Homework 5

Astro 1
Due Friday, November 1 by 4:30 pm

1. (U11.16.11) (**a**) Estimate how many kilograms of hydrogen the Sun has consumed over the past 4.56 billion years, and estimate the amount of mass that the Sun has lost as a result. Assume that the Sun's luminosity has remained constant during that time. (**b**) In fact, the Sun's luminosity when it first formed was only about 70% of its present value. With this in mind, explain whether your answers to part (a) are an overestimate or an underestimate.

2. (U11.16.24) In a typical solar oscillation, the Sun's surface moves up or down at a maximum speed of 0.1 m/s. An astronomer sets out to measure this speed by detecting the Doppler shift of an absorption line of iron with wavelength 557.6099 nm. What is the maximum wavelength shift that she will observe?

3. (U11.16.44) (**a**) Find the ratio of the energy flux from a patch of a sunspot's penumbra to the energy flux from an equally large patch of undisturbed photosphere. Which patch is brighter? (**b**) Find the ratio of the energy flux from a patch of a sunspot's penumbra to the energy flux from an equally large patch of umbra. Again, which patch is brighter?

4. (U11.17.7) Box 17-1. Kapteyn's star (named after the Dutch astronomer who found it) has a parallax of 0.255 arcsec, a proper motion of 8.67 arcsec per year, and a radial velocity of +246 km/s. (**a**) What is the star's tangential velocity? (**b**) What is the star's actual speed relative to the Sun? (**c**) Is Kapteyn's star moving toward the Sun or away from the Sun? Explain your answer.

5. (U11.17.28) Boxes 17-2 & 17-3. (**a**) Find the absolute magnitudes of the brightest and dimmest of the labeled stars in Figure 17-6b. Assume that all of these stars are 110 pc from Earth. (**b**) If a star in the Pleiades cluster is just bright enough to be seen from Earth with the naked eye, what is its absolute magnitude? Is such a star more or less luminous than the Sun? Explain your answer.

6. (U11.17.36) (**a**) On a copy of Figure 17-8, sketch the intensity curve for a blackbody at a temperature of 3000 K. Note that this figure shows a smaller wavelength range than Figure 17-7a. (**b**) Repeat part (a) for a blackbody at 12,000 K (see Figure 17-7c). (**c**) Use your sketches from parts (a) and (b) to explain why the color ratios b_V/b_B and b_B/b_U are less than 1 for very hot stars but greater than 1 for very cool stars.

7. (U11.17.41) What are the most prominent absorption lines you would expect to find in the spectrum of a star with a surface temperature of (**a**) 35,000 K, (**b**) 2800 K, and (**c**) 5800 K (like the Sun)? Briefly describe why these stars have such different spectra even though they have essentially the same chemical composition.