1. Which nation has contributed most to the discovery of celestial bodies among different historical periods? Are there spikes in discoveries with the advent of new technologies?

2. What is the relationship between number of moons and planet volume, mass, and gravity?

3. Is there a relationship between volume, mass, gravity, and escape velocity? Can we derive the physics formulas ourselves using the data?

We have discovered that there is an upward trend is discovery rate. Namely, there sharp increase in discovery in the 20th and 21st century. By tallying the number of discoveries in each half century, we find that is around ten discoveries every fifty years from 1600 to 1900. However, starting from 1950, the number of discoveries goes to fifty-nine from 1950 to 2000, and one hundred sixty-five from 1950 to 2000. We can see this in figure 1. We hypothesized that the advent of modern observation technologies and techniques would result in a greater rate of discovery. The increase of discoveries in the late 20th and early 21st century suggests our hypothesis is true. For example, the Hubble space telescope was launched in 1990 and could be a contributing factor in the increase of discoveries in the last few decades. The trend of increasingly more celestial bodies being discovered suggests that we are not running out of things to discover in the solar system. This is because there are still many entries in the database from recent years. However, many of the new entries are smaller non-planetary bodies such as asteroids and comets.

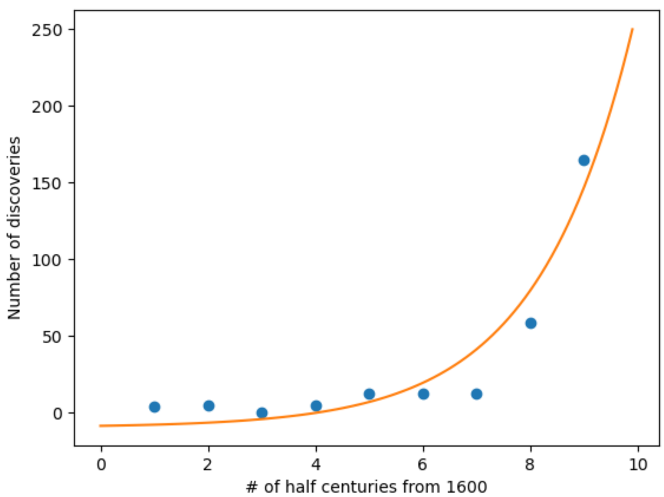

Figure 1: Number of discoveries plotted against half centuries

There is a weak correlation between the gravity of a planet and the number of natural satellites it has. Looking at the scatter plot with gravity and number of satellites we do not see a very clean trend. However, if we observe the corners with weak gravity and many satellites, and strong gravity with few satellites, we see that they are very empty. This suggests that planets with a stronger gravitational field have more satellites. Since volume and mass of a planet are proportional to gravity, planets with more mass and gravity are also expected to have more satellites on average.

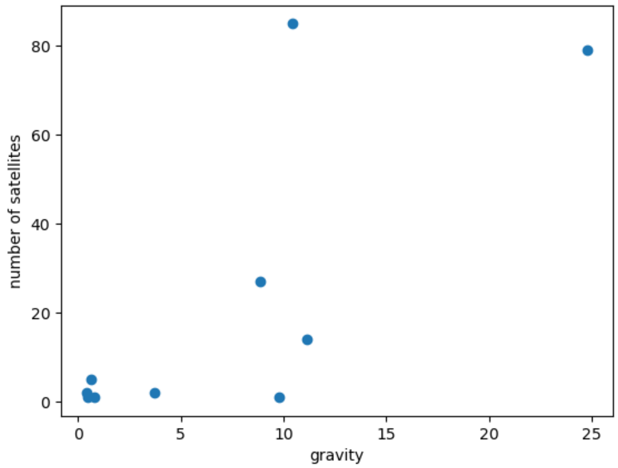

Figure 2: Number of natural satellites of a planet plotted against its gravitational field

For the following analysis we will be primarily using the formulas:

$$v_e = \sqrt{\frac{2GM}{r}}$$

$$F = \frac{Gm}{r^2}$$

The first formula represents the escape velocity v_e needed from an object with mass M and radius r. G represents the gravitational constant. The second equation represents the gravitational forces of an object with mass m and radius r. Again, G represents the gravitational constant. We found that mass divided by radius is quadratically proportional to the square of the escape speed. This can be seen in figure 3. The orange line of best fit is a quadratic. Examining the plot points graphically and numerically, we see that the points are exactly on the quadratic. Namely, we got 0 percent error between the calculated blue plots and the orange line. This suggests that some of the values of the database are calculated. Moreover, the values were calculated with the formulas we provided. For example, there are different ways to calculate escape velocity differing by how many different assumptions are assumed such as uniform density or spherical shape. Plugging in the database escape velocity, mass, and radius, we can solve for the gravitational constant G. We got the exact theoretical value from the calculation. This is expected as we had 0 percent error between the line of best fit and the plot points.

Analyzing the second formula, we found that mass divided by the radius squared of a planet is linearly proportional to its gravitational field. We get this by $a\frac{Gm}{r^2} = b\frac{m}{r^2} = \frac{m}{v^{\frac{2}{3}}}$ using the formula for the volume of a sphere and where a and b are constants. We get that a = 5.96267*10e-9 from adjusting the orange line. Thus solving for G we get that the magnitude of G is 6.454*10e-11. The standard value for G is

6.67*10e-11 thus giving us a 3.3 percent error. Since the error is nontrivial, this suggests that the values for the database used in this calculation are calculated differently from the way we did so.

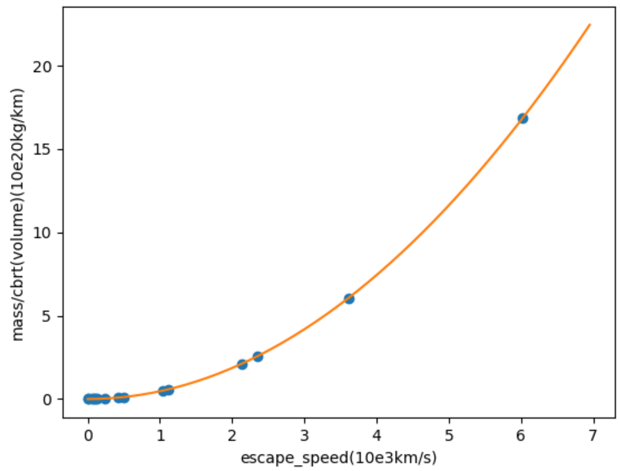

Figure 3: Mass of a planet over the cube root of its volume plotted against its escape speed

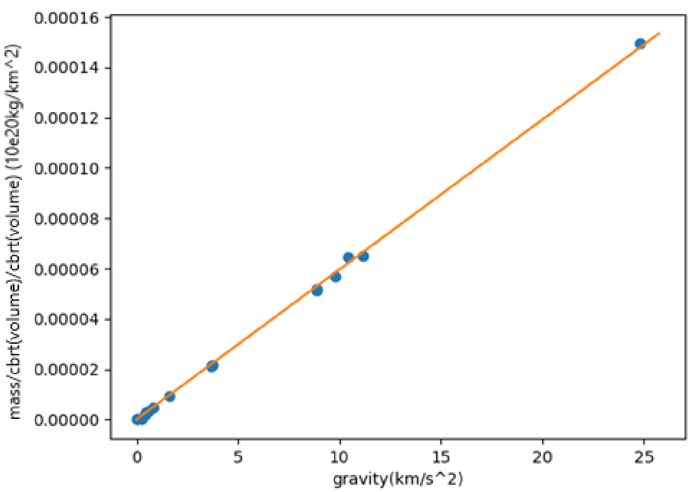

Figure 4: Mass of a planet over the cube root of its volume plotted against its gravity