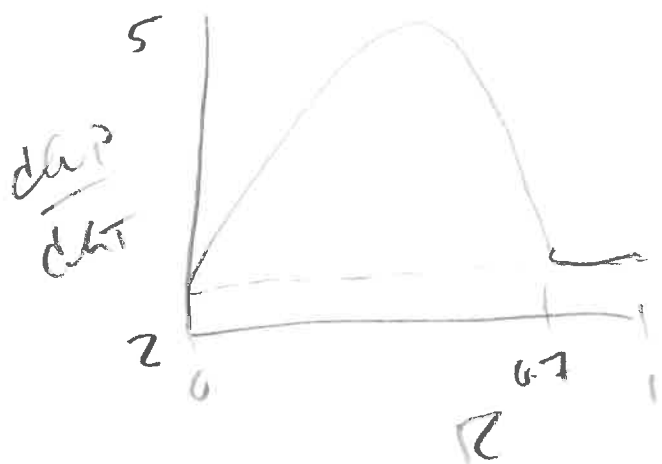
ASTR 702
HW #7

1) The graph should look like

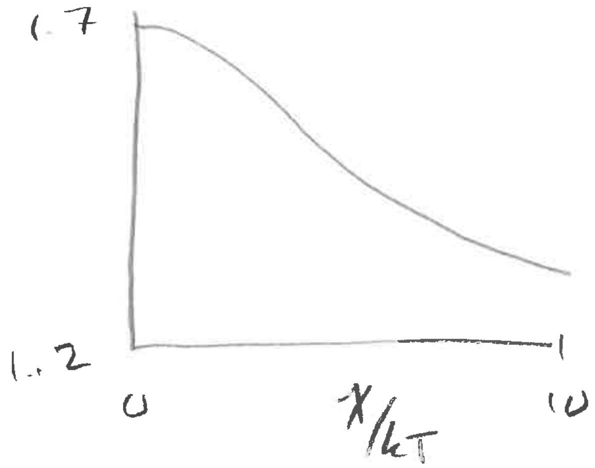


but mine is

so something is way off! I assumed
$T = T_c (1 - r/R) + T_{eff}$, so that's probably why.

2) $\gamma_a(x, T) = \dfrac{5 + \left(\frac{5}{2} + \frac{\chi}{kT}\right)^2 x(1-x)}{3 + \left[\frac{3}{2} + \left(\frac{3}{2} + \frac{\chi}{kT}\right)^2\right] x(1-x)}$ 360

If we pick $x = 0.5$ and do χ/kT from $0 \to 10$,



We want $\gamma_a(x, T)$ at a minimum, so that's why we chose $x = 0.5$

If $\gamma_a(0.5, T) = 4/3$,

$$4/3 = \frac{5 + (5/2 + z)^2 \cdot 0.5^2}{3 + [3/2 + (3/2 + z)^2] \, 0.5^2}$$

$$= \frac{5 + (5/2 + z)^2 \cdot 0.5^2}{27/8 + (3/2 + z)^2 \, 0.5^2}$$

$$= \frac{20 + (5/2 + z)^2}{27/2 + (3/2 + z)^2}$$

$$18 + 4/3 (3/2 + z)^2 = 20 + (5/2 + z)^2$$

$$0 = 2 + 25/4 + 5z + z^2 - 36/12 - 24/6 \, z - 4/3 z^2$$

$$0 = 21/4 + z - 1/3 z^2$$

3) For massive stars, the CNO cycle dominates. This has a strong temperature dependence so $d\ln T$ is large and

$$\frac{d\ln P}{d\ln T}$$ is small.

In solar-mass stars, the opacity is high in the outer layers. Thus, radiation cannot easily escape.

Low mass stars, because they are cool, have high opacities (κ_{ff}, κ_{es}, κ_{bf}, κ_{sc}). So, for the same reason, convection dominates.