AST/PHY 161 Test No. 1, F 2013

Instructions: For Part I**, use only upper case letters** for your answers; each question is worth 5 points.

Part I. Multiple Choice

01. D
02. Eliminated
03. D
04. A
05.
06.
07.
08. C
09. D
10. C
11. D
12. A
13. E
14. J
15. V
16.
17. H
18. L
19. D
20. B
21. B
22. B
23. A
24. B
25. B
26. L
27. F
28. C
29. E
30. B
31. 52^{O}
32. East
33. C
34. A
35. B
36. B
37. C
38. B

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Part II

#2 $E_S = 140°E$ on 10/22

$T_S = T_\odot - T_E$

$T_S = 18{:}00 - T_E$

$T_E = -140° / 15°/hr = -9.^h33 = -9{:}20$

$T_S = 18{:}00 - (-9{:}20)$

$= 18{:}00 + 9{:}20$

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$= 27{:}20 - 24{:}00$

$T_S = 3{:}20$

10 for chart.

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Part II $\quad$ 1 rad = 57.296°

#3 Given $P = 15.0$ yrs $\quad \epsilon = 0.700 \quad a = 6.00$ AU

A. Calculat perihelion distance, r_0

$$r = [a(1-\epsilon^2)]/(1+\epsilon \cos v)$$

At perihelion, $v = 0$ so $\cos v = 1$

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$$r_0 = [a(1-\epsilon^2)]/(1+\epsilon) = [a(1-\epsilon)(1+\epsilon)]/(1+\epsilon)$$

$$r_0 = a(1-\epsilon) = 6.00(1-0.7) = 6.00(.3) = 1.80 \text{ AU}$$

$$r_0 = 1.80 \text{ AU}$$

B. Find r for $v = ?$ when $M = 2\pi \frac{t}{P}$ $\quad t = 2$ yrs.

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$$M = 6.28(2/15) = 6.283(0.133) = 0.838 \text{ rads} = 48°$$

$$M = E - \epsilon \cdot \sin E$$

Solve for E: $\quad E_1 = M + \epsilon \sin M = 0.837 + (0.70)(0.743)$

$E_1 = 0.837 + 0.520 = 1.357$

$E_2 = 0.837 + \epsilon \sin E_1 = 0.837 + (0.70)(0.977)$

15 $\quad E_2 = 0.837 + 0.684 = 1.521$

837 / 700 / 1537

$E_3 = 0.837 + \epsilon \sin E_2 = 0.837 + (0.70)(0.999)$

$E_3 = 0.837 + 0.699 = 1.54$ rads $= 88.2°$

$E_4 = 0.837 + (.70)(\sin 1.54)$ $\quad \cos(88.2) = 0.03141$

$$\cos v = (\cos E - \epsilon)/(1 - \epsilon \cdot \cos E)$$

$$= (0.0348 - 0.70)/1 - (.70)(0.0348)$$

(0.0308 $\quad$ .0308)

10

$$= (-0.665)/(1 - 0.0244) = -0.665/0.976 = -0.684$$

(-.669 $\quad$ 1 - 0.0216 $\quad$ -0.669 $\quad$ 0.978)

$$\cos v = -0.682$$

$$v = \cos^{-1}(-0.682) = 133°$$

$$r = [a(1-\epsilon^2)]/(1+\epsilon \cos v) = [6(1-(.70)^2)]/1+(.70)(-0.682)$$

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$$r = [6(1-.490)]/(1-0.477)$$

$$= [6(.51)]/(0.523) = 3.06/0.523$$

$$r = 5.85 \text{ AU}$$

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4. λ_{max} from Fig is 190 nm. $= 1900\,\mathring{A}$

Wien's Law: $T = \frac{a}{\lambda_{max}} = \frac{2.898\times10^7\ K/\mathring{A}}{1900\ \mathring{A}}$

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$T = 15253\ K = 1.525\times10^4\ K$

6. $\Delta N_{\Delta v} = NP\Delta v \qquad \Delta v = 20\ m/s$

From Fig $P(v) = 2.12\times10^{-3}$ at $v = 400\ m/s$

This is the probability a molecule has speed v.

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$\Delta N_{\Delta v} = 6.200\times10^{24}\,(2.12\times10^{-3})(20)$

$= 6.200\times10^{24}\,(4.24\times10^{-2})$

$= 2.630\times10^{23}$ O_2 molecs/m3

$P\Delta v =$ The probability a molecule has speed between v and $v+\Delta v$ where $v = 390$ m/s and $v+\Delta v = 410$ ms

Now $\int \Delta N_{\Delta v} = \int N P(v)dv = N\int P(v)dv$

$= N\,P(v_0)\int_{v_1}^{v_2} dv = N\,P(v_0)\,\Delta v = NP_0(v_2 - v_1)$

where $P_0 = P(v_0) =$ probability at v_0

in this case $v_0 = 400$ m/s

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#5 Given $R_* = 8R_\odot = 8.0 \times 7.0 \times 10^8 m = 5.6 \times 10^9 m$

$F_{\lambda_{meas.}} = 3.011e\text{-}4 \ J/m^2/s \qquad T = 10{,}000 K$

Find r_* $\qquad r_*^2 = \dfrac{F_{\lambda *} R_*^2}{F_{\lambda\, meas}}$ $\qquad r_* = \sqrt{\dfrac{F_{\lambda *}}{F_{\lambda m}}}\, R_*$

$F_{\lambda *} = \pi B_{\lambda *} = \pi \left[\dfrac{a}{\lambda^5}\right] / \left[\exp(b/\lambda T) - 1\right]$

$\dfrac{a}{\lambda^5} = 1.192 \times 10^{-16} / (4.50 \times 10^{-7})^5 = \dfrac{1.192 \times 10^{-16}}{1.845 \times 10^{-32}}$

$a/\lambda^5 = 6.460 \times 10^{15}$

$\exp(b/\lambda T) - 1 = \exp\left[1.440 \times 10^{-2} / (4.50 \times 10^{-7} \times 10^4)\right] - 1$

$= \exp\left[1.440 \times 10^{-2} / 4.50 \times 10^{-3}\right] - 1$

$\exp(b/\lambda T) - 1 = \exp(3.2) - 1 = 24.5 - 1 = 23.5$

$F_{\lambda *} = \pi (6.46 \times 10^{15}) / 23.5 = \pi (2.75 \times 10^{14})$

$F_{\lambda *} = 2.75 \times 10^{14} (3.141) = 8.625 \times 10^{14}$

$r^2 = \dfrac{(8.625 \times 10^{14})(5.60 \times 10^9)^2}{3.011 e\text{-}4} = \dfrac{8.625 \times 10^{14} (3.136 \times 10^{19})}{3.011 e\text{-}4}$

$r^2 = \dfrac{2.705 \times 10^{34}}{3.011 \times 10^{-4}} = 89.83 \times 10^{36}$

$r = \sqrt{89.83 \times 10^{36}} = 9.478 \times 10^{18} \ m$

$r = 9.478 \times 10^{15} \ km \qquad 1pc = 3.090 \times 10^{13} km$

$r(pc) = \dfrac{9.478 \times 10^{15}}{3.090 \times 10^{13}} = 306.7 \ pc$