

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Orbital Mechanics or Coffee Shop Physics? Senior Astronomy Challenge

Calculate orbital perturbations and barycentric motions that satellite engineers and astrophysicists use to maintain global GPS synchronization.

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**1. The Milankovitch cycle known as 'precession' involves a 26,000-year wobble of Earth's axis. Which celestial mechanic is the primary driver of this specific cyclic variation?**

- A. Solar wind pressure on the magnetosphere
- B. Gravitational tugging by the Sun and Moon on Earth's equatorial bulge
- C. Magnetic pole reversal causing torque on the mantle
- D. Frame-dragging effects from the Sun's rotation

**2. In the Earth-Moon system, the center of mass around which both bodies actually orbit is located approximately 1,700 km below Earth's surface. This point is scientifically termed the \_\_\_\_.**

- A. Apogee
- B. Geocenter
- C. Barycenter
- D. Lagrange Point

**3. True or False: According to Kepler's Second Law, Earth travels at a higher orbital velocity during the Western Hemisphere's winter (perihelion) than it does during the summer (aphelion).**

- A. True
- B. False

**4. Consider the Saros cycle. Why do solar eclipses not occur every month during the New Moon phase?**

- A. The Moon's orbit is inclined at roughly 5 degrees relative to the ecliptic plane
- B. The Moon's speed varies too much due to its elliptical eccentricity
- C. Earth's atmosphere refracts light, preventing a perfect shadow alignment
- D. The Sun's parallax shift masks the Moon's shadow

**5. When the Sun, Earth, and Moon form a 90-degree angle (Quadrature), the solar tide partially cancels the lunar tide, resulting in the lowest tidal range of the month. This is known as a \_\_\_\_ tide.**

- A. Proxigean
- B. Perigean
- C. Spring
- D. Neap

**6. The ANALEMMA is a figure-eight shape seen when photographing the Sun from the same spot at the same time for a year. Which two factors synthesize to create this shape?**

- A. Axial tilt and orbital eccentricity
- B. Sidereal rotation and synodic period

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- C. Atmospheric refraction and the Coriolis effect
- D. Lunar libration and Earth's precession

**7. True or False: A 'Sidereal Day' is approximately 4 minutes longer than a 'Solar Day' because Earth must rotate further to realign with the Sun.**

- A. True
- B. False

**8. Beyond simple tides, gravitational interaction causes 'Tidal Acceleration.' What is the long-term measurable impact of this on the Earth-Moon system?**

- A. Earth's rotation speed increases and the Moon moves closer
- B. Earth's rotation speed slows down and the Moon recedes from Earth
- C. The Moon's orbit becomes perfectly circular over time
- D. The Earth's axial tilt eventually stabilizes to 0 degrees

**9. The 'Ecliptic' is the apparent path of the Sun across the celestial sphere. The point where the Sun crosses the celestial equator moving North is specifically termed the \_\_\_\_\_.**

- A. Winter Solstice
- B. Zenith Point
- C. Vernal Equinox
- D. Perihelion

**10. True or False: During a Total Solar Eclipse, the 'Baily's Beads' effect is caused by sunlight passing through the rugged topography of the lunar limb.**

- A. True
- B. False