UNIVERSITY OF CALIFORNIA AT BERKELEY

Astronomy 250

Fall 2010

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 (40 points)

Two low-mass, fully convective pre-main-sequence stars, both of mass M_*, are located near each other. Neither star is burning deuterium. Through a futuristic marvel of engineering, the stars are connected by a hollow pipe. The energy emitted by each star, which would normally radiate from its entire surface, flows only through this pipe. Star A has radius R_A and star B has radius $R_B = R_A/2$.

(a) Which star has the higher average interior temperature $\langle T \rangle$? By what factor?

(b) What direction does heat flow in the pipe - from A to B, or from B to A?

(c) Describe the temporal evolution of both stars.

(d) What are their final radii?

(e) Answer parts (a) through (d) for two pre-main-sequence stars that are both on the radiative portion of their evolutionary tracks.

Problem 2 (60 points)

A classical T Tauri star is observed to have $T_{\rm eff} = 3550$ K and $L_* = 1.0\ L_\odot$. The V-band flux from the star exhibits periodic variability, with a period of $P_* = 2.7$ days. Modeling of the star's spectral energy distribution shows it to be surrounded by a disk whose temperature varies with radius as

$$T(\varpi) = T_\circ\,(\varpi/\varpi_\circ)^{-q}\ .$$

Here, $T_\circ$ and $\varpi_\circ$ are the temperature and radius, respectively, of the inner disk edge. The numerical values are $T_\circ = 1500$ K, $\varpi_\circ = 6.0\ R_\odot$, and $q = 0.75$.

(a) What is the star's mass, M_*?

(b) Is the star rotating faster or slower than the inner disk edge?

(c) What is the disk luminosity, L_D? Assume the emission comes from optically thick radiation by dust grains.