

Astro HW 7

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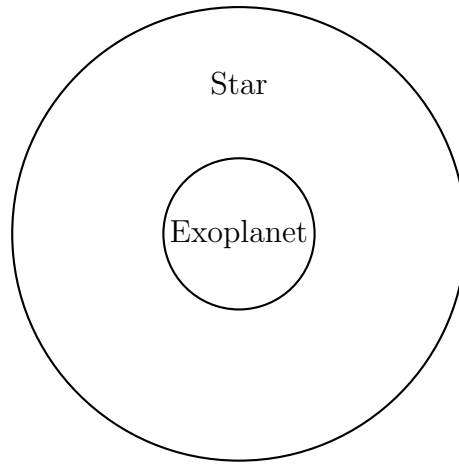
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7.1

a)

$$P = 4.727 \text{ days} \times \frac{1 \text{ year}}{365.25 \text{ days}} = .01294 \text{ years}$$
$$\frac{a^3}{1.09 M_{\odot}} = p^2, a = .01294^2 \times 1.09^{1/3}$$
$$a \approx .056 \text{ AU}$$

b)



Find 2d projection areas of the star and the planet, then calculate what percentage of the area of the star is covered, then use that to get planet

$$\text{radius.}^1$$
$$A_s = 2\pi r_s^2$$
$$A_p = 2\pi r_p^2$$
$$A_s \times \delta = A_p$$
$$r_p = r_s \sqrt{\delta}$$
$$r_s = .98 \times 6.944 \times 10^5 \text{ km}$$
$$r_p = 680512 \text{ km} \sqrt{2.2 \times 10^{-4}}$$

¹Probably didn't need to derive this, but it was a fun derivation, so oh well.

$$r_p \approx 10093.62 \text{ km}$$

$$r_p \approx 1.59 r_{\oplus}$$

c)

$$v_b = \frac{2\pi(.056 \times 1.4996 \times 10^{11})}{4.727 \times 24 \times 3600} \text{ km/s}$$

$$v_b = 131 \text{ km/s}$$

$$v_a = \frac{M_B}{M_A} v_b$$

$$v_a = \frac{3.2 m_e}{1.09 m_{\odot}} (131 \text{ km/s})$$

$$v_a = 1.15 \text{ m/s}$$

d)

$$R_S + R_B = \frac{1}{2} v_b (t_2 - t_1)$$

$$\frac{(2(.98 \times 6.944 \times 10^5) + 1.585 \times 6378)}{131} = t_2 - t_1$$

$$\Delta t = 10543.8 \text{ s}$$

$$\Delta t \approx 2.9 \text{ h}$$

7.2

a)

$$L = 4\pi R^2 \sigma_{sb} T^4$$

$$\frac{1}{R^2} = \frac{4\pi \sigma_{sb} T^4}{L}$$

$$R^2 = \frac{L}{4\pi \sigma_{sb} T^4}$$

$$R = \sqrt{\frac{L}{4\pi \sigma_{sb} T^4}}$$

$$R_a = \sqrt{\frac{1.1 \times 10^{26}}{4\pi \sigma_{sb} 3000^4}}$$

$$R_a = 1.379 \times 10^9 \text{ m}$$

$$R_b = \sqrt{\frac{5.2 \times 10^{25}}{4\pi \sigma_{sb} 32^4}}$$

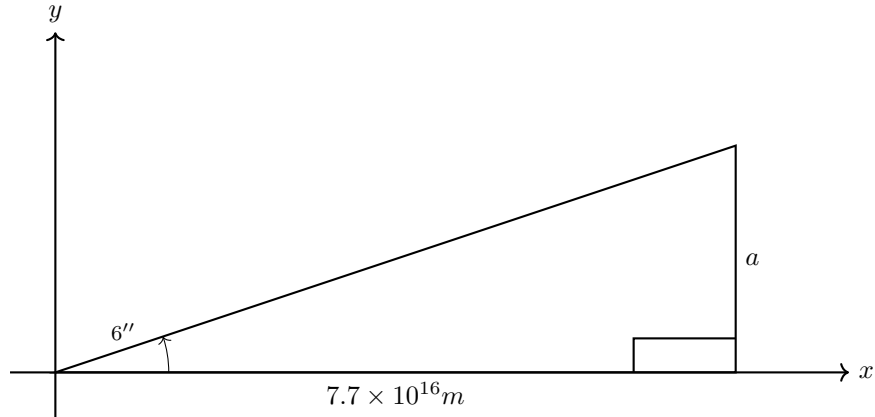
$$R_b = 8.34 \times 10^{12} \text{ m}$$

b)

One of the radii is very similar to the sun, The Sun has a radius of $\approx 6.95 \times 10^8 \text{ m}$, so it's about double.
However, R_b is **much** larger than our sun, by four orders of magnitude.

7.3

a)



$$d = \frac{1}{4} \text{ parsecs}$$

$$d = 2.5 \text{ parsecs}$$

$$d = 2.5 * 3.086 * 10^{16} \text{ m}$$

$$a \approx 2.39 \times 10^{12} \text{ m}$$

$$P^2 = \frac{4\pi^2 a^3}{GM}$$

$$M = \frac{4\pi^2 a^3}{GP^2}$$

$$P = 80 \times 365.25 \times 24 \times 3600 \text{ yr}$$

$$M_{tot} \approx 1.267 \times 10^{30} \text{ kg}$$

b)

Because we are assuming the orbits are circular and are effectively calculating the stars muddled together. If we had, for example, vectors of each, and thus eccentricity, we could find the gravitational pulls of each of the stars, and thus find the masses.

7.4

a)

$$\frac{m_a}{m_b} = \frac{v_b}{v_a}$$

$$\frac{m_a}{m_b} = \frac{111}{108}$$

b)

$$P = 3.96 \times 24 \times 3600 \text{ s}$$

$$v_a = 108 \text{ km s}^{-1}$$

$$v_b = 111 \text{ km s}^{-1}$$

$$m_a + m_b = \frac{P}{2\pi G} (v_1 + v_2)^3$$

$$m_{tot} = 8.57 \times 10^{30} \text{ kg}$$

c)

$$\frac{m_a}{m_b} = \frac{v_b}{v_a}$$

$$\frac{m_a}{m_b} = \frac{111}{108}$$

$$m_a + m_b = 8.57 \times 10^{30} \text{ kg}$$

$$m_a = \frac{111}{108} m_b$$

$$\frac{111}{108} m_b + m_b = 8.57 \times 10^{30}$$

$$\frac{219}{108} m_b = 8.57 \times 10^{30}$$

$$m_b = \frac{8.57 \times 10^{30} \times 108}{219} = 4.23 \times 10^{30} \text{ kg}$$

$$m_a = 8.57 \times 10^{30} - 4.23 \times 10^{30} = 4.34 \times 10^{30} \text{ kg}$$