Homework 8.

16.31. Sun's luminosity = 3.9×10^{26} W or Joules/second
When one kilogram of hydrogen converts into helium, it generates:- 6.3×10^{14} Joules.

∴ Sun converts $\frac{3.9 \times 10^{26} \text{ W}}{6.3 \times 10^{14}}$ = 6×10^{11} kg Hydrogen persecond.
(Refer Box 16-1 for more details)
So over Next 5 billion years Sun will convert:- $(5 \times 10^{9} \times 365 \times 24 \times 3600 \times 6 \times 10^{11})$ kg of H

$= 9.461 \times 10^{28}$ Kgs of Hydrogen.
Compared to its present mass. $M_\odot$ the fraction is = $\frac{9.461 \times 10^{28}}{1.989 \times 10^{30}} = 0.0476$

∴ Almost 4.76% of Solar mass would be converted.
This would change the composition of sun, There will be 30% helium in the sun.

From box 16-1., the sun consumes
16.32. 6×10^{11} kg of Hydrogen every second.
So over 4.56 billion years = 8.67×10^{28} kg.
Out of This 0.7% of Mass would be lost and converted into energy (Box 16-1)
∴ Mass lost = $0.007 \times 8.67 \times 10^{28} = 6.1 \times 10^{26}$ kg.

17.36 The proper motion of kapteyn = 8.67 arcsecs/year

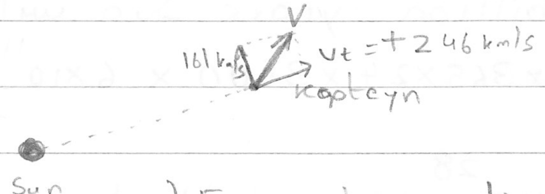
The parallax = 0.255 arcsec. ∴ distance = $\frac{1}{0.255}$ = 3.92 pc.

∴ Tangential velocity $V_t = 4.74 \times \mu \times d$

$= 4.74 \times 8.67 \times 3.92 = 161.1$ km/s

b) The actual speed Relative to Sun = $\sqrt{V_r^2 + V_t^2}$

$= \sqrt{246^2 + 161.1^2}$



= 294 km/sec

c) From above diagram, it can be seen that the resultant velocity is away from sun.

17.66. The parallax = 0.2 arcsec.

a) Distance till 70 Ophiuchi = $\frac{1}{0.2}$ = 5 parsecs.

b) d = 5 parsec = 5 × 3.26 × 63240 AU = 1030812 AU.

∴ $D = \frac{4.5 \times 1030812}{206265} = 22.48$ AU.

c) Using kepler's law.

$$P^2 = \frac{4\pi^2}{G(m_1+m_2)} a^3$$

$$(87.7 \times 365 \times 3600 \times 24)^2 = \frac{4\pi^2}{G(m_1+m_2)} (22.8)^3$$

$$[(m_1+m_2) = 3.069 \times 10^{30} = 1.54 M_\odot]$$

18.35 Using the formula for relation between luminosity, radius & Temperatures (Box 17-4)

$$\frac{R}{R_\odot} = \left(\frac{T_\odot}{T}\right)^2 \sqrt{\frac{L}{L_\odot}}$$

$$\frac{R}{R_\odot} = \left(\frac{5800}{1000}\right)^2 \sqrt{\frac{1000\,L_\odot}{L_\odot}}$$

$$\boxed{R = 1063\,R_\odot}$$

In AU = 4.94 AU.

18.37 From the Measurements, the radius of the accretion disk is around 200 AU.

b) For a star with Mass $1\,M_\odot$.

$$P^2 = \frac{4\pi^2\, r^3}{G M_\odot} = 3952.8 \text{ years.}$$