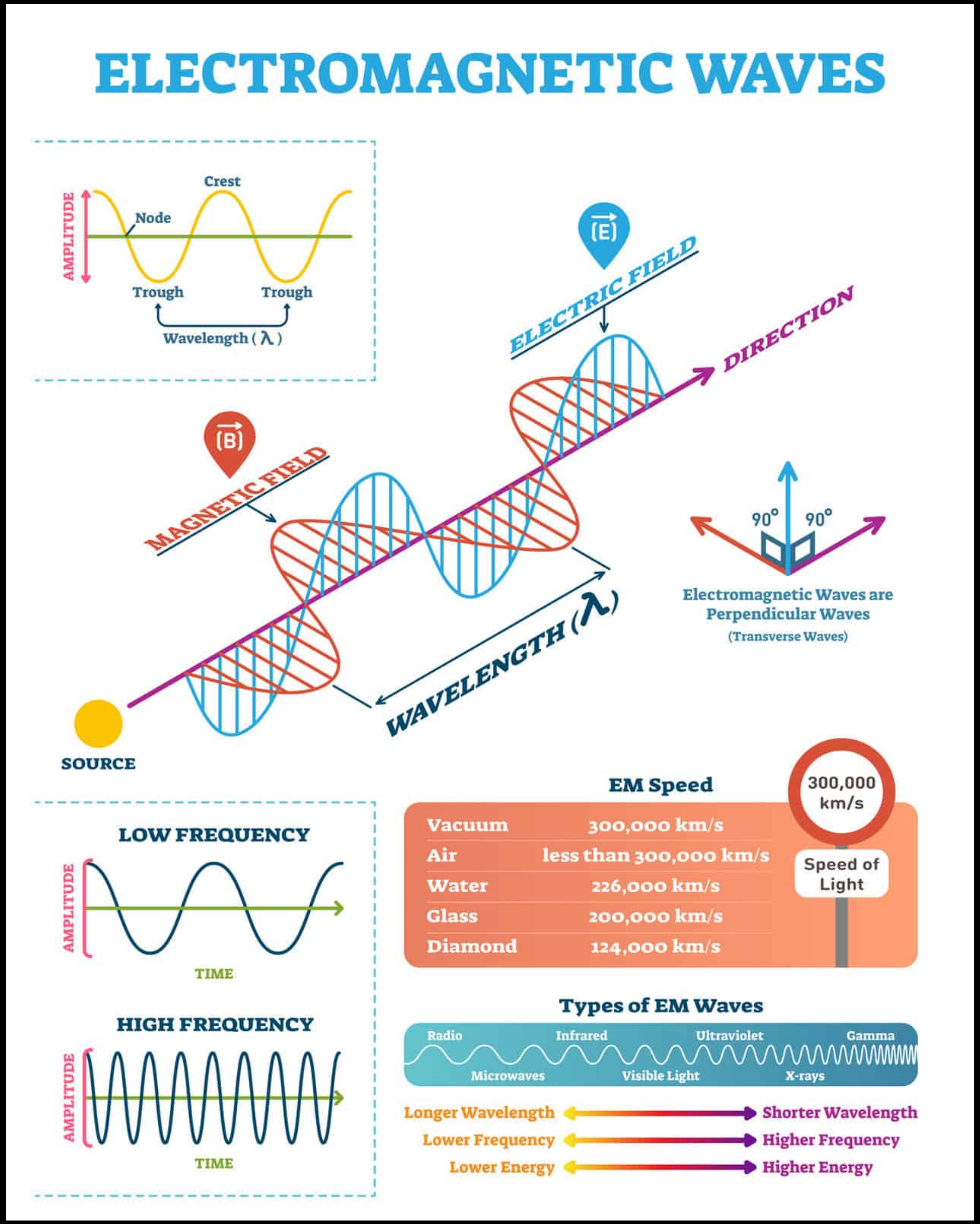
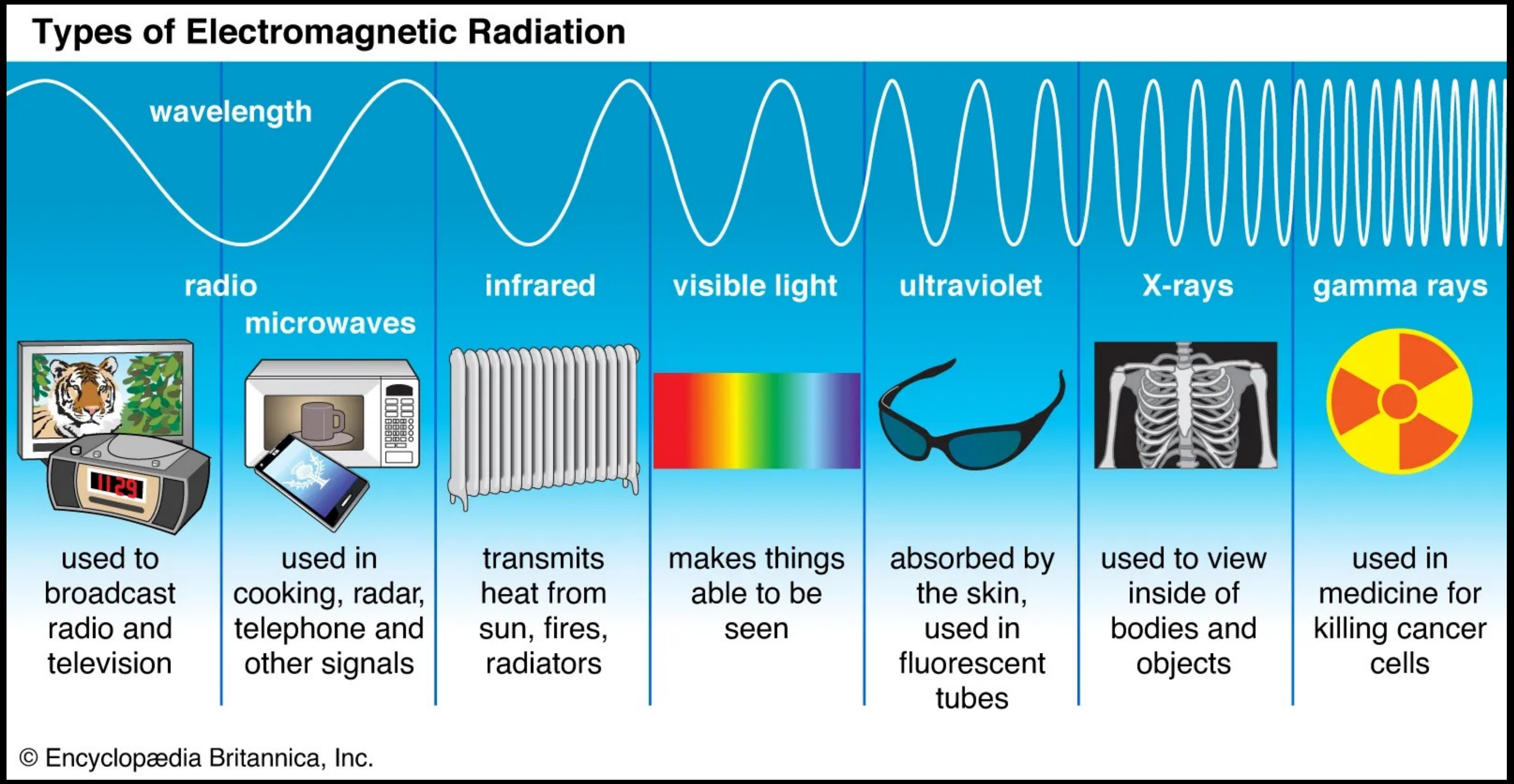
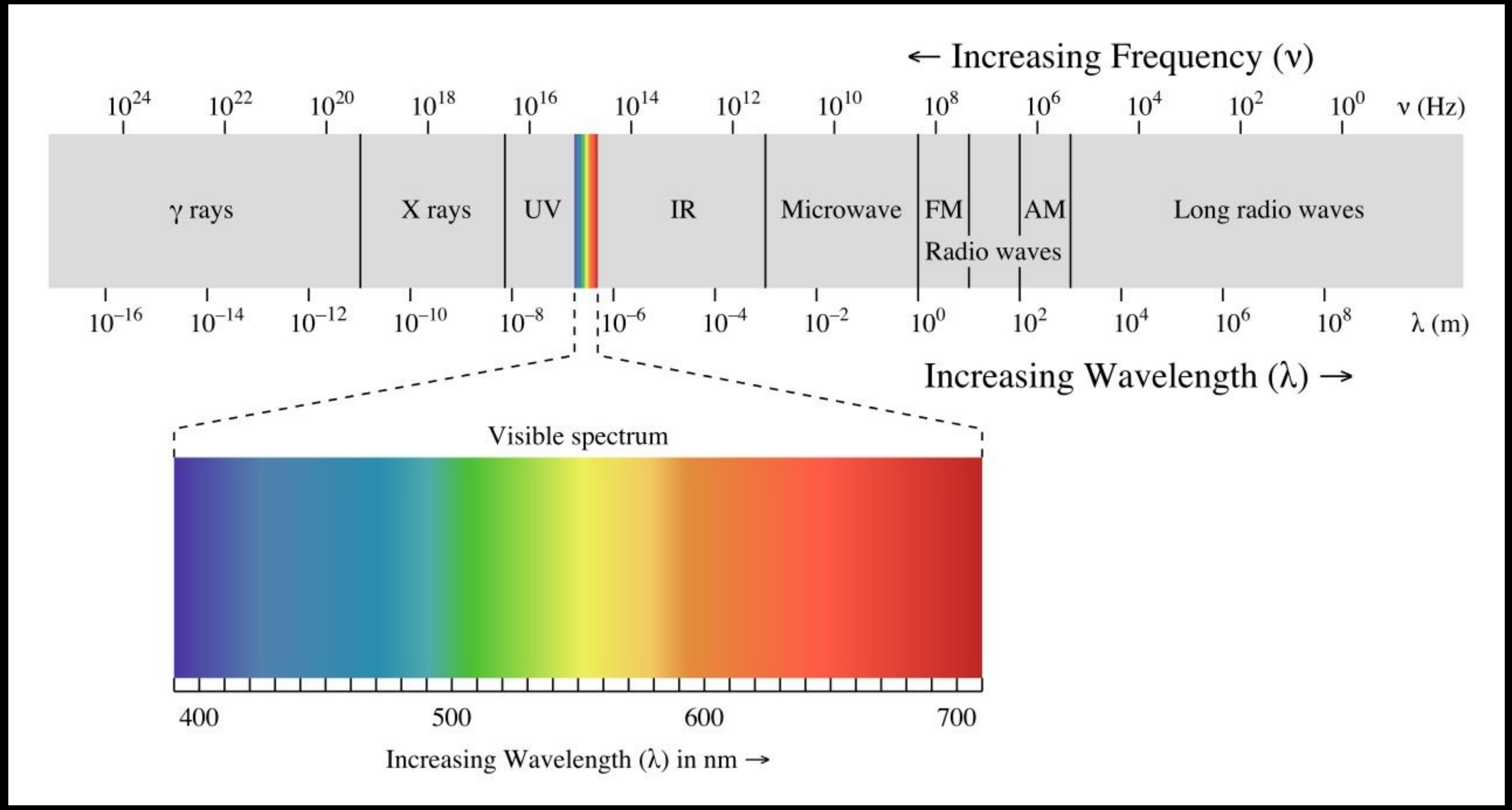
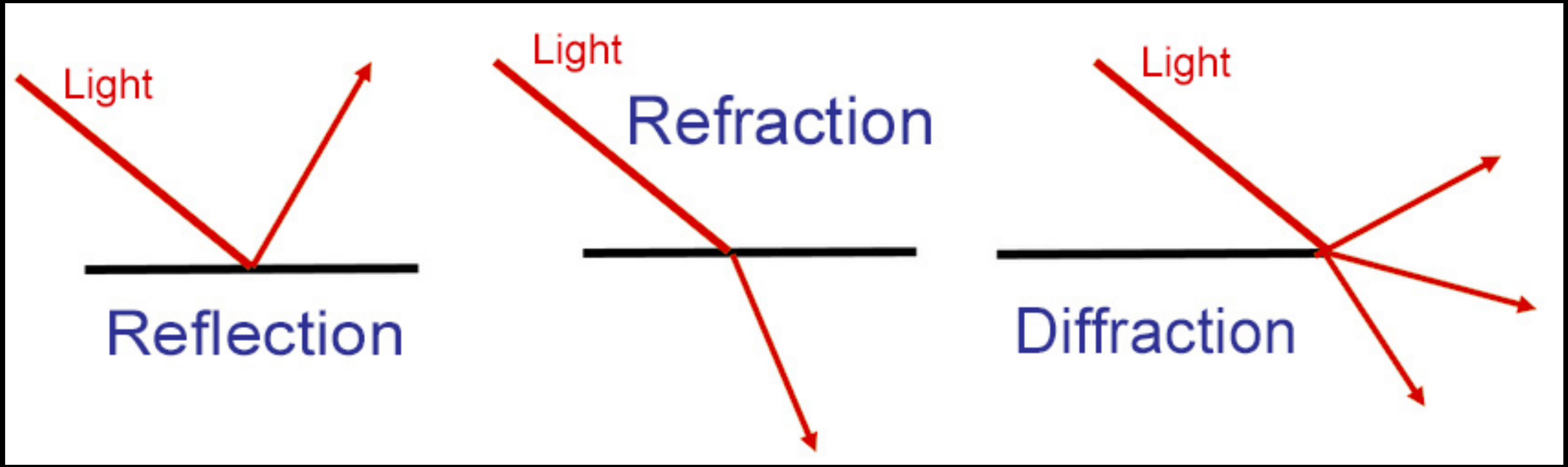


Maxwell showed in the mid-1800's that light is energy carried in the form of opposite but supporting electric and magnetic fields in the shape of waves, i.e. self-propagating electromagnetic waves or electromagnetic radiation.



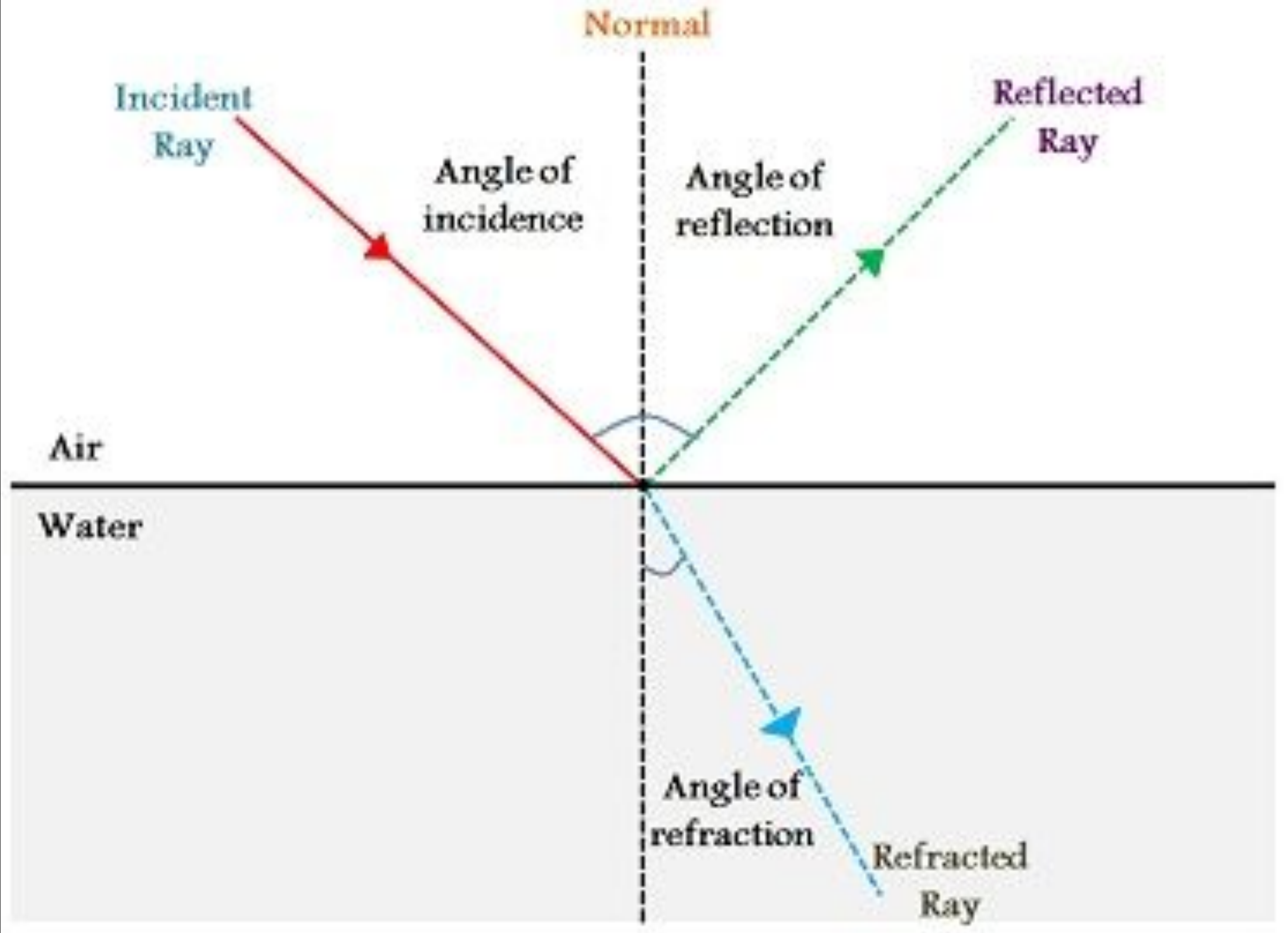
The wavelength of the light determines its characteristics. For example, short wavelengths are high energy gamma-rays and x-rays, long wavelengths are low energy radio waves. The whole range of wavelengths is called the electromagnetic spectrum.

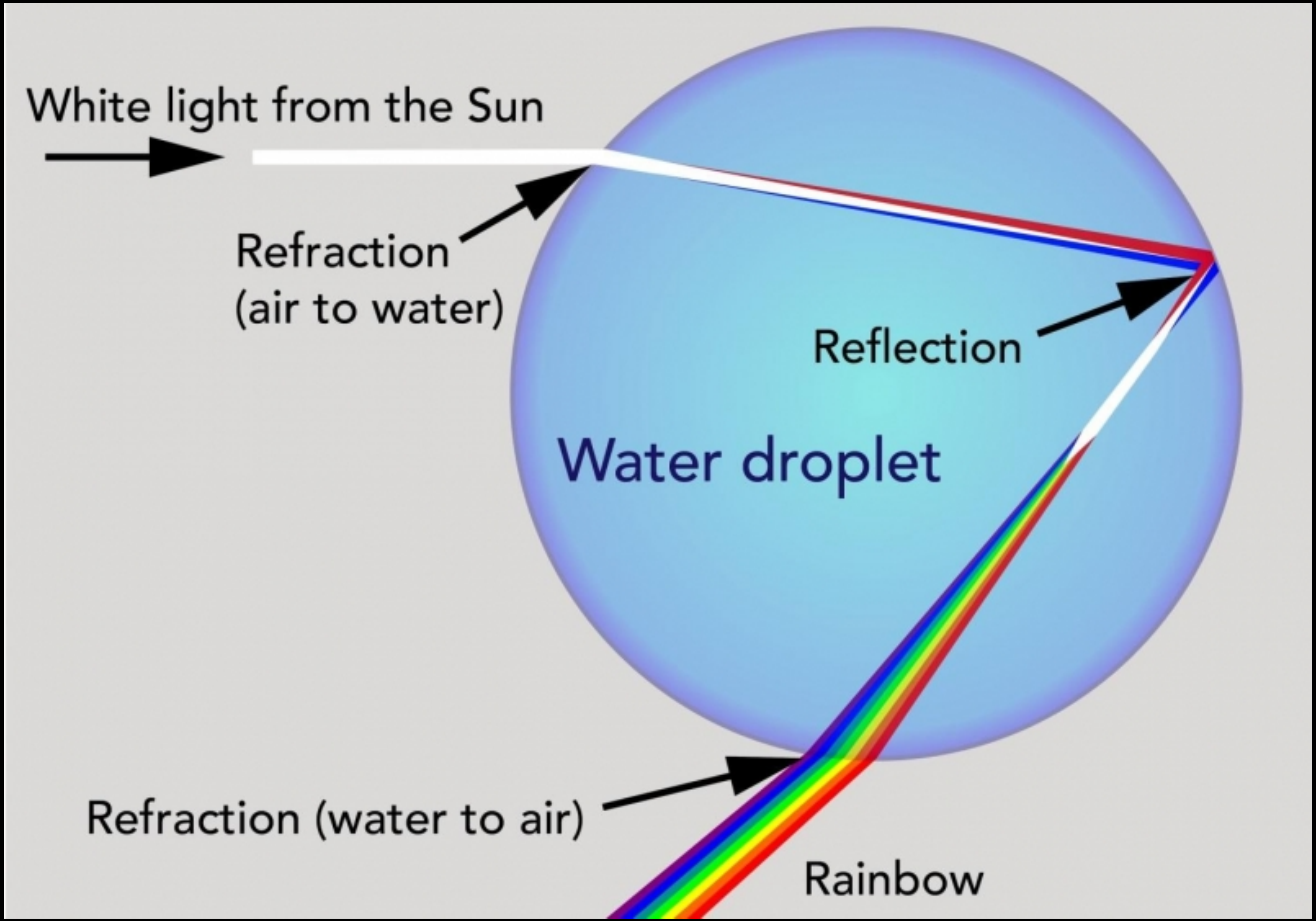




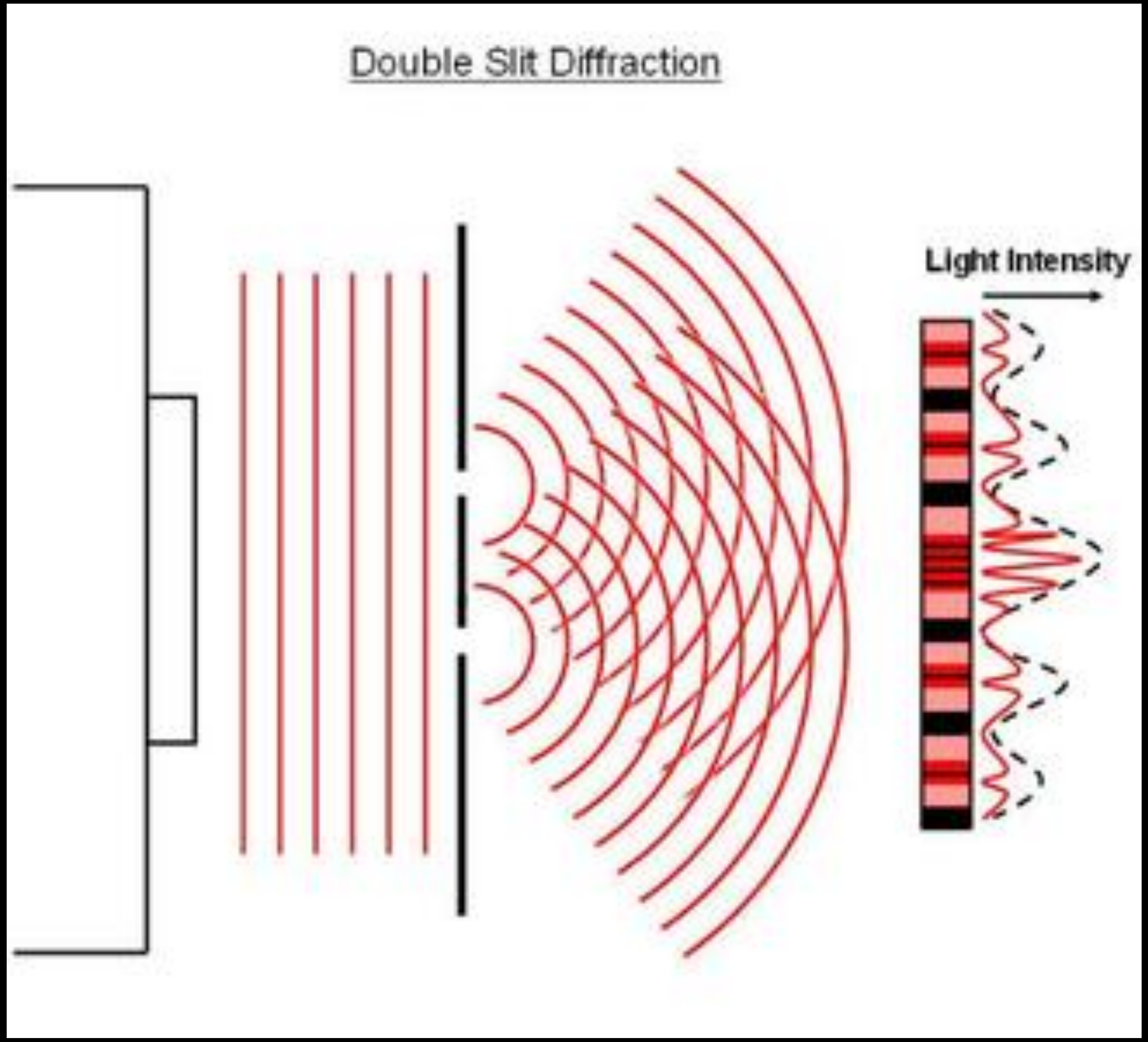
Due to its wave-like nature, light has three properties when encountering, or passing through, a medium:

1) reflection
2) refraction
3) diffraction

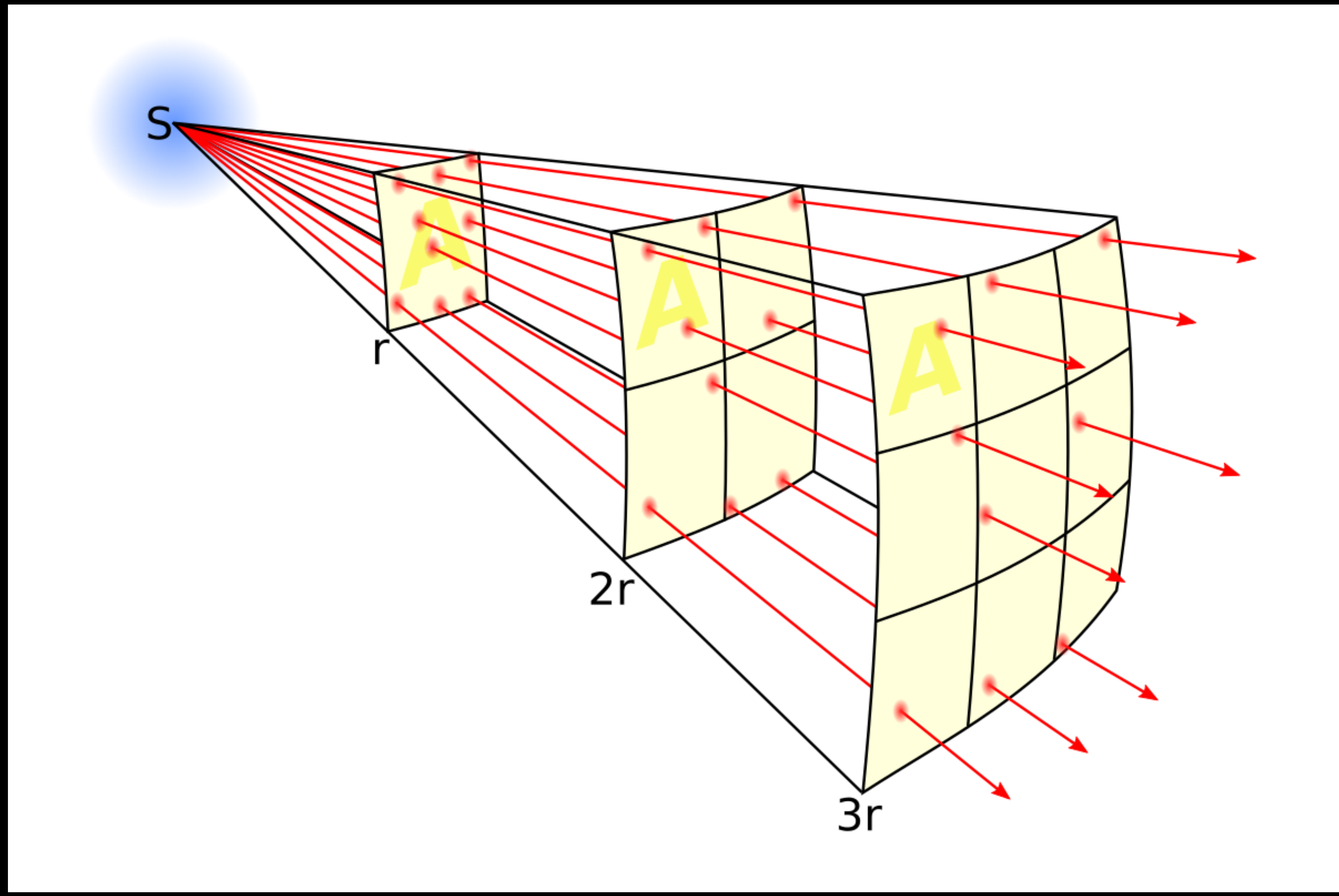




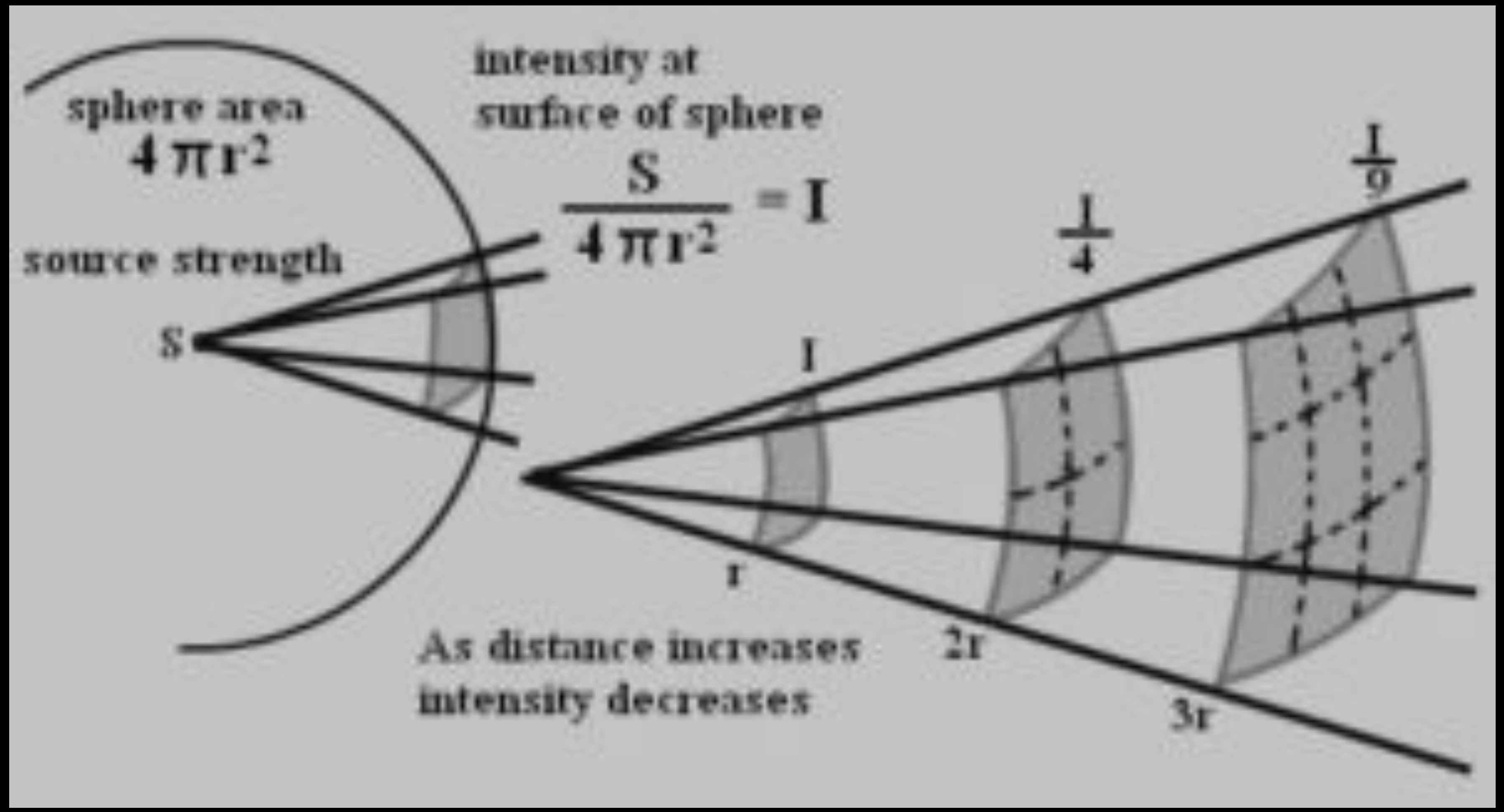
The amount of refraction increases for a denser medium, meaning the angle of refraction decreases, which is why glass can form a lens. And the angle of refraction is also a function of wavelength (i.e. blue light is more refracted compared to red) which is why a prism breaks white light into its colors. This is also the origin to rainbows from drops of water.

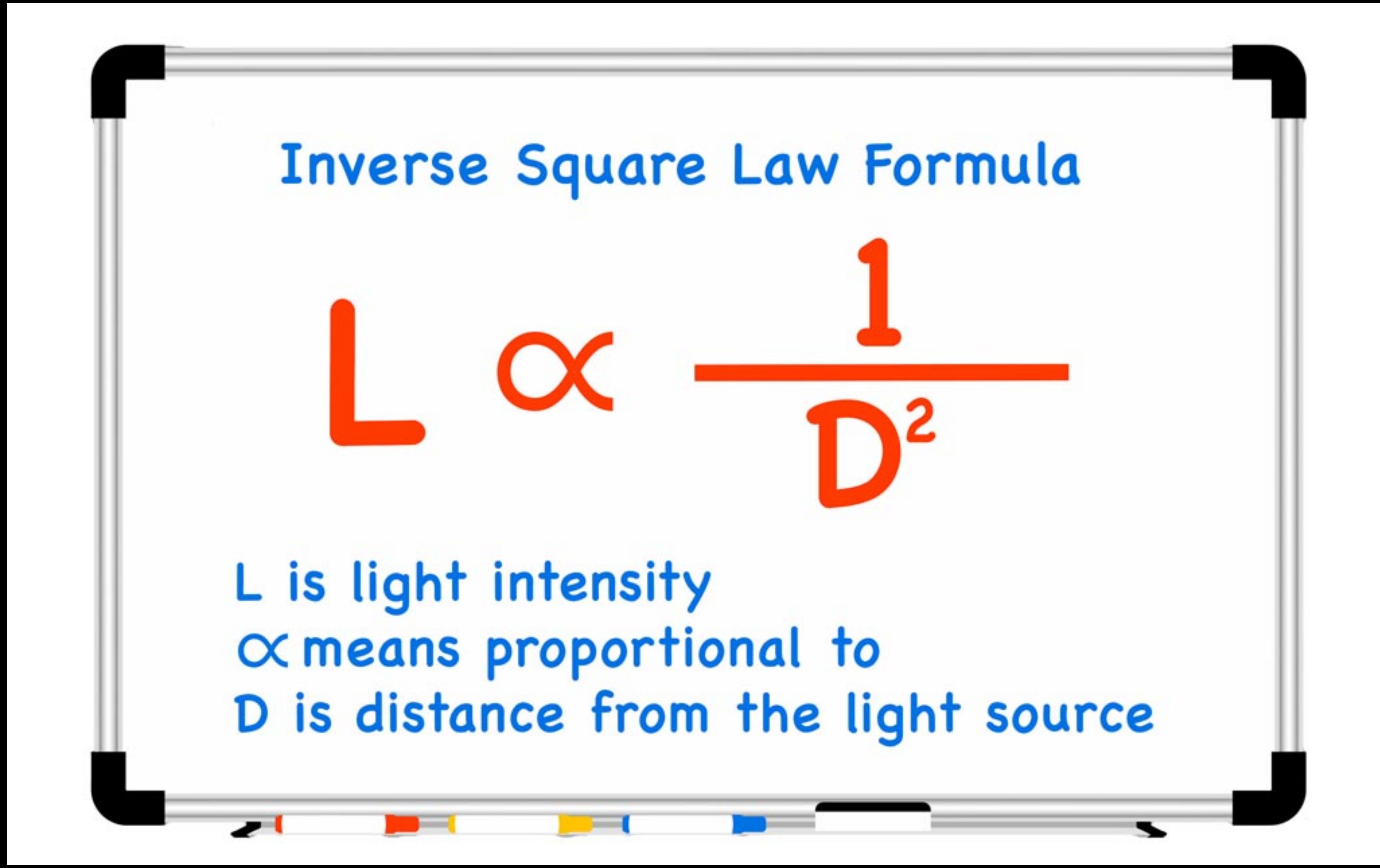


Diffraction is the constructive and destructive interference of two beams of light that results in a wave-like pattern. When two peaks of a wave intersect they combine to make a bigger wave. When a peak and a trough intersect, they cancel.

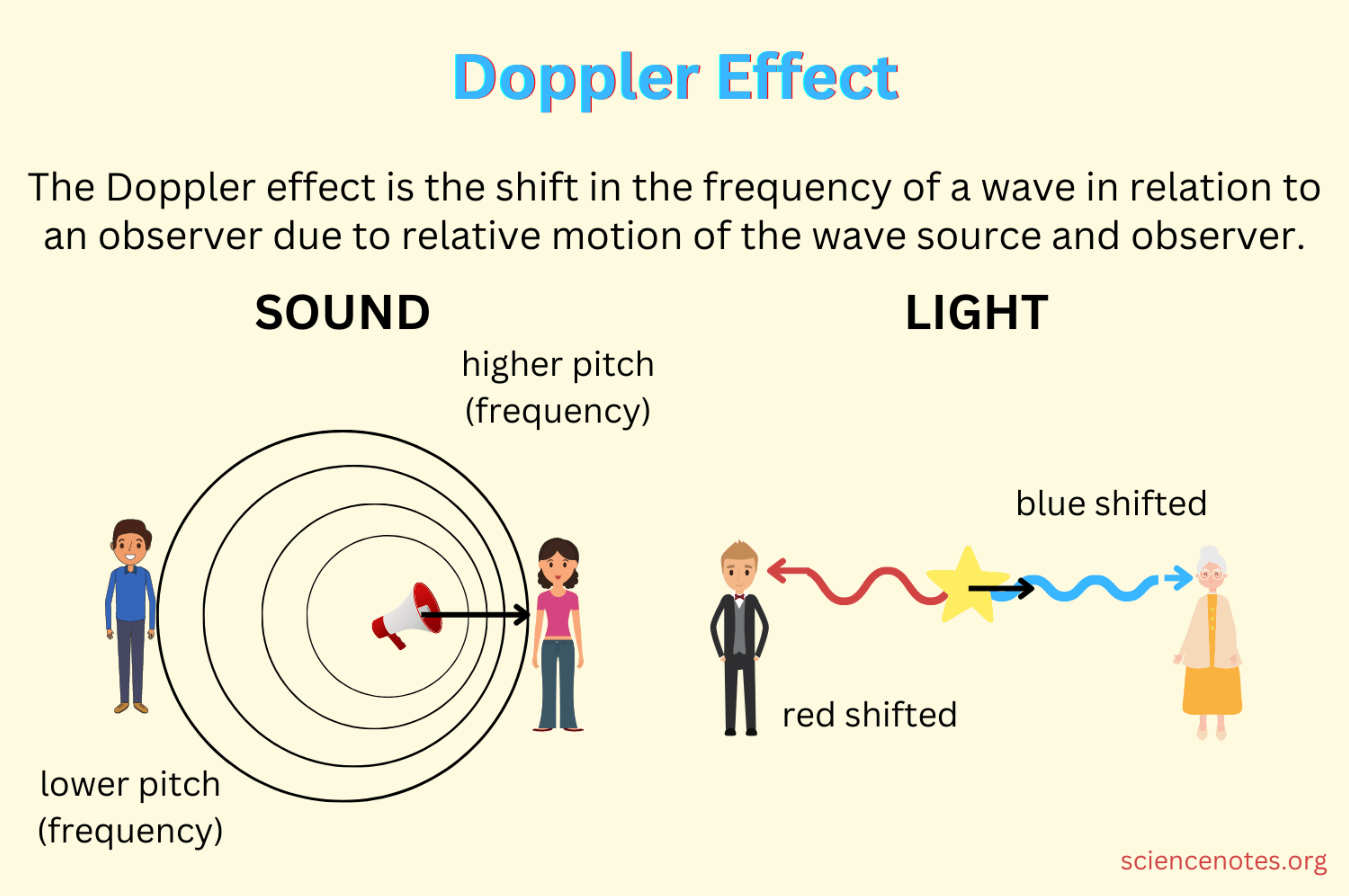


The brightness of an object varies inversely as the square of the distance. This means that objects farther away are dimmer.





$$\frac{I_A}{I_B} = \left(\frac{d_B}{d_A}\right)^2$$



The Doppler effect occurs when an object that is emitting light is in motion with respect to the observer. If the object is moving towards the observer the light is ``compressed'', meaning that the wavelength of the light becomes smaller. Smaller wavelength means bluer light, so we say the object is blueshifted. If the object is moving away from the observer the light is ``expanded'', the wavelength is increased or redshifted.

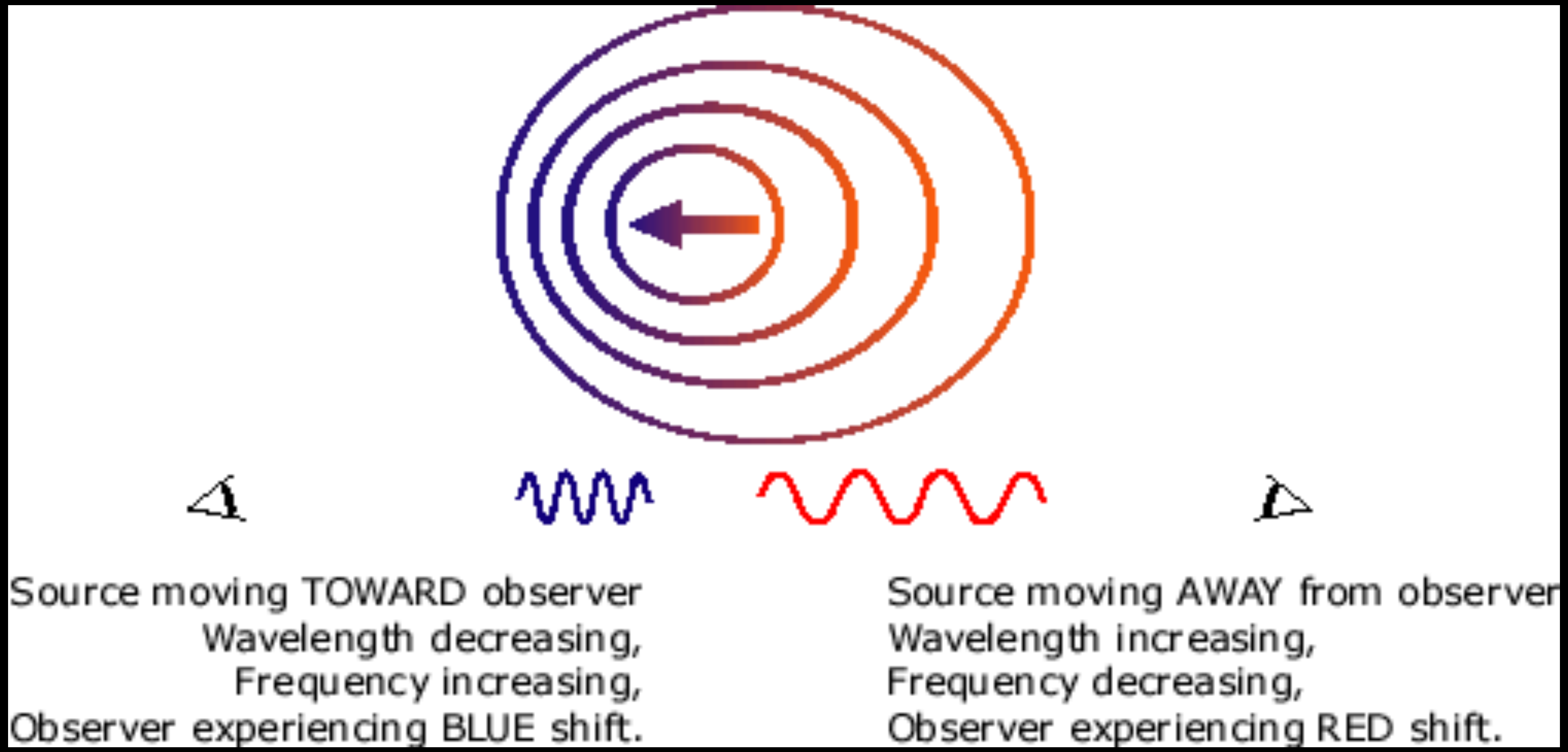
$$v = c\frac{\Delta\lambda}{\lambda_0}$$

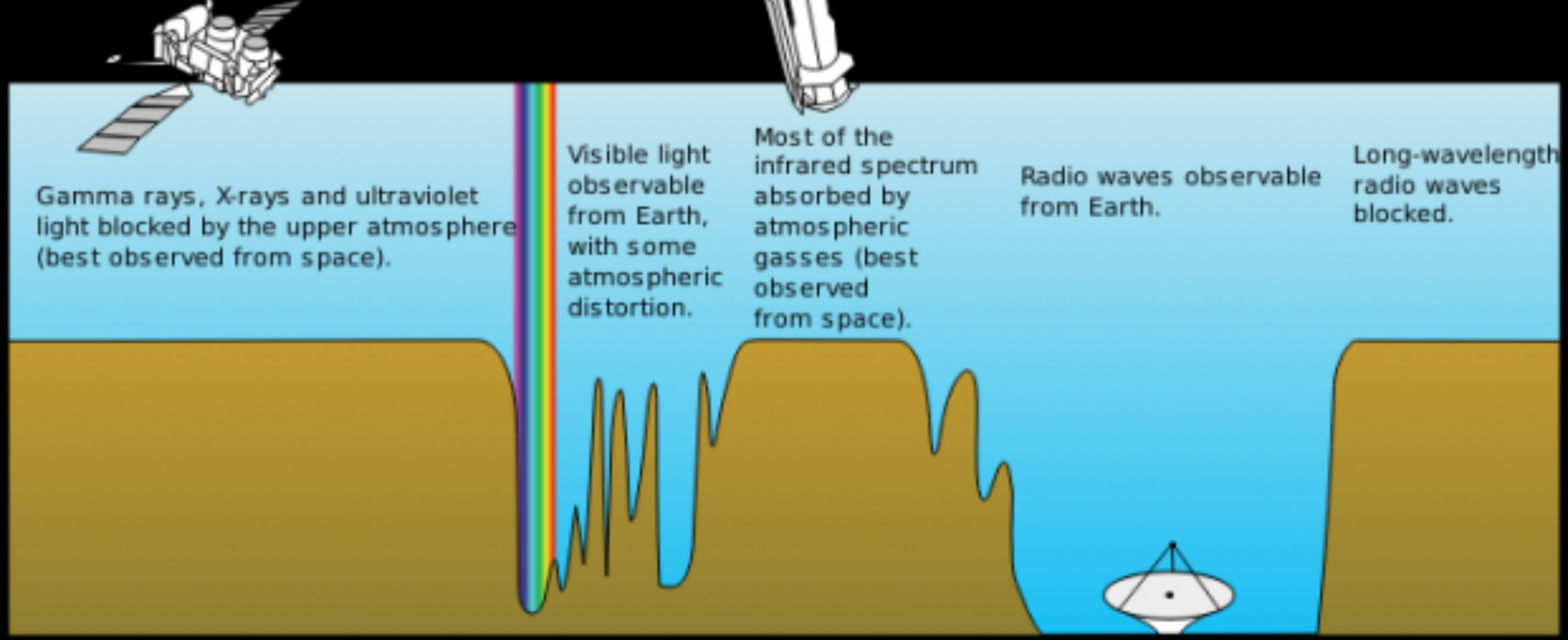
$$\Delta\lambda = wavelength\ shift$$

$$\lambda_0 = wavelength\ of\ source\ not\ moving$$

$$v = velocity\ of\ source - line\ of\ site$$

$$c = speed\ of\ light$$





note that observing at different wavelengths requires vastly different technology and conditions. In particular, our atmosphere is opaque to certain wavelengths (good for us) meaning that they can only be observed from space (expensive for astronomers).