

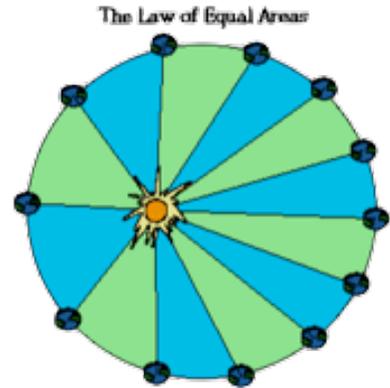
Kepler's Laws and Planetary Motion

Read from **Lesson 4** of the **Circular and Satellite Motion** chapter at **The Physics Classroom**:

<http://www.physicsclassroom.com/Class/circles/u6l4a.html>

MOP Connection: Circular Motion and Gravitation: sublevel 10

- Kepler's first law of planetary motion states that _____. Choose one.
 - the Sun is at the center of the solar system
 - planets orbit the Sun in elliptical orbits, with the Sun located at one focus
 - planets orbit the Sun in circular orbits, with the Sun located at the center
 - gravity provides the force that holds the planets in orbit about the Sun
- Kepler's second law of planetary motion states that a line connecting a planet to the Sun _____. Choose one.
 - is longest in winter and shortest in summer
 - sweeps out more area during a winter month than during the summer month
 - sweeps out the same amount of area in any two equal periods of time
 - sweeps out the same amount of area regardless of the planet.
- A planet would move _____.
 - at the same speed at all times during its orbit about the Sun
 - at faster speeds when positioned closer to the Sun during its orbit
 - at slower speeds when positioned closer to the Sun during its orbit
- Kepler's third law of planetary motion states that the ratio of _____.
 - the orbital period to the orbital radius is the same for all planets
 - the orbital periods of any two planets equals the ratio of the orbital radii
 - all planets would orbit with the same orbital period
 - the period squared to the radius cubed is the same ratio for all planets
- A planet that is further from the Sun would take _____ time to orbit the Sun compared to planets that are closer to the Sun.
 - more
 - less
 - the same amount of
- Planetary data for the nine planets is shown below. Radius and period data are expressed relative to the Earth's radius and period.



| <u>Planet</u> | <u>Period (Earth years)</u> | <u>Ave. Radius (astron. units)</u> |
|---------------|---------------------------------|--|
| Mercury | 0.241 | 0.39 |
| Venus | 0.615 | 0.72 |
| Earth | 1.00 | 1.00 |
| Mars | 1.88 | 1.52 |
| Jupiter | 11.8 | 5.20 |
| Saturn | 29.5 | 9.54 |
| Uranus | 84.0 | 19.18 |
| Neptune | 165 | 30.06 |
| Pluto | 248 | 39.44 |

Circular and Satellite Motion

Taking two planets at a time, compare the ratio of the square of the period to the ratio of the cube of their radius.

$$(T_{\text{Mars}} / T_{\text{Earth}})^2 = \underline{\hspace{2cm}} \quad (R_{\text{Mars}} / R_{\text{Earth}})^3 = \underline{\hspace{2cm}}$$

$$(T_{\text{Jupiter}} / T_{\text{Earth}})^2 = \underline{\hspace{2cm}} \quad (R_{\text{Jupiter}} / R_{\text{Earth}})^3 = \underline{\hspace{2cm}}$$

$$(T_{\text{Neptune}} / T_{\text{Uranus}})^2 = \underline{\hspace{2cm}} \quad (R_{\text{Neptune}} / R_{\text{Uranus}})^3 = \underline{\hspace{2cm}}$$

$$(T_{\text{Pluto}} / T_{\text{Uranus}})^2 = \underline{\hspace{2cm}} \quad (R_{\text{Pluto}} / R_{\text{Uranus}})^3 = \underline{\hspace{2cm}}$$

$$(T_{\text{_____}} / T_{\text{_____}})^2 = \underline{\hspace{2cm}} \quad (R_{\text{_____}} / R_{\text{_____}})^3 = \underline{\hspace{2cm}}$$

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7. Complete the following statements.

a. If planet A is twice as far from the Sun as planet B, then the period of its orbit will be _____ times as long.

b. If planet A is three times as far from the Sun as planet C, then the period of its orbit will be _____ times as long.

c. If planet A is four times as far from the Sun as planet C, then the period of its orbit will be _____ times as long.

d. If planet A is five times as far from the Sun as planet C, then the period of its orbit will be _____ times as long.

8. If a small planet were located eight times as far from the sun as the Earth's distance from the sun, how many years would it take the planet to orbit the sun. **PSYW**