

Quantum Mechanics Spring 2023

Exercise Sheet 2

Issued : 24 January 2022

Due : 31 January 2023

Note : *Please submit your scanned solutions directly on canvas before the deadline.*

Problem 1 (10 marks)

A star such as our Sun will eventually evolve to a “red giant” star and then to a “white dwarf” star. A typical white dwarf is approximately the size of Earth, and its surface temperature is about $2.5 \times 10^4 K$. A typical red giant has a surface temperature of $3.0 \times 10^3 K$ and a radius 100,000 times larger than that of a white dwarf. What is the average radiated power per unit area and the total power radiated by each of these types of stars? How do they compare?

Problem 2 (5 marks)

An iron poker is being heated. As its temperature rises, the poker begins to glow—first dull red, then bright red, then orange, and then yellow. Use either the blackbody radiation curve or Wien’s law to explain these changes in the color of the glow.

Problem 3 (5 marks)

Suppose that two stars, α and β , radiate exactly the same total power. If the radius of star α is three times that of star β , what is the ratio of the surface temperatures of these stars? Which one is hotter?

Problem 4 (10 marks)

A 1.0-kg mass oscillates at the end of a spring with a spring constant of 1000 N/m. The amplitude of these oscillations is 0.10 m. Use the concept of quantization to find the energy spacing for this classical oscillator. Is the energy quantization significant for macroscopic systems, such as this oscillator?

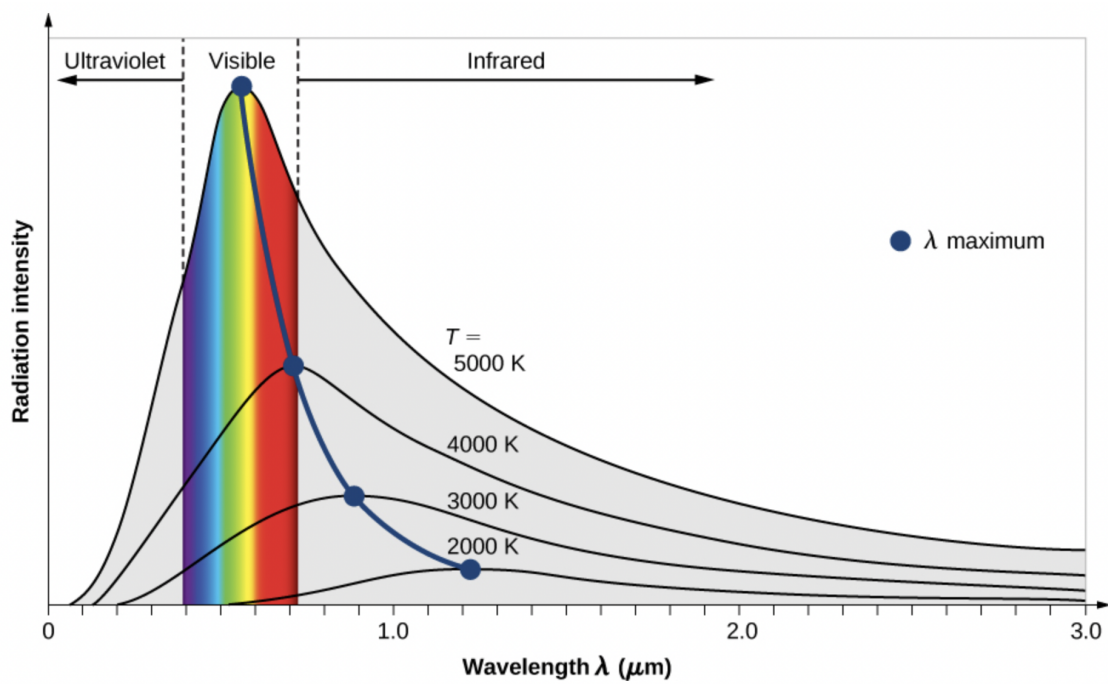


FIGURE 1 – The intensity of blackbody radiation versus the wavelength of the emitted radiation.