Exercise sheet 1

Gravitational contraction.
Assuming that star of mass M is devoid of nuclear energy sources, find the rate of contraction of its radius R, if it maintains a constant luminosity L. How does the temperature T of the star changes?

Star with fixed density profile.
Assume that the density ρ in star decreases quadratically,

$$\rho(r) = \rho_c \left[1 - (r/R)^2\right] .$$

i) Find $M(r)$, M as function of R and the mean density $\bar{\rho}$.
ii) Calculate the central pressure and check that the lower bound $P_c > M^2/(8\pi R^4)$ is respected.
iii) Estimate the minimal mass required for the ignition of different nuclear reactions; use the threshold temperatures of the table, the density profile from above and solar composition.

fuel	process	$T_{\min}/10^6\,\mathrm{K}$
H	pp	4
O	O+O	1000