Lab 5: The Solar System

Part I — Planetary Classification

The IAU has called you up and given you the task of creating a scientific definition for the word planet. Luckily, they have also provided you with a list of a bunch of the objects found that might be classified as a planet, as well as physical characteristics for each one. Unfortunately, the email they sent you cut off the names of the planets, so you're going to have to figure out the definition without knowing which is which. Compare their properties, and come up with a reasonable way to classify them.

1) The "Composition" column indicates in which form most of the mass in the body is found. Find the average distance from the Sun (i.e. orbital radius) of "rock" objects, the average distance from the Sun of "gas" objects, and the average distance from the Sun of "rock and ice" objects. Are there any bodies who do not seem to fit in with the others in their composition class? Which ones? If so, recalculate the average distance for that class again without this/these member(s). Does the composition of an object strongly correlate on its distance from the Sun?

2) Orbital eccentricity tells us how the orbit is shaped. Very eccentric orbits are much longer in one direction than they are in the other. Orbits that are almost circular have low eccentricities. Identify the bodies that have the most eccentric orbits — you can set your own "cutoff" value. Look at the other properties of the eccentric bodies. Is there anything they have in common?

3) Make a scatter plot of object mass versus distance from the Sun (Orbital Radius). The x-axis will be $\log_{10}(Orbital\ Radius)$ in units of AU and the y-axis will be $\log_{10}(Mass)$ in units of Earth masses (M_E). Do massive bodies tend to be farther or closer? What about low-mass bodies? What exceptions are there to this?

4) Make a scatter plot of object density versus orbital radius. The x-axis will again be $\log_{10}(Orbital\ Radius)$ and the y-axis will be density. Does there seem to be any relationship between density and distance from the Sun?

5) Make a scatter plot of number of moons versus mass of the object. Let your x-axis be $\log_{10}(Mass)$ in units of Earth masses (M_E) and your y-axis will be the number of moons. How do these two quantities tend to relate to each other? What does this seem to suggest to you?

6) The μ ("Mu") column tells us how much the body has "cleared out" its orbital zone — that is, collected stuff along its path around the Sun and accumulated it. More precisely, μ is the ratio of the mass of the body to the total mass of all objects in the orbital zone. Identify the objects with the lowest μ (define your own reasonable cutoff value). Look at the other properties of these low-μ objects. Is there anything that these objects share in common?

7) Based on what have you have done (or any of the numbers on your datasheet), come up with your own classification scheme for these bodies. Do you find obvious groupings in your plots, or is there no kind of correlation at all? You can have as many groupings as you want and as many objects in each group as you want. Are there bodies that don't seem to fit into any of your

classification groups? Take your time. There is no wrong answer to this!! Write down which bodies are put into each grouping, and explain your classification system in a few sentences.

8) Now that you've come up with a classification system with different groups, which of these groups do you think should be deemed *planets*. Should they all? Should none of them? What are your criteria for what is considered to be a planet? Write this down in a few sentences, and list the objects that you would consider to be a planet. Again, there is no wrong answer to this, just give it your best shot.