# Measuring Orbital Speed

Earth Science

## Introduction

A Boeing 747 can fly 624 miles per hour. That’s pretty fast! Right now, Earth and other objects in the solar system are orbiting the sun, but how fast are these objects moving? In this assignment, you will calculate the orbital speeds of objects in the solar system.

# Part A: Planetary Periods

In the 1600s, Johannes Kepler discovered three laws that govern the motion of objects around the sun. Kepler’s first law explains that objects travel in an elliptical, or oval-shaped, path around the sun. Kepler’s second law explains that an object travels faster in its orbit when it is closer to the sun and slower in its orbit when it is farther away from the sun. In this activity, you will investigate Kepler’s third law: the relationship between an object’s distance from the sun and the time it takes the object to complete an orbit around the sun.

Before moving on to part B, complete the “Solar System Explorer” Gizmo. The exploration guide found within the simulation will help you work through the Gizmo. Select the Lesson Materials link, which appears on the top left corner of the screen once you enter the simulation, to access the student exploration sheet. Use it as you work through Activity C and answer all parts.

# Part B: Calculating Orbital Speed

Every object moves at a different average speed in its orbit around the sun. In this activity, you will use data collected from Part A to calculate the average orbital speeds of each planet and of Pluto.

1. Recall that the path an object takes around the sun is an ellipse, and not a circle. However, to approximate the circumference, or length, of each orbit, you will treat the orbits as circles. Go back to your notes in your student exploration sheet from Part A. Using the mean orbital radius (R) that you recorded, calculate the circumference of each planet’s orbit and record it in the table below. Use the formula below to calculate the circumference.



1. Using the periods you recorded in your student exploration sheet and the circumference of orbit that you just calculated, calculate the average orbital speed of each planet and record it in the table below. Use the following formula to calculate speed:



The units of your answer will be in AU/year.

1. To give you a better perspective of how fast these orbital speeds really are, convert the orbital speeds you just calculated from AU/year to miles/hour. 1 AU/year = 10,604 miles/hour. Record your answers in the table below.

## Table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Object** | **Mean Orbital Radius (AU)**  **(copy from #6 in part A)** | **Circumference of Orbit (AU)** | **Period (Earth Years)**  **(copy from #6 in part A)** | **Orbital Speed**  **(AU/year)** | **Orbital Speed**  **(miles/hour)** |
| **Mercury** | 0.387 | 2.43 | 0.24 | 10.12 | 107387.30 |
| **Venus** | 0.723 | 4.54 | 0.62 | 7.32 | 77675.40 |
| **Earth** | 1.000 | 6.28 | 1.00 | 6.28 | 66639.55 |
| **Mars** | 1.52 | 9.55 | 1.88 | 5.08 | 53905.87 |
| **Jupiter** | 5.20 | 32.66 | 11.86 | 2.75 | 29181.33 |
| **Saturn** | 9.55 | 59.97 | 29.46 | 2.04 | 21647.24 |
| **Uranus** | 19.20 | 120.58 | 84.01 | 1.43 | 15174.29 |
| **Neptune** | 30.10 | 189.02 | 164.79 | 1.15 | 12203.10 |
| **Pluto** | 39.52 | 248.18 | 248.54 | 1.00 | 10611.39 |

## Drawing Conclusions

1. How does an increase in orbital radius affect average orbital speed?

As the radius increases, the orbital speed decreases.

## Extension

In astronomy, the term perihelion refers to the point in the orbit of an asteroid, comet, or planet when it is closest to the sun. Aphelion refers to the point when the object is farthest away from the sun. Research facts about the dwarf planet Ceres. Calculate the average orbital speed of Ceres in miles/hour when it is closer to the sun and when it is further away.