ASTR-3415-001: Astrophysics
Review Questions for Exam 1

1. All questions in Problem Set 1.

2. Describe (in detail) the reason that the H Balmer lines are strongest in A stars and decreases in strength as one goes to hotter stars and then to cooler stars.

3. Starting with the definition of flux (Equation I–5), show that

$$L_\nu = \frac{8\pi^2 R^2 h\nu^3}{c^2} \left(e^{h\nu\ kT} - 1\right)^{-1},$$

   for a single star with a radius of R. What assumption(s) did you have to make to come up with this solution? Are these assumptions valid?

4. Compare and contrast $\lambda_{\rm max}$ and F for stars with $T_{\rm eff}$ = 50,000 K, 10,000 K, and 3000 K.

5. What is optical depth? How is it related to *opacity* and the *mean-free-path* of a photon? What is meant by these last 2 terms?

6. Write down the equation of transfer and define all terms. What is meant by the term *source function*?

7. What are the 4 basic types of continuous opacity? What are the 4 different types of scattering events? What is H^- opacity and in what types of stars is it important?

8. What are the 5 different bound-bound events? What is meant by *oscillator strength*?

9. Three states exist in an atomic model: level 1 is an $^1S_{3/2}$ state at 0 eV, level 2 is an $^1P^\circ_{1/2}$ state at 0.68 eV, and level 3 is an $^3P_{3/2}$ state at 0.76 eV. Describe the transitions 1↔2, 1↔3, and 2↔3 (*i.e.*, allowed, semiforbidden, forbidden transition; wavelength; etc.). Give a complete explanation for each descriptive point and mathematical proof where appropriate. If these transitions arise out of an atmospheric layer with T = 6000 K, what are the values of n_2/n_1, n_3/n_1, and n_3/n_2?

10. Compare and contrast the energy levels of the 2nd and 3rd levels of hydrogen to the 2nd and 3rd levels of He II. What type of wavelength shift is there between the hydrogen Balmer α and the ionized helium Balmer α line?

11. What is the difference between a resonance line and an intersystem line?

12. What is the difference between a fine structure line and a hyperfine line?

13. What is a metastable state? How does this relate to the He I λ10830 line and its appearance across the solar disk?

14. A 12.6 magnitude star has a measured flux of 2.34×10^{-14} erg/s in the V filter. What is the flux of a 14.8 magnitude star in the same filter?

15. The 14.8 magnitude star has an absolute magnitude of +4.6 in the V filter, how far away is it? If this star has a bolometric correction of -1.2, what is its luminosity? If this star has an effective temperature of 4200 K, how big is it compared to the Sun?

16. Star A has strong TiO bands, while star B has strong C_2 bands, and star C has strong H Balmer lines. What is the approximate spectral class of each star?

17. Compare and contrast natural, collisional, thermal, rotation, and instrumental broadening of spectral lines. Which type of profile function is represented by each? If both thermal and rotation broadening are the only 2 mechanisms important in a line, what type of profile will the line display? If natural and thermal are the only two, what type of profile is displayed?

18. Using the HR diagram as a guide, compare the masses and the main sequence lifetimes of an O5, A0, G2, and M0 main sequence star. What is the difference between an observational and a theoretical HR diagram?