29:61 General Astronomy
Fall 2012
Third (and last) Hour Exam . . . December 10, 2012

Write legibly. Start each question on a new page. It allows me to make comments and generally keeps me in a better mood. Explain what ideas you are using and what you are trying to do. There are 10 questions. Good luck. No whining.

Walk with Ursus!!!

1. Saturn's moon Enceladus has an albedo of 0.95. The semimajor axis of the orbit of Saturn is 9.5 AU. What is the equilibrium temperature of Enceladus?

2. A planetary system has just formed around another star. A certain planet in that system has an escape speed of 8.0 km/sec. It has an atmosphere that is predominantly CO_2, and the atmospheric temperature is 290K. Will the planet be able to retain that atmosphere for a period of several billion years? Give your reasoning and show calculations to support your conclusion.

3. Planet X has a mass of 3.0×10^{24} kg, and a radius of 6380 km.
   (a) With *just this information*, what quantity of interest could you calculate?
   (b) What is the value of this quantity (identified in part (a)) for Planet X?
   (c) What does the value of this quantity tell you about the nature of Planet X?

4. Describe what we mean by the concept of *hydrostatic equilibrium*? It would be "groovy" (as we used to say) if you know the equation and can write it down. However, I also want a physical description of hydrostatic equilibrium.

5. What is meant by the term *plasma* in astronomy?

6. The Earth's magnetic field has the positive pole in the south and the negative pole in the north, so the magnetic lines of force point from the south to the north. Here in Iowa, a proton is moving straight north at a speed of 400 m/sec.
   (a) What is the magnitude of the Lorentz force acting on the proton? **Warning:** To calculate the force exactly, you need to know a variable that is not given above. Choose a plausible value for this quantity, and proceed with your calculation.
   (b) In what direction does the Lorentz force act? I don't want an exact answer, only an approximate one like "downward and to the southwest".

7. In class I discussed the properties of craters on the planet Venus. A major conclusion was stated about craters on Venus, and the information they convey about the geology of Venus. Discuss this conclusion, the implications for Venus, and possible connections with terrestrial geology.

8. There have been numerous spacecraft missions to Mars since 1996. Discuss, on approximately 1 page, the main scientific goal of these missions, taken as a unified program of research.

9. How long ago did the solar system form? How do we know that?

10. Describe three ways in which the Jovian planets differ in a major way from the terrestrial planets.

Physical and Astronomical Constants

All constants SI

1. Magnetic field at Earth's surface: $B_\oplus = 3.1 \times 10^{-5}$ Tesla
2. Gravitational constant: $G = 6.673 \times 10^{-11}$
3. Boltzmann's constant: $k_B = 1.381 \times 10^{-23}$
4. Stefan-Boltzmann's constant: $\sigma = 5.670 \times 10^{-8}$
5. Luminosity of the Sun: $L_\odot = 3.839 \times 10^{26}$ Watts
6. Mass of the Sun: $M_\odot = 1.989 \times 10^{30}$ kg
7. Radius of the Sun: $R_\odot = 6.955 \times 10^{8}$ m
8. Astronomical Unit: $1au = 1.496 \times 10^{11}$ m
9. Boltzmann's constant: $k_B = 1.381 \times 10^{-23}$
10. Mass of proton: $m_p = 1.673 \times 10^{-27}$ kg
11. Fundamental charge: $e = 1.602 \times 10^{-19}$ C
12. Mass of the Earth: $M_\oplus = 5.974 \times 10^{24}$ kg
13. Radius of the Earth: $R_\oplus = 6.378 \times 10^{6}$ m