

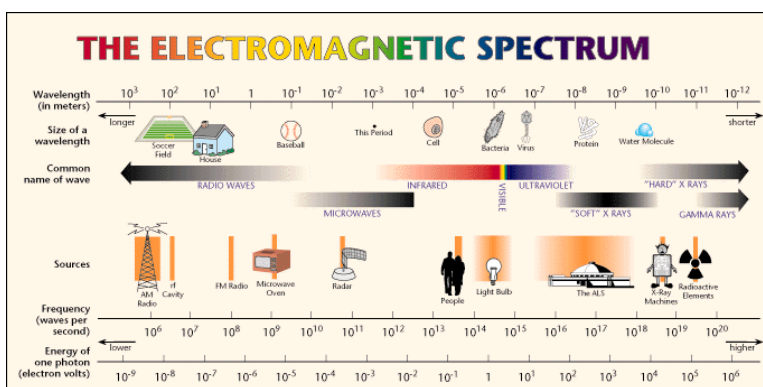
# HOMEWORK – LIGHT AND THERMAL RADIATION

Due Thursday, October 28, before the beginning of class

## 1 Reference for the Electromagnetic Spectrum

The relationships between wavelength, frequency, and photon energy, as well as the names of different “colors” of light, are shown on this chart from Lawrence Berkeley National Laboratory:

Note here that the wavelength, frequency, and photon energy are shown in scientific notation. As the wavelength gets shorter, both the frequency and the energy of one photon increase.



The visible range is roughly from 380 nm (blue) to 750 nm (red).<sup>6</sup>

## 2 Reference for Thermal Radiation

(If you are looking at this before Tuesday’s class and it doesn’t make sense – don’t worry! We’ll talk about this then.)

There is also a relationship between the temperature of an object and the type of light it emits. As the temperature of an object increases:

- The types of light it emits shift to shorter wavelengths
- It emits much *more* light

This is a range, however: an object that *mostly* emits visible light, like the Sun, will also emit some near infrared and ultraviolet, too.

Everything on the chart is approximate.

Example	Temperature (Kelvin)	Peak Emission
Deep space	3 K	Microwaves
Room temperature	300 K	Far infrared
A hot stove	1000 K	Near infrared (plus a little bit of visible)
A “cool” star	3500 K	Red (plus a lot of infrared)
The Sun	5800 K	Visible light (even balance)
A “hot” star	10,000 K	Blue (plus a lot of ultraviolet)
The hottest stars	100,000 K	Ultraviolet
Gas falling into a black hole	1 million K	X-rays

### 3 Questions for Homework

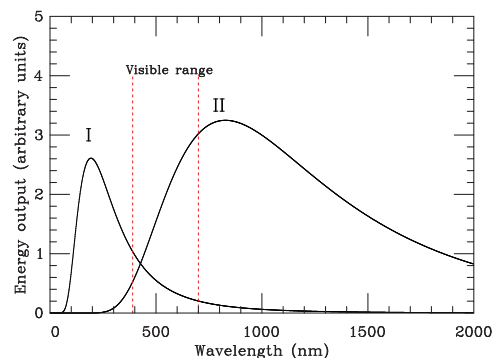
- Photons with more than about 10 eV of energy per photon are capable of ionizing atoms – tearing their electrons off. If this happens to atoms that are part of your body, this can cause chemical change that can make you sick or cause genetic changes that can lead to cancer.

What types of light are capable of doing this?

- Wifi uses either 2.4 GHz or 5 GHz to carry its signals. Which one has longer wavelength?
- Photons that comprise visible light range from 1.6 eV to 3.2 eV (approximately). What color are 1.6 eV photons? What color are 3.2 eV photons? (Note that blue and violet have short wavelengths, and red has long wavelengths.)
- We often think of red as a ‘warm’ color and blue as a “cool” color. Is this correct? If you see a blue star and a red star, which one is hotter?
- You observe two stars that produce the spectral curves shown here.

If they are the same distance away, explain:

- Which star would look brighter?
- What color would each star appear to be to the eye?
- Which star is larger?



6. You observe three objects that produce the spectral curves shown here.

- (a) What color would each one appear to be glowing *to the eye*?
- (b) Estimate the temperature of each one based on the light they emit.
- (c) Could any of them represent the light emitted by a living human? If so, which one? If not, how do you know?

