

Mathematical Patterns in the Natural World

Pre-Calculus · Practice Test · 8 Questions

1. The spiral pattern of a nautilus shell can be modeled by a logarithmic spiral. If the polar equation is $r = a * e^{(b*\theta)}$, what represents the rate of expansion?

- A) The constant b
- B) The variable θ
- C) The initial value a
- D) The eccentricity

2. Many tree species, such as the spruce, exhibit growth patterns that follow the Fibonacci sequence. Which function best approximates the growth of these structures as n approaches infinity?

- A) Linear function
- B) Binet's formula
- C) Quadratic equation
- D) Step function

3. The population growth of a bacteria colony in an oxygen-rich environment is modeled by $N(t) = N_0 * e^{(rt)}$. What is the specific term for ' r ' in this continuous exponential growth equation?

- A) Doubling period
- B) Malthusian parameter
- C) Logistic capacity
- D) Half-life

4. The intensity of sound produced by a cicada is measured in decibels using the formula $L = 10 * \log_{10}(I/I_0)$. This is an example of what type of mathematical scale?

- A) Logarithmic
- B) Arithmetic
- C) Hyperbolic
- D) Trigonometric

5. In the study of phyllotaxis, the divergence angle between successive leaves on a stem is approximately 137.5 degrees, derived from the golden ratio. What is the approximate value of this ratio (ϕ)?

- A) 1.414
- B) 2.718
- C) 1.618
- D) 3.141

6. The predator-prey relationship between lynx and hares follows cyclical oscillations often modeled by systems of periodic trigonometric functions. Which function would best model a repeating seasonal oscillation?

- A) $f(x) = x^2$
- B) $f(x) = A \sin(Bx + C)$
- C) $f(x) = e^x$
- D) $f(x) = 1/x$

7. Honeycombs are constructed in hexagonal prisms to minimize surface area for a given volume. If the volume V is fixed, the surface area A is minimized when the hexagonal cells are arranged in a pattern where the side length ' s ' satisfies what relationship?

- A) $V = 6s^3$
- B) $V = 3s^2h$
- C) $V = 2.598s^2h$
- D) $V = s^3$

8. The carbon-14 dating method used to determine the age of organic matter in environmental samples utilizes an exponential decay function $N(t) = N_0 * e^{(-?t)}$. What does '?' represent?

- A) The decay constant
- B) The atmospheric carbon concentration
- C) The initial mass of the sample
- D) The time elapsed