

Name: _____ Date: _____

Celestial Cycles and Stellar Soccer: College Astronomy Challenge

Evaluate the complex gravitational choreography and orbital perturbations that influence planetary motion through rigorous mathematical and theoretical analysis.

1. The Milankovitch cycles involve long-term variations in Earth's orbital eccentricity. Which of the following best analyzes the impact of eccentricity changes from 0.005 to 0.060 on the Earth's climate system?

- A. It primarily shifts the timing of the equinoxes relative to perihelion.
- B. It modulates the total annual solar insolation received by the entire planet by approximately 10%.
- C. It alters the difference in solar radiation received at perihelion versus aphelion, intensifying seasonal contrasts.
- D. It creates a permanent shift in the obliquity of the ecliptic regardless of axial precession.

2. The barycenter of the Earth-Moon system is located approximately 1,700 kilometers beneath the Earth's surface, meaning the Earth technically 'wobbles' around this internal point rather than orbiting the Moon's center.

- A. True
- B. False

3. In the context of tidal resonance, the Bay of Fundy experiences extreme tidal ranges because its natural oscillation period closely matches the period of the ____.

- A. Sidereal day
- B. Lunar semidiurnal tide (M2 component)
- C. Solar tropical year
- D. Anomalistic month

4. Consider the Saros cycle used to predict eclipses. Why does a solar eclipse occurring today not repeat exactly at the same geographic coordinates after one Saros period (18 years, 11 days, 8 hours)?

- A. The lunar perigee rotates westward during that interval.
- B. The 8-hour fraction in the cycle causes Earth to rotate about 120 degrees further west.
- C. Atmospheric refraction shifts the path of totality by several thousand miles.
- D. The Earth's axial tilt changes by 0.5 degrees during every Saros interval.

5. Precession of the equinoxes, caused by the gravitational torque of the Sun and Moon on Earth's equatorial bulge, will make Polaris the North Star again in approximately 5,000 years.

- A. True
- B. False

6. The _____ is the tendency for a moving object to veer to the right in the Northern Hemisphere due to the Earth's rotation, and its magnitude is a function of the sine of the latitude.

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- A. Hadley Cell effect
- B. Rossby wave force
- C. Coriolis acceleration
- D. Foucault velocity

7. Analemma patterns represent the Sun's position in the sky at the same time each day. What would happen to the analemma if Earth's orbit were a perfect circle but the axial tilt remained 23.5 degrees?

- A. The analemma would be a figure-eight.
- B. The analemma would be a single point.
- C. The analemma would be a straight North-South line.
- D. The analemma would be a horizontal ellipse.

8. A _____ day is approximately 3 minutes and 56 seconds shorter than a solar day because the Earth must rotate slightly more than 360 degrees to realign with the Sun.

- A. Synodic
- B. Sidereal
- C. Anomalistic
- D. Tropical

9. During a Neap Tide, the gravitational pull of the Sun and the Moon act at right angles to each other, resulting in the highest high tides and lowest low tides of the month.

- A. True
- B. False

10. In the study of Earth's orientation, 'Nutation' refers to which specific phenomenon?

- A. The long-term 26,000-year circular sweep of the axis.
- B. Small, short-term 'nodding' oscillations in the Earth's axis due to the Moon's varying orbital plane.
- C. The gradual slowing of Earth's rotation due to tidal friction.
- D. The seasonal shifting of atmospheric mass between hemispheres.