Homework # 2

Due before Tuesday, October 6th

README: Make sure you write down all steps to solve the problems, so that I can give partial credit if needed. If I do not see the procedure you followed to solve the problem, you will get a zero on that problem. Also, be careful with units: they are extremely important! Only use the constants and values provided to solve the problems. Finally, make sure you write neatly so that I can understand it: if I don't understand what you wrote, you will get a zero. Scan the solution (into a single PDF, preferably) and send it back to me before the deadline. When a comparison between quantities is asked for, you need to calculate the ratio between the two quantities. When asked to make a figure/ plot/diagram, make sure you produce this figure electronically, either with python coding (preferably) or with Excel (or similar).

CONSTANTS and OTHER VALUES (only use the provided constants/values to solve the problems):

Solar irradiance: $F_{Sun} = 1365$ W m^{-2}
1 pc = 3.2616 ly 1 pc = 206264.806 AU 1 pc = 3.08568×10^{16} m
Bolometric absolute magnitude of the Sun: $M_{bol,Sun}=4.74$
Stefan-Bolzmann constant = 5.6704×10^{-8} W m^{-2} K^{-4}
Solar luminosity $L_{Sun} = 3.839 \times 10^{26}$ W

1) At what distance from a 80 W light bulb (which is typical light bulb in households) is the radiant flux equal to the solar irradiance?

2) Aldebaran (the brightest star in the constellation of Taurus) is an orange giant star. Its parallax angle is 0.05009 arcsec and its proper motion is 0.1995 arcsec/yr.
   a) find the distance to Aldebaran in units of (i) parsecs, (ii) light years, (iii) AU, and (iv) meters
   b) determine the distance modulus for Aldebaran
   c) if Aldebaran's radial speed is v_R=54.1 km/s, calculate its total velocity through space with respect to the Sun and the direction of its motion with respect to the line of sight between the Sun and Aldebaran.
   d) calculate the distance traveled by Aldebaran in a year in AU units.

3) Using the information obtained from the previous problem, and the value for the bolometric apparent magnitude of Aldebaran (m_{bol} = -0.08), determine the absolute bolometric magnitude of Aldebaran and compare it with that of the Sun ($M_{bol,Sun}$=4.74). What is the ratio of Aldebaran's luminosity to that of the Sun (i.e., calculate $L_{Aldebaran}/L_{Sun}$)?

4) The average person has 1.4 m^2 of skin at a skin temperature of roughly 306 K (92 F). Consider the average person to be an ideal radiator (a perfect blackbody) standing in a room at a temperature of 293 K (68 F).

a) calculate the energy per second radiated by the average person in the form of blackbody radiation. Express your answer in watts.

b) determine the peak wavelength of the blackbody radiation emitted by the average person. In what region of the electromagnetic spectrum is this wavelength found?

c) A blackbody also absorbs energy from its environment, in this case from the 293 K room. The equation describing the absorption is the same as the equation describing the emission of blackbody radiation (i.e., the Stefan-Boltzmann law). Calculate the energy per second absorbed by the average person expressed in watts.

d) calculate the net energy per second lost by the average person via blackbody radiation.

5) Consider a model of the star Dschubba (delta Sco), the center star in the head of the constellation Scorpius. Assume that Dschubba is a spherical blackbody with a surface temperature of 28,000 K and a radius of $R=5.16 \times 10^9$ m. Let this model star be located at a distance of 123 pc from Earth. Determine the following for the star:

a) luminosity (in units of solar luminosity)

b) absolute bolometric magnitude

c) apparent bolometric magnitude

d) distance modulus

e) radiant flux at the star's surface

f) radiant flux at Earth's surface (compare this with the solar irradiance, i.e., calculate f_{Sun}/f)

g) peak wavelength