**Background:** The 17th century German astronomer Johannes Kepler didn’t understand gravity the way we do today. (He worked before Isaac Newton). He did have access to meticulous measurements of planetary motions. He was convinced that planets moved according to hidden rules and by some trial and error, he found some! The patterns he discovered were shown later to be consistent with Newton’s law of universal gravitation.

**Why are we doing this?** To make predictions from observed patterns in planetary orbits

**Observations to be explained:** The planets farther from the Sun take the most time to orbit the Sun.

**Essential Question:** Can we predict a planet’s orbital period from its distance from the Sun, or the other way around?

**Part A** Kepler only knew about the planets Mercury, Venus, Earth, Mars, Jupiter and Saturn. Please complete the table below

| **Planet** | **R= Average Distance to the Sun (AU)** | **T = Orbital Period (Earth Years)** | **Calculate R3/T2** |
| --- | --- | --- | --- |
| **Mercury** | R = 0.3871  R3 = <0.0580> | T = 0.247  T2 = <0.0610> | <0.9508> |
| **Venus** | R = 0.7233  R3 = <0.3784> | T = 0.615  T2 = <0.3782> | <1.0005> |
| **Earth** | R =1.000  R3 = <1.000> | T = 1.0  T2 = <1.0> | <1> |
| **Mars** | R = 1.524  R3 = <3.5396> | T = 1.884  T2 = <3.5495> | <0.9972> |
| **Jupiter** | R = 5.203  R3 = <140.8515> | T = 11.861  T2 = <140.6833 | <1.0012> |
| **Saturn** | R = 9.537  R3 = <867.4318> | T = 29.499  T2 = <870.1910> | <0.9968> |

What is the average R3/T2? <0.9918333>

**Part B** After Kepler, some new orbiting bodies were discovered. Can you complete this table?

| **Planet** | **R= Average Distance to the Sun (AU)** | **T = Orbital Period (Earth Years)** | **R3/T2**  **Hint: It is always the same!** |
| --- | --- | --- | --- |
| **Ceres (Asteroid)** | R = <2.7675>  R3 = <21.1968> | T = 4.604  T2 = <21.1968> | 1 |
| **Uranus** | R = 19.19  R3 = <7066.8346> | T = <84.0645>  T2 = <7066.8346> | 1 |
| **Neptune** | R = <30.0550>  R3 = <27148.8234> | T = 164.769  T2 = <27148.8234> | 1 |

**Analysis/Conclusion**

1. Do you think this general law would apply to planets orbiting other stars? If yes, do you think the ration R3/T2 would have the same value or some other value?

<I believe that the law in general could apply and be used with planets orbiting other stars.>

<I think the ratio would remain constant because even if it is a different star and not our sun the further a plant is the slower their orbit will be so the law would still apply. It might be difficult because it could be a harder value to work with or a harder area to measure but as long as the values are there the equation will work. And the average solution will most likely stay around the same constant. >

1. If a new planet is discovered that is more distant than Neptune, can you make any general predictions about the magnitude of R? The magnitude of T? The relationship between R and T?

< The value of R will most likely continue to increase and have the greatest overall value because thats a trend amongst the planets and it will now be the furthest from the sun>

<The same a R, T will also be the greatest number for that new platelet which is the furthest away will take the longest to orbit the sun.

<The relationship will be mostly the same to all the other planets and when divided the solution will be close to 1 making the answer proportional and when cubed and squared they will be around the same number.>