

ASTR 121: Homework 5

Due Thursday, October 8th, 2009

For problems of a mathematical nature, show all work for full credit (including multiple choice responses).

1. **(10 pts) Kepler's Third Law.** A planet orbits the Sun according to Kepler's Third Law. What happens to the semi-major axis of the orbit if the period **(a)** increases by a factor of 8; **(b)** decreases by a factor of 27?
2. **(10 pts)** Which star is hottest?
 - (a) A blue star.
 - (b) A yellow star.
 - (c) An orange star.
 - (d) A red star.
3. **(10 pts)** Which of the following lists types of light from highest frequency to lowest frequency?
 - (a) Radio waves, microwaves, infrared, visible, ultraviolet, x-rays, gamma rays
 - (b) X-rays, gamma rays, ultraviolet, visible, infrared, microwaves, radio waves
 - (c) Visible, microwaves, x-rays, ultraviolet, infrared, gamma rays, radio waves
 - (d) Gamma rays, x-rays, ultraviolet, visible, infrared, microwaves, radio waves
4. **(10 pts) Fill in the blanks:** A(n) _____ line spectrum is a series of bright spectral lines against a dark background. A(n) _____ line spectrum is a series of dark spectral lines among the colors of the continuous spectrum.
5. **(10 pts)** A prism:
 - (a) Adds colors to white light.
 - (b) Does nothing to white light.
 - (c) Separates white light into its component colors.
 - (d) Makes infrared light visible.

Hint: refer to Pink Floyd's album cover for Dark Side of the Moon.

6. (20 pts) The sun emits an energy flux of $F_{\odot} = 6.41 \times 10^7 Wm^{-2}$ and has a surface temperature $T_{\odot} = 5800K$. A distant blackbody emits an energy flux $F = 8.3 \times 10^4 Wm^{-2}$. Using the Stefan Boltzmann law, we can find a ratio of the form (refer to box 5-2 in Freedman & Kaufmann):

$$\frac{F}{F_{\odot}} = \frac{T^4}{T_{\odot}^4}. \quad (1)$$

- (a) Using the above ratio, what is the distant blackbody's temperature in kelvin? (b) What is its wavelength of maximum emission? (c) What is the frequency of maximum emission? (d) What is the energy (in Joules) of an incoming photon with the frequency found in part (c)?
7. (15 pts) **The Hydrogen Atom.** Calculate the wavelengths of the first three lines in: (a) the Balmer series ($n = 3, 4, 5$) and (b) the Lyman series ($n = 2, 3, 4$). Use p. 120 in Freedman & Kaufmann to check your answers but no credit will be given without calculations shown.
8. (15 pts) **Doppler Shifts.** (a) A Martian holds a light of wavelength $\lambda = 700nm$ (red). You travel **towards** him at a speed $v = 8.6 \times 10^4 kms^{-1}$. What is the wavelength shift you perceive? (b) What is the wavelength λ you perceive? (c) Electrical fires on your ship cause your speedometer to stop working, and your speed to change. Now the Martian's light appears to have a wavelength $\lambda = 600nm$. What is your new speed as you travel towards him?