HW 4.   Astro 1.

7.22. Phobos circles Mars once in 0.31891 day.

$P = 0.31891 \times 24 \times 60 \times 60$ seconds

$P = 27553$ seconds.

$R = (6794/2) + 5982 = 9377\ km = 9377 \times 10^3\ m$

Using kepler's law.

$$P^2 = \frac{4\pi^2}{G M_{mars}} \times R^3$$

$$M_{mars} = \frac{R^3}{P^2} \times \frac{4\pi^2}{G} = 6.428 \times 10^{23}\ kg$$

$$\text{Volume of Mars} = \frac{4}{3}\pi \times (9377 \times 10^3)^3 = 1.642 \times 10^{20}\ m^3$$

$$\text{Density of Mars} = \frac{\text{Mass}}{\text{Volume}} = 3.914 \times 10^3\ kg/m^3$$

7.23. The Spectrum measured for Titan also has effects of the atmosphere of sun and earth. Hence any additional signatures of absorbtion can be confidently accounted due to Titan's atmosphere.

7.28) Speed of Hydrogen atoms = 1.2 m/s.

Escape velocity of Sun is given by

$$V_{escape} = \sqrt{\frac{2GM_\odot}{R}} = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times M_\odot}{6.96 \times 10^8}}$$

$V_{escape} = 6.18 \times 10^5\ m/s.$

Hence as Escape velocity is much greater than velocity of hydrogen atoms, hydrogen can't escape Sun's Gravity.

8.35) The length of the line ≡ 280 AU.
About 2.5 lines Fit in the disk image.

a) Diameter of disk = 600 AU.

b) Thickness = 50 AU.

i.e. Volume = $\pi R^2 h = \pi \times (300)^2 \times 50$ AU

$= 14137167$ A.U^3.

$= 4.733 \times 10^{40}$ m^3

$\approx 5 \times 10^{40}$ m^3

c) Mass of disk = 2×10^{28} kg, Mass of H $= 1.673 \times 10^{-27}$ kg

∴ Total Number of atoms $= \dfrac{2 \times 10^{28}}{1.673 \times 10^{-27}}$

$= 1.195 \times 10^{55}$ atoms.

d) Atoms per cubic meter = $\dfrac{\text{Total Atoms}}{\text{Volume of disk}}$

$= \dfrac{1.195 \times 10^{55}}{5 \times 10^{40} \text{ m}^3} = 2.39 \times 10^{14}$ at

8.37 Semimajor Axis of planet = 0.48 AU

Period = 116.7 days

Period = 116.7 × 24 × 60 × 60 seconds

$= 1.008 \times 10^{7}$ seconds.

$R = 0.48 \times 1.496 \times 10^{11}$ m

$R = 7.18 \times 10^{10}$ m.

Using Kepler's law

$$P^2 = \left(\frac{4\pi^2}{GM_{star}}\right) R^3$$

$$M_{star} = \frac{R^3}{P^2} \times \frac{4\pi^2}{G} = \frac{3.7 \times 10^{32}}{1.0167 \times 10^{14}} = 2.16 \times 10^{30} \text{ kg}$$

$$\frac{M_{star}}{M_{\odot}} = \frac{2.16 \times 10^{30}}{1.989 \times 10^{30}} \approx 1.1 \text{ times.}$$

8.40. Distance of Star from earth = 170 light years.

Distance between star & planet = 55 AU.

$170 \text{ Ly} = 170 \times 9.46 \times 10^{15} \text{ m} = 1.61 \times 10^{18}$

$55 \text{ AU} = 55 \times 1.496 \times 10^{11} = 8.228 \times 10^{12}$

a) Using Small angle formula

$$\alpha = \frac{206265 \times 8.228 \times 10^{12}}{1.61 \times 10^{18}}$$

$\alpha = 1.05$ arc secs

b) Mass of star = $0.025 \times M_\odot$

$= 0.025 \times 1.989 \times 10^{30}$ kg

$= 4.97 \times 10^{28}$ kg

Using keplar's law

$$P^2 = \frac{4\pi^2}{GM_{star}} \times R^3$$

$P^2 = 6.63 \times 10^{21}$

$P = 8.144 \times 10^{10}$ sec ≈ 2582 years

No astronomer can observe this orbital period.