UNIVERSITY OF CALIFORNIA AT BERKELEY

Astronomy 202

Spring 2011

FINAL EXAM

Please do all your work on the front and back pages of this exam.

You should attempt all parts of both problems. Be sure to show your reasoning clearly, since partial credit will be allotted. **Remember to circle your final answer.**

NAME:

Problem 1 (50 points)

Suppose a white dwarf of mass 0.5 $M_\odot$ and radius 0.01 $R_\odot$ were to sink to the center of a main-sequence star of mass 1 $M_\odot$ and radius 1 $R_\odot$. Gas within the main-sequence star settles, adiabatically and subsonically, onto the surface of the white dwarf. A gas element starts settling, far from the white dwarf, with $T_\infty = 2 \times 10^7$ K and $\rho_\infty = 200$ gm cm^{-3}. What is T_0, the temperature of the gas just before it reaches the white dwarf? Assume for simplicity that the gas is fully ionized hydrogen.

Problem 2 (50 points)

In lecture, we noted that astrophysical regions of higher density tend to have stronger magnetic fields. Since gas within these regions is moving, does this fact mean that $D(\boldsymbol{B}/\rho)/Dt = 0$? Instead of simply responding yes or no, answer the following questions:

(a) Consider a perfectly conducting, magnetized fluid with internal motion. Find an expression for $D\boldsymbol{B}/Dt$, in terms of $\boldsymbol{B}$ itself and the fluid velocity $\boldsymbol{u}$.

(b) From your knowledge of $D\rho/Dt$, find an expression for $D(\boldsymbol{B}/\rho)/Dt$, in terms of $\boldsymbol{B}/\rho$ itself and the fluid velocity.

(c) Is $D(\boldsymbol{B}/\rho)/Dt$ generally zero?