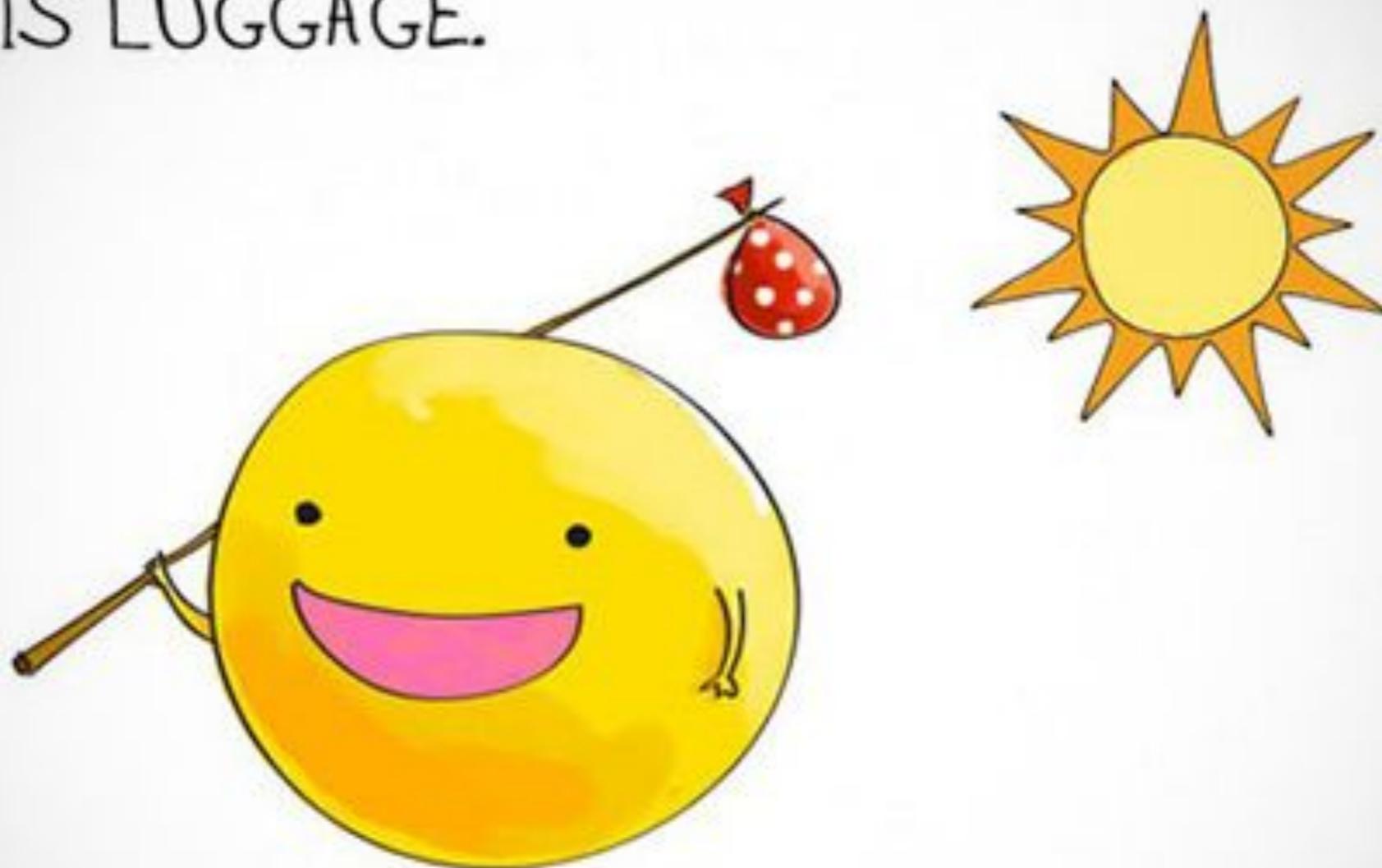
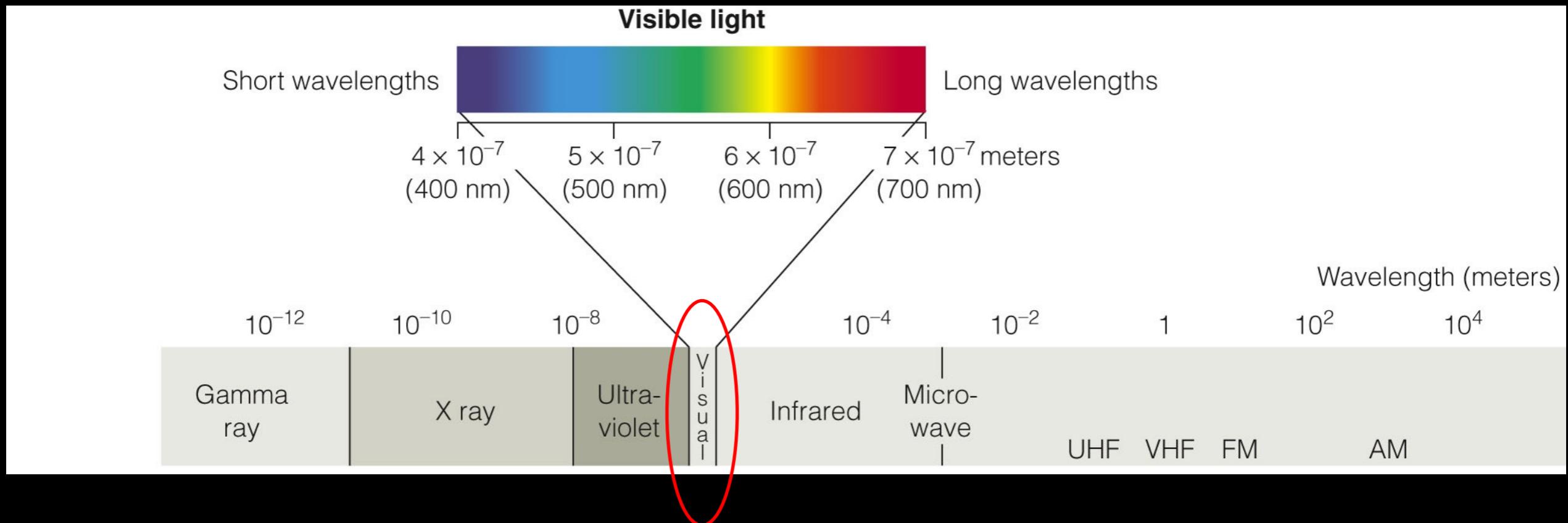


A PHOTON CHECKS INTO A HOTEL AND IS ASKED IF HE NEEDS ANY HELP WITH HIS LUGGAGE.



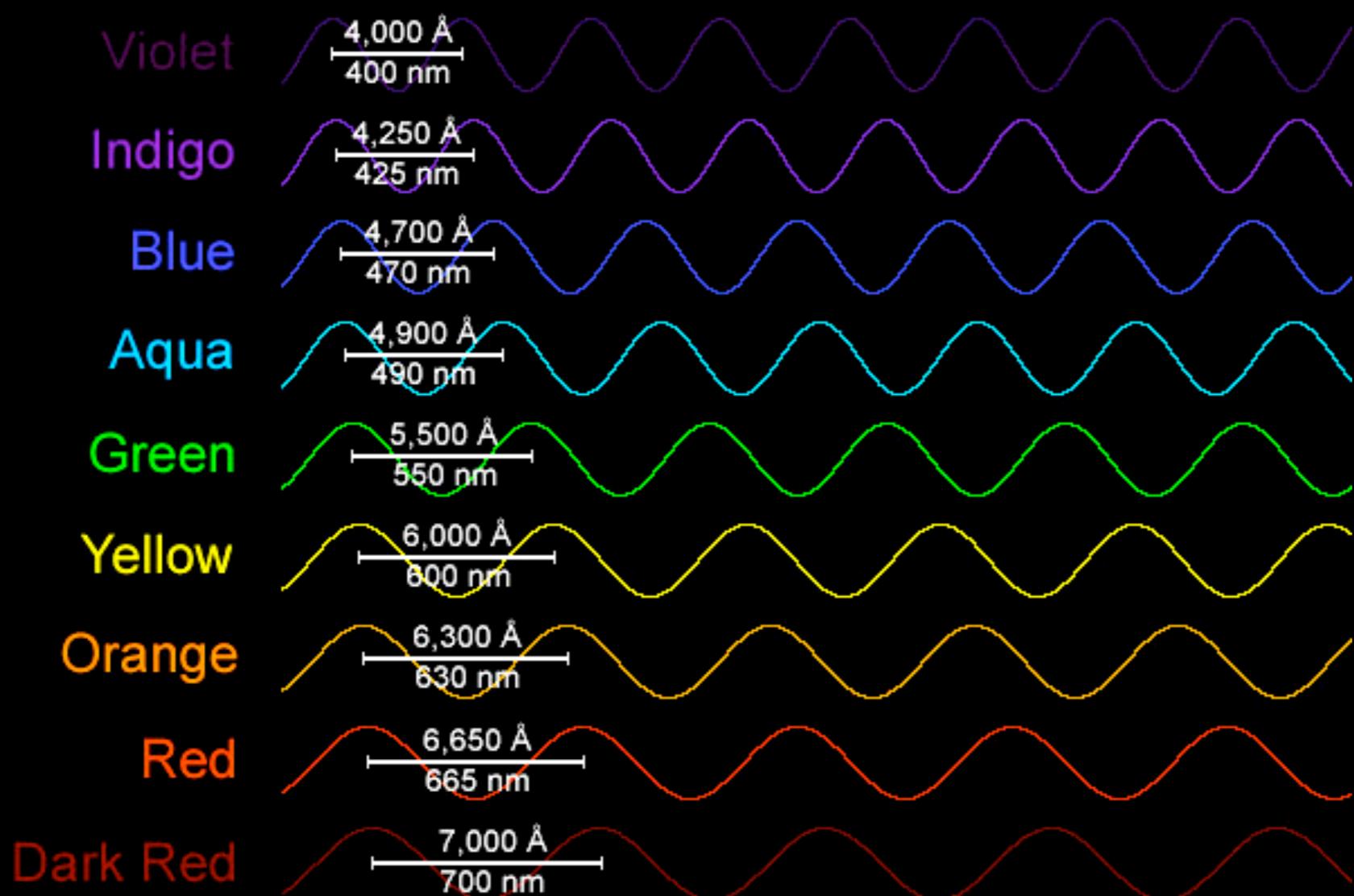
"NO, I'M TRAVELLING LIGHT."

Visible light makes up only a small part of the electro-magnetic spectrum.



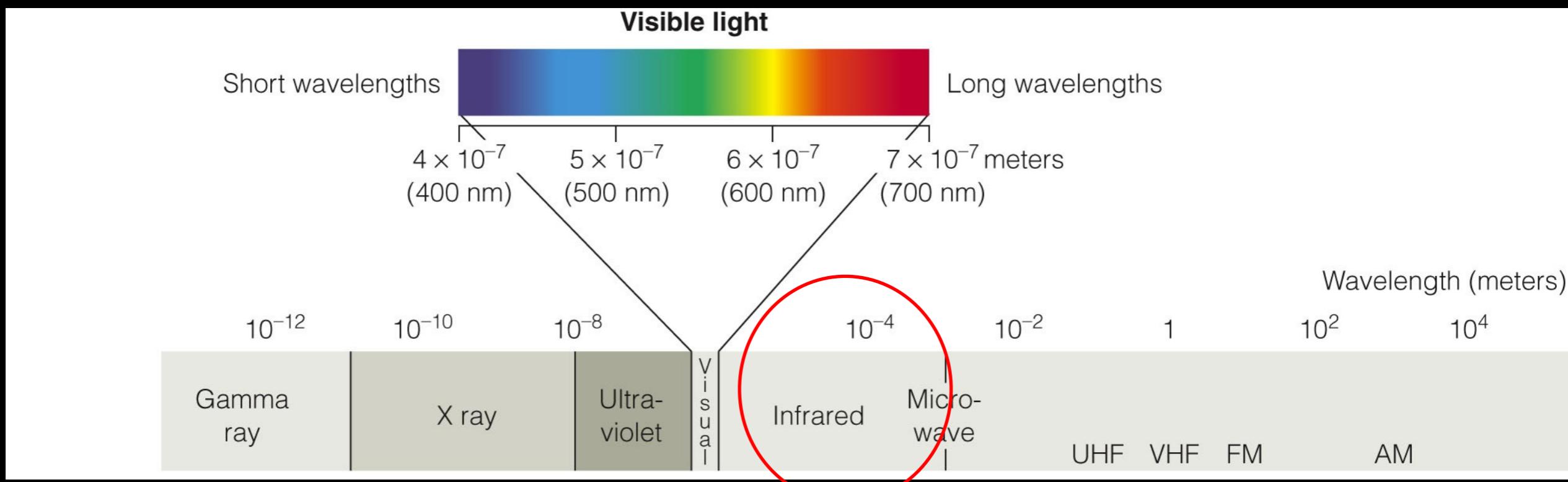
This is the only part of the EM spectrum that we can SEE!!!

- The colors of visible light have different wavelengths.
 - Red has the longest wavelength.
 - Violet has the shortest.



Our eyes see
in the range of
400 – 700 nm

Beyond the red end of the visible range lies **infrared (IR) radiation**—with wavelengths ranging from 700 nm to about 1 mm.



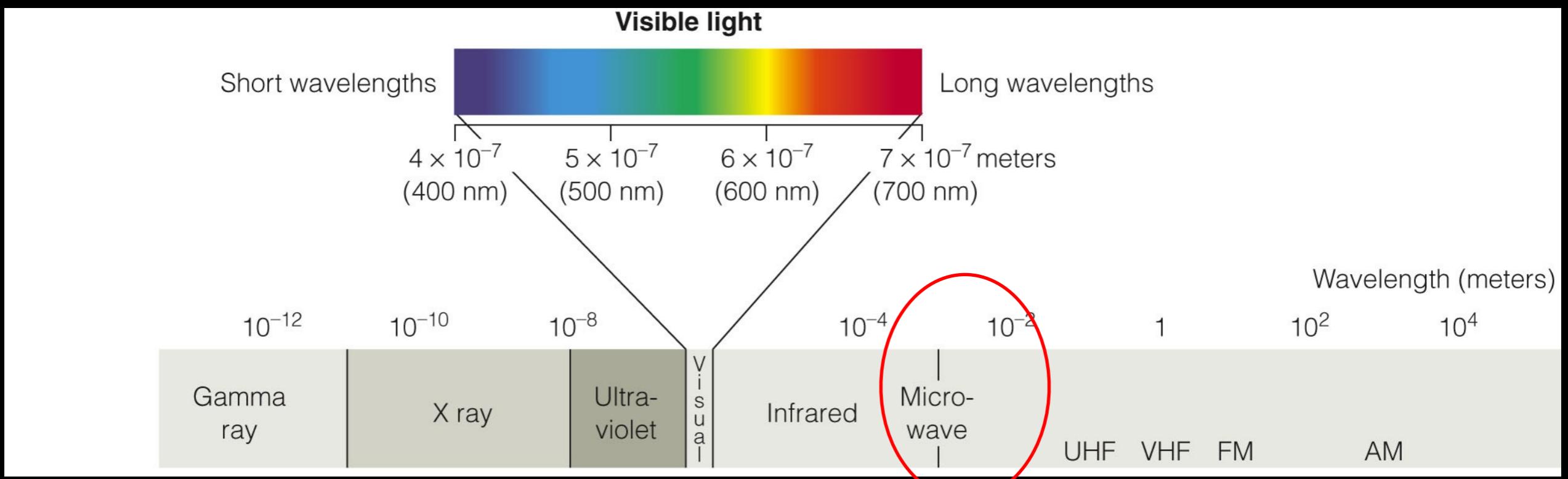
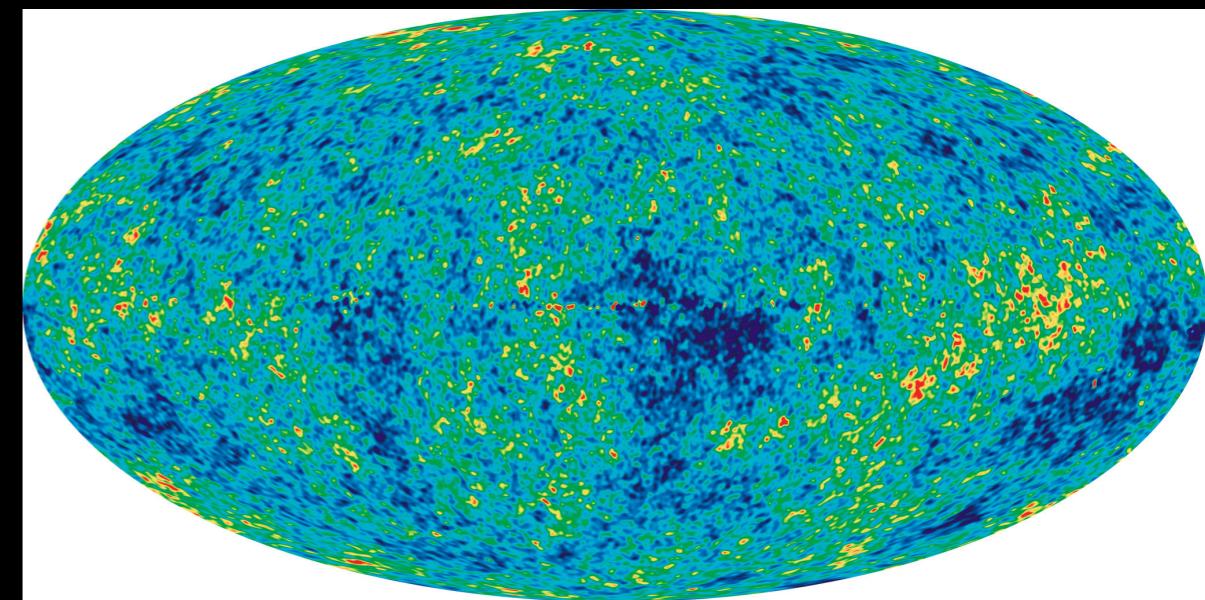
Why don't we glow in the dark?

- A) People do not emit any kind of light.
- B) People only emit light that is invisible to our eyes.
- C) People are too small to emit enough light for us to see.
- D) People do not contain enough radioactive material.

Why don't we glow in the dark?

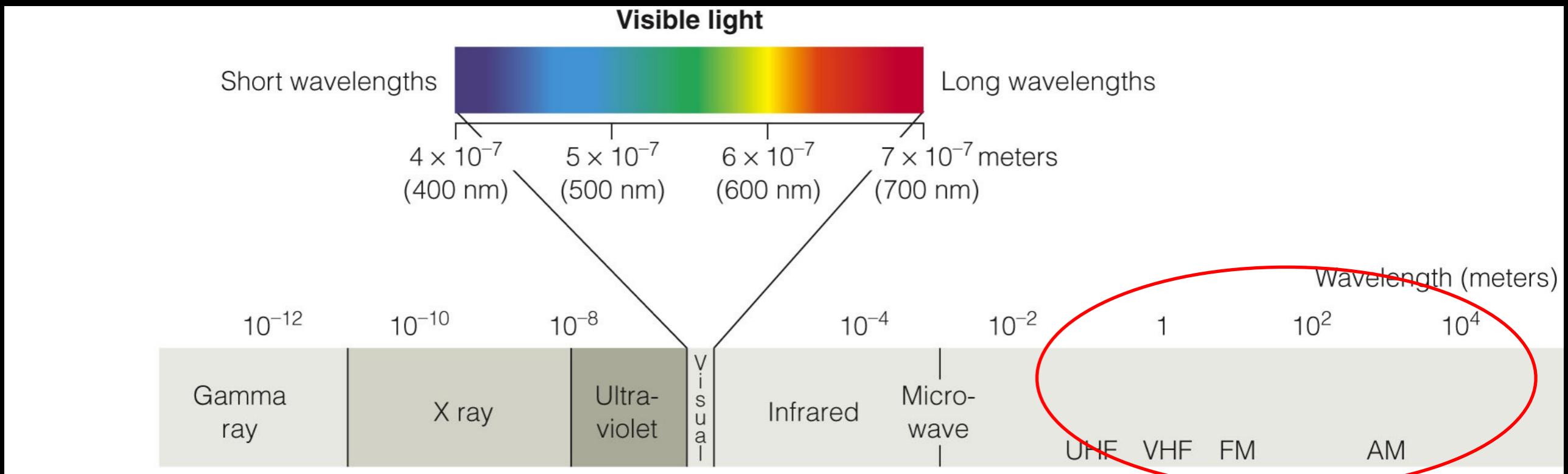
- A) People do not emit any kind of light.
- B) **People only emit light that is invisible to our eyes.**
- C) People are too small to emit enough light for us to see.
- D) People do not contain enough radioactive material.

Microwave transmissions, used for radar and long-distance telephone communications, have wavelengths from about 1 mm to a few cm.

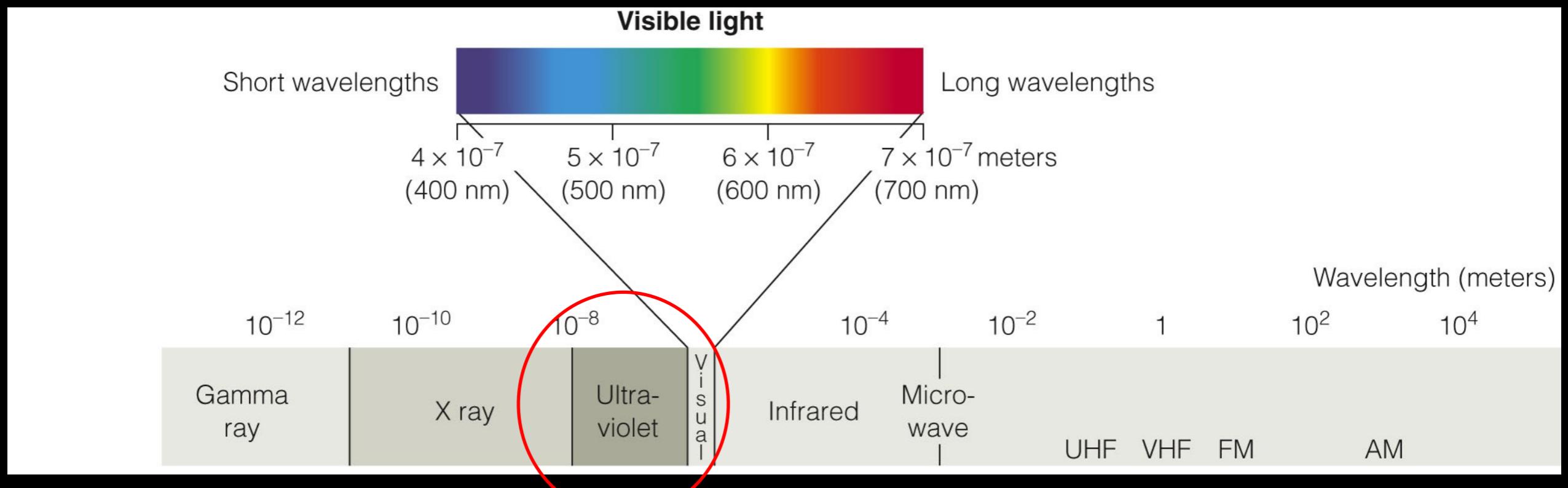
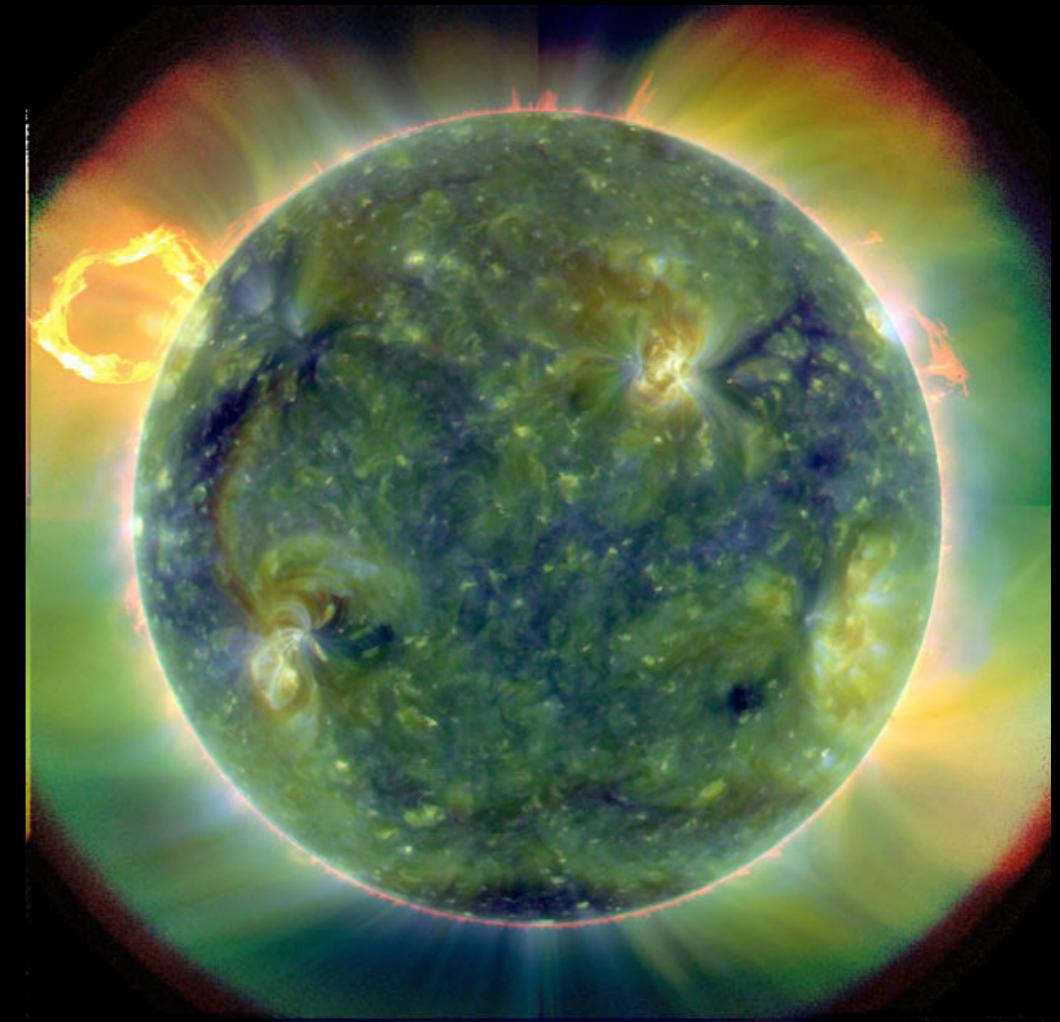


Radio waves have even longer wavelengths than microwave radiation.

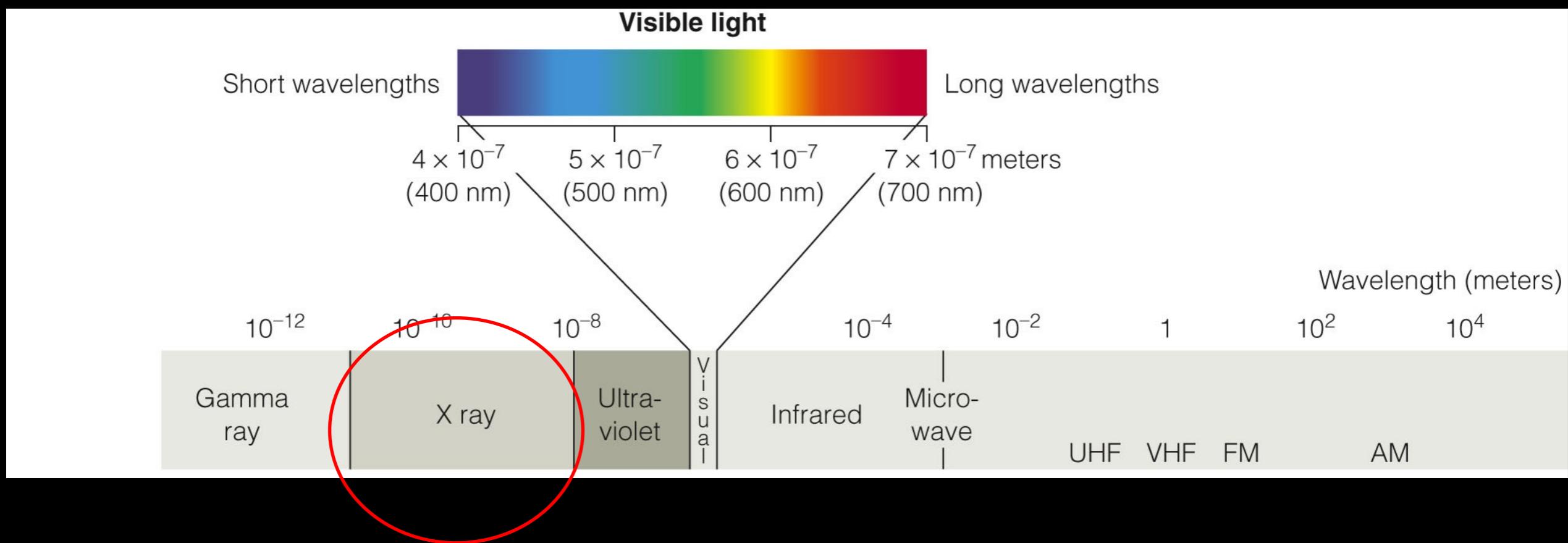
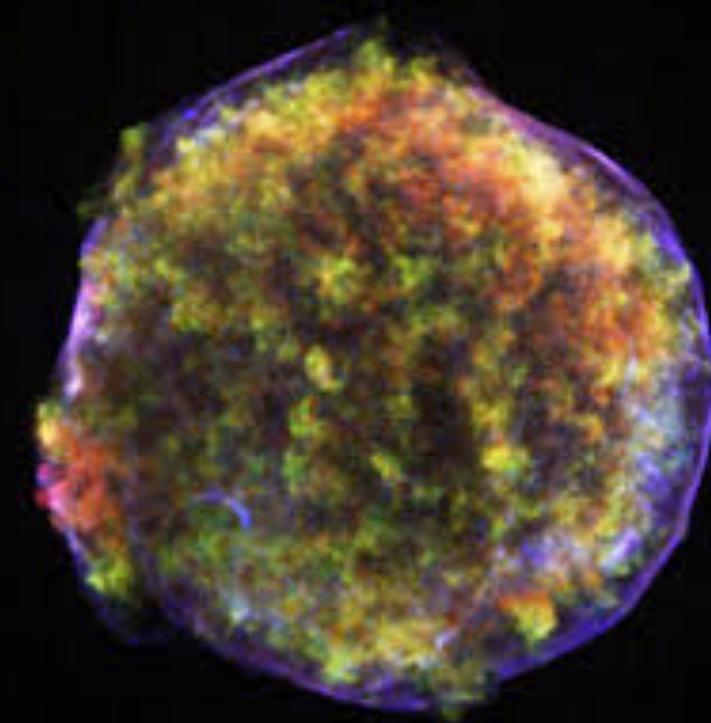
- FM, television, and also military, governmental, and amateur radio transmissions have wavelengths from a few tens of centimeters to a few tens of meters.



Electromagnetic waves with wavelengths shorter than violet light are called **ultraviolet (UV)**.



Shorter-wavelength electromagnetic waves than UV are called X rays.

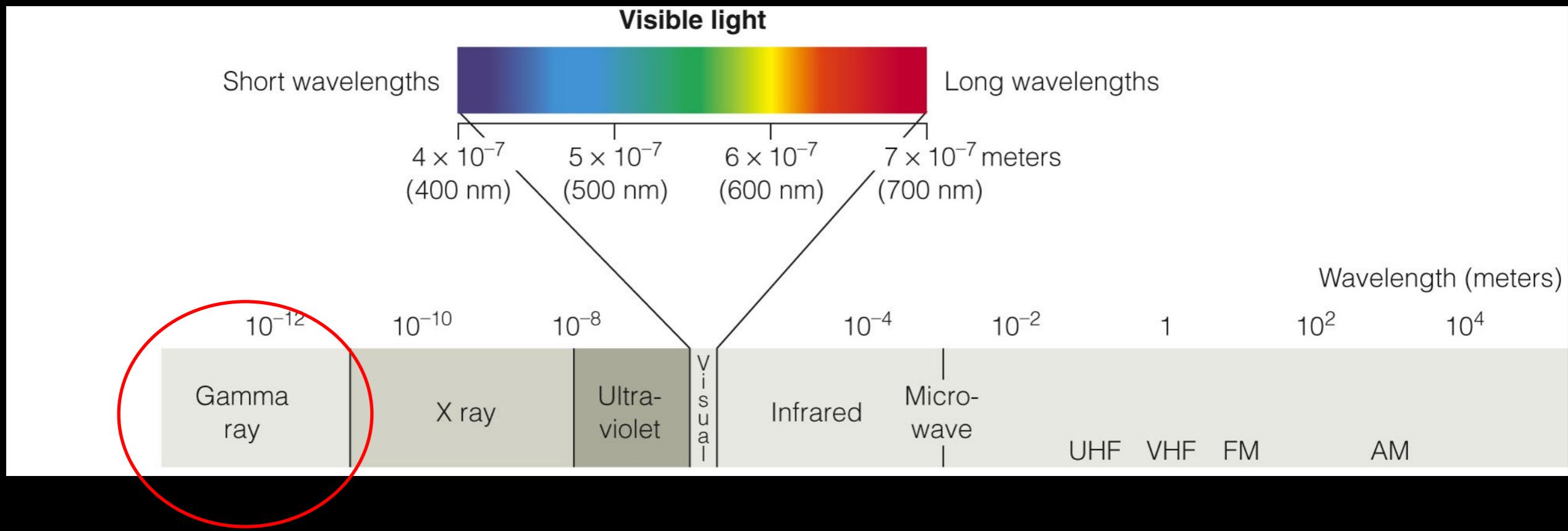


The EM radiation with the shortest wavelengths are **gamma rays**.

GAMMA RAY BURST

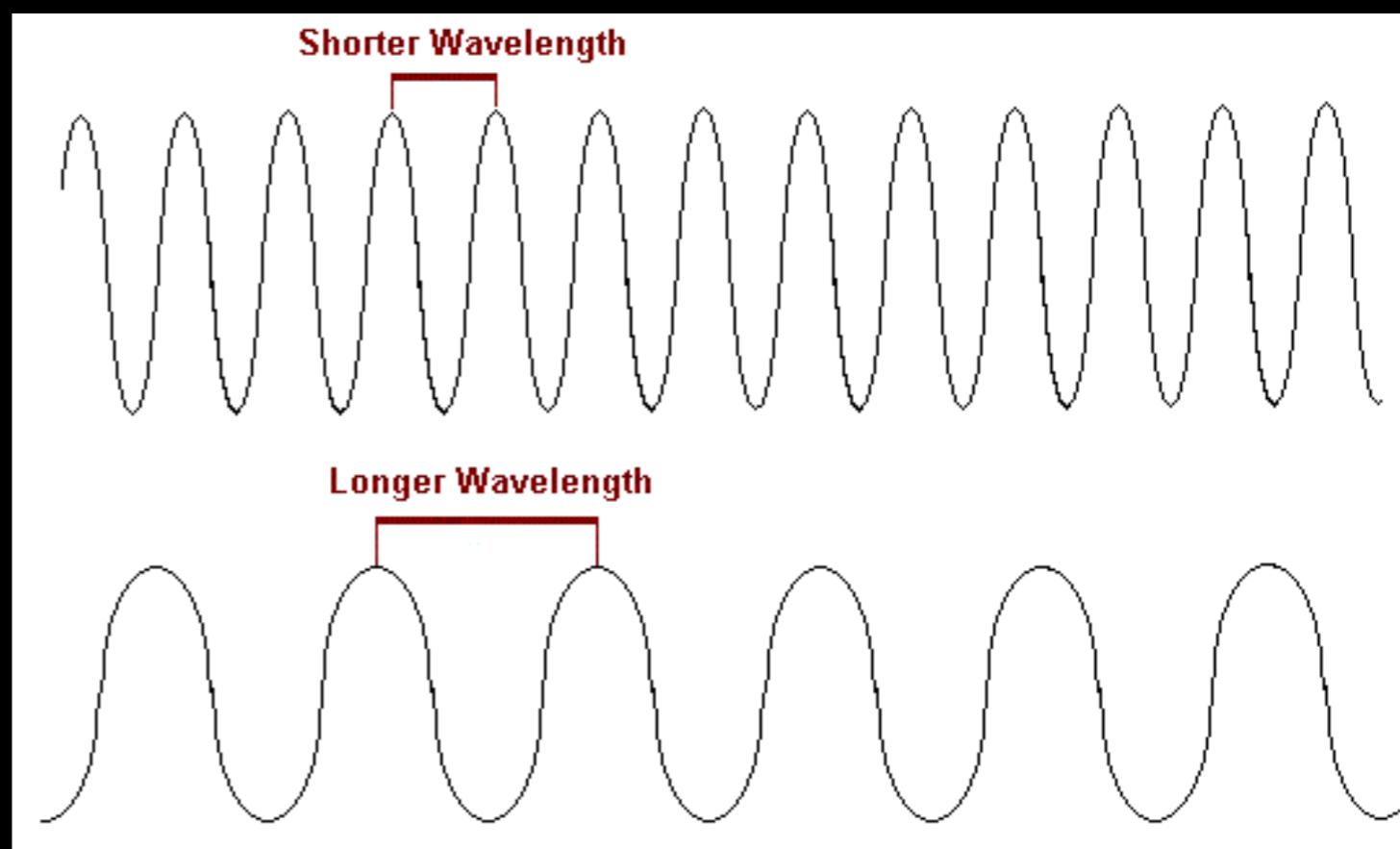
Gamma Ray

Visible and UV



Which of the following has the shortest wavelength?

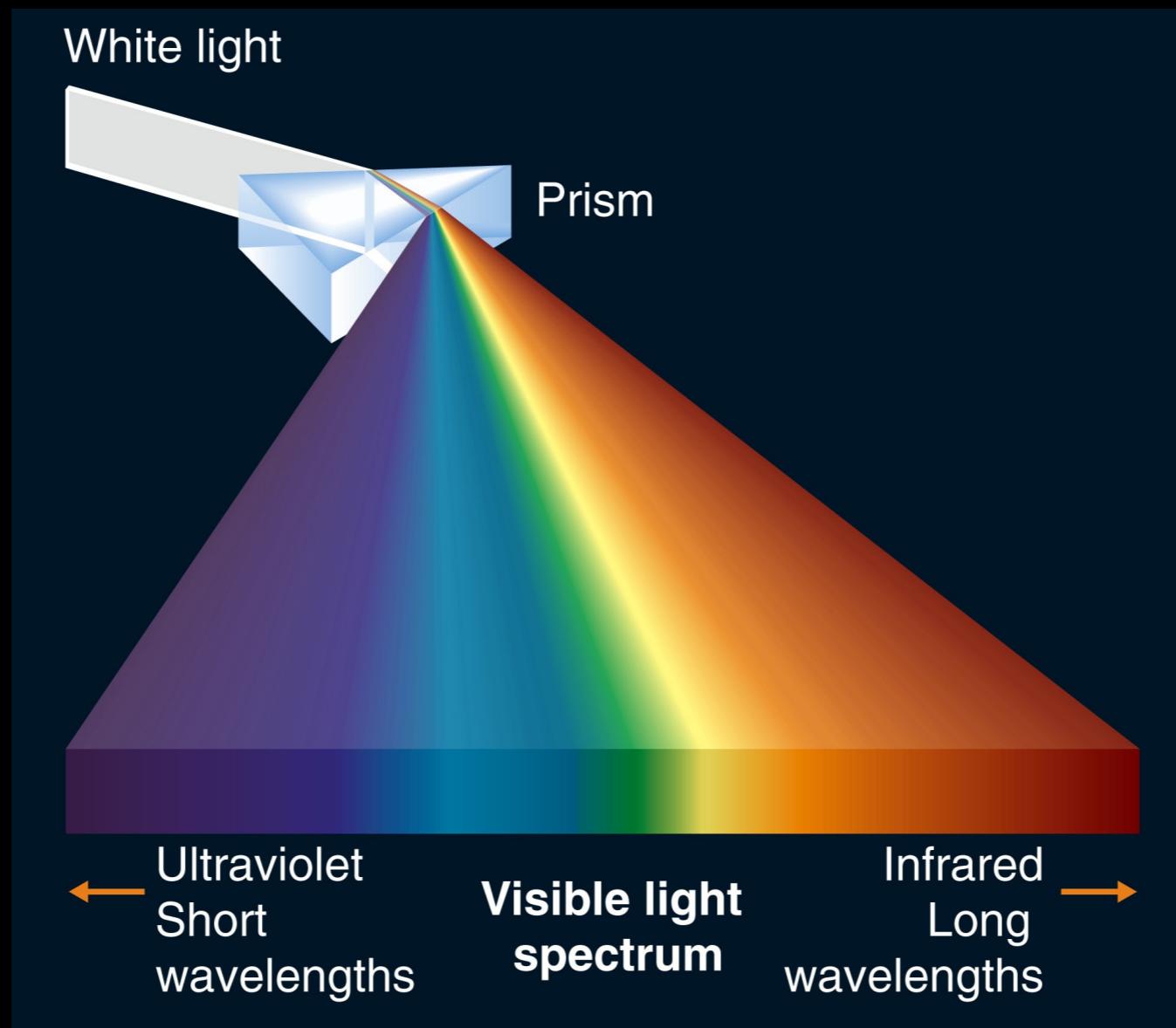
- a) A photon of ultraviolet light.
- b) Blue electromagnetic radiation.
- c) An X-ray.
- d) A radio wave.
- e) Infrared radiation.



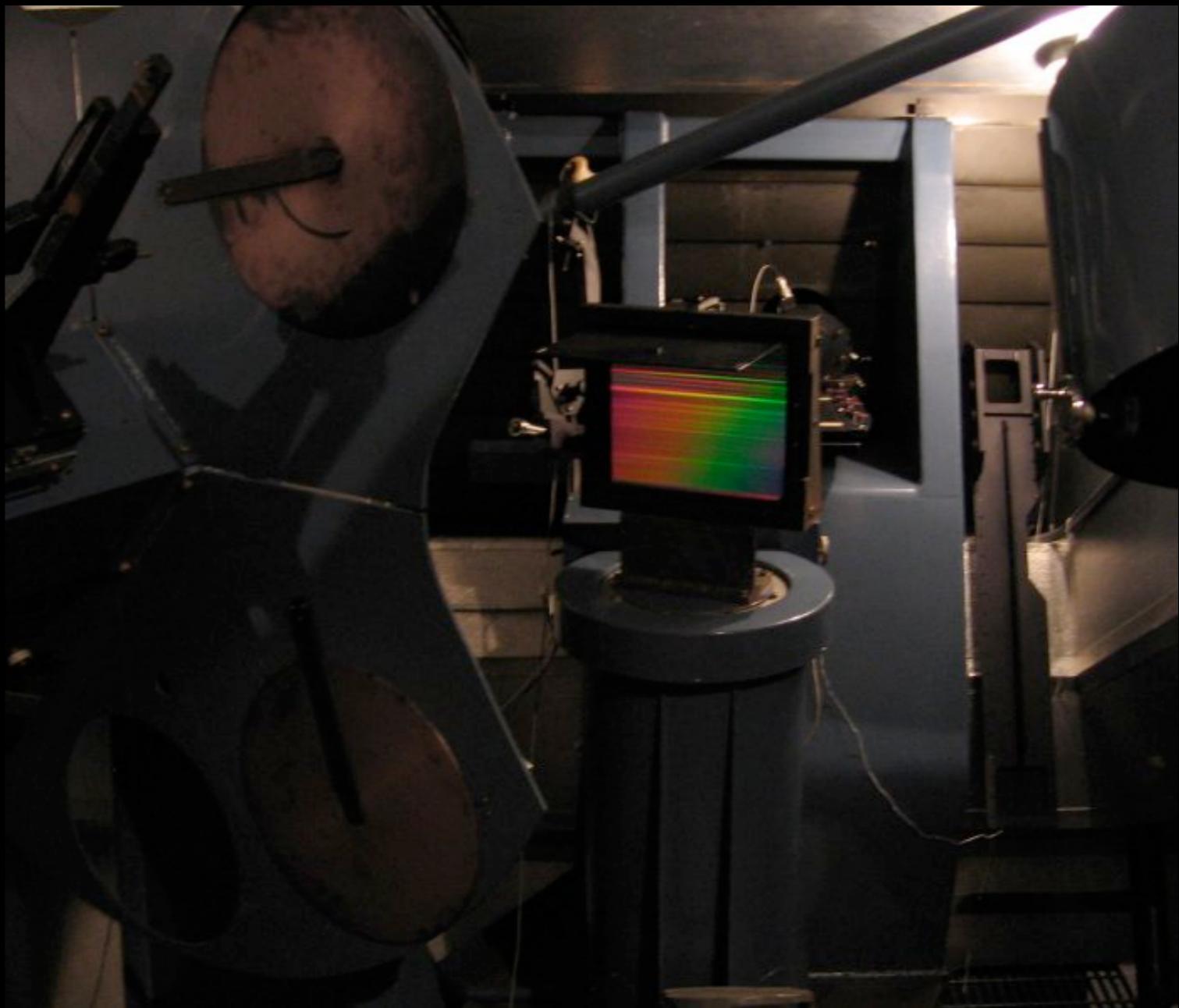
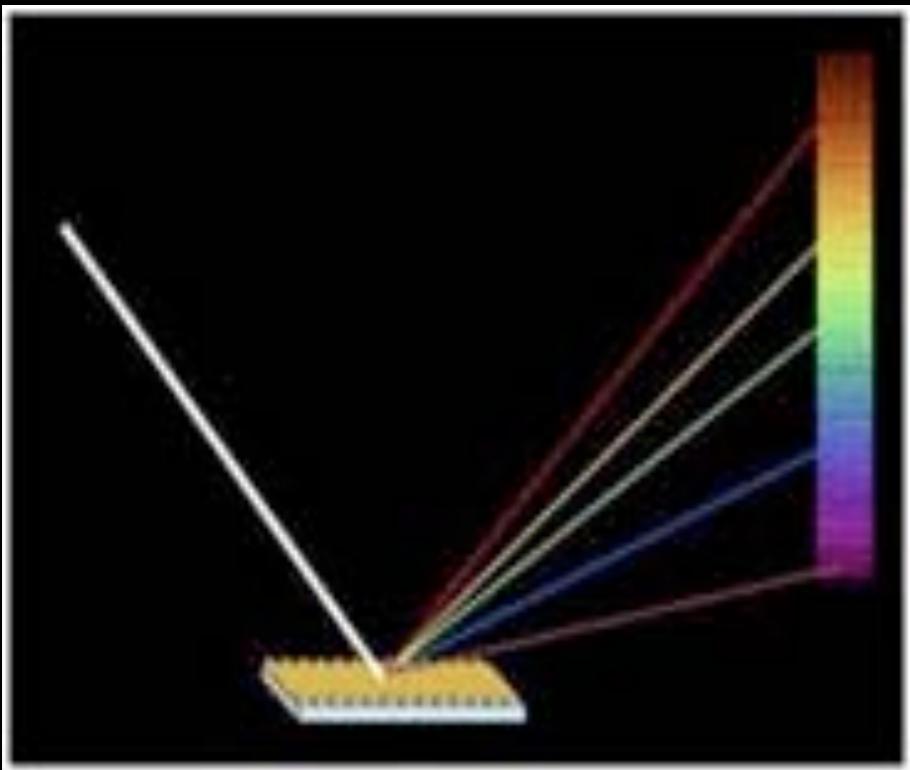
Which of the following has the lowest energy?

- a) A photon of ultraviolet light.
- b) Blue electromagnetic radiation.
- c) An X-ray.
- d) A radio wave.
- e) Infrared radiation.

To analyze light in detail, we need to spread the light out according to wavelength into a spectrum—a task performed by a **spectrograph**.

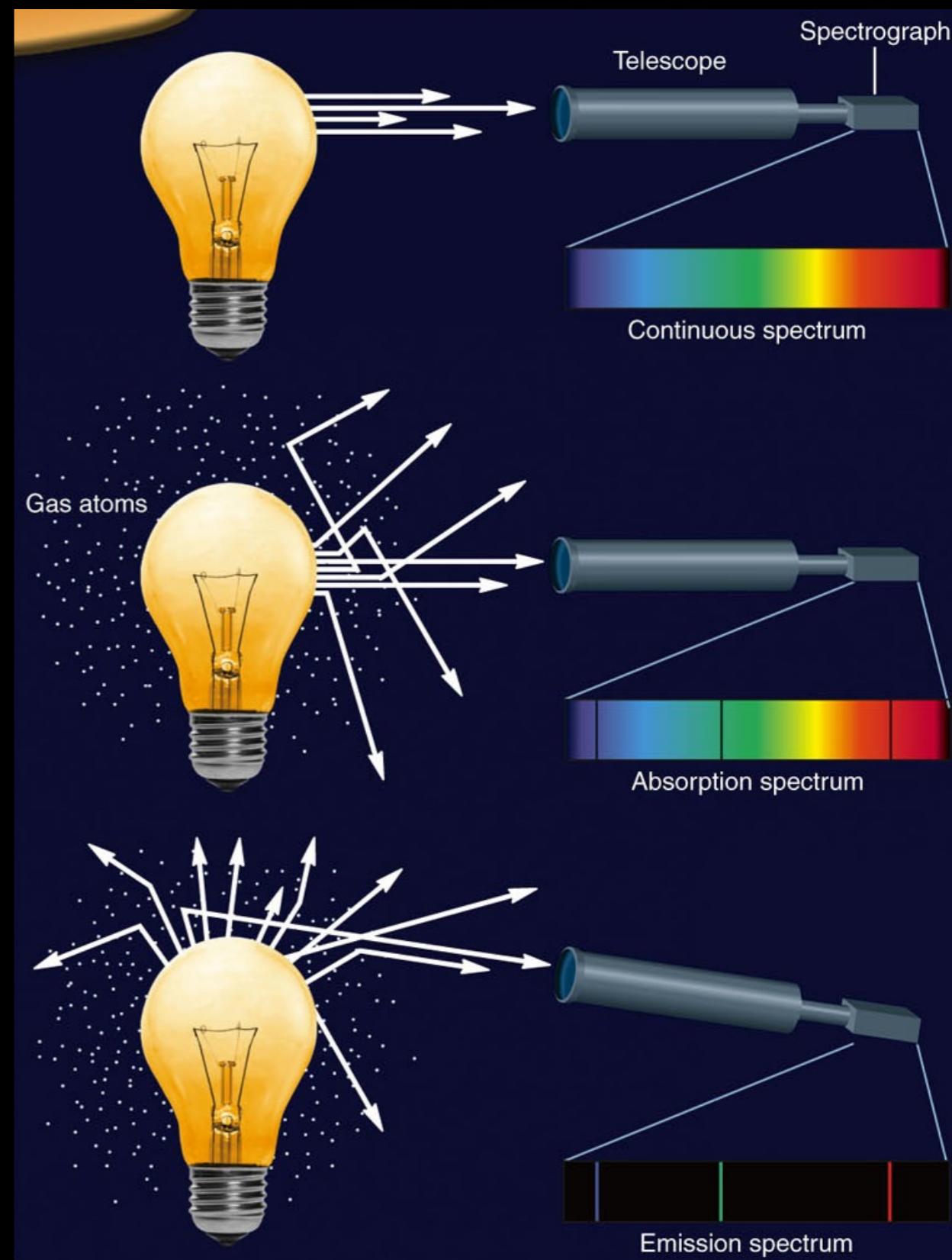


- Most modern spectrographs use a grating in place of a prism.
 - A grating is a piece of glass with thousands of microscopic parallel lines scribed onto its surface.

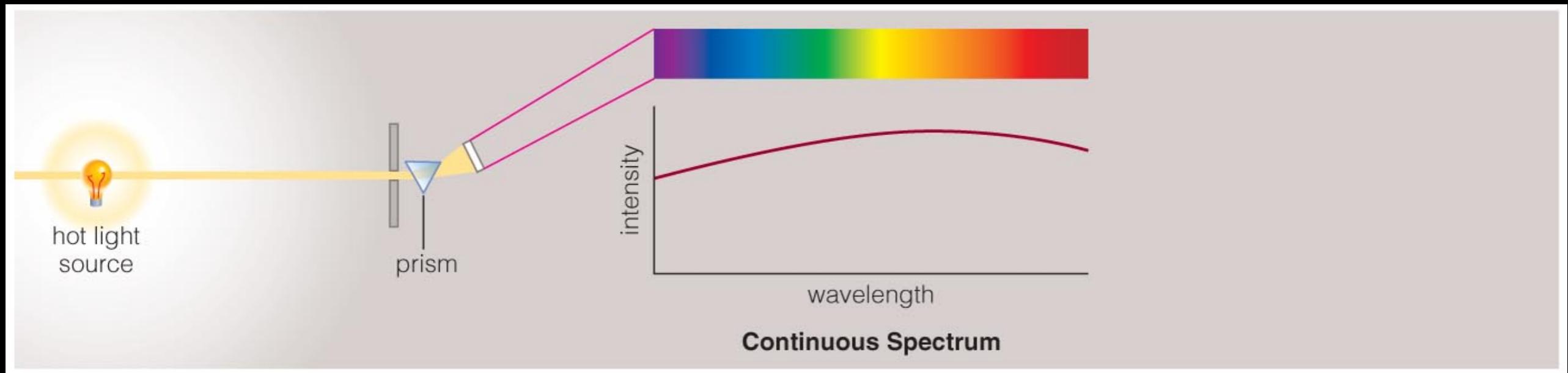


Three kinds of spectra

Continuous
Absorption
Emission



Continuous Spectrum



The spectrum of a common (incandescent) light bulb spans all visible wavelengths, without interruption.

What Emits a Continuous Spectrum?

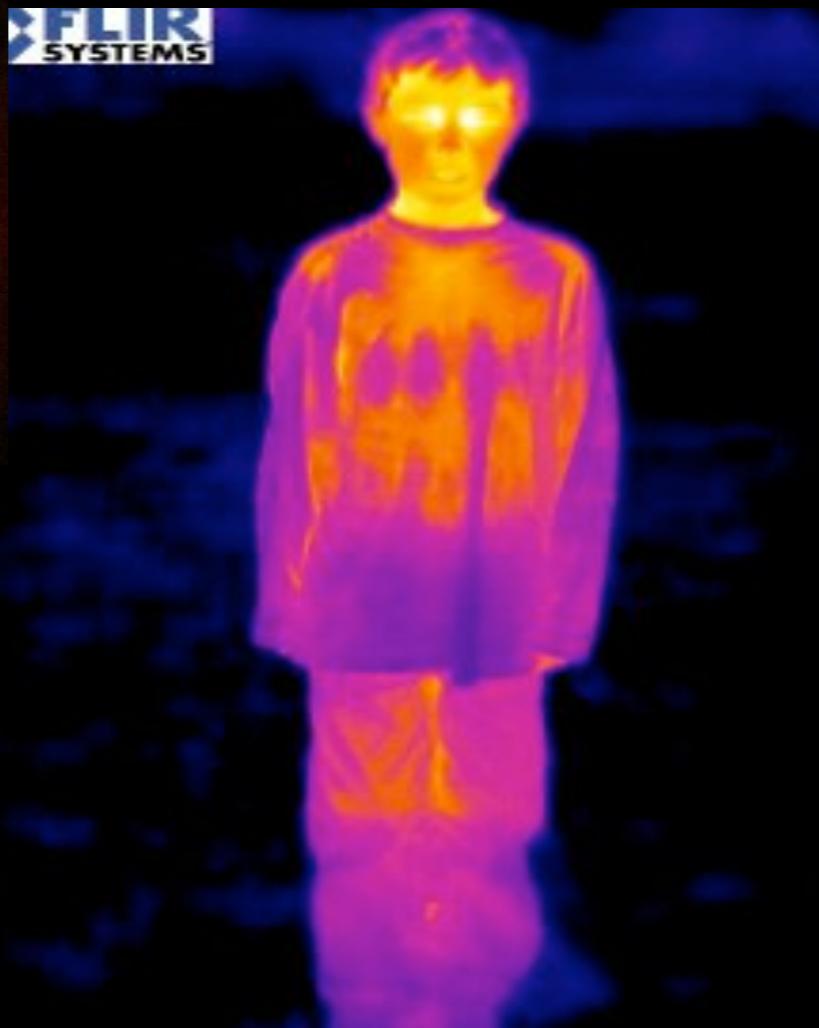
Really hot pokers



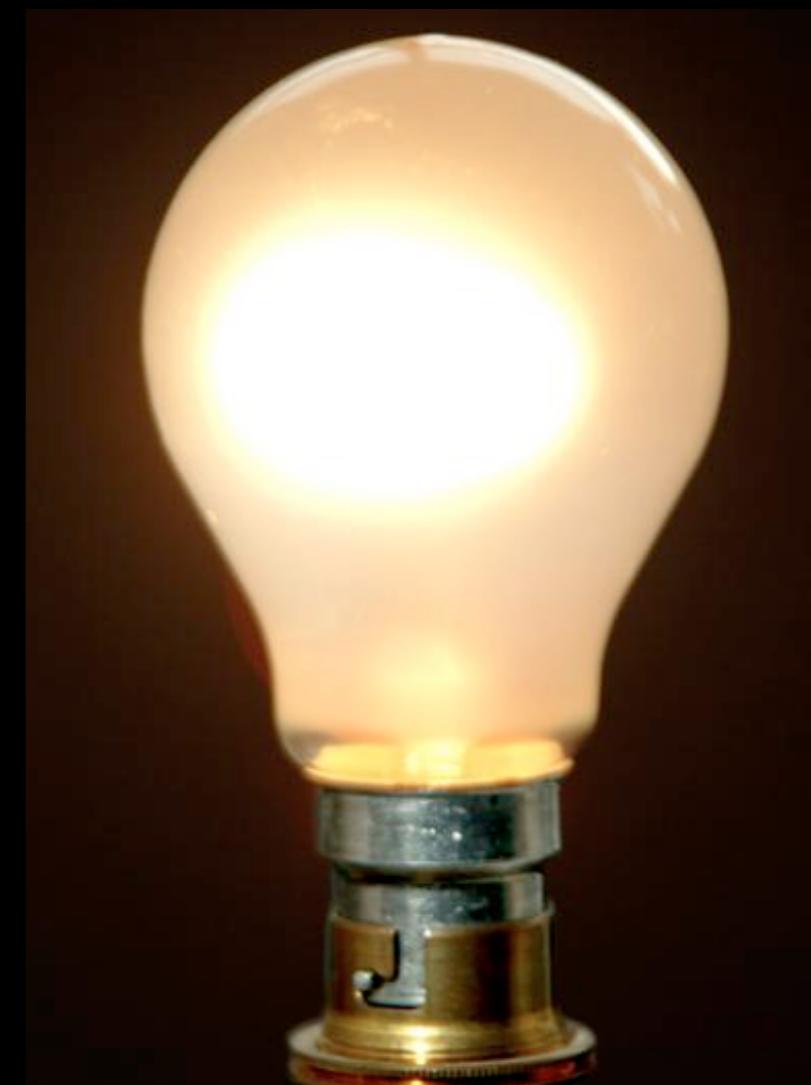
Cats



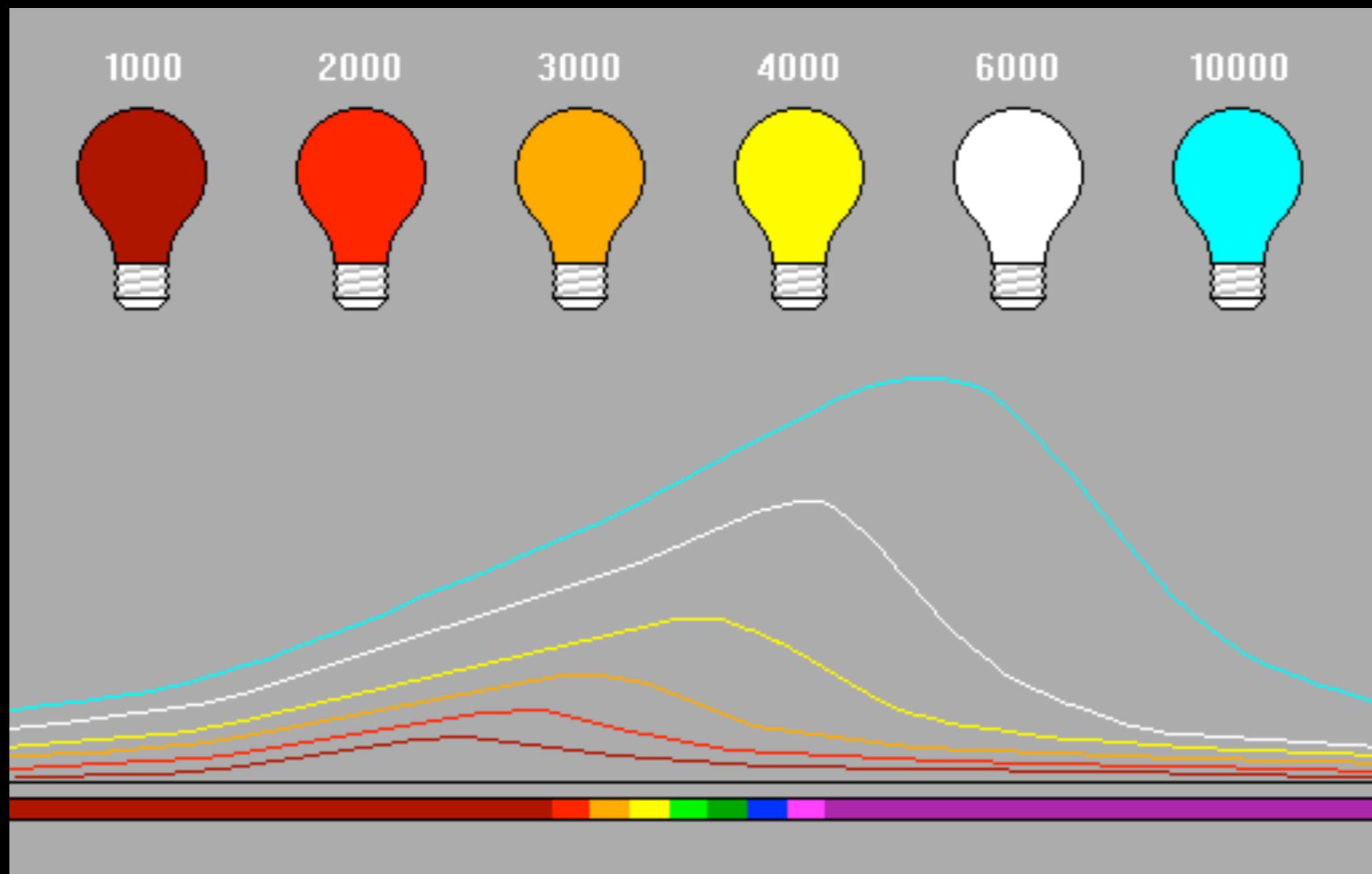
Us



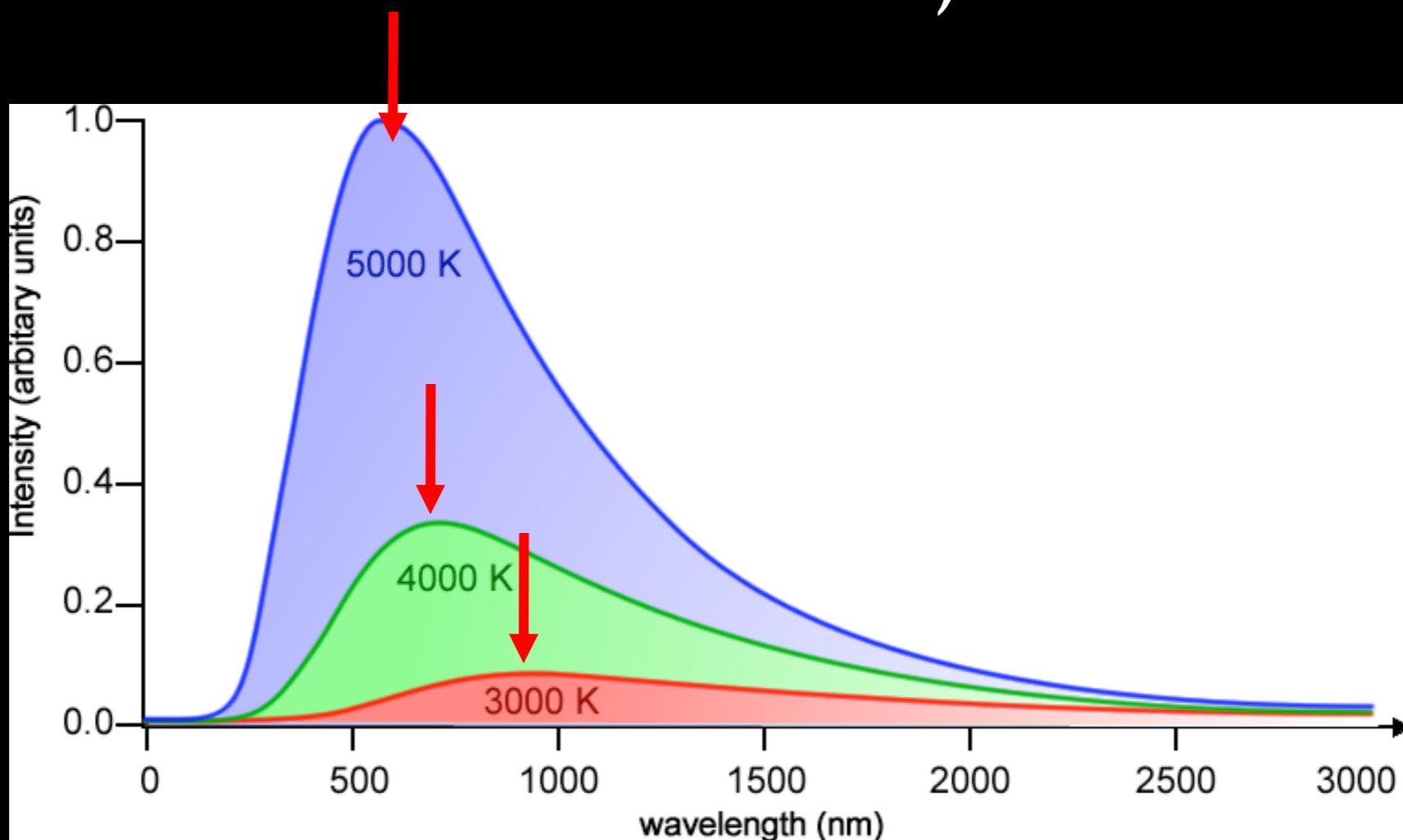
Incandescent Bulb



Objects that emit a continuous spectrum are giving off **blackbody radiation**

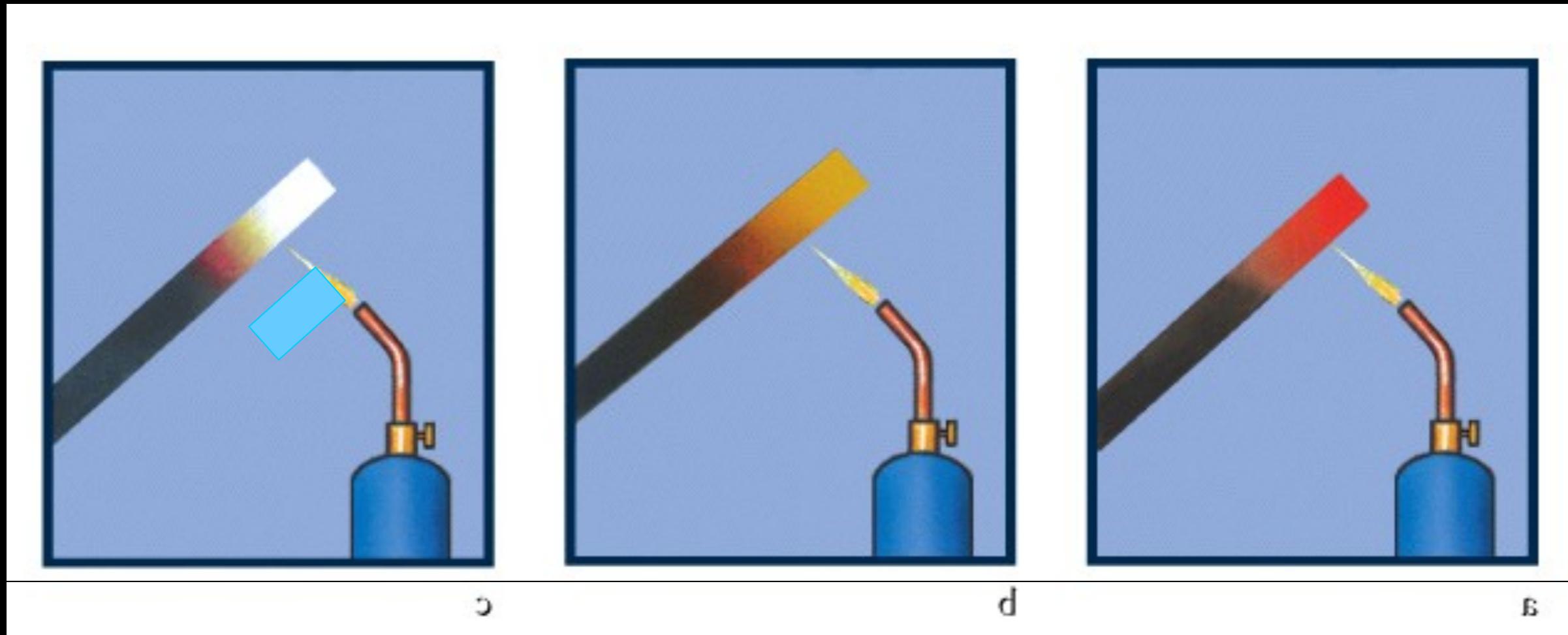


Wein's law states that, the hotter an object is, the shorter is the wavelength of its peak output (and vice versa)



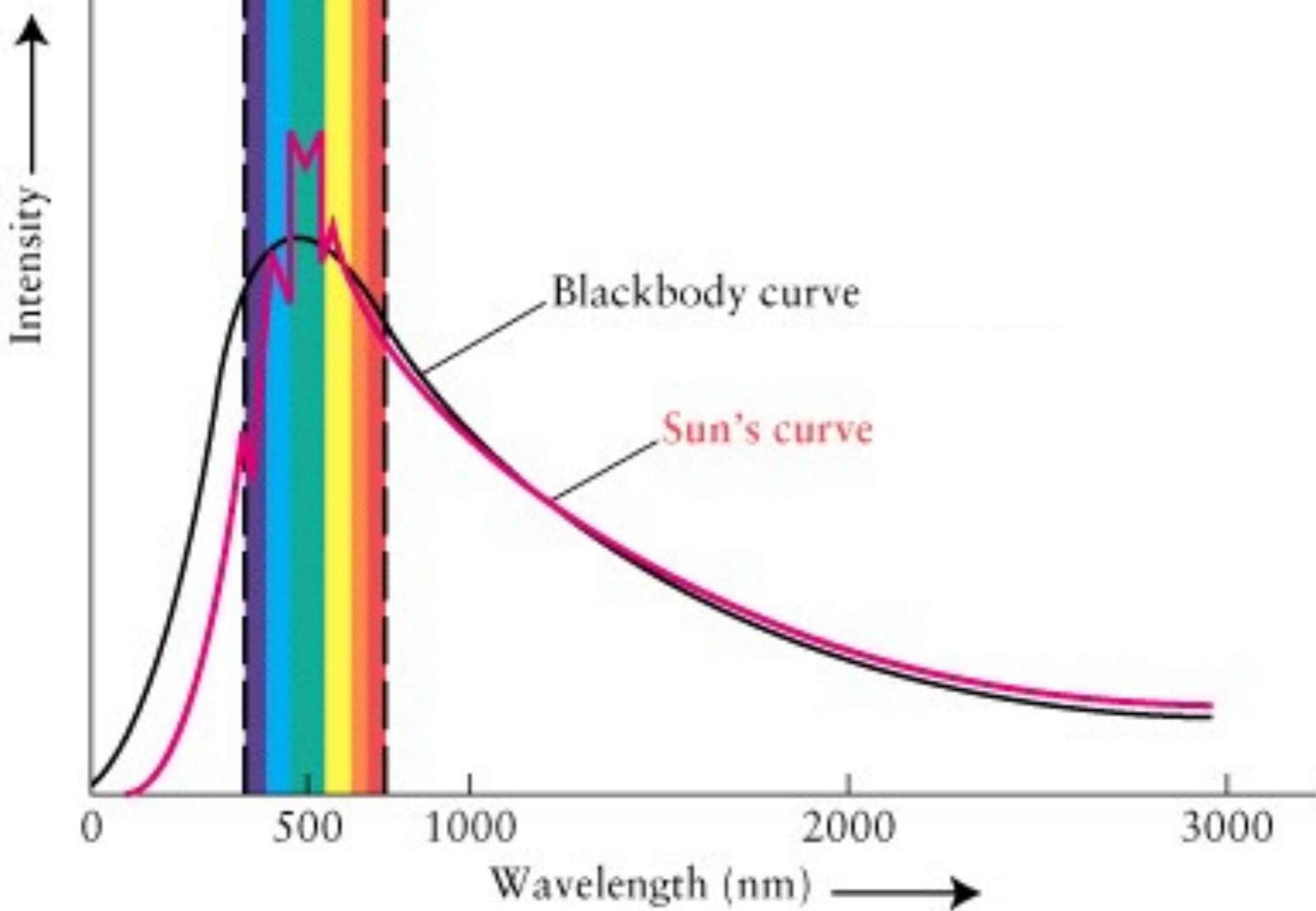
$$\text{Degrees K} = 273.15 + \text{Degrees celsius}$$

Which object is hotter, an object that is emitting mainly red light or mainly blue light?



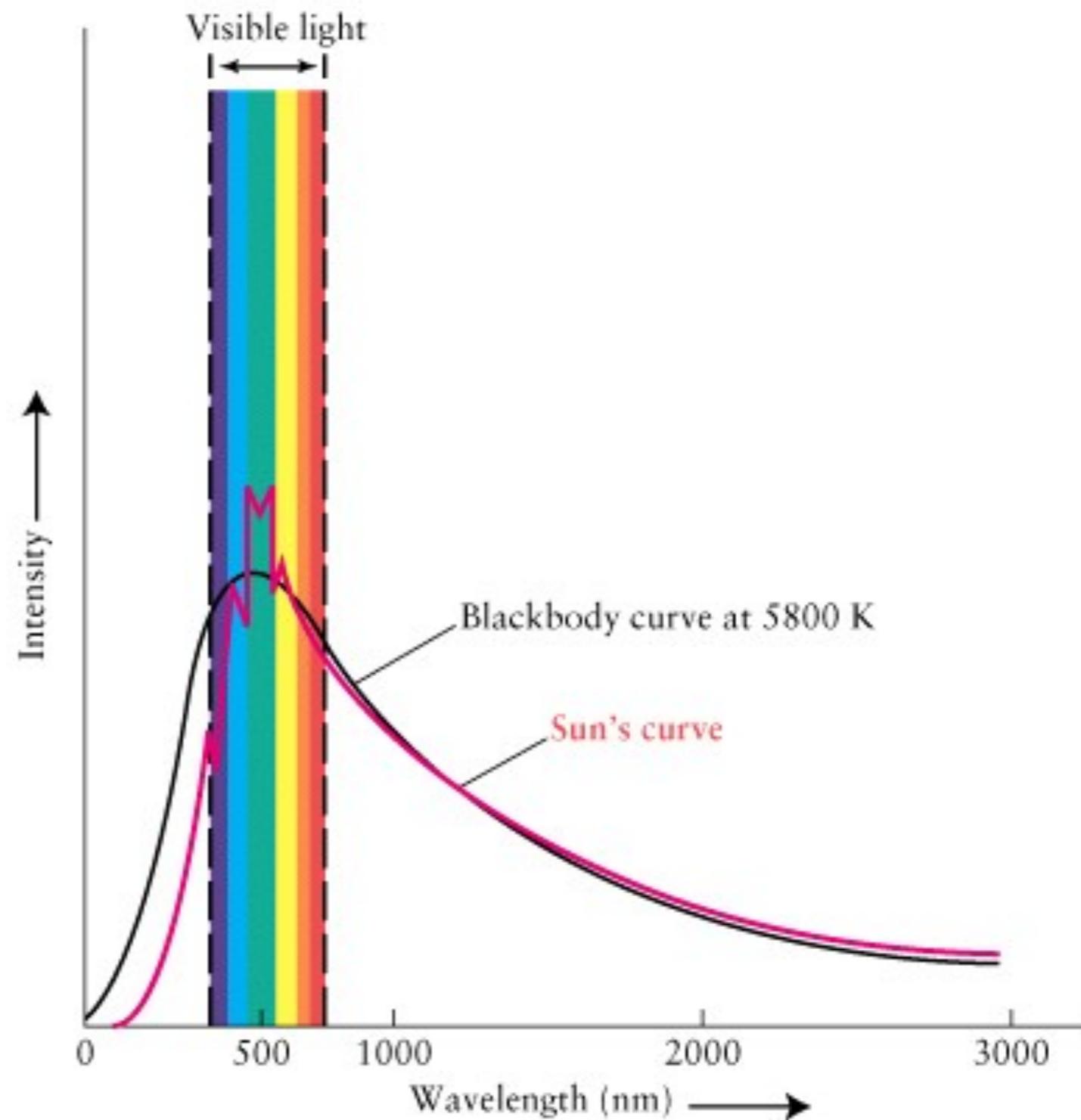
increasing temperature

What is the wavelength
of the PEAK of this
“Blackbody” curve



What color is our 5800K Sun?

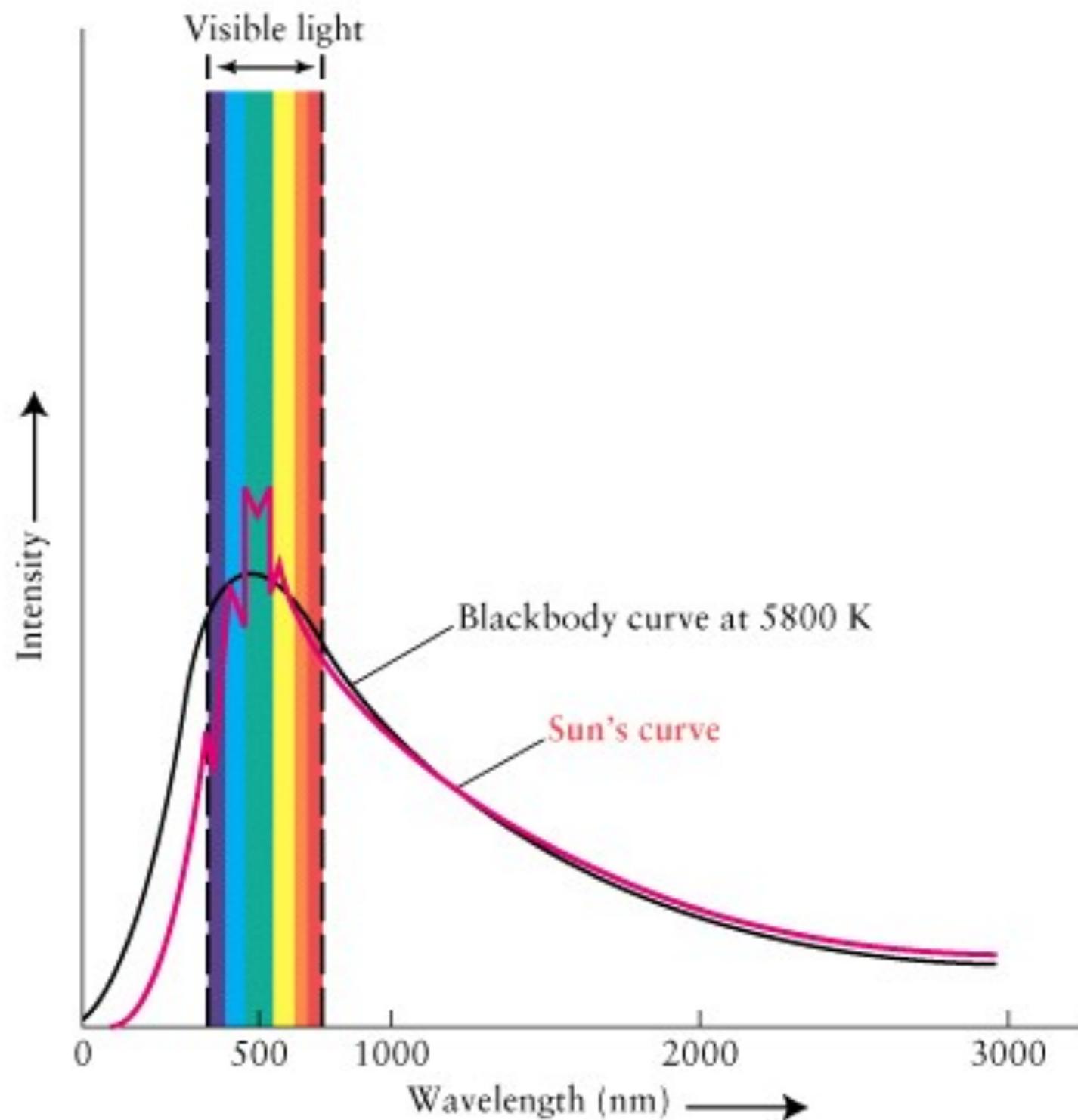
The Sun emits all wavelengths of electromagnetic radiation (light); however, the wavelengths of light it emits most intensely are in the green/yellow part of the spectrum.



What color does the Sun appear?

WHITE!!

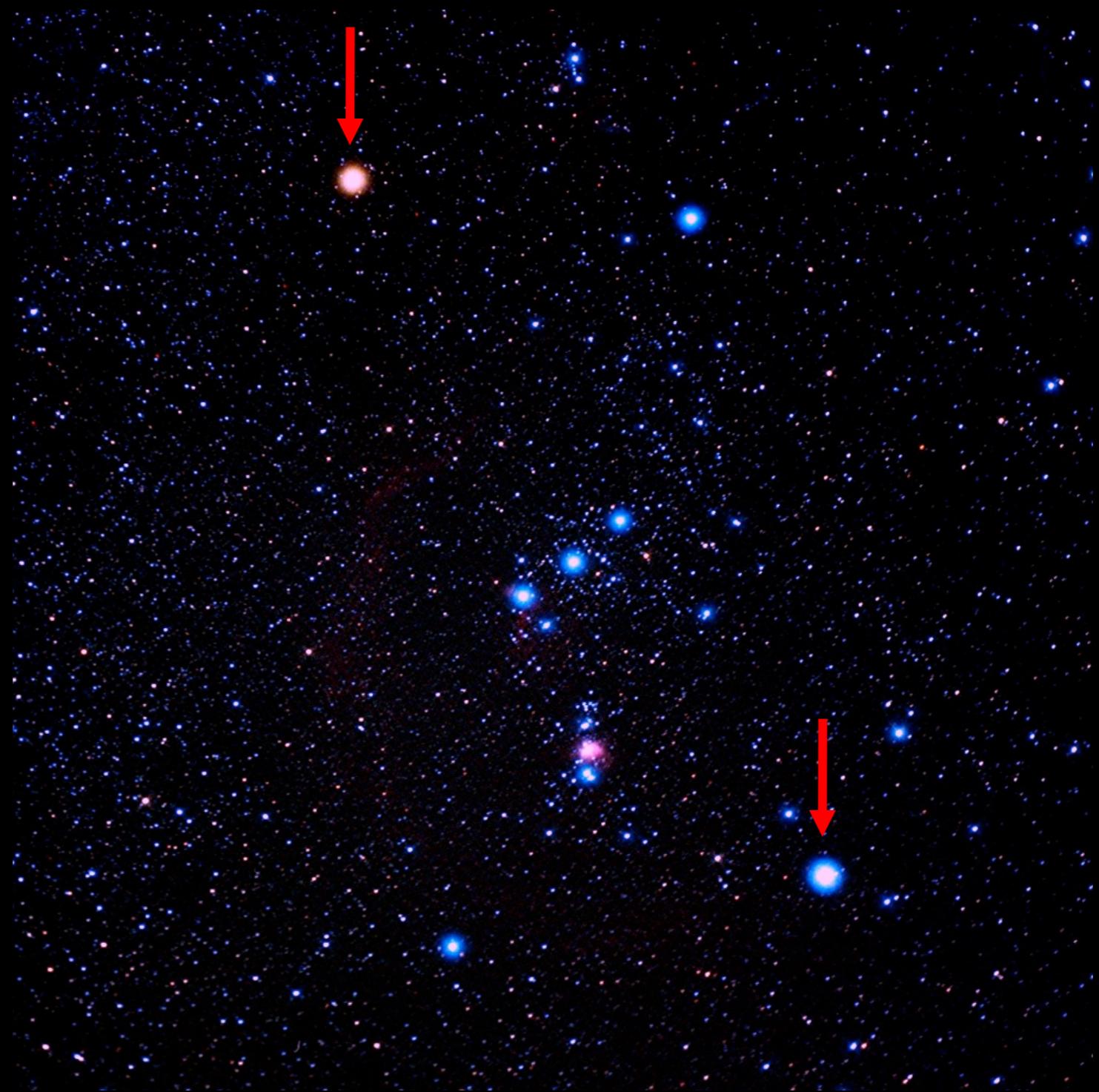
star, like the Sun, which peaks in the middle of the visible part of the spectrum (green/yellow light) will appear WHITE to the human eye because it is giving off nearly equal amounts of all the visible colors of light.



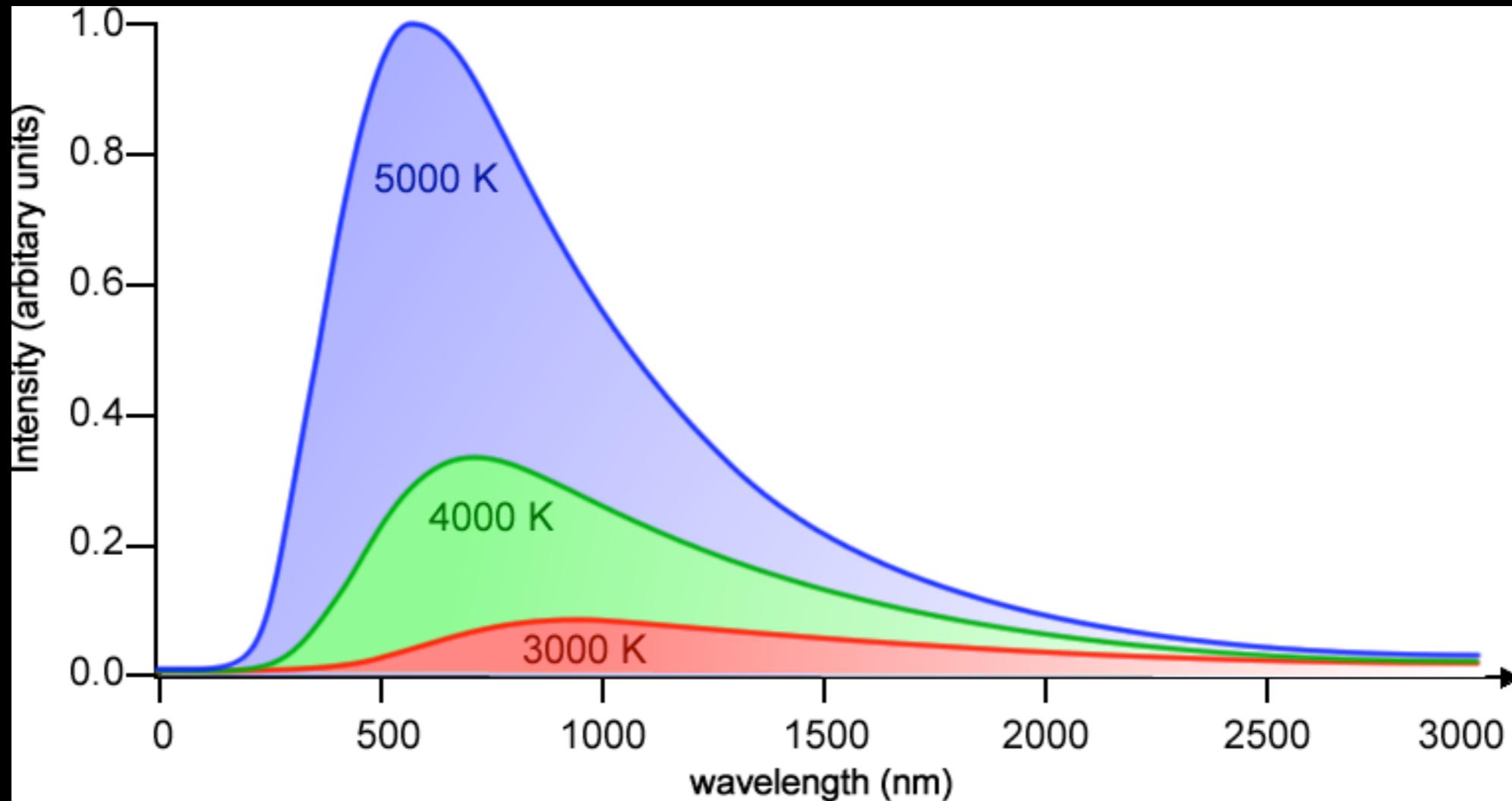
Stars are different colors!!!



This is why Betelgeuse and Rigel,
have such different colors.



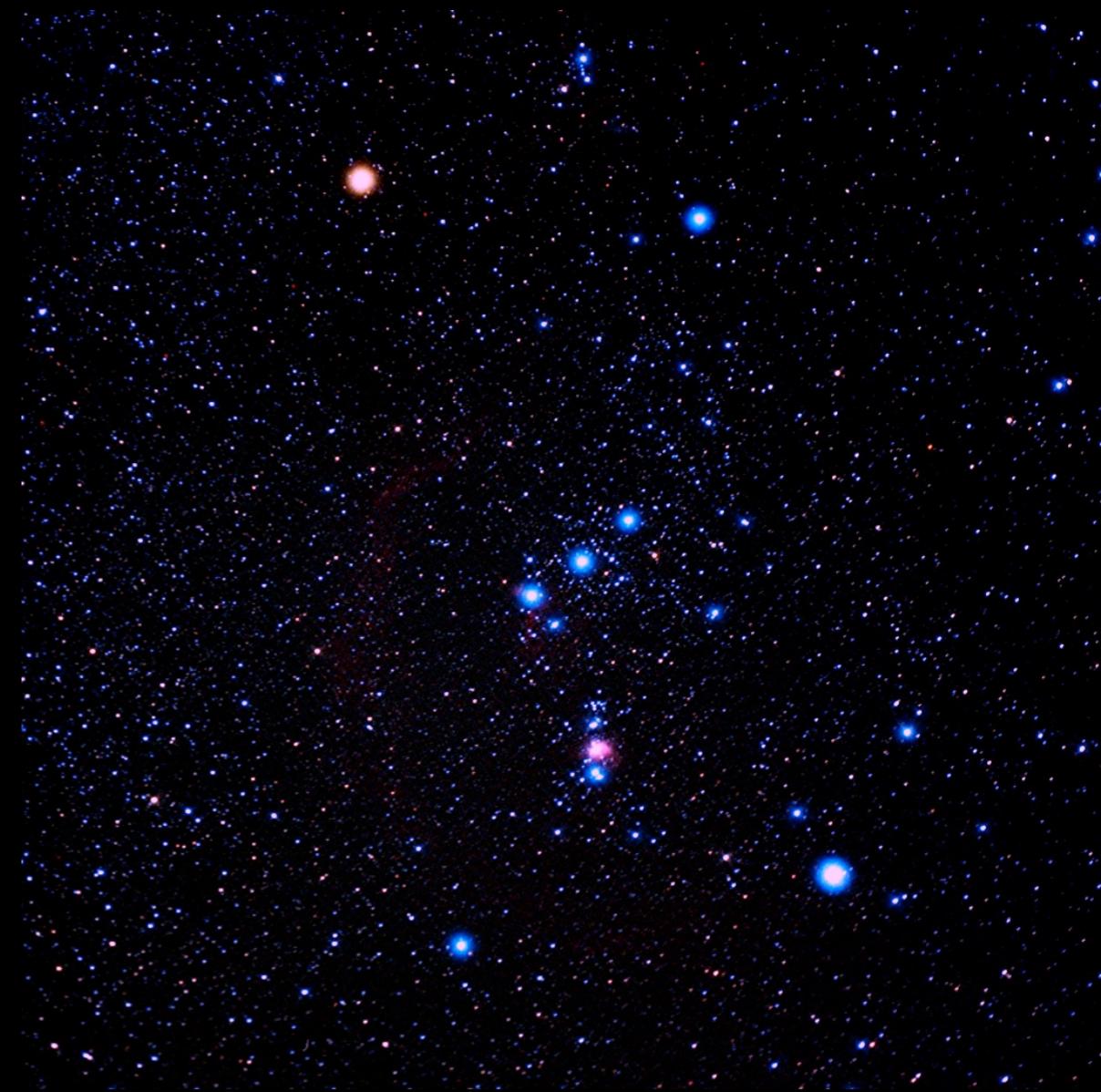
Stefan-Boltzmann Law states that hotter objects emit more energy than cooler objects of the same size.



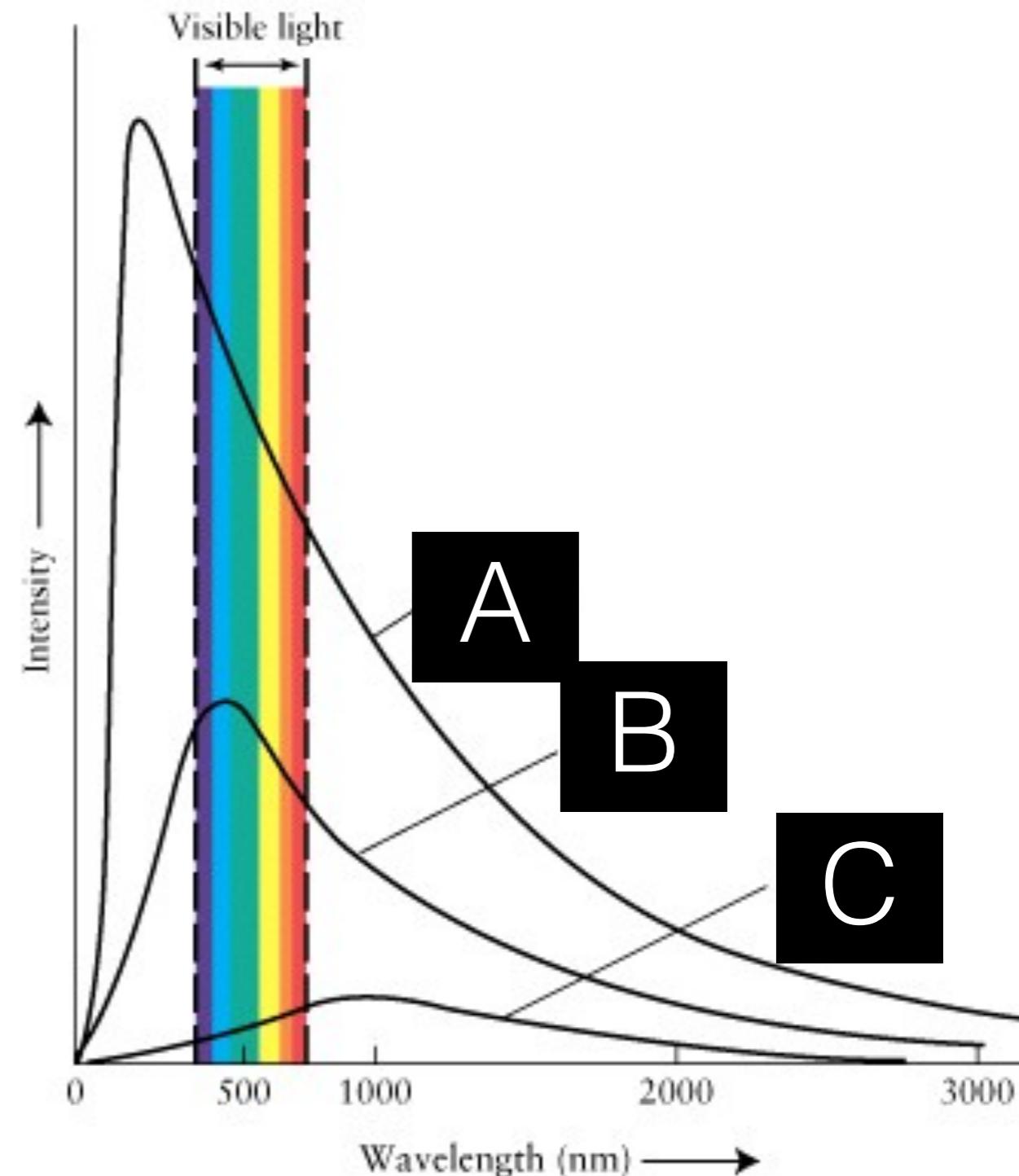
Energy = the area under the blackbody curve
This is also called *luminosity*.

Which is hottest?

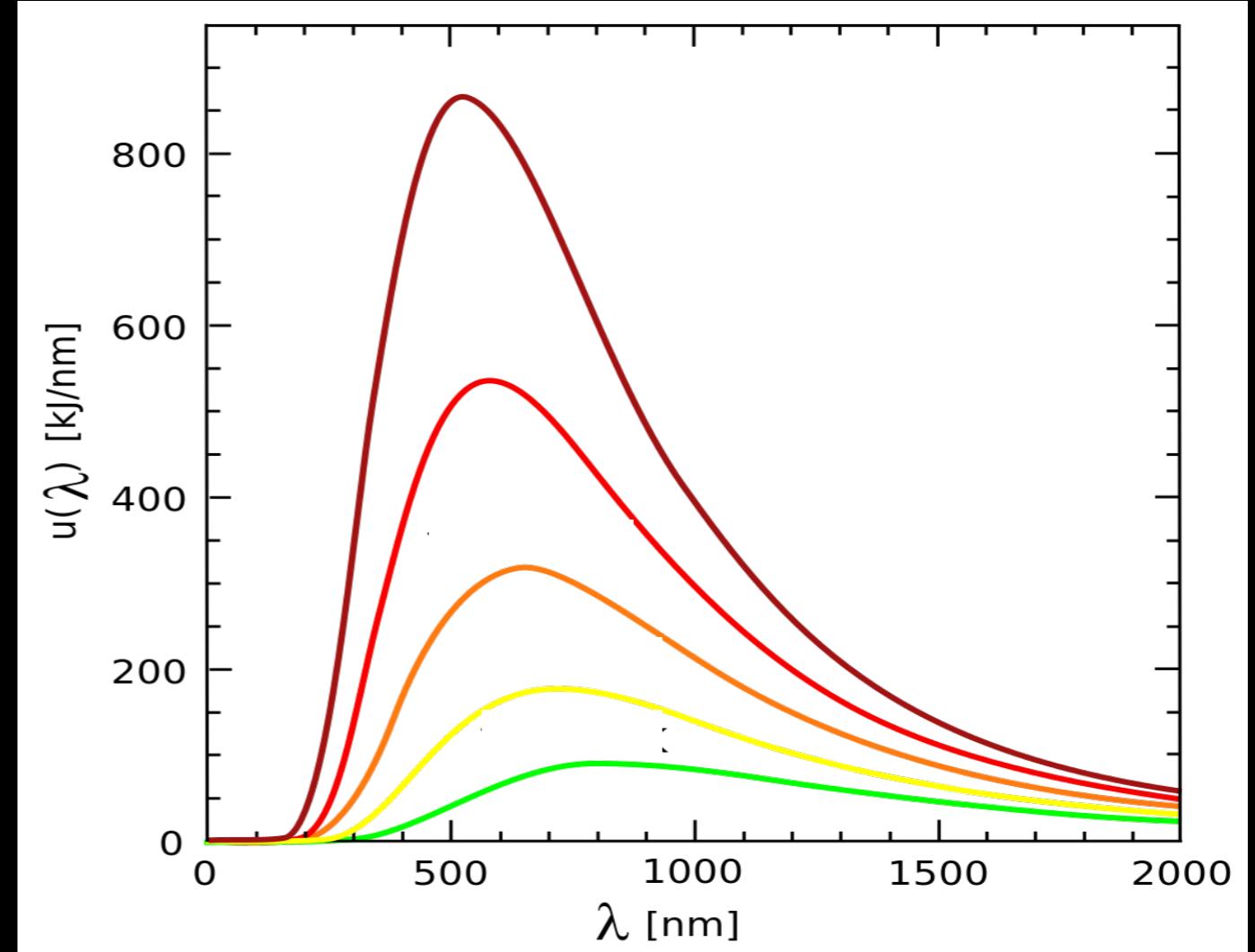
- a) a blue star
- b) a red star
- c) a planet that emits only infrared light



1. Which object gives off the greatest amount of Blue light?
2. Which object gives off the greatest amount of Red light?
3. Which object would appear Red?
4. Which object would have the lowest temperature?



- Rank the temperature (from coolest to hottest) of the stars:

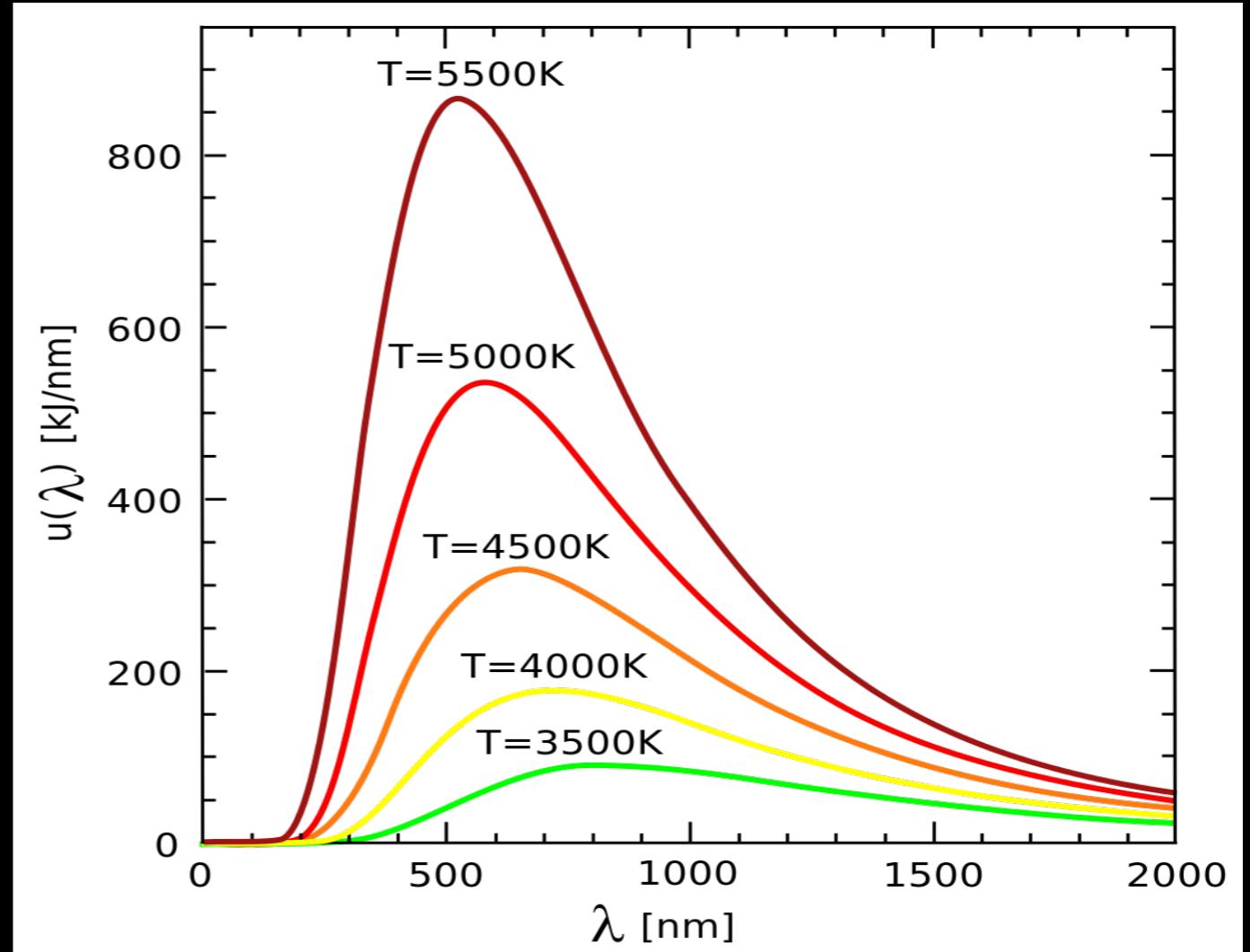


Ranking Order:

Coolest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ Hottest

Or, are all the stars the same temperature??

- Rank the luminosity (from brightest to faintest) of the stars:



Ranking Order:

Brightest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ Faintest

Or, all all the stars the luminosity??