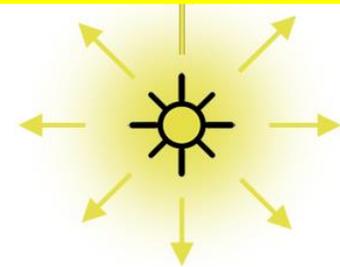
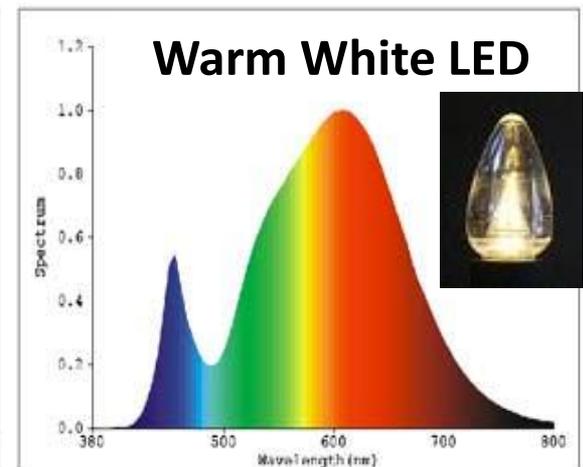
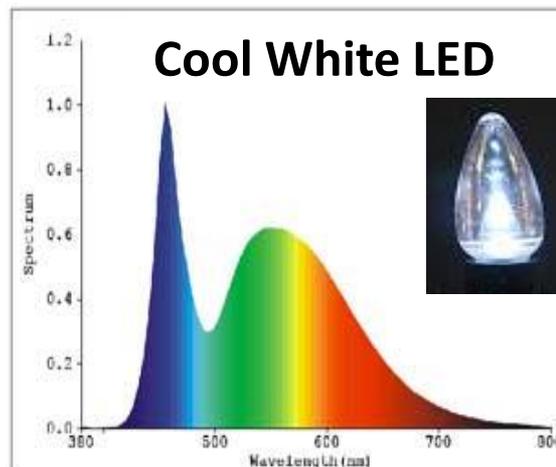


# Summary: how to *graph* light?

- “What color?” The apparent color of light is determined by the wavelength(s) of light waves.
- “How much?” The intensity of light is the amount of light energy falling on a surface per a unit of time.
- **“How much of each color?”**



The spectrum (spectral composition) of light is the relative light intensity for each wavelength present.



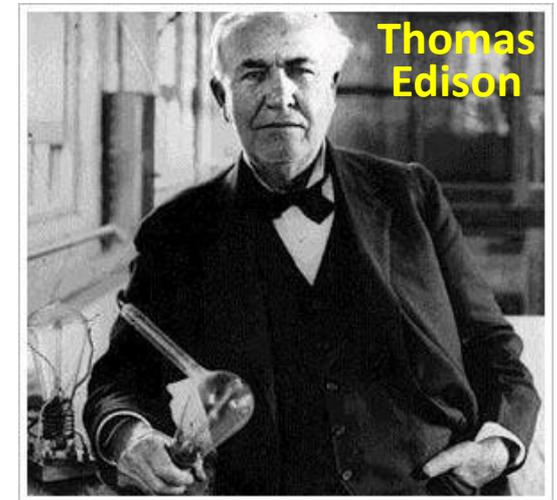
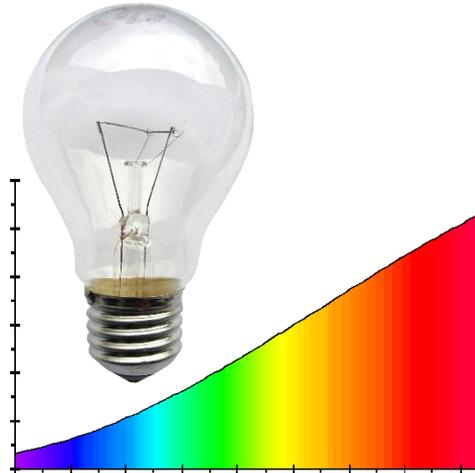
# How to Make Light?



# Incandescence

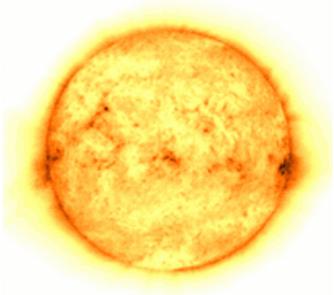
Incandescence (from Latin “glowing white”) is a special case of thermal radiation, specifically **emission of visible light by a hot body.**

**Sunlight** is the incandescence of the “white hot” surface of the Sun.



## Incandescent bulb:

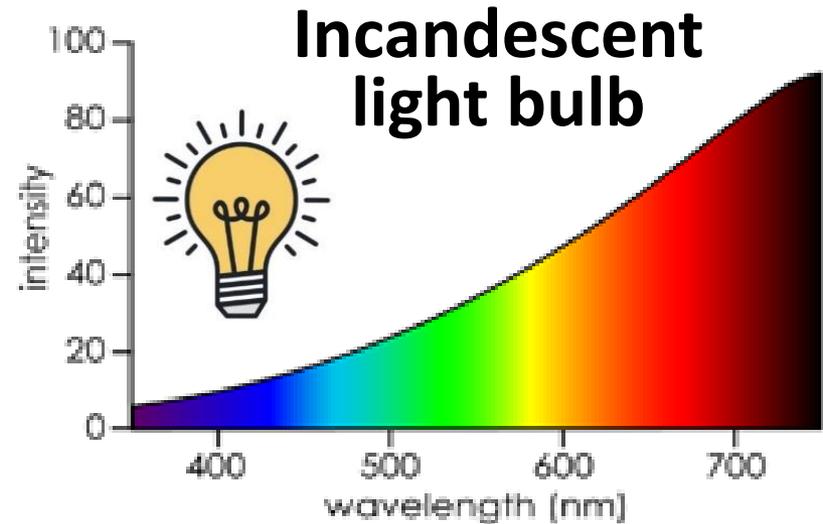
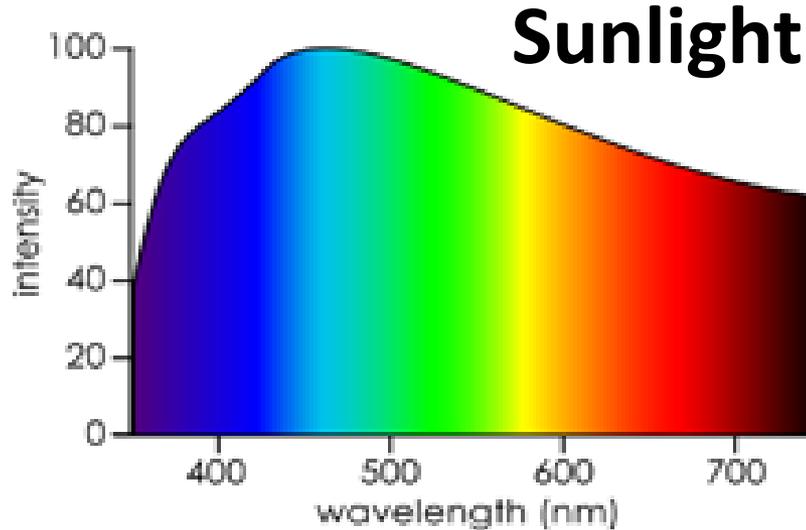
- electricity passes through a thin piece of metal wire called a filament
- the filament heats up and gives off thermal radiation composed of ~5% visible light and ~95% **infrared** light...
- ...**very low energy efficiency!**



# Incandescent Spectrum

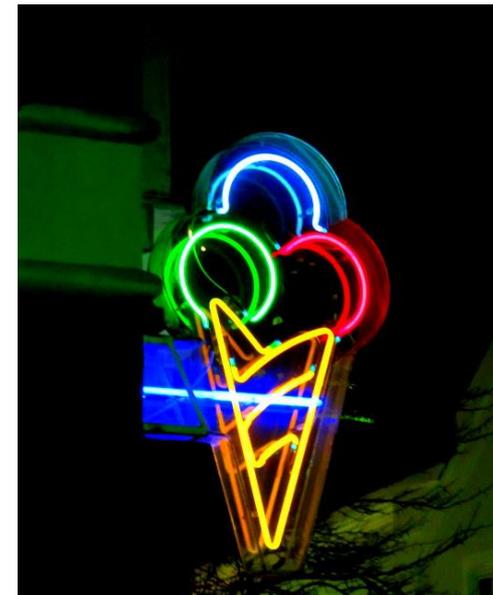
“How much of each color is made?”

- X-AXIS: wavelength
- Y-AXIS: relative light intensity



**Incandescent light sources produce light waves in a wide continuous range of wavelengths with gradually changing intensities; the light often appears “white”.**

# How to Make Light?



# Luminescence

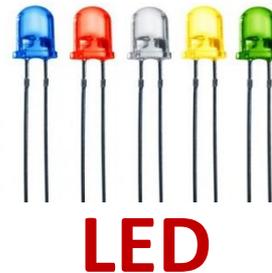
Luminescence is emission of light by a substance not resulting from heat:

- *Chemiluminescence* (including *bioluminescence*), a result of a chemical reaction.

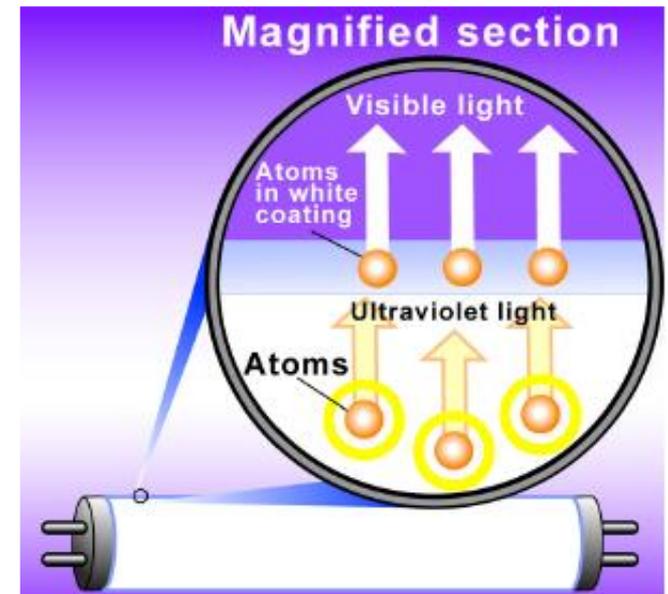


**Glow Sticks**

- *Electroluminescence*, emission of light due to electric current passed through a substance.



- *Photoluminescence* (*fluorescence* and *phosphorescence*) due to absorption of light with subsequent re-emission.

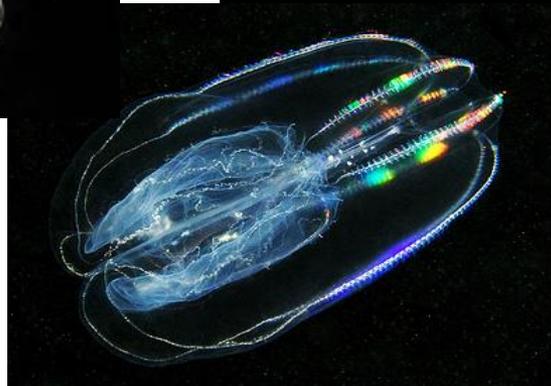
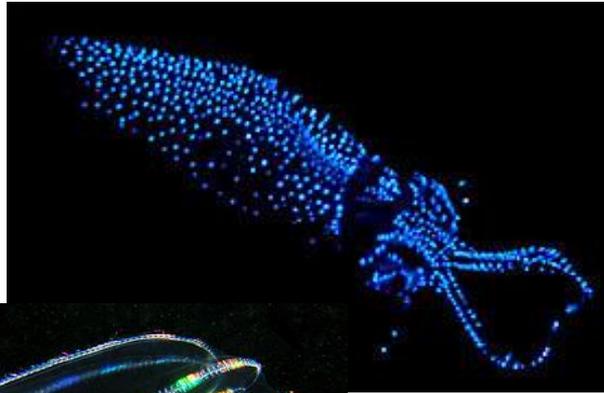


**Fluorescent Lamps**

- Some other types.

# Bioluminescence

Bioluminescence is **emission of light by a living organism** by means of a chemical reaction (type of *Chemiluminescence*).

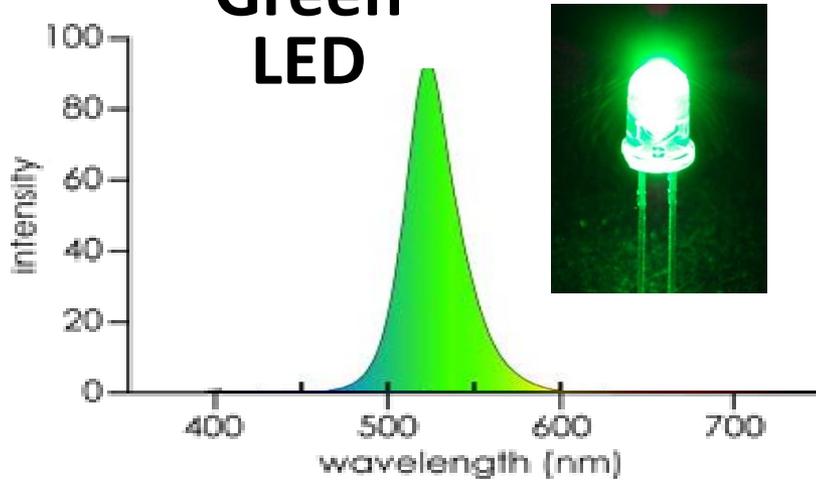


It occurs widely among animals (many creatures of the open sea, and insects) as well as in some fungi and bacteria.

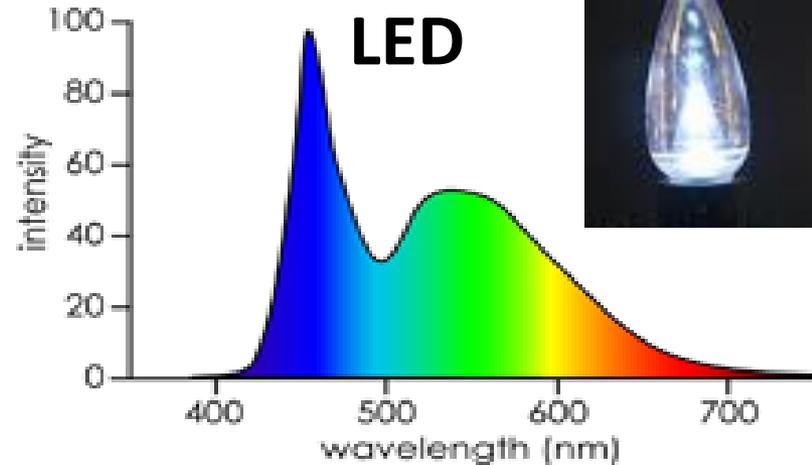


# Luminescent Spectrum

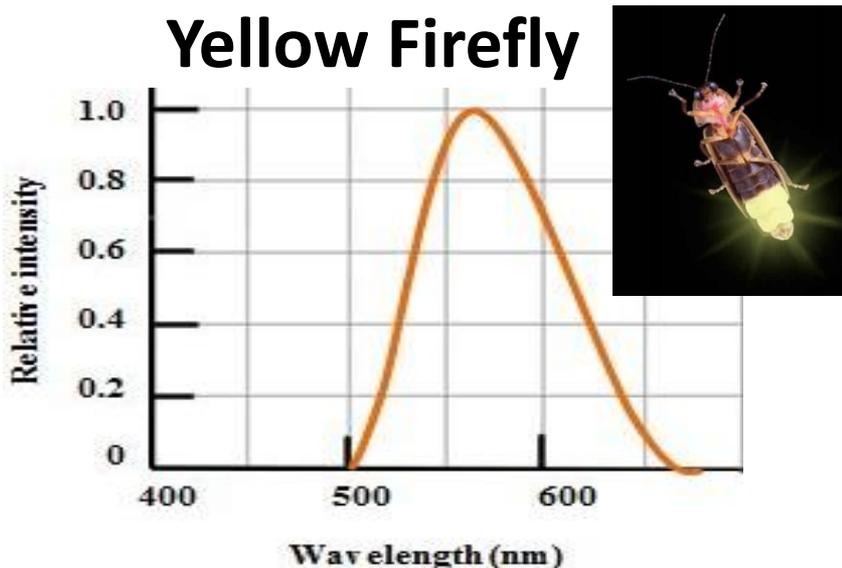
**Green LED**



**Cool White LED**



**Yellow Firefly**



**Luminescent light sources produce light waves in rather narrow “peaks” of wavelengths; the resulting light often appears to have a “distinct color”.**