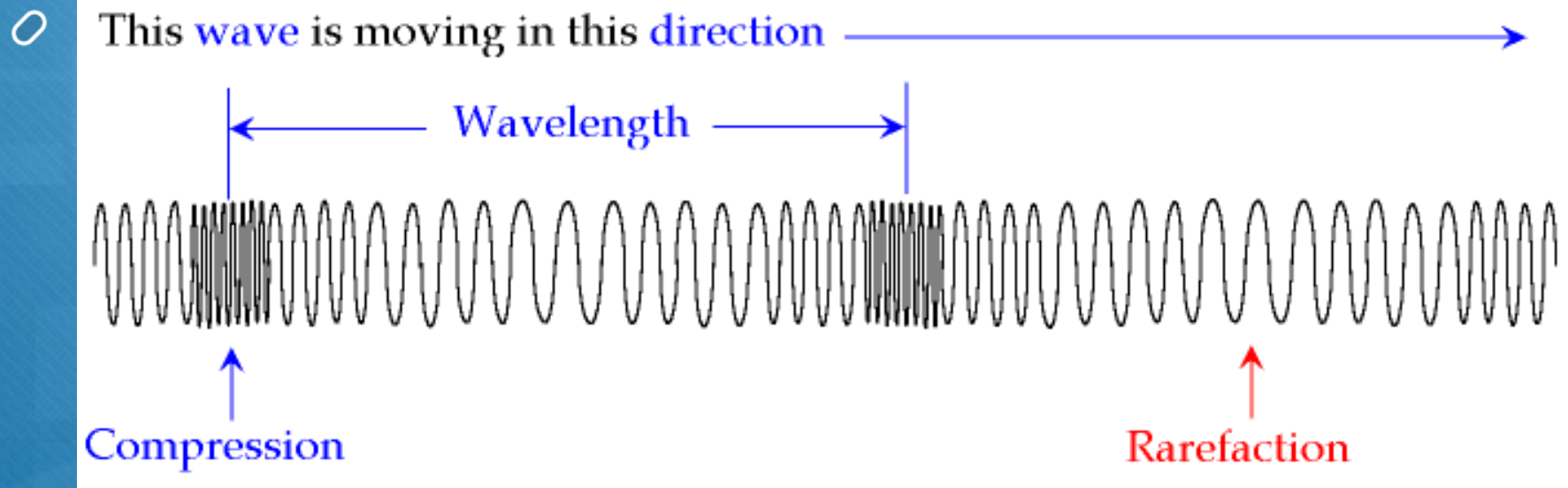


# Mechanical Waves

- They are divided into transverse and longitudinal waves
- **Mechanical waves** are waves that require a medium. This means that they have to have some sort of matter to travel through.
- These waves travel when molecules in the medium collide with each other passing on energy.
- One example of a mechanical wave is sound.
  - Sound can travel through air, water, or solids, but it can't travel through a vacuum.
  - It needs the medium to help it travel.
  - Other examples include water waves, seismic waves, and waves traveling through a spring.

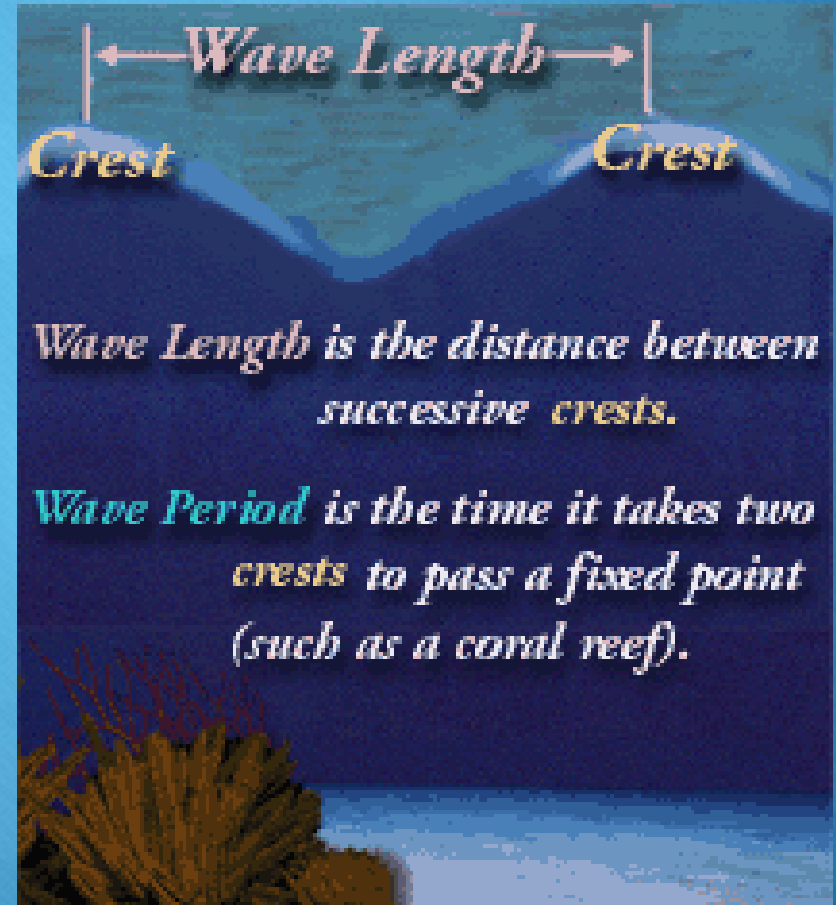
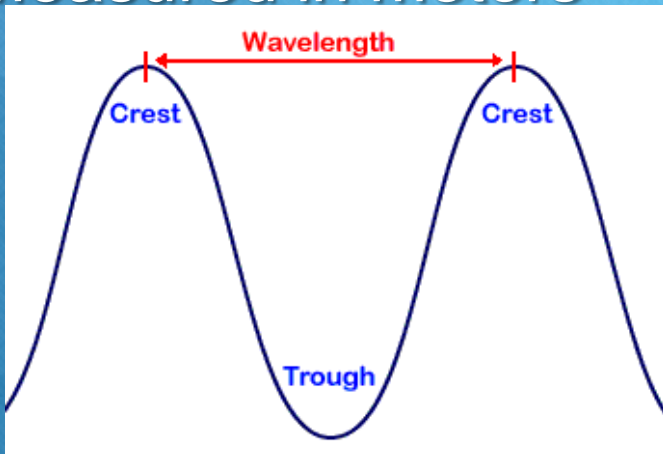
# Longitudinal

- Waves that travel parallel to the direction of motion
- Made up of compressions and rarefactions in the medium that they are traveling in
- Water waves are examples of surface waves



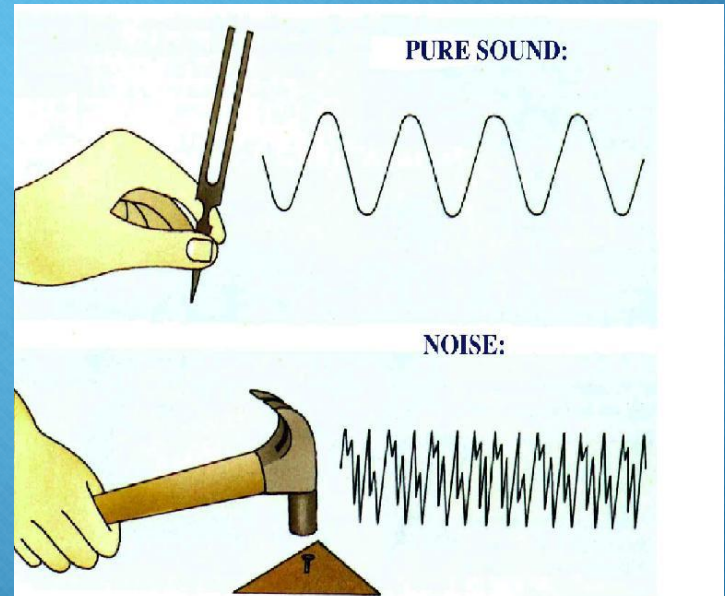
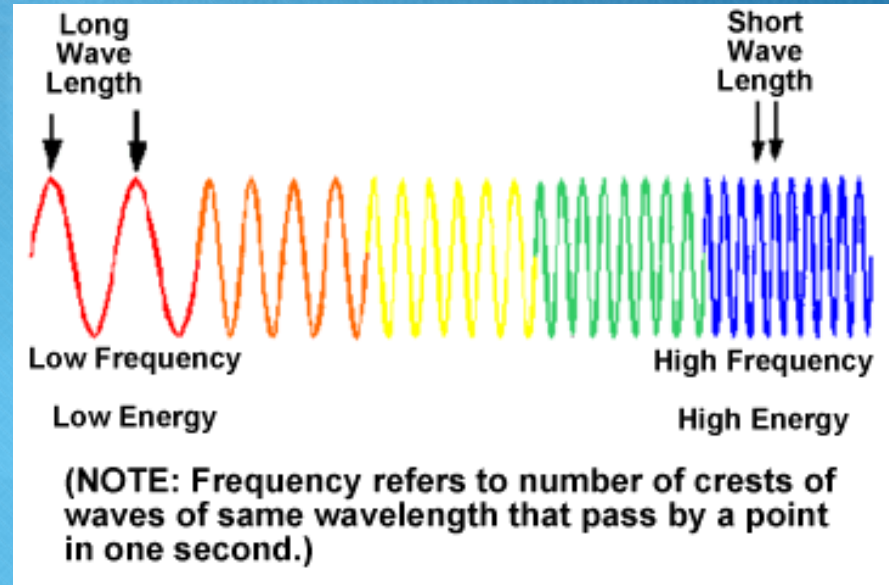
# Wavelength

- Distance from successive crest to crest or trough to trough
- The distance from any point on a wave to an identical point on the next wave.
- Measured in meters



# Frequency

- Number of crests passing by per second
- Measure the rate of vibrations
- Measured in Hertz (Hz)
- Number of full wavelengths that pass a point in a given time interval.



# Amplitude

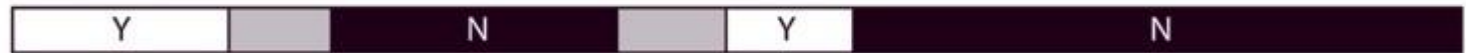
- The amplitude will have different units depending on the type of wave
- In a sketch of the wave, it is the distance from the middle of the wave to the peak
- Large waves have more amplitude and more energy.



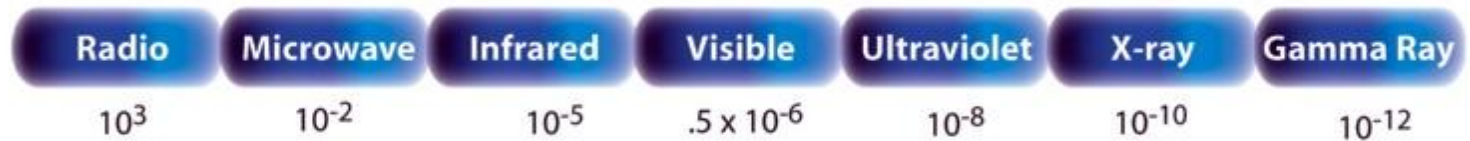


# THE ELECTROMAGNETIC SPECTRUM

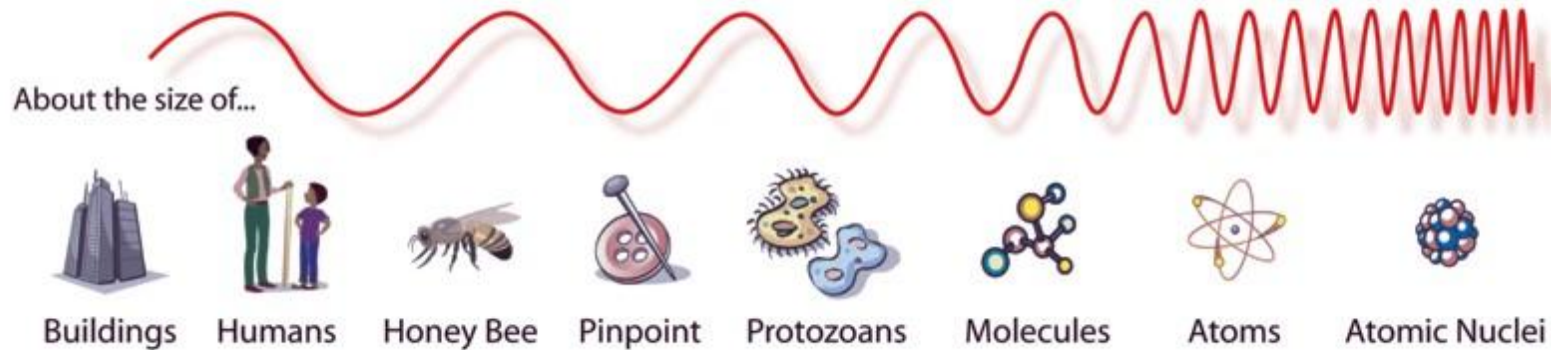
Penetrates Earth Atmosphere?



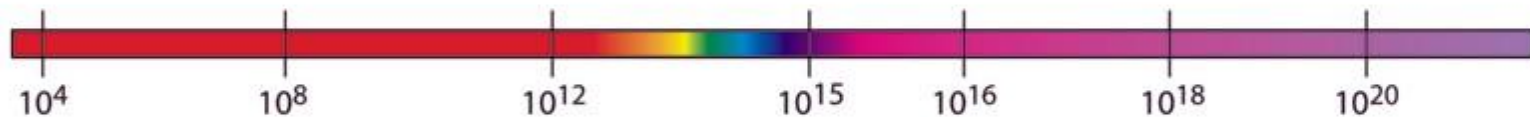
Wavelength (meters)



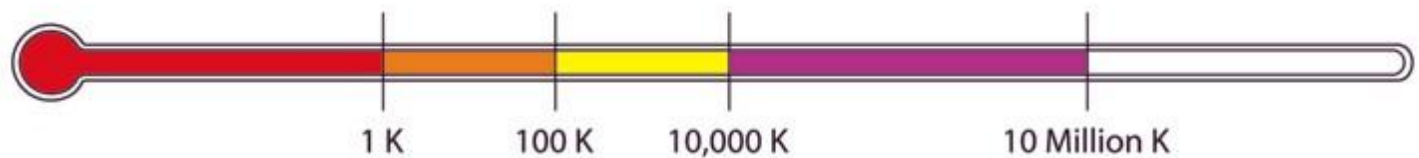
About the size of...



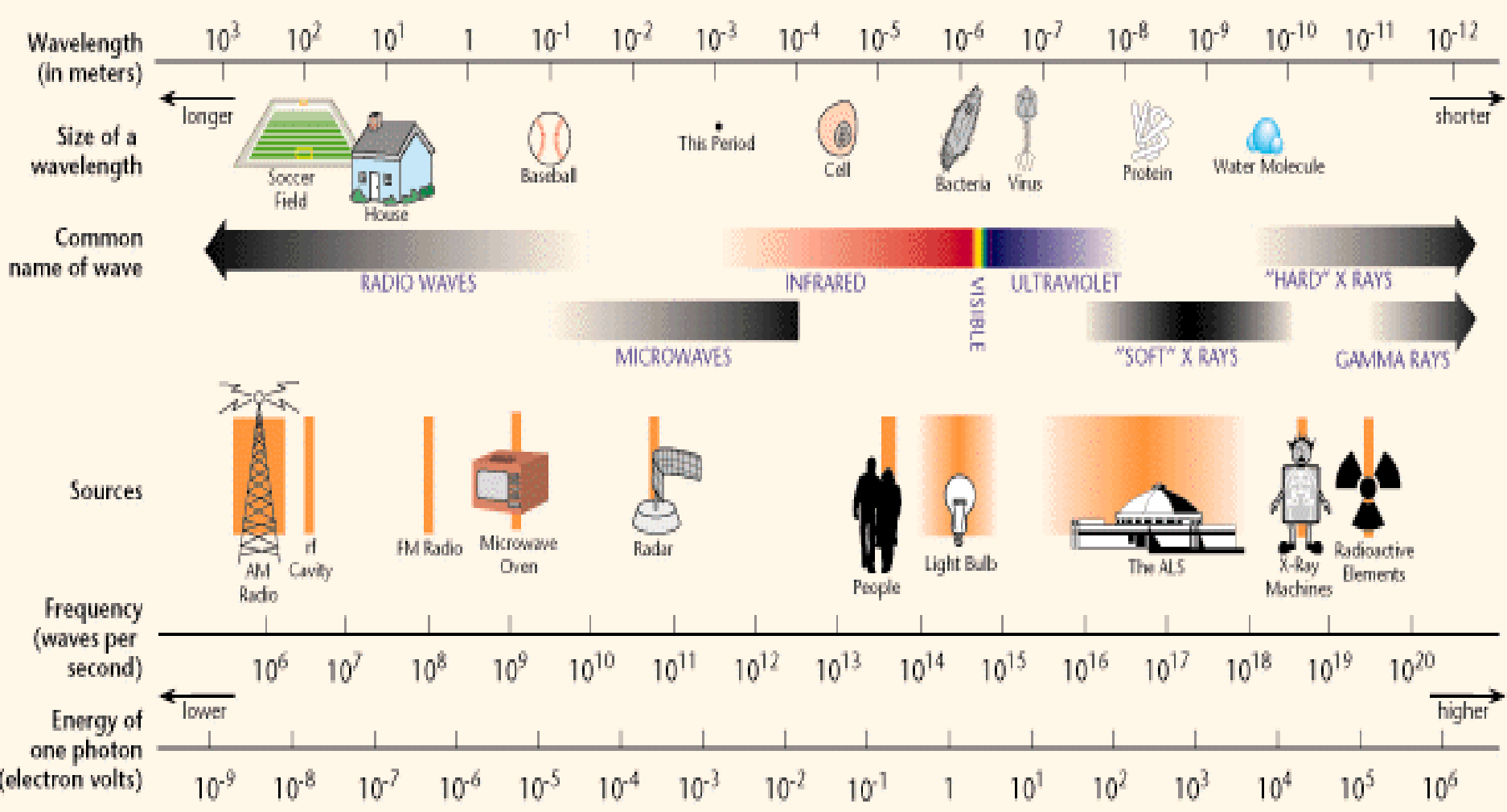
Frequency (Hz)



Temperature of bodies emitting the wavelength (K)



# THE ELECTROMAGNETIC SPECTRUM



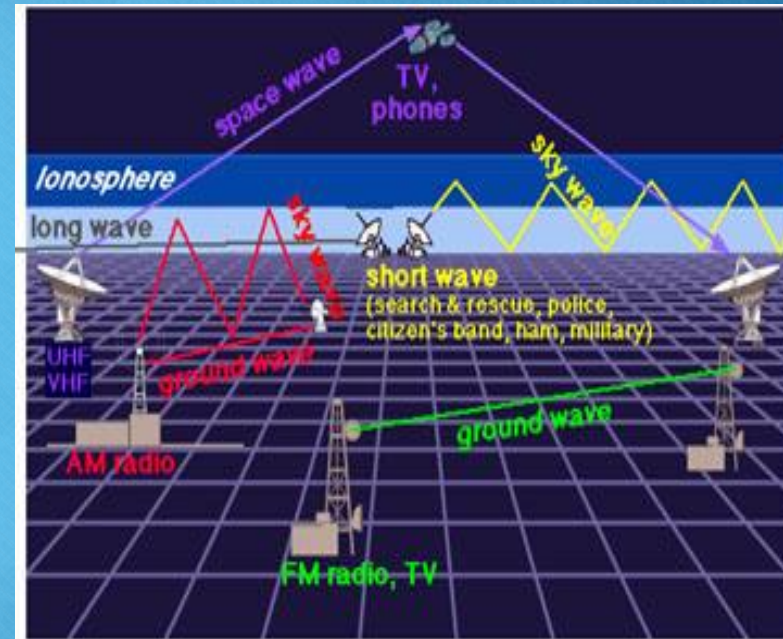


# Electromagnetic Spectrum

## ■ Invisible Spectrum

### ■ Radio Waves


- – Longest wavelength & lowest frequency.
- Cause of noise
- 3 Hz – 300 GHz (100km – 1m)
- Heinrich Hertz – founded radio waves





# Why Do We Care About Radio Waves?

- Gadgets- cell phones, microwaves, remote controls, garage door openers
- Uses – Radio & T.V. broadcasting, radar communication.
- Science- radio astronomy, atmospheric research

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- Microwaves
  - Long wavelength
    - Very high frequency
    - Heinrich Hertz
    - 300MHz – 300GHz (1m-1mm)

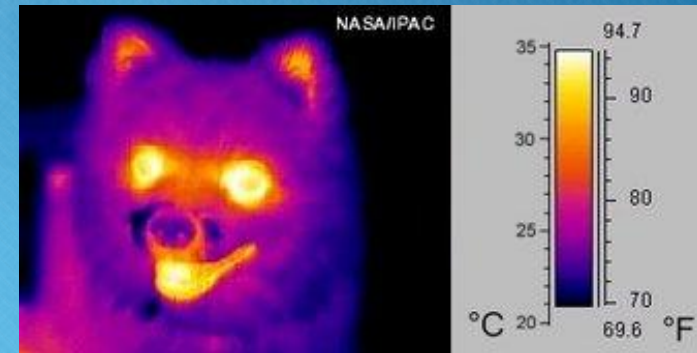


# Why Do We Care About Microwaves?

- Gadgets – Wi-Fi, mobile phones
- Absorbed by water molecules – how microwave ovens heat food
- Uses - telecommunications and power transmission
- Science: stars, traffic speed cameras, radar (aircrafts and weather)

# Electromagnetic Spectrum

- Invisible Spectrum
- Infrared Rays



- Light rays with longer wavelength than red light.
- Easily absorbed.
- William Herschel
- 300GHz – 400THz (1mm-750nm)



# Why Do We Care About Infrared Waves?

- Gadgets- remote controls, TV
- **Uses: Cooking, Medicine (muscle therapy)**
- Science- night vision

<https://www.youtube.com/watch?v=i8caGm9Fmh0#action=share>





- Visible Spectrum

- Visible Light

- Only EM waves we can see, we see the colors
- Each color has a different wavelength
- Easily absorbed.
- 400THz – 770THz (750nm-390nm)



# Why Do We Care About Visible Light?

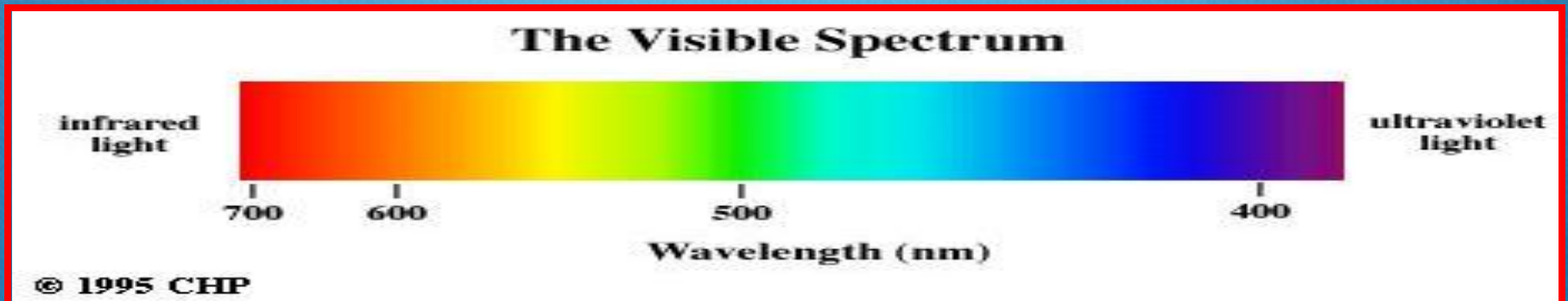
- Gadgets- photography, CD's
- **Uses: vision, colors (ROY G BIV)**
- Science- illumination, lasers

<http://www.pbslearningmedia.org/resource/npe11.sci.phys.energy.emvisible/tour-of-the-electromagnetic-spectrum-visible-light/>

# Electromagnetic Spectrum

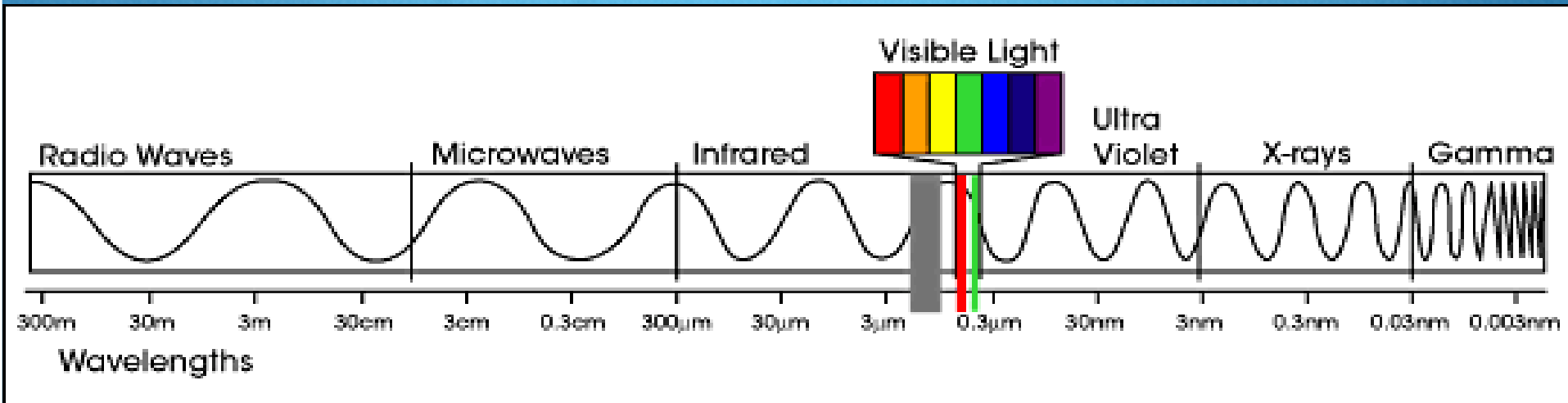
Visible Spectrum – Light we can see  
Roy G. Biv – Acronym for **Red**,  
**Orange**, **Yellow**, **Green**, **Blue**, **Indigo**,  
& **Violet**.

**Largest** to **Smallest** Wavelength.



# Electromagnetic Spectrum

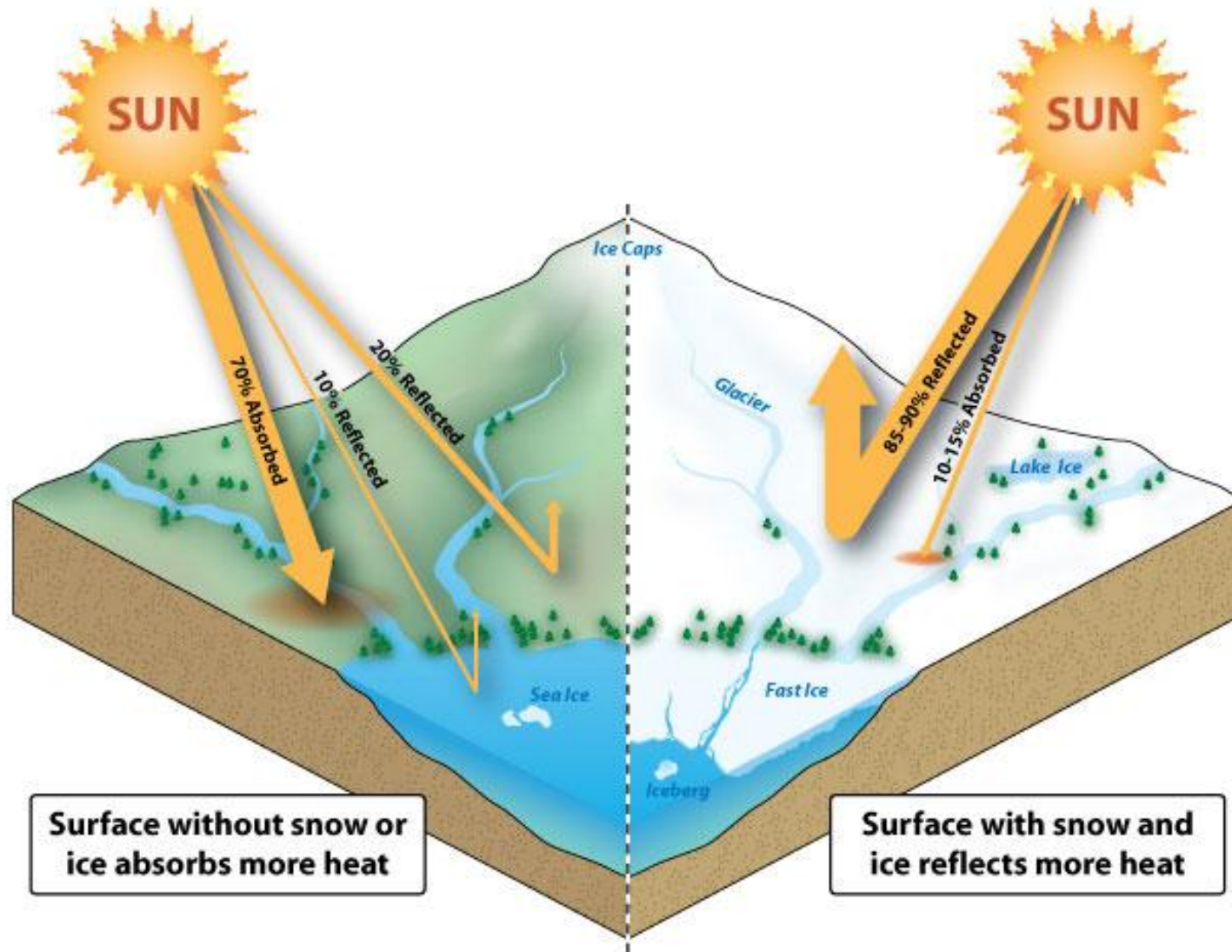
- White light: combination of **all** the colors
  - Rainbow: example of white light that has been separated into a continuous spectrum of colors
  - The names of colors are assigned in order of their wavelengths
  - Used for communications (fiber optics)
- Sources: very hot objects

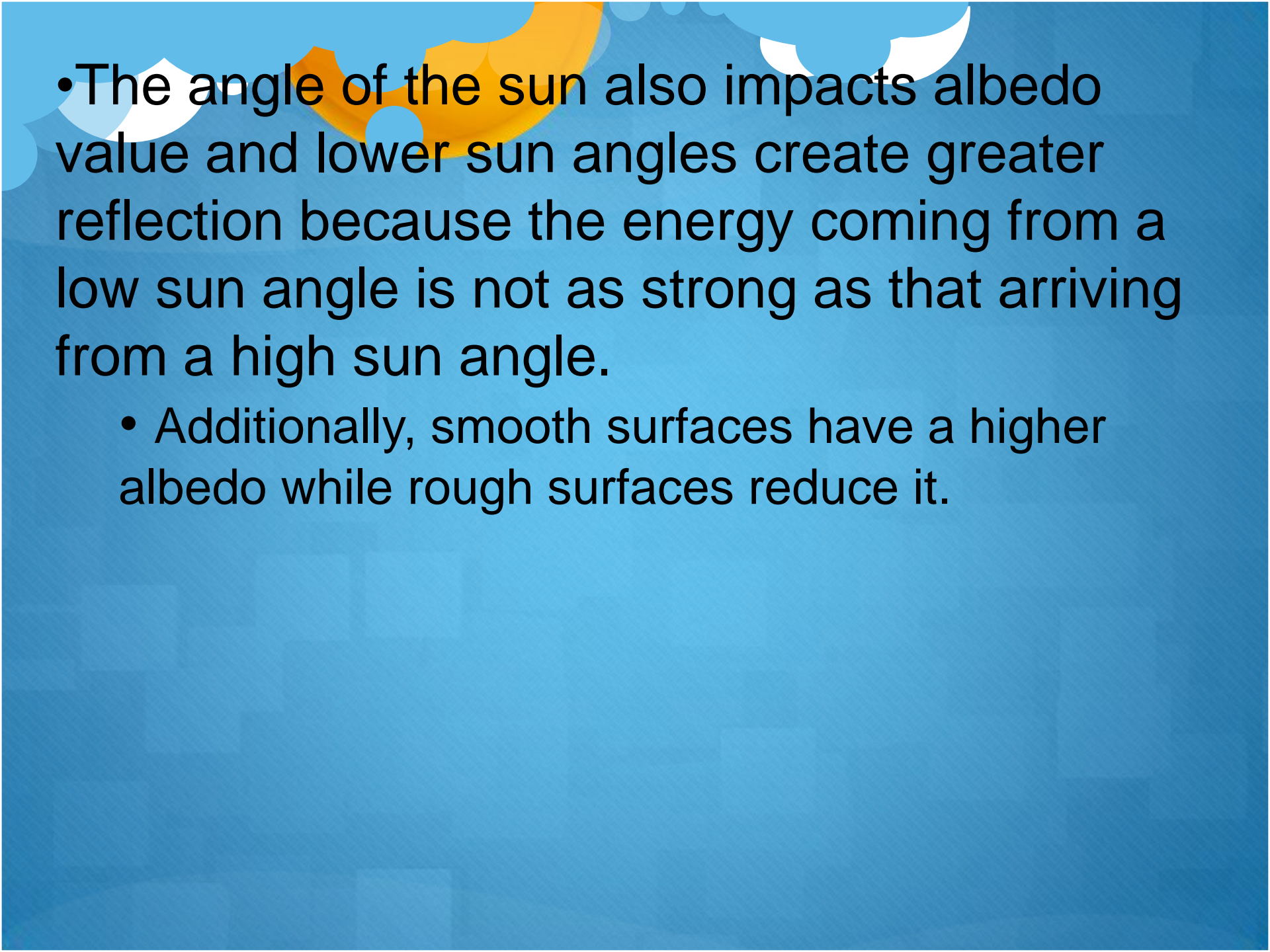


# What is Albedo?

- Albedo is defined as the reflective quality of a surface.
- It is expressed as a percentage of reflected insolation to incoming insolation and zero percent is total absorption while 100% is total reflection.
- In terms of visible colors, darker colors have a lower albedo, that is, they absorb more insolation, and lighter colors have high albedo, or higher rates of reflection.
  - For example, snow reflects 85-90% of insolation, whereas asphalt reflects only 5-10%.

# Absorption vs Reflection of Albedo

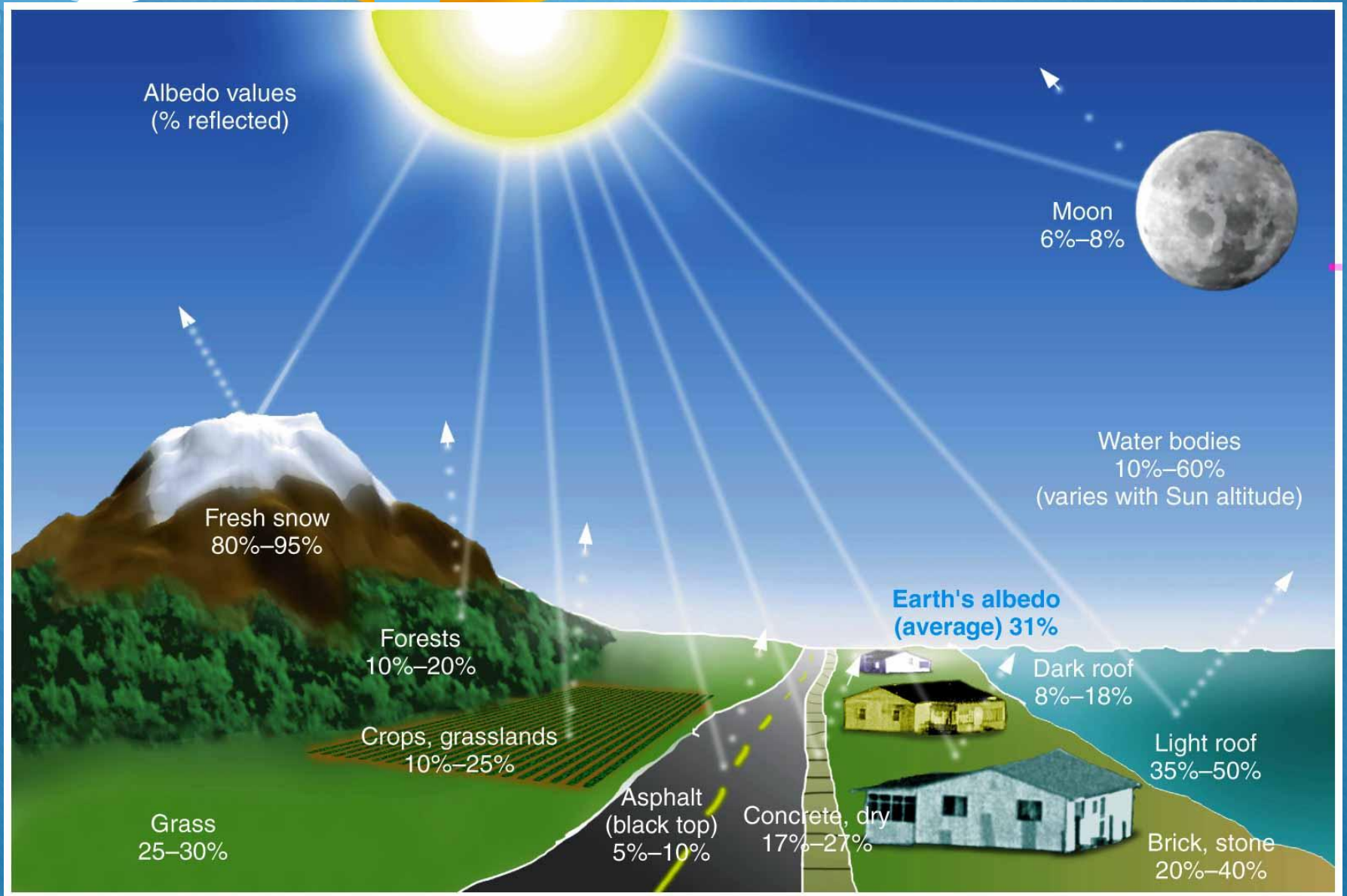




- The angle of the sun also impacts albedo value and lower sun angles create greater reflection because the energy coming from a low sun angle is not as strong as that arriving from a high sun angle.

- Additionally, smooth surfaces have a higher albedo while rough surfaces reduce it.

# Albedo







# Electromagnetic Spectrum

- Invisible spectrum (cont.).
  - Ultraviolet rays.
    - Def. – EM waves with frequencies slightly higher than visible light
    - Helps your body use vitamin D.
    - 750THz-30PHz (400nm-10nm)
    - Johann Ritter



# Why Do We Care About Ultraviolet Waves?

- Gadgets- tanning beds
- Uses: food processing & hospitals to kill germs' cells
- Science- dental curing, sunburns

<https://www.youtube.com/watch?v=QW5zeVy8aE0#action=share>

# Electromagnetic Spectrum

## ■ Invisible Spectrum (Cont.)

### ■ X-Rays

- Def. - EM waves that are shorter than UV rays.
- Lead absorbs X-rays.
- 30PHz-30EHz (10nm-.01nm)
- Wilhelm Rontgen



# Why Do We Care About X-rays?

- **Uses: Medicine – Bones absorb x-rays; soft tissue does not.**
- Science- Medical x-ray, bone scan, baggage screen

# Electromagnetic Spectrum

## ■ Gamma rays

- Def. Highest frequency EM waves; Shortest wavelength. They come from outer space.
- $>15 \text{ Ehz}$  ( $<.02\text{nm}$ )
- Paul Villard, William Henry Bragg, Ernest Rutherford, Edward Andrade



# Why Do We Care About Gamma Rays?

- **Uses: cancer treatment**
- Science- PET imaging, cosmic rays

# How microwaves work



# Tanning Beds

