Physics 3374/6351 Professor Scalise
Homework Assignment #10 Fall 2024

3374

1. Read Schroeder sections 7.3 and 7.5-7.6. Did you read all the pages?
2. (a) What is the energy density of the photons in an oven at 350°F?
   (b) What is the energy density of the air in an oven at 350°F?
3. At the surface of the sun, what fraction of the energy is in the visible part of the spectrum? You will need to perform an integral numerically; it will be easier if you use dimensionless variables.
4. (a) What is the energy of the Cosmic Microwave Background (CMB) today in the visible Universe?
   (b) What is the entropy of the CMB today in the visible Universe?
5. Write the formula for the partition function Z of an electron in a hydrogen atom. If the sum is finite, to what value does it converge? If the sum is infinite, prove it.

6351

1. (a) For the black body spectrum, find $\frac{h\nu_{\text{peak}}}{k_B T}$ numerically.
   (b) Derive a formula for the black body spectrum in terms of wavelength λ.
   (c) Find $\frac{hc}{\lambda_{\text{peak}} k_B T}$ numerically.
   (d) Explain why $\nu_{\text{peak}} \neq \frac{c}{\lambda_{\text{peak}}}$.
   (e) For the sun, find ν_{peak} and λ_{peak}. To what part of the spectrum (what color) do they correspond?
2. We saw that the energy density of photons in a box at temperature T is $u = aT^4$, where a is the radiation constant. Show that the intensity of radiation escaping from a small hole in the box is $(\frac{c}{4})aT^4 = \sigma T^4$, where σ is the Stefan-Boltzmann constant.

Bonus: Solve as much of the other class' assignment as you can.