What are Kepler's Laws?

Worksheet

Kepler's Laws state: (1) planets orbit the Sun in ellipses with the Sun at one focus, (2) a line from the Sun to a planet sweeps equal areas in equal times, and (3) the square of the orbital period is proportional to the cube of the semi-major axis: T = a (in years and AU).

T^2 = @frac{4@pi^2}{GM}a^3

Questions

1. Kepler's First Law states that planetary orbits are

A) Perfect circles
B) Ellipses with the Sun at one focus
C) Straight lines
D) Spirals

2. According to Kepler's Second Law, a planet moves fastest when it is

A) Farthest from the Sun
B) Closest to the Sun
C) At a constant speed always
D) Stopped momentarily

3. Using T = a, what is the orbital period of a planet at a = 4 AU?

A) 4 years
B) 8 years
C) 16 years
D) 64 years

4. Kepler's Third Law relation T = a is valid when

A) T is in days and a in km
B) T is in years and a in AU (Sun-orbiting bodies)
C) Only for the Moon
D) Only for circular orbits

5. Earth's semi-major axis is 1 AU. Find its orbital period.

6. Mars has a semi-major axis of 1.52 AU. Find its orbital period.

7. An asteroid orbits the Sun with a semi-major axis of 3 AU. Find its orbital period.

8. Define: What does Kepler's First Law state?

9. Define: What does Kepler's Second Law state?

10. Define: What does Kepler's Third Law state?

Answer Key

1. B) Ellipses with the Sun at one focus - Orbits are ellipses, not circles, with the Sun at one of the two foci.

2. B) Closest to the Sun - Equal areas in equal times means higher speed near the Sun (perihelion).

3. B) 8 years - T = 4 = 64, so T = 64 = 8 years.

4. B) T is in years and a in AU (Sun-orbiting bodies) - This simplified form holds specifically for years and AU around the Sun.

5. T = a T = 1 = 1 T = 1 = 1 year

6. T = a = 1.52 = 3.512 T = 3.512 T 1.87 years (about 684 days)

7. T = a = 3 = 27 T = 27 T 5.20 years

8. Planets orbit the Sun in ellipses, with the Sun at one focus (not the center).

9. A line from the Sun to a planet sweeps out equal areas in equal times - so planets move faster near the Sun (perihelion) and slower far away (aphelion).

10. T = a (in years and AU) - the square of the period is proportional to the cube of the semi-major axis.