Name: _____ **Date:** _____

Answer Key: Why is Orbit Elliptical? 9th Grade Orbital Mechanics Quiz

High schoolers analyze Kepler’s Second Law, the barycenter of the Earth-Moon system, and the geometric consequences of axial precession on long-term climate cycles.

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1. Regarding Kepler’s Second Law (Law of Equal Areas), how does Earth’s orbital velocity change throughout the year?

Answer: C) Velocity increases at perihelion when Earth is closest to the Sun.

To sweep out equal areas in equal time, a planet must travel faster when it is closer to the gravitational center (perihelion) and slower when further away (aphelion).

2. The 'Barycenter' of the Earth-Moon system is located exactly at the geometric center of planet Earth.

Answer: B) False

The barycenter is the center of mass of the Earth-Moon system; because Earth is much more massive, it is located inside Earth but about 1,700km away from the actual center.

3. The slow 'wobble' of Earth’s axis, which takes approximately 26,000 years to complete a cycle, is known as _____.

Answer: B) Precession

Axial precession is the change in the orientation of the rotational axis of an astronomical body, primarily caused by the gravitational influence of the Sun and Moon.

4. What is the primary cause of the 'Precession of the Equinoxes'?

Answer: C) The gravitational pull of the Sun and Moon on Earth's equatorial bulge.

Because Earth is an oblate spheroid with an equatorial bulge, the Sun and Moon exert a torque that causes the axis to wobble like a spinning top.

5. Milankovitch cycles involve long-term changes in Earth's _____, affecting the shape of its orbit and long-term climate.

Answer: A) Eccentricity

Name: _____ **Date:** _____

Eccentricity refers to the variation in the shape of Earth's orbit around the sun, which fluctuates between more circular and more elliptical over about 100,000 years.

6. The sidereal day (the time it takes Earth to rotate 360 degrees relative to stars) is shorter than the solar day.

Answer: A) True

A sidereal day is about 23 hours and 56 minutes; it is shorter because Earth rotates as it orbits, requiring it to turn slightly more than 360 degrees to align again with the Sun.

7. Which term describes the slight 'nodding' or oscillation in the Earth's axis of rotation, superimposed over precession?

Answer: C) Nutation

Nutation is a small, periodic motion in the axis of rotation of Earth that lasts about 18.6 years, caused by the changing position of the Moon.

8. In the context of the Earth-Moon-Sun system, a 'Syzygy' refers to the _____ of three celestial bodies in a gravitational system.

Answer: B) Linear alignment

Syzygy is the configuration where the Sun, Earth, and Moon are in a straight line, which is the underlying geometry of eclipses and spring tides.

9. Earth is at its closest point to the Sun (perihelion) during the Northern Hemisphere's summer month of July.

Answer: B) False

Earth is actually at perihelion in early January and aphelion in early July. Seasons are caused by tilt, not distance from the Sun.

10. How would Earth's seasons be affected if the axial tilt were increased from 23.5 degrees to 45 degrees?

Answer: C) Seasons would become significantly more extreme.

A greater axial tilt increases the difference in solar radiation received between summer and winter, leading to hotter summers and colder winters.