PHYSICS 4E   QUIZ 1 (open book)   SPRING QUARTER 2015
PROF. HIRSCH   APRIL 6

Constants: hc=12,400 eVÅ. Boltzmann constant k=1/11,600 eV/K

Problem 1 (10 pts)
In a three-dimensional ideal gas at room temperature the rms speed of the molecules is
$v_{rms} = \sqrt{< v^2 >} = 300 m/s$
(a) If 5,000 molecules have velocity in the x direction v_x in the range betweem 99m/s to 101m/s, how many molecules have velocity in the x direction v_x in the range -1m/s to 1m/s?
(b) If 5,000 molecules have velocity in the x direction v_x in the range betweem 99m/s to 101m/s, how many molecules have velocity in the x direction v_x in the range 199m/s to 201m/s?
(c) If 5,000 molecules have *speed* in the range between 99m/s to 101m/s, how many molecules have speed in the range 199m/s to 201m/s?

Problem 2 (10 pts)
In a box there are 10^{12} modes of the electromagnetic field with wavelength between 10,000Å and 10,005 Å.
(a) What is the volume of this box, in cm^3?
(b) The average energy in a mode of wavelength 10,000Å in this box is $1.24x10^{-6}$eV. What is the temperature of this box, in K?
(c) At what temperature will there be on average 10 photons in the mode of wavelenght 10,000Å, and what fraction of $k_B T$ is the average energy in this mode at that temperature?

Problem 3 (10 pts)

The filament in the right lightbulb is twice as long as the one in the left lightbulb, their diameters are the same. The left lightbulb emits 40W, the right one 60W. The filament of the left lightbulb is at temperature 4000K. Assume the filaments are black bodies.
(a) One of the bulbs looks more yellowish, the other more whiteish. Which is which? Justify.
(b) What is the temperature of the filament of the right lightbulb?
(c) For which wavelenghts does the right filament emit fewer photons than the left filament? Find at least one wavelength, preferably the entire range where this occurs.
(d) Find at least one wavelength for which the right filament emits more photons that the left filament.
Give the answers for wavelengths in Å.

Justify all your answers to all problems