

Vocabulary: Orbital Motion – Kepler’s Laws

Vocabulary

- Astronomical unit – a distance unit equal to the average Earth-Sun distance.
 - The symbol for astronomical unit is “AU.”
 - One astronomical unit is approximately equal to 150 million kilometers. (The actual distance is 149,597,870.691 km.)
 - Eccentricity – the degree by which the shape of an *orbit* differs from a circle.
 - The eccentricity of an *ellipse* can vary between 0 and 1. An ellipse with an eccentricity of 0 is a circle. An ellipse with an eccentricity of 1 is a line segment.
 - To measure the eccentricity of an ellipse, divide the distance between the *foci* by the width of the ellipse. (On the diagram below, the foci are labeled “F₁” and “F₂.”)
 - Ellipse – a flattened circle.
 - An ellipse contains two foci, labeled “F₁” and “F₂” on the diagram at right.
 - The sum of the distances from any point on the ellipse to the two foci is constant. On the diagram, $a_1 + a_2 = b_1 + b_2$.
 - The orbits of planets and other objects in the solar system are elliptical, with the Sun at one focus.
- The diagram shows an ellipse with two foci, F₁ and F₂, and a center point C. Two points, A and B, are marked on the ellipse. Dotted lines connect A to F₁ (labeled a₁) and A to F₂ (labeled a₂). Similarly, dotted lines connect B to F₁ (labeled b₁) and B to F₂ (labeled b₂). The text explains that the sum of the distances from any point on the ellipse to the two foci is constant, so $a_1 + a_2 = b_1 + b_2$.
- Force – something that can cause a change in motion; a push or a pull.
 - When you push or pull an object, you exert a force on the object. Other examples of forces include *gravity*, the electrostatic force, and the strong and weak nuclear forces.
 - Gravity – the force of attraction between all objects in the universe.
 - The magnitude of the gravitational force between two objects depends on the masses of the two objects and the distance between them.
 - The force of gravity is proportional to the product of the masses.
 - The force of gravity is inversely proportional to the square of the distance.
 - Kepler’s first law – law that states that planets orbit in ellipses, with the Sun at one focus.
 - Kepler’s second law – law that states that planets speed up as they get nearer the Sun and slow down as they move farther from the Sun.
 - Kepler’s third law – law that states that the square of a planet’s *period* is proportional to the cube of the planet’s *orbital radius*.

- Orbit – the path of one body around another body in space, such as the path of Earth around the Sun.
- Orbital radius – the average distance from an orbiting object to the object it is orbiting around.
 - The orbital radius of a planet is the mean distance from the planet to the Sun.
- Period – the amount of time it takes for an object to complete one full orbit.
- Vector – a representation that specifies the direction and magnitude of a quantity.
 - In physics, vectors are used to represent displacement, *velocity*, acceleration, force, and other quantities that have a specific direction.
 - A vector can be resolved into perpendicular components.
 - For example, “ $6.0\mathbf{i} + 3.0\mathbf{j}$ ” describes a vector that points 6 units east and 3 units north.
- Velocity – the speed and direction of a moving object.
 - The velocity of an object can be described by a vector.