70. (a) The equation preceding Eq. 14-40 is adapted as follows:

$$\frac{m_2^3}{(m_1+m_2)^2} = \frac{v^3 T}{2\pi G}$$

where $m_1 = 0.9M_{\rm Sun}$ is the estimated mass of the star. With $v = 70\,{\rm m/s}$ and $T = 1500$ days (or $1500 \times 86400 = 1.3 \times 10^8$ s), we find

$$\frac{m_2^3}{(0.9M_{\rm Sun}+m_2)^2} = 1.06 \times 10^{23}\ {\rm kg}\ .$$

Since $M_{\rm Sun} \approx 2 \times 10^{30}$ kg, we find $m_2 \approx 7 \times 10^{27}$ kg. This solution may be reached in several ways (see discussion in the Sample Problem). Dividing by the mass of Jupiter (see Appendix C), we obtain $m \approx 3.7 m_J$.

(b) Since $v = 2\pi r_1/T$ is the speed of the star, we find

$$r_1 = \frac{vT}{2\pi} = \frac{(70\,{\rm m/s})\left(1.3 \times 10^8\,{\rm s}\right)}{2\pi} = 1.4 \times 10^9\ {\rm m}$$

for the star's orbital radius. If r is the distance between the star and the planet, then $r_2 = r - r_1$ is the orbital radius of the planet. And r can be figured from Eq. 14-37, which leads to

$$r_2 = r_1\left(\frac{m_1+m_2}{m_2} - 1\right) = r_1\,\frac{m_1}{m_2} = 3.7 \times 10^{11}\ {\rm m}\ .$$

Dividing this by 1.5×10^{11} m (Earth's orbital radius, r_E) gives $r_2 = 2.5 r_E$.