Q 1

$$\frac{d\theta}{d\xi} = \frac{\xi\cos\xi - \sin\xi}{\xi^2} \qquad \theta_1 = \frac{\sin\xi}{\xi}$$

$$\frac{1}{\xi^2}\frac{d}{d\xi}\left(\xi^2\frac{d\theta}{d\xi}\right) = \left[\cancel{\cos\xi} - \xi\sin\xi - \cancel{\cos\xi}\right]\frac{1}{\xi^2}$$

$$= -\frac{\sin\xi}{\xi} = -\theta_1'$$

$$M_* = -\frac{4}{3}\pi R_*^3\rho_c\frac{3}{\xi_1}\frac{\xi_1\cos\xi_1 - \sin\xi_1}{\xi_1^2} \qquad \xi_1 = \pi$$

$$= \frac{4}{\pi}R_*^3\rho_c$$

$$\xi^2\frac{d\theta}{d\xi} = -\frac{1}{3}\xi^3\left(1+\frac{\xi^2}{3}\right)^{-3/2} \qquad \theta_5 = \left(1+\frac{\xi^2}{3}\right)^{-1/2}$$

$$\frac{1}{\xi^2}\frac{d}{d\xi} \to \quad -\left(1+\frac{\xi^2}{3}\right)^{-3/2} + \frac{1}{3}\xi^2\left(1+\xi^2/3\right)^{-5/2}$$

$$\left(1+\frac{\xi^2}{3}\right)^{-5/2}\left(-\left(1+\cancel{\xi^2/3}\right) + \cancel{\frac{1}{3}\xi^2}\right) = -\theta_5^5$$

Q 2

$$L \propto T^4\frac{R^4}{M} = \frac{M^4}{R^4}\frac{R^4}{M} = M^3$$

$$T \propto \frac{M}{R}$$ משו' גז אידיאלי

$$P \propto \frac{M^2}{R^4} \qquad P \propto T^4$$ עבור לחץ קרינה

$$T^4 \propto \frac{M^2}{R^4}$$

$$\Rightarrow L \propto \frac{M^2}{R^4}\frac{R^4}{M} \propto M$$

Q4

$$4 - 7.5 = -3.5 = -\frac{7}{2}$$

$$4 + \frac{7}{2} = \frac{15}{2} = 7.5$$

$$\Rightarrow L \propto \frac{R^3}{M}\left(\frac{M}{R}\right)^{\frac{15}{2}} \quad \frac{R^4}{M} = R^{-\frac{1}{2}} M^{11/2}$$

$$L \propto \rho T^{\alpha} M = \frac{M^2}{R^3}\left(\frac{M}{R}\right)^{\alpha} = \frac{M^{2+\alpha}}{R^{3+\alpha}}$$

$$R^{-\frac{1}{2}} M^{11/2} \propto M^{2+\alpha} R^{-3-\alpha}$$

$$\frac{5+2\alpha}{2} = R^{-\frac{1}{2}+3+\alpha} \propto M^{2+\alpha-\frac{11}{2}} \quad \frac{4+2\alpha-11}{2} = \frac{2\alpha-7}{2}$$

$$R \propto M^{\frac{2\alpha-7}{2\alpha+5}}$$

$$L \propto M^{-\frac{2\alpha-7}{4\alpha+10}} M^{\frac{11}{2}} = M^{\frac{10\alpha+31}{2\alpha+5}}$$

$$\frac{11}{2} - \frac{2\alpha-7}{4\alpha+10} = \frac{11(4\alpha+10) - 4\alpha + 14}{8\alpha+20}$$

$$= \frac{11(2\alpha+5) - 2\alpha + 7}{4\alpha+10} = \frac{20\alpha+62}{4\alpha+10}$$

$$= \frac{10\alpha+31}{2\alpha+5}$$

2)

$$\alpha = 4 \Rightarrow L \propto M^6 R^{-7}$$

$$L \propto M^{71/13} \Rightarrow M \propto L^{13/71}$$

$$L \propto L^{78/71} R^{-7}$$

$$L^{-\frac{7}{71}} \propto R^{-7}$$

$$R \propto L^{\frac{1}{71}}$$

$$L \propto R^2 T_{eff}^4 = L^{2/71} T_{eff}^4$$

$$L^{69/71} \propto T_{eff}^4$$

$$L \propto T_{ee}^{\frac{4\cdot 71}{69}} \quad \frac{4\cdot 71}{69} = 4.116$$

Q5

1) $$L = \tilde{L}\, \cancel{f_L(1)}^{=1} = \frac{ac}{\kappa}\left(\frac{\mu m_p G}{k_B}\right)^4 M_0^3$$

$$= \frac{7.6\cdot 10^{-15}\cdot 3\cdot 10^{10}}{300}\left(\frac{0.7\cdot 1.7\cdot 10^{-24}\cdot 6.7\cdot 10^{-8}}{1.4\cdot 10^{-16}}\right)^4 (2\cdot 10^{33})^3$$

$$= \frac{7.6\cdot 3\cdot 8}{300}\left(\frac{0.7\cdot 1.7\cdot 6.7}{1.4}\right)^4 10^{-5}\cdot 10^{-64}\cdot 10^{99} = 640\cdot 10^{30}$$

$$= \boxed{6.4\cdot 10^{32}\ \frac{erg}{s}}$$

2) $$\Omega = -G\int \frac{m\,dm}{r} \qquad U = \int \frac{3}{2} k_B T n \to \frac{dm}{m_p}$$

$r = R f_r(x)$ $\quad x = \frac{m}{M}$ $\quad m = xM$ $\quad dm = dx\,M$

3) $$\Omega = -G\int \frac{M^2\, x\,dx}{R\, f_r(x)} = -\frac{GM^2}{R}\underbrace{\int \frac{x\,dx}{f_r(x)}}_{\alpha_\Omega}$$

$$U = \frac{3}{2}k_B \int f_T(x)\, TM\, x\,dx = \frac{3}{2}\frac{k_B}{m_p} TM \underbrace{\int f_T(x)\, x\,dx}_{\alpha_U}$$

4) $$U = -\frac{1}{2}\Omega \Rightarrow \frac{3}{2}\frac{k_B}{m_p} TM\alpha_U = \frac{1}{2}G\frac{M^2}{R}\alpha_\Omega$$

$$3\frac{k_B}{m_p}\underbrace{\frac{\mu m_p}{k_B} G\frac{M}{R}}_{T} M\alpha_U = G\frac{M^2}{R}\alpha_\Omega$$

$$\Rightarrow 3\mu\alpha_U = \alpha_\Omega$$

5) $$E = U + \Omega \qquad U = 3\mu G\frac{M^2}{R}\alpha_U = \frac{1}{2}G\frac{M^2}{R}$$

$$= \frac{1}{4}G\frac{M^2}{R} \qquad \Omega = -\frac{1}{2}G\frac{M^2}{R}\alpha_\Omega$$

$$= -\frac{1}{4}G\frac{M^2}{R}$$

$$= \frac{1}{\cancel{4}}\, 6.7\cdot 10^{-8}\ \frac{4\cdot 10^{66}}{100\cdot 7\cdot 10^{10}}$$

$$= 9.6\ 10^{45}\ erg$$

6) $$L = -\frac{dE}{dt}$$ הכוכב קורן את האנרגיה שלו?

$$= -\frac{dE}{dR}\frac{dR}{dt} = \frac{1}{4}G\frac{M^2}{R^2}\frac{dR}{dt}$$

$$L\,dt = \frac{GM^2}{4}\frac{dR}{R^2}$$

$$Lt = \frac{GM^2}{4}\frac{1}{R}\Big|_{R(t=0)=100R_\odot}^{R(t)}$$

$$Lt = \frac{GM^2}{4}\left(\frac{1}{R(t)} - \frac{1}{100R_\odot}\right)$$

$$\frac{4}{GM^2}Lt + \frac{1}{100R_\odot} = \frac{1}{R(t)}$$

$$\frac{4}{GM^2}\frac{ac}{12}\left(\frac{\mu m_p G}{k_B}\right)^4 Mt + \frac{1}{100R_\odot} = \frac{1}{R(t)}$$

Q6

$$\left(\frac{M}{\delta_n}\right)^{n-1}\left(\frac{R}{\xi_1}\right)^{3-n} = \frac{1}{4\pi}\left(\frac{(n+1)K_n}{G}\right)^n$$ ראינו שקיים

$$\left(\frac{M}{\delta_n}\right)^{n-1}\left(\frac{R}{\xi_1}\right)^{3-n} = \frac{1}{4\pi}\left(5\frac{R_\odot}{\xi_1}\right)^{3-n}\left(\frac{\delta_n}{M_\odot}\right)^{1-n}$$ נציב את K_n

$$\Rightarrow \left(\frac{M}{M_\odot}\right)^{n-1}\left(\frac{R}{R_\odot}\right)^{3-n} = \frac{5^{3-n}}{4\pi}$$

$$\frac{R}{R_\odot} = \frac{5}{(4\pi)^{\frac{1}{3-n}}}\left(\frac{M}{M_\odot}\right)^{\frac{1-n}{3-n}}$$

$$n = \frac{3}{(1.4)^2}\left(\frac{M}{M_\odot}\right)^2 = \frac{3}{(1.4)^2}x^2$$

$$y = \frac{5}{(4\pi)^{\frac{1}{3-n}}}\cdot x^{\frac{1-n}{3-n}}$$

ex10.py

```python
import numpy as np
import matplotlib.pyplot as plt

def func(x):
    n = 3 / (1.4**2) * x**2
    return (5 / ((4 * np.pi) ** (1 / (3 - n)))) * x ** ((1 - n) / (3 - n))


x = np.linspace(0, 1.4, 500)

plt.plot(x, func(x))
plt.show()
```

NORMAL main python 23% 3:1

Figure 1 1% 25% 47°C English (US) 60% 59% 24-08 17:46