Temperature Summary and Practice

Fahrenheit and Centigrade (or Celsius)

In the Fahrenheit scale, water freezes at 32° and boils at 212°. Actually the boiling point depends a lot on altitude and that value is for sea level, but let's just ignore that, eh? 212-32 = 180, so there are 180° between freezing and boiling.

In the Centigrade (or Celsius) scale, water freezes at 0° and boils at 100°.

So in that scale there are 100° degrees between freezing and boiling.

Comparing those two, you see that each Centigrade degree is $\frac{180}{100} = \frac{9}{5}$ of a Fahrenheit degree.

Fahrenheit is also offset by 32°, so if you want the conversion formula, you have to include the offset, and the formula is

$T_{\text{in Fahrenheit}} = \frac{9}{5} T_{\text{in Celsius}} + 32.$

Kelvin Scale

There are things colder than ice, like liquid nitrogen. You might think that no matter how cold you make something, there will always be something else you could make that is much colder. However, it turns out there is an absolute minimum temperature.

This temperature is called "absolute zero." On the Centigrade scale, absolute zero is -273.15°.

It turns out to be extremely convenient to make a scale that has zero at absolute zero instead of at the freezing point of water. This scale is called the Kelvin scale. On this scale, water freezes at +273° and boils at 100° more than that, so +373°. In the Kelvin scale, room temperature is about 300 K. The abbreviation for temperature on the Kelvin scale is just K.

The surface of the Sun is 5777K.

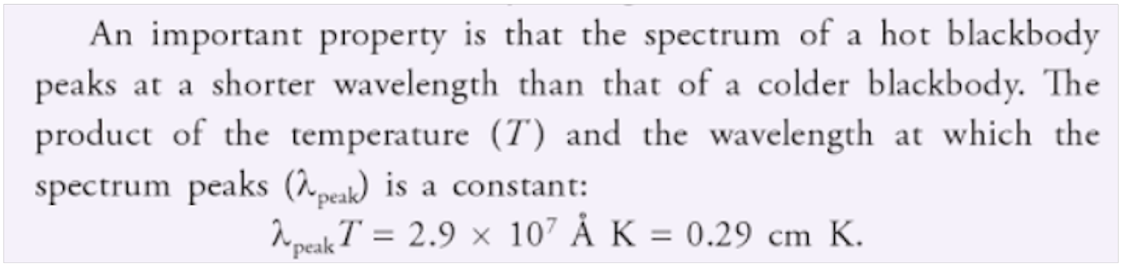
Practice Problem 1

(a) Convert the surface temperature of the Sun to degrees Celsius.

(b) Convert the surface temperature of the Sun to degrees Fahrenheit.

Wien’s Law for Blackbody Radiation

Here is how Pasachoff and Filipenko (an excellent textbook I have used in prior years) summarizes Wien’s Law, which concludes with:



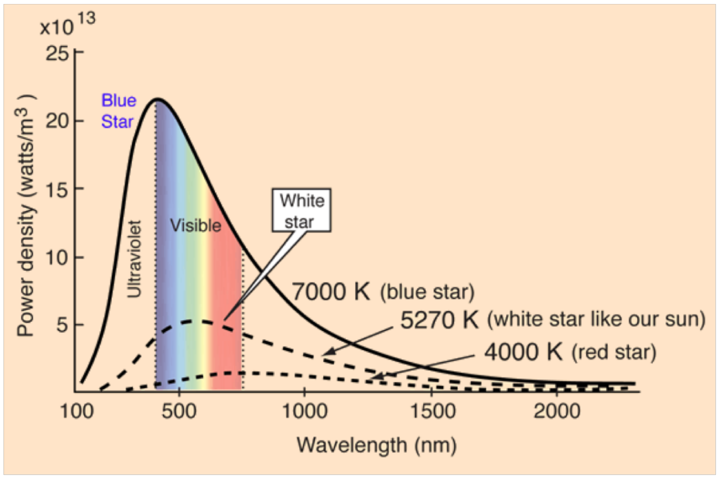
An important property is that the spectrum of a hot blackbody peaks at a shorter wavelength than that of a colder blackbody. The product of the temperature (T) and the wavelength at which the spectrum peaks (λ_{peak}) is a constant:

$$\lambda_{\text{peak}} T = 2.9 \times 10^7 \text{ Å K} = 0.29 \text{ cm K}.$$

This is telling you the peak wavelength of a “black body.” The Å means Angstrom, and is 10^{-10} meters or 0.1 nanometers. Let’s solve that formula for λ_{peak}. If you do that, you get:

$\lambda_{\text{peak}} = b\,/\,T$ where $b = 2.9 \times 10^6 \text{nm K}$

I converted Angstroms to nanometers, because I don’t want to bug you with quite so many units. Below is a nice illustration of blackbody radiation that was in yesterday’s handout:



What this illustration shows is the light of a blue (hot) star peaking at shorter wavelengths than the light of a cooler (reddish) star.

Practice Problem 2

(a) At what wavelength does the Sun’s spectrum peak?

(b) Compare your answer to (a) with whatever you get Googling for the wavelengths of red light, green light and blue light. (c) Why does the Sun appear white?