Spectra

I. Thermal Radiation

Solids and dense gases give off a continuous spectrum of electromagnetic radiation simply due to the thermal motion of the atoms and molecules jostling each other about. For example, a chunk of lead is heated to 1,000 degrees Kelvin, then 2,000 degrees Kelvin, then 3,000 degrees Kelvin. The amount of electromagnetic radiation given off at each wavelength of the spectrum is measured, using a light meter. The following results are obtained:

Wavelength	AMOUNT OF EM RADIATION EMITTED		
(Angstroms)	at 1,000 K	at 2,000 K	at 3,000 K
4,000	8.7 X 10-7	56	23,000
5,000	3.8 X 10-4	675	82,000
6,000	0.018	2986	162,000
7,000	0.26	7660	236,000
8,000	1.8	14,000	285,000
10,000	21	28,000	312,000
15,000	336	41,000	210,000
20,000	879	33,000	117,000
30,000	1283	15,000	39,000
40,000	1030	7249	16,000

a) Graph the amount of EM radiation emitted versus wavelength for each temperature all on one plot. (So you should have 3 curves, one for each temperature, on your graph. Put wavelengths on the horizontal axis (from 4,000 to 40,000 angstroms), and amount of radiation emitted on the vertical axis (from 0 to 350,000 ergs/cm2/s/angstrom).

b) Referring to Figure 4-3 on p. 48 of your text, label the type of electromagnetic radiation that corresponds with the wavelengths on your horizontal axis (for example, "x-rays", "blue visible light", "radio").

c) The peak of the curve shows the wavelength at which most of the radiation is being emitted. At which temperature would you most likely be able to see radiation with your naked eye? Explain your answer.

d) From the three curves you plotted, at which temperature does the lead give off the most radiation at ALL wavelengths?

e) Describe how your graph would be different if a chunk of aluminum were heated instead of a chunk of lead. Note that aluminum has 13 protons and lead has 82 protons.

II. Line Radiation

a) The above section described radiation from a solid chunk of material. The spectrum of a thin gas (many examples of which are in the spectroscopy lab) is very different from the thermal radiation spectrum of a solid or dense gas. How is the spectrum different?

b) Describe how a photon would interact with the atom drawn at right to create:

i) an absorption line
ii) an emission line

c) The above hydrogen atom absorbs a photon which has just the right amount of energy to kick the electron from the 2nd energy level to the 3rd. When this energized atom relaxes, how will the wavelength of the emitted photon compare with the wavelength of the photon which was absorbed?

d) The spectrum from a star has continuous thermal radiation with absorption lines. Explain how this could be (a drawing may be helpful).

III. Stars

a) Suppose you observe three stars with both a red and a blue filter. Star A is brighter in the blue than in the red. Star B is brighter in the red than in the blue and Star C is equally bright in both the red and the blue. With this information, put the three stars in order of increasing temperature. Explain briefly how you got your answer.

b) Suppose you see two stars with the same color--the peak of the thermal radiation curve is at the same wavelength. Yet one star appears 100 times brighter than the other. What can you conclude?