Assignment

Instructions:

- *The assignment has 5 parts and is worth 100 marks in total*
- *Please show full, step-by-step working and reasoning to earn full credit*

In lecture you were introduced to blackbody radiation, whose spectral intensity is given by Planck's law as

$$R(\lambda, T) = \frac{2\pi c^2 h}{\lambda^5} \frac{1}{e^{hc/\lambda k_B T} - 1}$$

(a) Using Python, Matlab, Mathematica, or your programming language of choice (graphing calculator and hand-drawn not permitted), plot the above equation as a function of lambda for the radiation emitted by the sun, from lambda = 100 nm to lambda = 1000 nm. Ensure that your graph is clearly labelled and professionally presented. For the purpose of this assignment, you can treat the sun as a perfect black body at temperature T = 5775 K. Attach your full code in the appendix of the submission. [20 marks]

(b) What is the peak spectral intensity of the curve and at what wavelength does it occur? Show your work and explain your reasoning in detail [20 marks]

(c) What is the total intensity emitted by the sun in the visible range i.e., between lambda = 400 nm and lambda = 700 nm? You may need to perform an integral computationally to answer this question -- the integral has to be implemented in a programming language and not performed by a graphing calculator. Show your work and explain your reasoning in detail. Attach your full code in the appendix of your submission. [20 marks]

(d) What fraction of the sun's total power reaches the earth and its atmosphere? For the purpose of this question, you may treat the earth as a perfect sphere of radius 6370 km, located 1.496×10^8 km from the sun, and the sun as a perfect sphere of radius 696340 km. Show your work and explain your reasoning in detail [20 marks]

(e) Using the code you have written in the previous parts, answer the question about which color reaching the earth and its atmosphere is the most intense. For this question you may consider the 7 colors to have the wavelength ranges in Table 1. Show your work and explain your reasoning in detail. Attach your full code in the appendix of your submission. [20 marks]

Table 1. The visible light spectrum

Color	Red	Orange	Yellow	Green	Cyan	Blue	Purple
Wavelength range [nm]	625 - 740	590 - 625	565 - 590	520 - 565	500 - 520	435 - 500	380 - 435