7.3 (a) For the smallest angle, \( a \cos \theta = r_1 + r_2 \), implying
\[
i = \cos^{-1} \left( \frac{r_1 + r_2}{a} \right).
\]
(b) \( i = 88.5^\circ \).

7.4 (a) For \( \rho'' = 0.37921'' \), the distance to Sirius is \( d = \frac{1}{\rho''} = 2.63 \) pc. This means that the linear size of the semimajor axis of the reduced mass is approximately \( a = \alpha d = 3.00 \times 10^{12} \) m. Using Kepler’s third law (Eq. 2.37),
\[
m_A + m_B = \frac{4\pi^2}{GP^2}d^3 = 3.24 \, M_\odot.
\]
Since \( m_A a_A = m_B a_B \), we have that \( m_A (1 + a_A/a_B) = 3.24 \, M_\odot \). Solving for the individual masses, \( m_A = 2.21 \, M_\odot \) and \( m_B = 1.03 \, M_\odot \).

(b) From Eq. (3.7), with the bolometric magnitude of the Sun taken to be 4.74, \( L_A = 22.5 \, L_\odot \) and \( L_B = 0.0240 \, L_\odot \).

(c) Using the Stefan–Boltzmann equation (3.17), \( R = 5.85 \times 10^6 \) m = 0.0084 \( R_\odot \) = 0.917 \( R_\odot \).

7.6 (a) From Eq. (7.5), \( m_B/m_A = 0.341 \).

(b) From Eq. (7.6), \( m_A + m_B = 5.13 \, M_\odot \).

(c) \( m_A = 4.13 \, M_\odot \) and \( m_B = 1.00 \, M_\odot \).

(d) According to Eqs. (7.8) and (7.9),
\[
r_s = \frac{(v_A + v_B)}{2} (t_b - t_a) = 1.00 \, R_\odot,
\]
and
\[
r_e = r_s + \frac{(v_A + v_B)}{2} (t_e - t_b) = 2.11 \, R_\odot,
\]
respectively.

(c) Brightness ratios can be determined from Eq. (3.3), giving (for the primary and secondary eclipses, respectively)
\[
\frac{B_e}{B_0} = 0.0302 \quad \text{and} \quad \frac{B_s}{B_0} = 0.964.
\]
Finally, using Eq. (7.11),
\[
\frac{T_s}{T_e} = \left( \frac{1 - B_e/B_0}{1 - B_s/B_0} \right)^{1/4} = 2.28.
\]

7.7 (a) The ratio of the durations of eclipses of minimum to maximum is approximately 0.9. (Lacy, *Astron. J.*, 105, 657, 1993 finds the ratio of the radii to be 0.907 ± 0.015.) Note: In order to accurately obtain the ratio of the radii, the light curve must be carefully modeled, a process beyond the scope of this text. This part of the problem may be modified or omitted in a future revision.

(b) From the light curve \( m_0 = 10.04 \), \( m_p = 10.76 \), and \( m_s = 10.68 \). Using the procedure outlined in the solution to Problem 7.6,
\[
\frac{B_p}{B_0} = 0.515 \quad \text{and} \quad \frac{B_s}{B_0} = 0.555.
\]
This implies that \( T_s/T_e = 1.090 \).
Homework #5 Solutions

7.12  (a) For the planet orbiting 51 Peg, \( P = 4.23077 \text{ d} \), and \( a = 0.051 \text{ AU} \). From Kepler’s third law, the total mass of the system is \( M = 0.99 \text{ M}_\odot \). Since \( m \sin i = 0.45 \text{ M}_\jupiter \ll M \), the mass of 51 Peg is approximately \( 0.99 \text{ M}_\odot \).

(b) For the planet orbiting HD 168443c, \( P = 1770 \text{ d} \), and \( a = 2.87 \text{ AU} \). Again, from Kepler’s third law, \( M = 1.01 \text{ M}_\odot \). We can again neglect the mass of the planet.