Your name: _____

Arvind Borde

AST 9: Homework 11

1] The formula for the Stern-Levison parameter, Λ, involves $m^2/a^{3/2}$, where m is the mass and a is the length of the semimajor axis. If $\Lambda > 1$ the object is supposed to have sufficient gravitational power to "clear its neighborhood," if $\Lambda < 1$, then not. Remember that $a^{3/2}$ means "take the cube of the square root of a." Have you seen $a^{3/2}$ anywhere before? (How soon you forget homework 8.) What other planetary attribute is $a^{3/2}$ proportional to?

Λ and decreasing "Clearing Power"

Object	Λ	Mass (earth masses)	Year (earth years)	Mass^2/Year
Jupiter	1.30×10^9	318.00000	12.00	8.43×10^3
Saturn	4.68×10^7	95.00000	29.50	3.06×10^2
Uranus	3.84×10^5	15.00000	84.00	2.68
Neptune	2.73×10^5	17.00000	164.80	1.55
Venus	1.66×10^5	0.81500	0.62	1.08
Earth	1.53×10^5	1.00000	1.00	9.99×10^{-1}
Mercury	1.95×10^3	0.05500	0.24	1.25×10^{-2}
Mars	9.42×10^2	0.10000	1.88	5.31×10^{-3}
Pluto	2.95×10^{-3}	0.00200	247.70	1.61×10^{-8}
Eris	2.15×10^{-3}	0.00280	557.00	1.41×10^{-8}
Ceres	8.32×10^{-4}	0.00016	4.60	5.57×10^{-9}
Haumea	2.68×10^{-4}	0.00070	285.40	1.72×10^{-9}
Makemake	2.22×10^{-4}	0.00067	309.88	1.45×10^{-9}

a) The Λ column goes down steadily and there's a big jump between Mars and Pluto. Do you agree?
b) The last column goes down steadily and there's a big jump between Mars and Pluto. Do you agree?
c) Why do the Λ column and the last column behave the same?
d) "Clearing power" *largely* depends on mass: more mass, higher on the table. Do you agree?
e) Is that rough pattern broken anywhere? Why?
f) One of the entries in the last column is wrong (deliberately). For one buck, which?
(The error does not affect the answer to the previous questions. I may be crazy, but I'm not a lunatic.)

2] From your planetary table, which planet has the greatest eccentricity? What is that eccentricity? Apart from that eccentric character, is there a planet with eccentricity greater than 0.1?

3] The eccentricities of the dwarf planets are these: Ceres (0.07976), Makemake (0.159), Haumea (0.18874), Pluto (0.2482), Eris (0.44177). Would you say that the dwarves have less eccentricity than the other planets, on average, or more?

4] We said that the atmospheres of Pluto and Eris expand and contract as they get closer to or further from the sun. What might make gases expand as they get closer to the sun and contract as they get further? (More or less light? Stronger or weaker gravitational effects? More or less heat? Some other factor?)

5] Why is this expansion and contraction effect more pronounced in the case of Pluto and Eris compared to planets such as earth? (Hint: the answer would stare you in the face if you glanced upward.)