ASTR-3415-001: Astrophysics
Review Questions for Exam 2

1. Problem Set #2: Questions 4, 5, 6, 7, 8, and 10.

2. Describe the solar photosphere, chromosphere, and corona in detail. What is the transition region? What causes the solar wind?

3. What does HSE and RE mean (describe in detail)? Assume $F_R = A_1/r^2 + A_2 \cos\theta$, where A_1 and A_2 are constants, what is the functional form of r with respect to θ under the assumption of RE?

4. What was the significance of the ACRIM measurements?

5. How can the Mg II h and k lines and the Ca II H and K lines be used to map the temperature structure of stellar chromospheres?

6. What is the relationship between supergranules and spicules?

7. Compare and contrast solar coronal loops with solar coronal holes? How can we observe coronal holes from the ground?

8. What's the difference between the K and F coronas? What is an active region? Why must there be a mechanical heating mechanism for chromospheres and coronae?

9. What is meant by the coronal dividing line? Where on the main sequence do stellar chromopsheres first show their presence?

10. Assume that density scales as $\rho = K\, e^{-\alpha r}$ in a stellar interior, where both K and α are constants. Calculate both the mass distribution and the pressure distribution with respect to the distance from the center of the star.

11. Assume that the ideal gas law is valid in the model above. What is the temperature distribution with r in this model? If a star represented by this model has an effective temperature of 10,000 K, what is the central temperature of this star? Does your answer seem realistic? Why or why not? What does this imply about our assumed density distribution?

12. What are the four laws of stellar structure? Be specific.

13. What are the 3 methods of energy transport? From Equation (IV-12) in the notes, mathematically prove Equation (IV-15).

14. What are the 4 known forces in nature? Describe the particle description of these forces (*i.e.*, field particles and their effect on elementary particles). How does this describe the standard model of particle physics?

15. What are the differences between leptons, mesons, and baryons? How are they related to hadrons?

16. What are the 6 quarks and how are they related to the particles mentioned above? What is quantum chromodynamics?

17. Describe the difference between fermions and bosons. Is Dr. Luttermoser a boson or a bozo? What is meant by the Pauli Exclusion Principle?

18. What conservation laws are important in nuclear reactions?

19. Describe the details of the proton-proton chain, the CNO cycle, and the triple-α process. Using $E = mc^2$, determine the amount of energy released as 3 He-nuclei fuse to form carbon ($m_{He} = 4.0026$ amu, $m_C = 12.01115$, and 1 amu $= 1.66 \times 10^{-24}$ gm). What is the efficiency of this reaction chain? How do both the energy release per particle and the efficiency of triple-α compare with the proton-proton chain ($m_H = 1.0078$ amu)?

20. These following problems will be on Problem Set #3, Look at them now as a study guide for questions about stellar interiors on Exam 2. Textbook questions 10.1, 10.2, 10.3, 10.11, 10.13, 10.15, and 10.16

21. Assume there is a giant molecular cloud with $R = 10$ pc at a temperature of 20 K with an average particle density of 10^4 cm^{-3}. Compare the total thermal energy in the cloud to the gravitational potential energy of the cloud. Will this cloud collapse? Calculate both the Jeans' length and Jeans' mass of this cloud. Are these values consistent with your *cloud collapse* statement above?

22. Describe the details of stellar formation. What is meant by agglomeration, condensation, and accretion in this formation process? Assume a cloud has a mass of 10 $M_\odot$ and a temperature of 100 K, what would be the free fall time of this cloud? What's the difference between the free-fall stage and the Hayashi stage of stellar formation?

23. Draw a picture of the T Tauri model and lable all parts.

24. With Equation (VI-1), compare the nuclear time scale for a 3 $M_\odot$ fusing hydrogen to that of one burning helium.

25. Compare and contrast the interior structure of a 0.2 $M_\odot$, 1.2 $M_\odot$, and a 5.0 $M_\odot$ main sequence star.

26. What are the 3 times scales that are important to stellar evolution? How and when are each important?

27. Why do most stars become red giants? Why don't the lowest mass stars become red giants? Why do high mass stars supernova when low mass stars do not? What is the helium flash? How is this related to thermal pulses.

28. Procyon has a luminosity class of IV, where is it in its evolution?

29. Describe the details of the evolution of a 0.2 $M_\odot$ star from birth to death.

30. Describe the details of the evolution of a 1.0 $M_\odot$ star from birth to death.

31. Describe the details of the evolution of a 20 $M_\odot$ star from birth to death.

32. Why do AGB stars pulsate? How is the pulsation of a Mira star different than a Cepheid variable? What is meant by a thermal pulse? What is the difference between a fundamental mode pulsator and a first-overtone mode pulsator?

33. What is a W Virginis star and how is it related to the Cepheid variable? Assume a Cepheid has period of 3 days which gives it a luminosity of 700 $L_\odot$. The HST can accurately record star light down to 27th magnitude. How far away can this Cepheid be and still be detected by HST?

34. What is the difference between a Type I and Type II supernova? Actually there are 2 kinds of Type II supernova, describe the detonation processes of both of these Type II supernovae. What is a Type $\mathrm{I}\frac{1}{2}$ supernova?

35. A 20 eV electron collides with a neutral hydrogen atom. This electron imparts all of its kinetic energy to the hydrogen atom causing only a negligible change to the hydrogen atom's kinetic energy. What will be the result of this collision? What specifically happen to this energy?

36. What is meant by bremsstrahlung?