P2 = a3

P = period of revolution in Earth years

G = universal gravitational constant (6.67 x 10-11 m3 kg-1 s-2)

M = mass of the Sun (1.99 x 1030 kg)

a= distance in astronomical units

$$P^{2}=\frac{4π^{2}}{GM}a^{3}$$

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Object | Perihelion (au) | Aphelion (au) | Average Distance (au) | Period of Revolution (Earth Years) | Length of time required for Hohmann Transfer from Earth |
| Mercury | .307 | .467 |  |  |  |
| Venus | .718 | .728 |  |  |  |
| Earth | .983 | 1.017 |  | 1 | N/A |
| Mars | 1.382 | 1.666 |  |  |  |
| Jupiter | 4.95 | 5.459 |  |  |  |
| Saturn | 9.041 | 10.124 |  |  |  |
| Uranus | 18.33 | 20.11 |  |  |  |
| Neptune | 29.81 | 30.33 |  |  |  |
| Pluto | 29.658 | 49.305 |  |  |  |

Directions: First find the average distance of each planet from the Sun. Then, using Kepler’s third law, determine the amount of Earth years each orbit takes. Finally, follow the steps from class to find the Hohmann transfer time.

**Discussion Questions**

1. What assumptions does this model make that could alter its accuracy?
2. Where do you think the largest error in our calculations are (which answer do you have the most uncertainty about)? Explain your reasoning.
3. How should a spacecraft’s velocity relative to the Sun change if they are trying to get from Earth to Venus? What about from Earth to Mars?
4. NASA intends to send humans to Mars (at least in orbit) by the year 2033. Assuming they spend 14 days in orbit around mars, how long will these astronauts be in space for, round trip?
5. Eros (a dwarf planet) has an aphelion of 97.457 AU and a perihelion of 38.271 AU. What is this dwarf planet’s period? How long would the Hohmann transfer take?