PHY 291- Computational Physics
Homework 2
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Homework 2

Introduction: It is usually observed that as an object's temperature increases, the object will begin to glow. This relationship is proportional, as temperature increases, so does the glow. This pattern is completely temperature dependent, with no correlation to the object's material. This is the phenomena physicists studied in the 1900's. The first formula derived to explain black body radiation is shown in **Formula 1.** This formula modeled most of the black body radiation curve. Sadly the formula showed that if the temperature of an object continued to increase, the objects would eventually emit x-rays. This did not correlate to experimental measurements. Max Planck later proposed the idea that energy is quantized, meaning you can have 1 quanta or 200 quanta, but not 1.5 quanta. Planck then derived **Formula 2** as well as planck's constant (h). This formula could be perceived as the explanation for the black body radiation curve. Sadly no again, it was known that particles behave as waves at the time. Therefore Planck's attempt to quantize energy was in direct violation of this.

Formula 1: Original Derivation

$$\boxed{I = \frac{2\pi cKT}{\lambda^4}}$$

Formula 2: Planck's Derivation

$$\boxed{B(\lambda,T) = \left(\frac{2\pi hc^2}{\lambda^5}\right)\frac{1}{e^{\left(\frac{hc}{\lambda KT}\right)}-1}}$$

In class, we were asked to write a matlab script using **Formula 2** that would plot the spectral exitance for 7000K. This temperature is close to a white star. We were also given a range for light wavelength, [0.01um – 3um]. This range encapsulates the visible spectrum of light as well as a small amount of invisible light. For the program, iterative loops were used to continually execute the range of wavelengths, while all other values in **Formula 2** were kept constant. This iterative loop was later plotted onto a graph, along with the range of wavelengths. The results are shown in **Figure 1.** From **Figure 1,** it can be concluded that an object of 7000K, has a majority of spectral exitance that will occur in the range of [400-700nm]. Given that this range usually produces white light, this would explain why stars of a temperature 7000K would appear white. This mathematical formula still models reality accurately for the macroscopic, making it very useful for astronomers.

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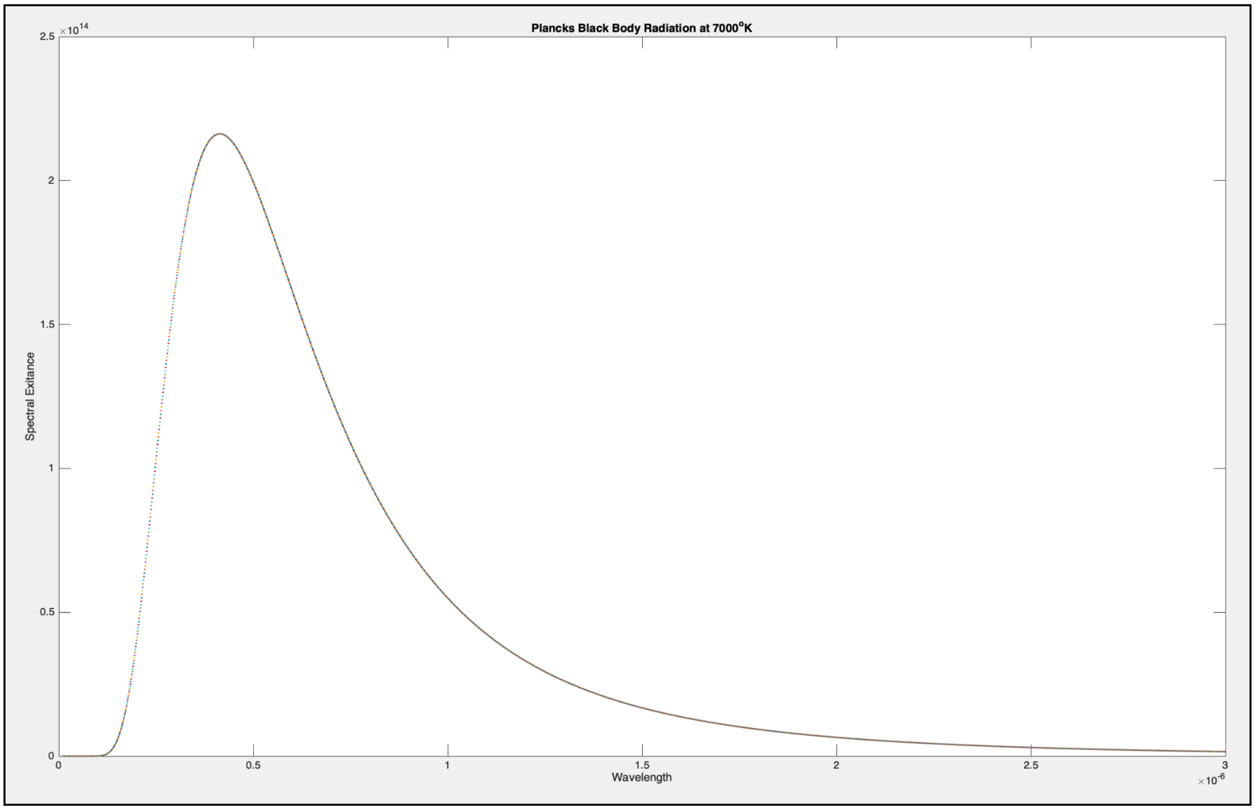
Figure 1: Black Body Radiation Curve at 7000k



Introduction: Our experiment continues with Albert Einstein's interpretation of the nature of light. It was observed that if light strikes a photoelectric material, electrons will be emitted into the experimental element. **Formula 3** shows this relationship, it explains how the energy of the emitted electron is dependent on the difference of the work function. If the threshold frequency of the material is surpassed then electrons will be emitted.

Formula 3: Energy & Work Function

$$KE = hf - \phi$$
$$\phi = hf_0$$
$$\mathrm{f}_0 = \text{Threshold frequency}$$
$$\mathrm{hf} > \phi \Rightarrow \text{Electrons Emitted}$$

Figure 2: Given Data

Wavelength of light (nm)	Kinetic Energy of electrons (eV)
545	0.50
422	1.10
385	1.50
361	1.70
300	2.40
252	3.20

For this experiment we were directed to use the given data shown in **Figure 2**. The data was used to plot points within a graph. These graphed points were used to acquire a linear function relationship that aligned with the given values. This linear function's slope was supposed to be equivalent in value to planck's constant. The y-intercept was supposed to give us the minimum work function value. It was asked to have the program print these values for Planck's constant in the units of J·s and the work function in eV as well as the percent difference of the calculated constant and actual value. These results are shown in **Figure 3.** The calculated Planck constant was off by about 2.5%, showing this was a very accurate result considering the order of magnitudes. The closest element I could find that has a similar work function is cesium. Finally the graph produced within matlab using polyfit and polyval is shown in **Figure 4.** The graphs slope and y-intercept return the values given in **Figure 3.**

Figure 3: Returned Values

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The Calculated value of plancks constant is: 6.816346e-34 Js
The Calculated value of the work function is: 1.853560e+00 eV
The Percent difference of Plancks constant to calculated is: 2.791459e+00 Percent
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Figure 4: Work function