ASP3011

~~MAB091~~ Sheet 1

Q1 a) i) ϵ in erg/gm/sec $= \dfrac{L\ (erg/sec)}{M\ (gm)}$

$= 1.93$ erg/gm/sec

ii) ϵ in erg/cm^3/sec $= \dfrac{L\ (erg/sec)}{V\ (cm^3)}$

$V = \frac{4}{3}\pi R^3 = 1.41 \times 10^{33}$ cm^3

$\therefore \epsilon = \dfrac{3.86}{1.41} = 2.73$ erg/cm^3/sec

iii) $\bar{\rho} = \dfrac{\epsilon\ (erg/cm^3/sec)}{\epsilon\ (erg/gm/sec)} = \dfrac{2.73}{1.93} = 1.41$ g/cm^3

Q2 $T_c \sim 10^7$K $\therefore \left|\dfrac{dT}{dr}\right| \sim \left|\dfrac{T_c - T_{surf}}{R_c - R_{surf}}\right| \sim \dfrac{10^7 K}{7\times 10^{10} cm}$

$\sim 1.4 \times 10^{-4}$ K/cm

Given $l \sim 2$cm $\Rightarrow \Delta T \simeq \left|\dfrac{dT}{dr}\right| \times l \simeq 3 \times 10^{-4}$K.

$U = aT^4 \Rightarrow \Delta U = 4aT^3 \Delta T$

$\dfrac{\Delta U}{U} = \dfrac{4\Delta T}{T} \simeq \dfrac{4 \times 3 \times 10^{-4}}{10^7} \simeq \underline{10^{-10}}$

Q3. $t_{ff} = \left(\dfrac{R^3}{GM}\right)^{1/2} = \dfrac{(R/R_\odot)^{3/2}}{G^{1/2}(M/M_\odot)^{1/2}} \left(\dfrac{R_\odot^3}{M_\odot}\right)^{1/2}$ *cgs

$= \dfrac{1}{2.436} \left[\dfrac{(R/R_\odot)^3}{G(M/M_\odot)}\right]^{1/2}$ secs

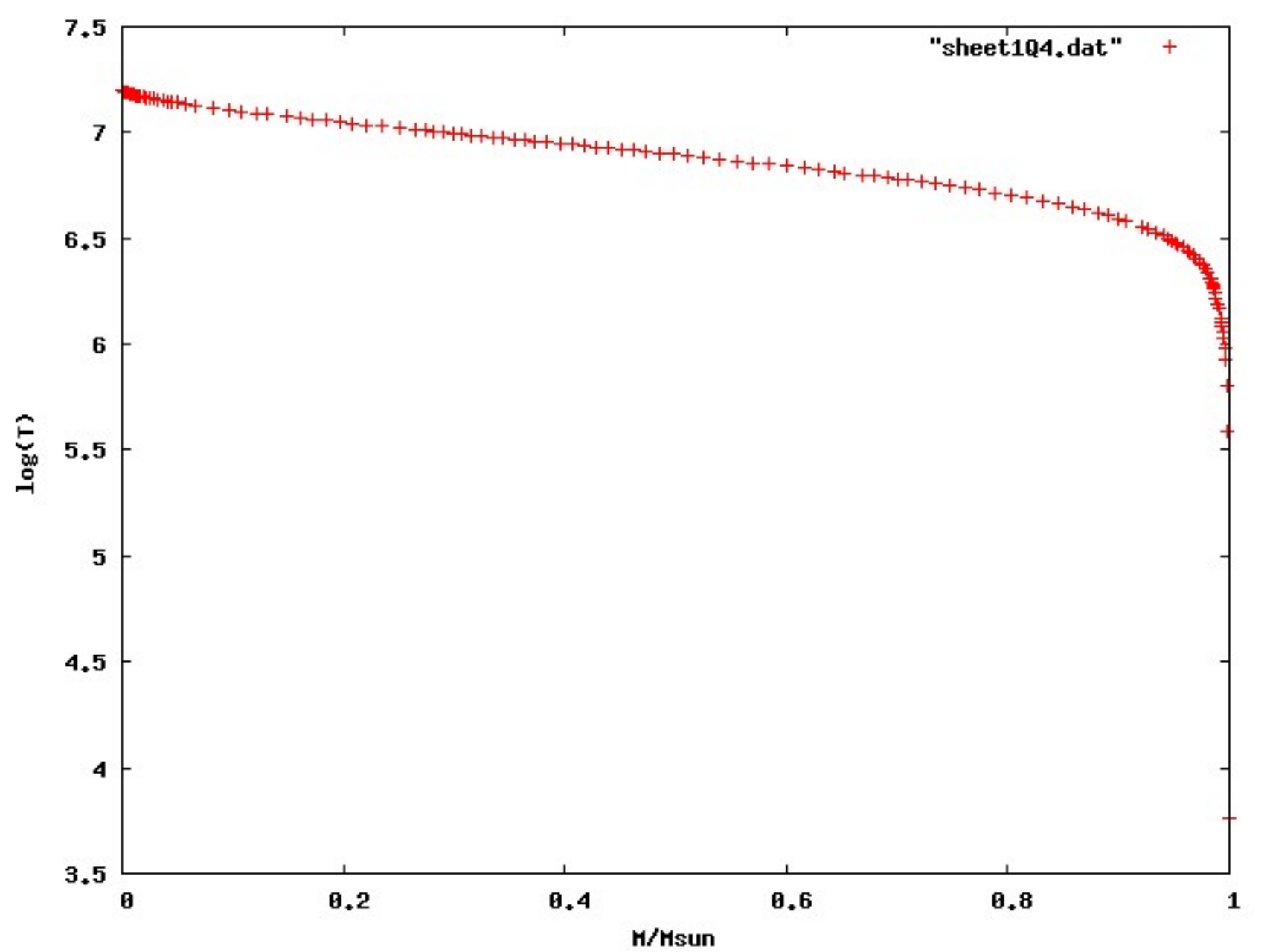
$= 1589 \left(\dfrac{R}{R_\odot}\right)^{3/2} \left(\dfrac{M}{M_\odot}\right)^{-1/2}$ seconds

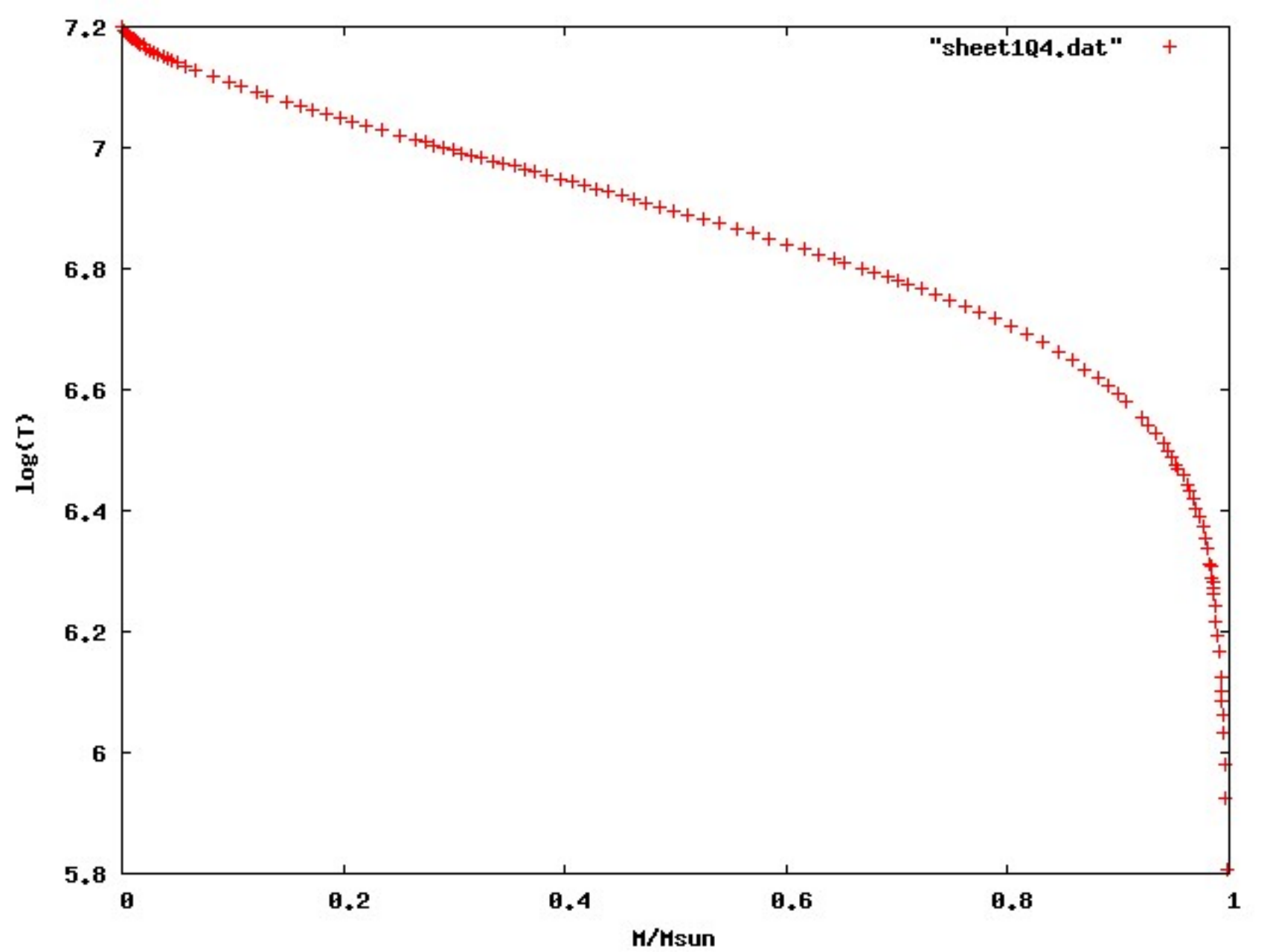
$$t_{KH} = \frac{GM^2}{RL} = G\left(\frac{M}{M_\odot}\right)^2\left(\frac{R}{R_\odot}\right)^{-1}\frac{1}{R_\odot}\left(\frac{L}{L_\odot}\right)^{-1}L_\odot^{-1}$$

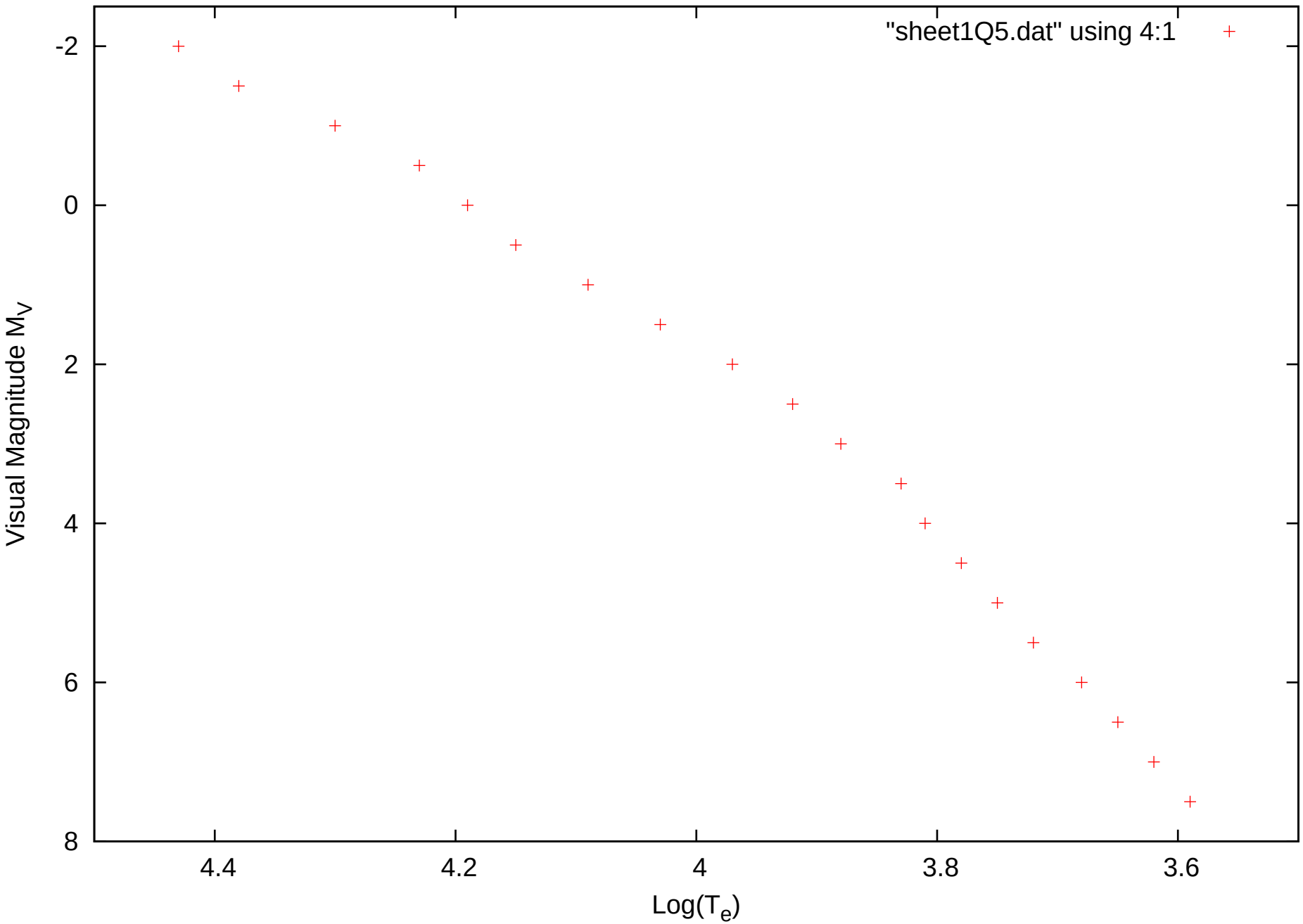
$$= 9.931\times10^{14}\left(\frac{M}{M_\odot}\right)^2\left(\frac{R}{R_\odot}\right)^{-1}\left(\frac{L}{L_\odot}\right)^{-1}\text{ sec.}$$

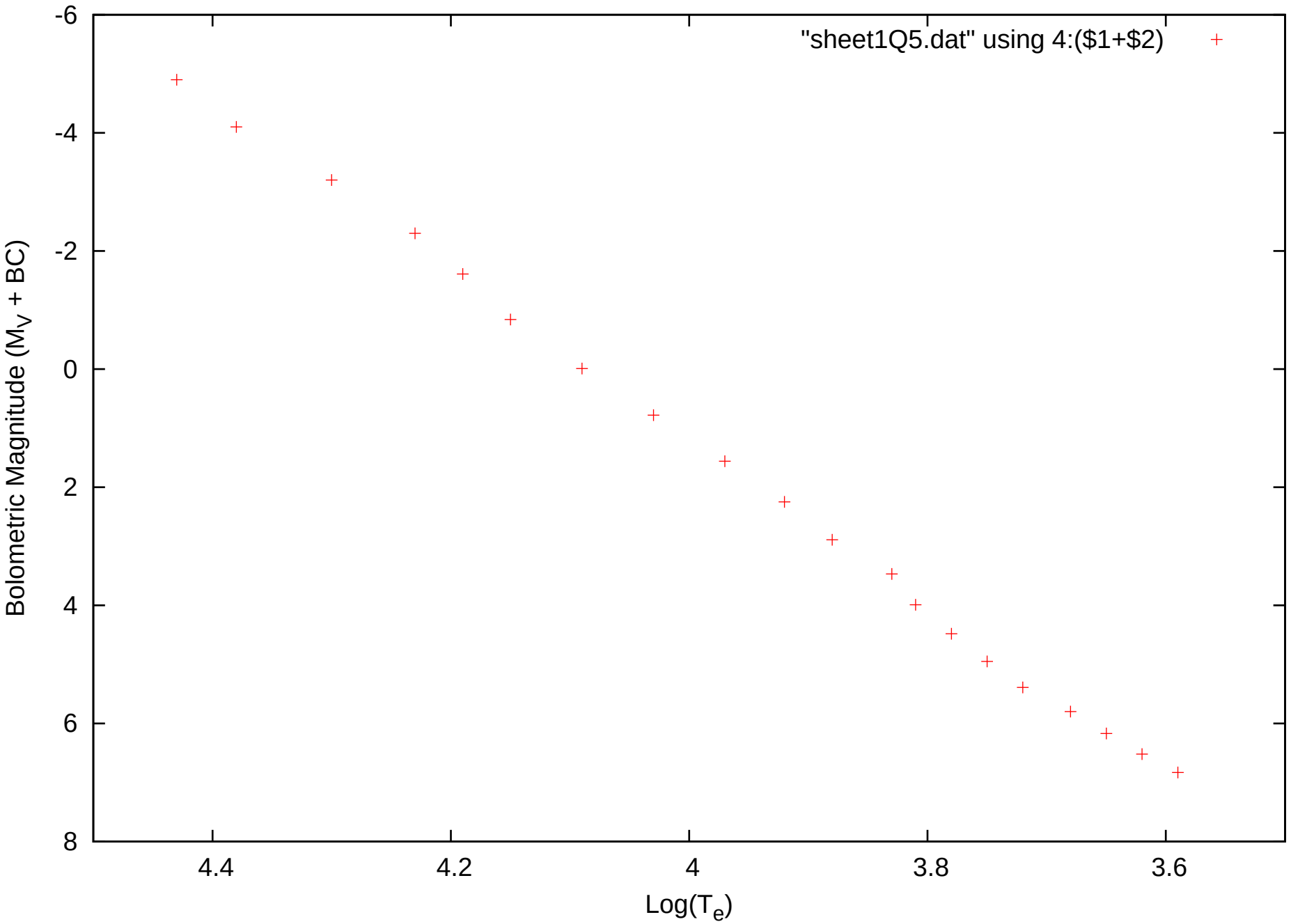
$$= 3.16\times10^{7}\left(\frac{M}{M_\odot}\right)\left(\frac{R}{R_\odot}\right)^{-1}\left(\frac{L}{L_\odot}\right)^{-1}\text{ yr}$$

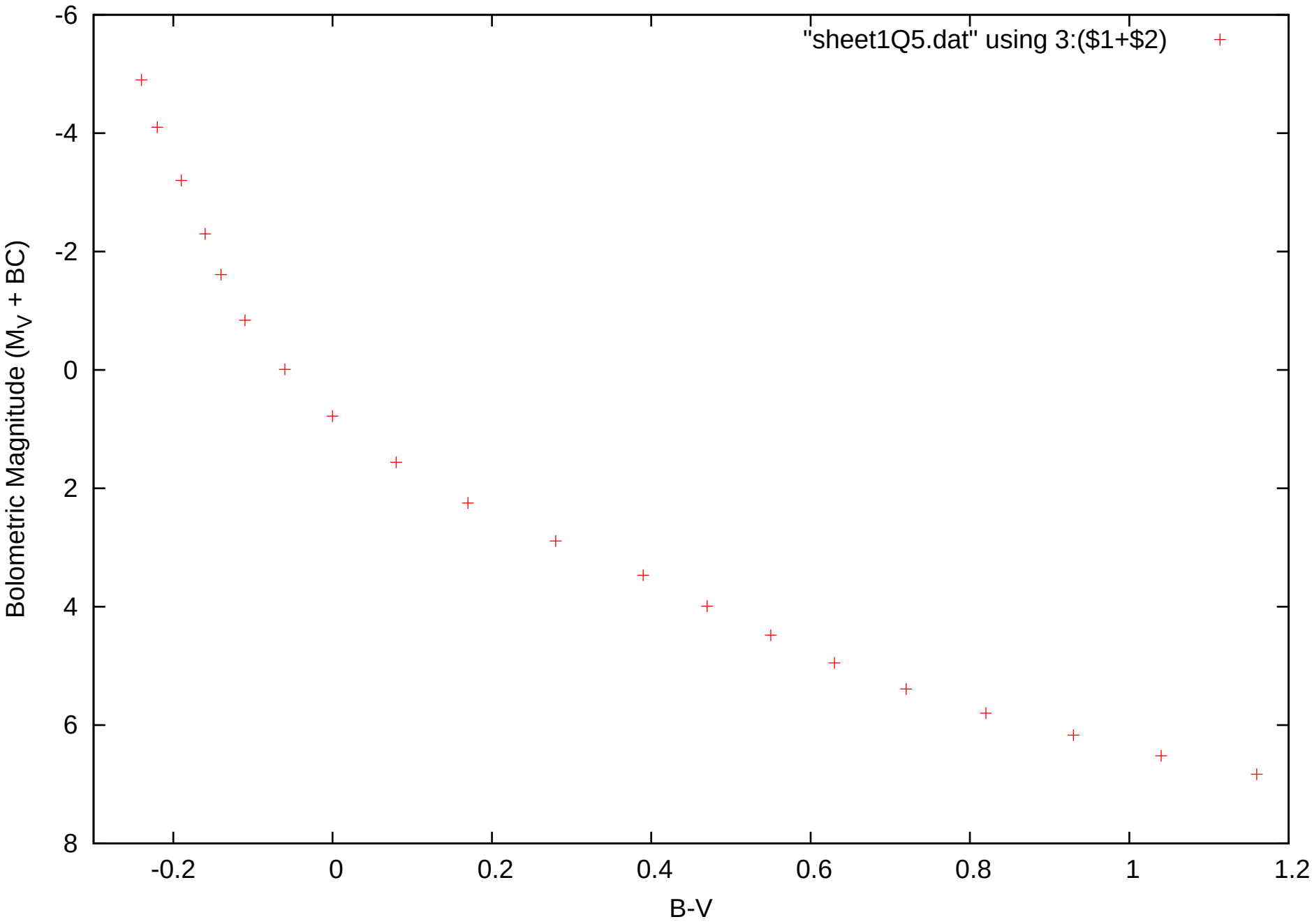
Object	t_{ff} (secs)	t_{KH} (y)
Earth	810	—
Jupiter	1695	2.7×10^{11} y
Brown D	449	1.6×10^{9} y
Sun	1589	3.16×10^{7} y
Blue Giant	5222	70 000
White D	2.05	1.1×10^{11} y

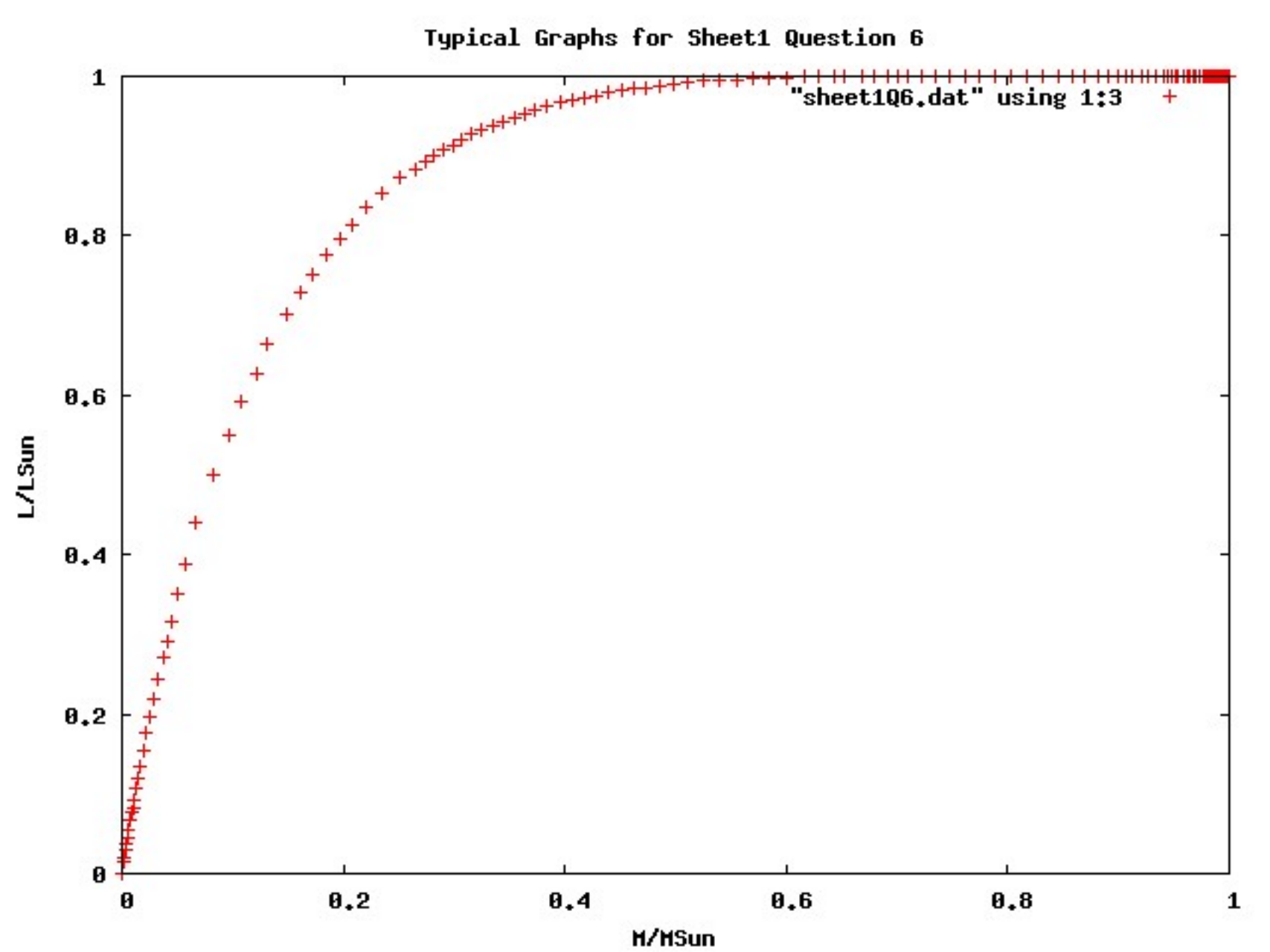

"sheet104.dat"
log(T)
M/Msun
7.5
7
6.5
6
5.5
5
4.5
4
3.5
0
0.2
0.4
0.6
0.8
1

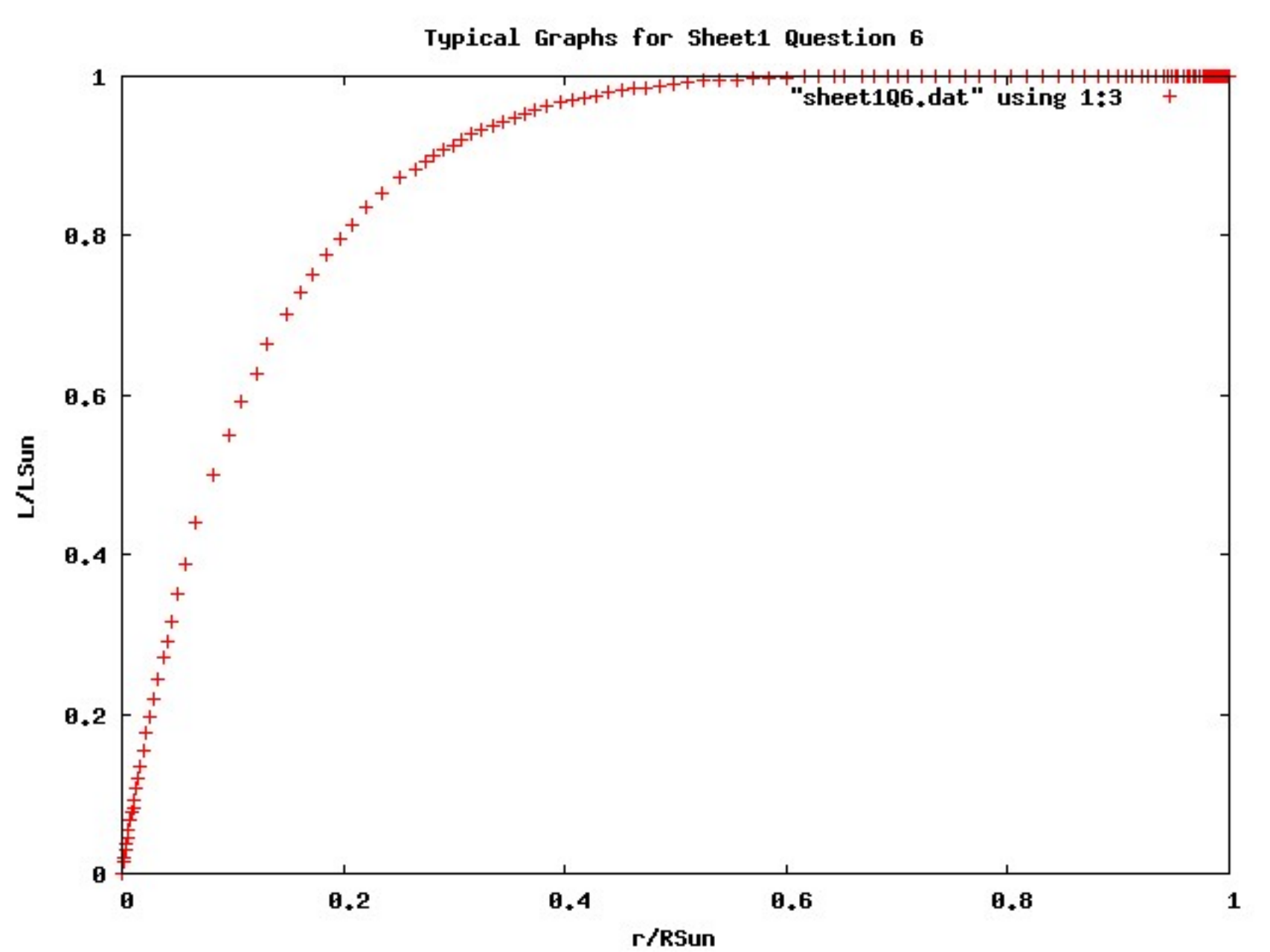

"sheet1Q4.dat"
7.2
7
6.8
6.6
6.4
6.2
6
5.8
log(T)
0
0.2
0.4
0.6
0.8
1
M/Msun

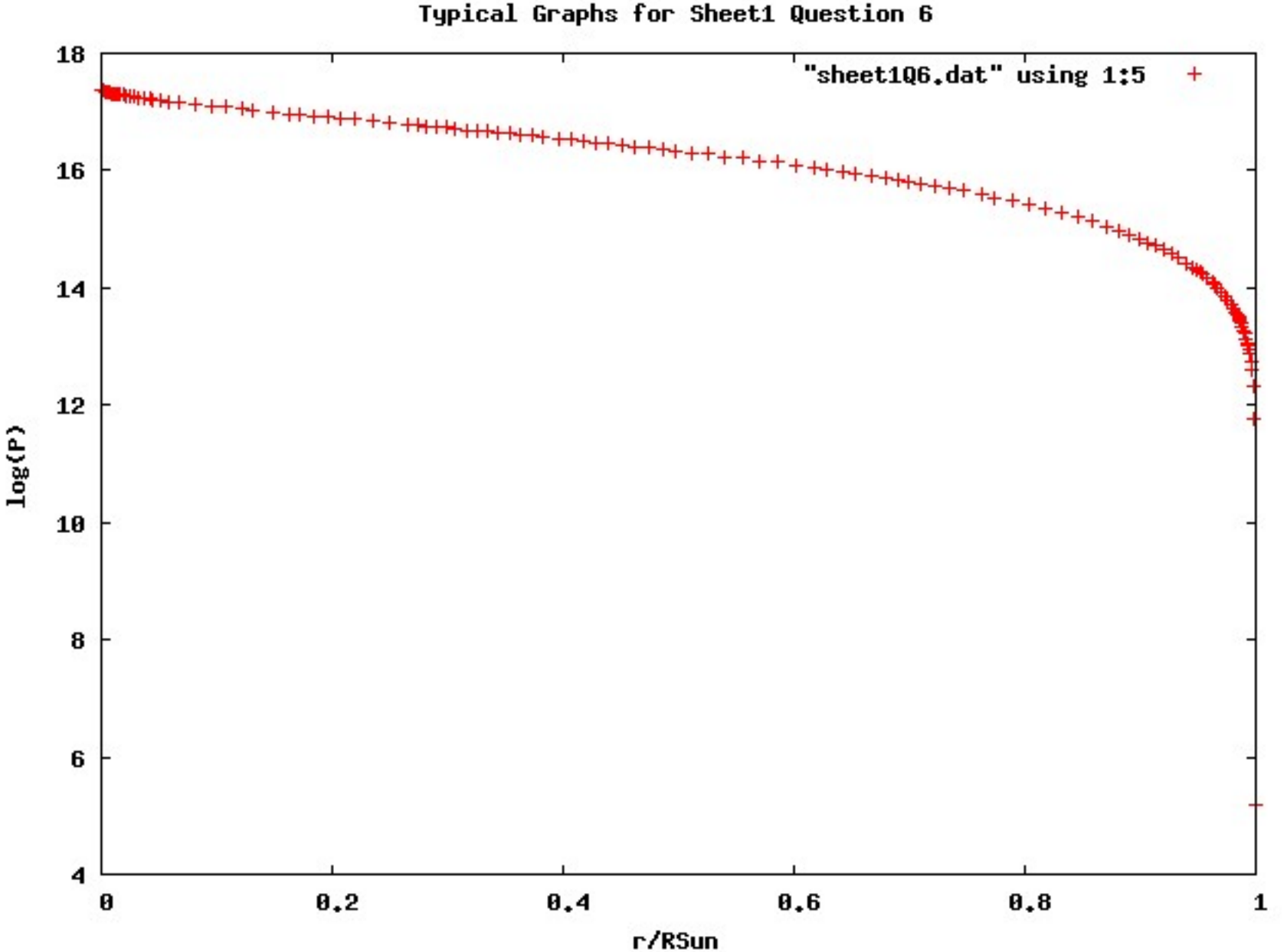

"sheet1Q5.dat" using 4:1
-2
0
2
4
6
8
Visual Magnitude M_V
4.4
4.2
4
3.8
3.6
Log(T_e)

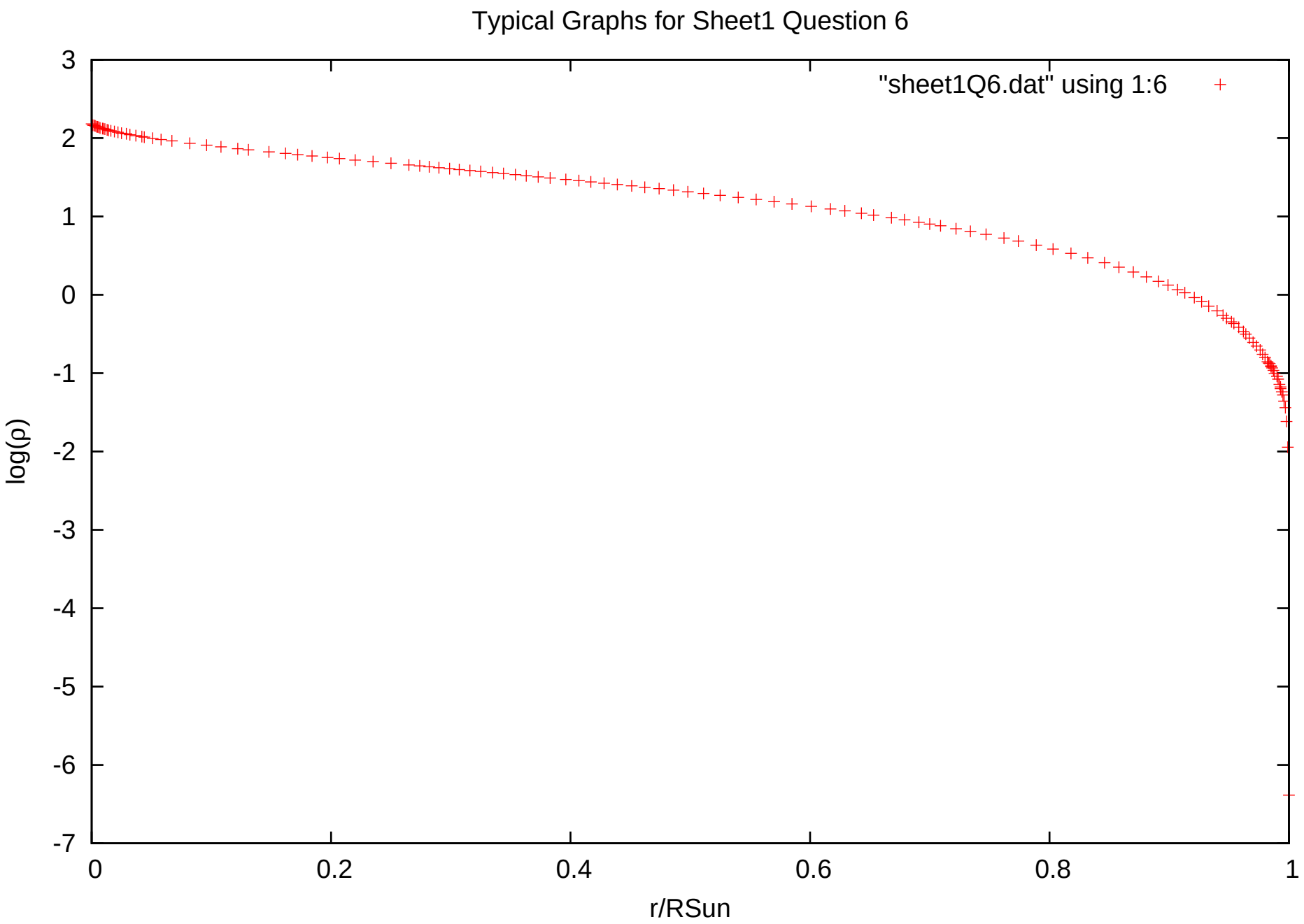

"sheet1Q5.dat" using 4:($1+$2)
-6
-4
-2
0
2
4
6
8
4.4
4.2
4
3.8
3.6
Bolometric Magnitude (M_V + BC)
Log(T_e)

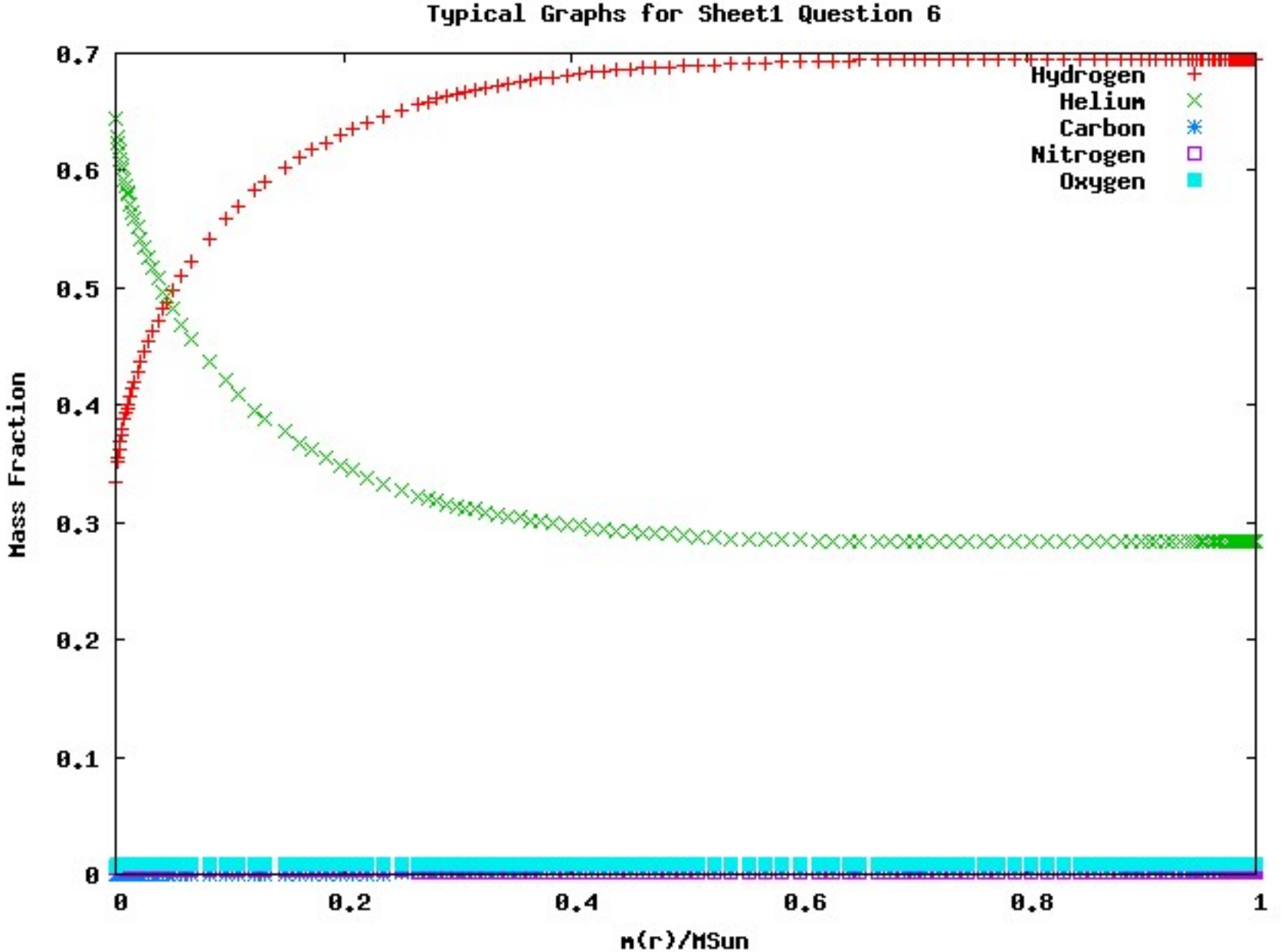

"sheet1Q5.dat" using 3:($1+$2)
Bolometric Magnitude (M_V + BC)
B-V
-6
-4
-2
0
2
4
6
8
-0.2
0
0.2
0.4
0.6
0.8
1
1.2

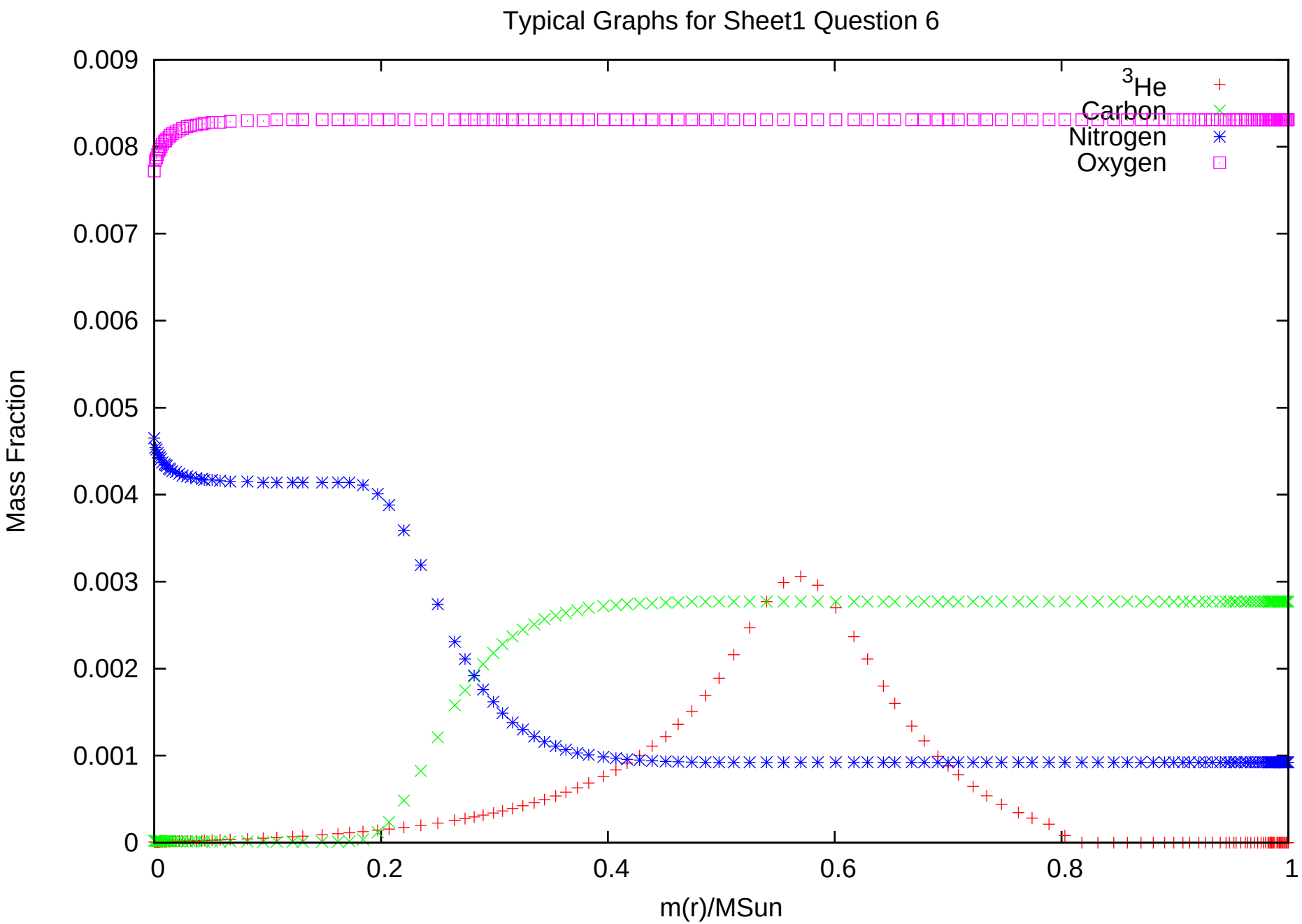

Typical Graphs for Sheet1 Question 6
"sheet1Q6.dat" using 1:3
L/LSun
M/MSun
0
0.2
0.4
0.6
0.8
1


Typical Graphs for Sheet1 Question 6
"sheet1Q6.dat" using 1:3
L/LSun
r/RSun
0
0.2
0.4
0.6
0.8
1


Typical Graphs for Sheet1 Question 6
"sheet1Q6.dat" using 1:5
log(P)
r/RSun
18
16
14
12
10
8
6
4
0
0.2
0.4
0.6
0.8
1


Typical Graphs for Sheet1 Question 6
"sheet1Q6.dat" using 1:6
log(ρ)
r/RSun
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
0
0.2
0.4
0.6
0.8
1


Typical Graphs for Sheet1 Question 6
Hydrogen
Helium
Carbon
Nitrogen
Oxygen
Mass Fraction
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
m(r)/MSun


Typical Graphs for Sheet1 Question 6
Mass Fraction
m(r)/MSun
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
0.2
0.4
0.6
0.8
1
3He
Carbon
Nitrogen
Oxygen