 Name ________________________

Kepler's Swinging System

Introduction:

Kepler’s Laws of planetary orbits explain why the planets move at the speeds they do. You’ll be making a scale model of the solar system and tracking orbital speeds.

Kepler’s 1st Law states that planetary orbits about the Sun are not circles, but rather ellipses. The Sun lies at one of the foci of the ellipse. Kepler’s 2nd Law states that a line connecting the Sun and an orbiting planet will sweep out equal areas in for a given amount of time. Translation: the further away a planet is from the Sun, the slower it goes.

In this experiment, you're going to be making a scale model of our solar system. You'll need at least one partner, but more partners are better. Each person will represent the Sun or a planet in the solar system!

Materials:

- 30 Foot Measuring Tape (or 30 feet of rope)
- 2 – 10 People
- Large area or field
- Stopwatch

Procedure:

1. Begin with one person holding onto the 30 foot tape measure (they will be the Sun).
2. Have another person grab the end of the tape measure and start walking away (they will be Pluto).
3. Have Pluto keep walking away until the Sun sees the 7 foot mark. At this point, Neptune should grab onto the tape measure at the sun, and keep walking with Pluto.
4. At 15' 4”, Uranus should grab hold as did Neptune and keep walking.
5. At 22' 8”, Saturn should grab hold.
6. At 26', Jupiter grabs hold.
7. At 28' 10”, Mars grabs hold.
8. At 29' 3”, Earth grabs hold.
9. At 29' 6”, Venus grabs hold.
10. Finally at 29' 8”, Mercury grabs hold.
11. Make sure the measuring tape is taught. You have now made a scale model of the solar system!

12. Next, grab your stopwatch and have everyone except Pluto and the Sun let go of the measuring tape (but don't let them move!).
13. Have the Sun stand in the same place, and have Pluto walk around the Sun at a constant steady pace while keeping the measuring tape taught.
14. Time how long it takes Pluto to make one complete revolution and record it in the table below.
15. Next it's Uranus' turn. Have Uranus do the same thing as Pluto while maintaining the exact same walking speed.
16. Once Uranus has made a complete rotation, record the time, and let Saturn take their turn.
17. Keep this process going until times for each planet have been recorded.

Planet	Distance from Sun	Time to Walk Around Sun
Pluto	30'	
Uranus	23'	
Neptune	14' 8”	
Saturn	7' 4”	
Jupiter	4'	
Mars	1' 2”	
Earth	9”	
Venus	6”	
Mercury	4”	

You should clearly see that it takes Pluto <u>much</u> longer to complete an orbit around the Sun than Mercury. This is Kepler’s 2nd Law in action. The further away a planet is, the longer it takes to orbit!

This 30 foot model of the solar system is an incredibly small scale compared to the real thing. In fact, with Pluto 30 feet from the Sun, you've made a 1 : 642,388,000,000 model! In reality, Pluto is about 3,650,000,000 miles from the Sun! Not only are the distances between the planets extraordinarily larger than what you've created, the sizes of the individual planets is also way different. At this scale, the Sun would be the size of a flea, and Pluto would be the size of a red blood cell!

Problems:

1. Salt flats are the result of bodies of water that have dried up over long periods of time. The resulting areas are incredibly flat and can be very large. The Salar de Uyuni in Bolivia is the largest salt flat on Earth. It has an area of 4,086 square miles, and only varies in elevation by around three feet! If you were to go to Bolivia with a 50 mile long tape measure and had Pluto go 50 miles away from the Sun, how far away would the Earth be from the Sun?

2. Since Pluto is actually 3,650,000,000 miles from the Sun, what scale would this model be? (Hint: Take the ratio of the distances form the Sun)

3. On this scale, how far would someone representing Pluto have to walk to make a complete circle around the Sun? (Hint: Try using the circumference of a circle **C = 2 π r**)

Answers:

1. About 2.2 miles
2. 1 : 73,000,000
3. 314 miles! Let's hope the don't have to walk!