Cosmic Calculations and Planetary Pre-Calculus

Pre-Calculus · Answer Key · 12 Questions

1. The brightness of stars is measured on a logarithmic magnitude scale where a difference of 5 magnitudes corresponds to a factor of 100 in intensity. What is the base of this logarithmic relationship?

A) e
B) 10
C) 100
D) 2.512

2. Kepler's Third Law relates the orbital period (P) of a planet to its semi-major axis (a) using the formula P^2 is proportional to a^3. If a planet's distance from the Sun is 4 astronomical units, what is its orbital period in Earth years?

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

3. In orbital mechanics, the eccentricity (e) of an elliptical orbit is defined by the conic section formula. If a comet has an eccentricity of exactly 1, what is the shape of its orbit?

A) Circle
B) Ellipse
C) Parabola
D) Hyperbola

4. The inverse square law dictates that the gravitational force between two celestial bodies is proportional to 1/d^2. If the distance between two planets is tripled, by what factor does the gravitational force decrease?

A) 3
B) 6
C) 9
D) 12

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5. The angular size of the Moon viewed from Earth is approximately 0.5 degrees. If you wanted to express this angle in radians for use in circular motion formulas, what is the value rounded to three decimal places?

A) 0.005
B) 0.009
C) 0.087
D) 0.523

6. Radioactive decay is modeled by exponential functions. The half-life of Carbon-14 is approximately 5,730 years. Using the formula N(t) = N0 * e^(kt), what is the decay constant k approximately?

A) -0.000121
B) 0.000121
C) 0.00573
D) 0.000057

7. The tilt of the Earth's axis is approximately 23.5 degrees. What is the cosine of this angle, representing the scaling factor for solar flux reaching the tropics?

A) 0.399
B) 0.821
C) 0.917
D) 0.999

8. The distance to nearby stars is often calculated using stellar parallax, which relies on the trigonometric tangent function in a right-angled triangle. If the parallax angle p is very small, which approximation is used?

A) tan(p) ? sin(p)
B) tan(p) ? p
C) tan(p) ? 1/p
D) tan(p) ? cos(p)

9. A light-year is the distance light travels in one Julian year. Given the speed of light is 299,792,458 m/s, approximately how many meters are in a light-year using scientific notation?

A) 9.46 x 10^12 m
B) 9.46 x 10^15 m
C) 9.46 x 10^18 m
D) 9.46 x 10^21 m

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10. The Sun's output is so vast it is measured using orders of magnitude. The Sun's luminosity is approximately 3.8 x 10^26 Watts. What is the log base 10 of this value?

A) 26.58
B) 27.42
C) 26.00
D) 10.38

11. Escape velocity (v) is defined by the function v = sqrt(2GM/r). If the radius (r) of a planet is doubled while keeping mass (M) constant, how does the escape velocity change?

A) It doubles
B) It is halved
C) It decreases by a factor of 1.414
D) It stays the same

12. The density of the universe is often expressed using the critical density formula. If the density parameter is omega = 1, what does this indicate about the geometry of the universe?

A) Spherical
B) Hyperbolic
C) Flat
D) Elliptical