Astronomy (West-Liberty Salem) Answer Key

Part I (48 points)

Rules for Grading: Each question is worth 3 points. No points deducted for the wrong answer.

1. C
2. C
3. B
4. A
5. A
6. B
7. C
8. A
9. C
10. A
11. C
12. C
13. A
14. C
15. C
16. B

Part II (55 points)

Rules for Grading: Give them 5 points if ALL roman numerals are correct. Else, give them one point for each correct numeral listed and SUBTRACT ONE POINT for each extra roman numeral listed.

1. i. ii. iii. iv. v.
2. i. ii. iv. v. vi.
3. i, iii
4. ii
5. i, ii, iii
6. i, iii, iv
7. i, iii, v
8. i, iii
9. i
10. i ii, iii
11. ii, iii

Part III (53 points)

Rules for Grading: If the answer is correct, check to see if work vaguely matches work shown below (basically see if they actually showed work) and give the points listed next to the question number. If the answer is correct, give partial points according to the scoring scheme in the answer key for each step that they have.

1. (***10 points total***)

   a.) (***4 points***)

   $1 = a^3/p^2$ (***2 points***) $a^3 = p^2$ $a = (91.0 \text{ days} / 365 \text{ days/Earth year})^{2/3}$ (***1 points***) $= (0.249)^{2/3} = 0.396$ A.U. = **$5.9*10^{10}$ m**

   or

   $a^3 = p^{2*}G(M_\odot)/(4*\pi^2)$ (*1 point*) p = 91*24*3600 = 7862400 s. (***1 point***)
   $a = (7862400)^2*6.67*10^{-11}*(2*10^{30})/(4*\pi^2)$ (***1 point***) = **$5.9*10^{10}$ m**

   b.) (***6 points***)

   $m_s v_s = m_p v_p$ (***2 points***) $v_p = 2\pi r/t$ (***2 points***) $= 2*\pi*(5.9*10^{10})/(91*24*3600) =$ 47,149 m/s.
   $m_p = (2*10^{30})*17.1 / 47149$ (***1 point***) = **$7.2*10^{26}$ kg**

2. (***16 points total***)

   a.) (***6 points***)

   0.072 / 24 = 0.003 (***2 points***) (this is the fraction of the star's flux that the planet blocks during transit)

   r_{planet}/r_{star} = sqrt(0.003) (***2 points***) = 0.054772 because flux is determined by area, and essentially we are observing a 2-D circle blocking a larger 2-D circle.

   $0.054772*4.1*10^8$ m (***1 point***) (star's radius) = **$2.2*10^7$ m**

   b.) (***4 points***)

   M(total in solar masses) = a^3/p^2 (***2 points***)
   $a^3 = (1.6*10^{30} \text{ kg})/(1.989*10^{30} \text{ kg/solar mass}) *(5 \text{ days}/365 \text{ days/yr}) = 1.5095*10^{-4}$ A.U.^{3}
   a = 0.053 A.U. * 149,597,870,000 m/A.U. (***1 point***) = **$8.0*10^9$ m**

c.) (***6 points***)

$T_{planet} = T_{star}*(1-a)^{1/4}*sqrt(r_{star}/2D)$ (***2 points***)
$T_{star} = [L/(4*\pi*r_{star}^2*\sigma)]^{1/4}$ = 5739.7857 K (***2 points***)
T_{planet} = 5739.7857 K *sqrt[$4.1*10^8$ m / (2*$8.0*10^9$ m)] (***1 point***) = **920 K**

3. (***3 points total***)

T = $2.89*10^{-3}$ / ($30.7*10^{-6}$) (***2 points***) = **94.1 K**

4. (***4 points total***)

$T = [L/(16*\pi*\sigma*D^2)]^{1/4}$ (***2 points***) 71.0 K = $[(4.0*10^{26})/(16*\pi*\sigma*D^2)]^{1/4}$ (***1 point***)
Rearranging the above, you get D = **$2.3*10^{12}$ m**

5. (***3 points total***)

$f = r^2/(4D^2)$ (***2 points***), where f is the fraction of light intercepted by a spherical planet. Taking the dust grains to be mini spherical planets, **$f = nr^2/(4D^2)$**

6. (***4 points total***)

linear diameter / linear distance = angular size / 206265" (angular size is in arcseconds) (***2 points total***)
linear diameter = (3.12 / 206,265) * 9.27 pc (***1 point***) = $1.40*10^{-4}$ pc = **$4.33*10^{12}$ m**

7. (***5 points total***)

2.2 pc * 3.08568 * 10^{16} m / pc = 6.788 * 10^{16} m (***1 point***)
$L = 4*\pi*r^2*$flux (***2 points***) = $4*\pi*(6.788 * 10^{16}\ m)^2 * (1.32*10^{-14}\ W/m^2)$ (***1 point***) = **$7.6*10^{20}$ W**

8. (***4 points total***)

L (in Watts) = $4*\pi*r^2*\sigma*T^4$ (***2 points***)
$3.3\times10^{22}W = 4*\pi*r^2*\sigma*(1630\ K)^4$ (***1 point***) **$r = 8.1*10^7$ m**