Astron 211 Problem Set 6

Given: Oct 27. Due: Tuesday, Nov 3 at the beginning of class

Homework Policy: You can consult class notes and books. Always try to solve the problems yourself; if you cannot make progress after some effort, you can discuss with your classmates or ask the instructor. However, you cannot copy other's work: what you turn in must be your own. Make sure you are clear about the process you use to solve the problems: partial credit will be awarded.
Reading: Kutner Chapter 10,11

Problem 1 Kutner 10.10

Calculate the escape speed from a $1\,M_\odot$ white dwarf. Compare it with that of a main sequence star of the same mass.

Problem 2 Kutner 10.11

a. At white dwarf densities, what is the average separation between electrons?

b. What is their momentum uncertainty Δp?

c. What is the velocity corresponding to that momentum?

Problem 3 Kutner 10.12

a. Use the mass-radius relationship for white dwarfs to calculate the radius of a $1\,M_\odot$ white dwarf.

b. Use this result to rewrite

$$GM^{1/3}R = 2\left(\frac{h^2}{4\pi m_e}\right)\left(\frac{Z}{4Am_p}\right)^{5/3}$$

in a form that gives R in km when M is expressed in solar masses. Z is the atomic number and A is the atomic mass of the white dwarf.

Problem 4 Kutner 10.13

a. What is the thermal energy stored in a 10^7 K white dwarf of 1 $M_\odot$?

b. Assuming that it radiates like a blackbody with effective temperature 10^4 K, estimate its lifetime as a luminous object.

Problem 5 Order of Magnitude: Asteroid 2005 YU55

Consider Asteroid 2005 YU55 (e.g., http://neo.jpl.nasa.gov/news/news171.html). A couple of years ago it passed rather close to the Earth, although it did not hit. But pretend that it did. Take it to be 400 m in diameter.

a. Assuming it hits the Earth (which it will not), what are the chances that it will hit a person? By this you should consider hitting a person directly, not merely injuring a person from the impact.

b. With approximately how much energy would it hit the Earth? How much TNT is this? What would the equivalent rest-mass be, assuming perfect conversion of mass into energy?