C.I. APPLIED PHYSICS AND BIOSTATISTICS

Sample questions · Mathematics and Statistics

These questions show the format and the level of the written exam. The exam draws from a much larger bank, so studying the topics (not these questions) is what matters. The answer key is on the last page: try the questions first.

SECTION A — TRUE / FALSE

Select True or False · 0.75 pts each in the exam

A1.	In $\mathbb{N}$, subtraction is always possible.	○ T ○ F
A2.	A quadratic equation can have two distinct real solutions, two coincident real solutions, or no real solutions.	○ T ○ F
A3.	A function may assign the same image value to different elements of the domain.	○ T ○ F
A4.	$\log_a x$ is the inverse function of a^x.	○ T ○ F
A5.	$\log_a x$ is defined only for $x > 0$.	○ T ○ F
A6.	If $\lim_{x \to \pm\infty} f(x) = \pm\infty$, then f has a horizontal asymptote.	○ T ○ F
A7.	A removable (third-kind) discontinuity occurs when the limit exists and is finite, but f is either undefined at the point or its value does not match the limit.	○ T ○ F
A8.	If f is continuous at x_0, then f must be differentiable at x_0.	○ T ○ F
A9.	Every stationary point (where $f'(x_0) = 0$) is necessarily a local extremum of f.	○ T ○ F
A10.	The indefinite integral of a function is a single, unique function.	○ T ○ F
A11.	Integration and differentiation are inverse operations, in the sense that $d/dx \int_a^x f(t)\,dt = f(x)$.	○ T ○ F
A12.	A high correlation between two variables proves that one of them causes the other.	○ T ○ F
A13.	An extreme outlier changes the mean of a data set more than it changes the median.	○ T ○ F
A14.	For the same data, dividing the sum of squared deviations by $n - 1$ gives a larger value than dividing it by n.	○ T ○ F
A15.	Sensitivity measures the proportion of healthy individuals who are correctly identified as test-negative.	○ T ○ F

SECTION B — MULTIPLE CHOICE

Choose one answer · 1 pt each in the exam

B1. A real number whose decimal expansion is infinite and non-periodic is:

- ○ A) Rational
- ○ B) Irrational (a real number that is not rational)
- ○ C) An integer
- ○ D) A natural number

B2. $pH = -\log_{10}[H^+]$. If the pH of a solution falls by one unit, the concentration $[H^+]$ becomes:

- ○ A) Ten times smaller
- ○ B) Larger by 1 mol/L
- ○ C) Twice as large
- ○ D) Ten times larger

B3. The calibration line $A = \varepsilon \cdot l \cdot c$ (with $\varepsilon, l > 0$) is strictly increasing in c. This means that:

- ○ A) It is injective, so it admits an inverse: $c = A/(\varepsilon \cdot l)$
- ○ B) It is not injective, so no inverse exists
- ○ C) It is bounded, so c cannot be recovered
- ○ D) It is constant, so all concentrations give the same A

B4. A drug is eliminated according to $C(t) = C_0 e^{-\lambda t}$. About its half-life, which statement is correct?

- ○ A) It doubles each time the concentration halves
- ○ B) It is proportional to the initial concentration C_0
- ○ C) It is constant: it does not depend on the initial concentration C_0 (it equals $\ln 2 / \lambda$)
- ○ D) It is the time at which the drug is completely eliminated

B5. In the Michaelis–Menten law $v = V_{max}[S]/(K_m + [S])$, what happens to v as $[S] \to +\infty$?

- ○ A) v grows without bound
- ○ B) v tends to V_{max}: a horizontal asymptote
- ○ C) v tends to 0
- ○ D) v tends to K_m

B6. Let f be continuous on [a, b] and differentiable on (a, b). If $f'(x) \leq 0$ for all x in (a, b), then f is:

- ○ A) Increasing on [a, b]
- ○ B) Constant on [a, b]
- ○ C) Convex on [a, b]
- ○ D) Decreasing on [a, b]

B7. A plasma concentration curve C(t) has its peak at $t = T_{max}$. Which condition holds?

- ○ A) $C'(T_{max}) = 0$, with $C' > 0$ before and $C' < 0$ after
- ○ B) $C(T_{max}) = 0$
- ○ C) $C''(T_{max}) = 0$
- ○ D) $C'(T_{max}) > 0$

B8. A drug is infused at a rate r(t) (mg/h). The total amount delivered between t = a and t = b is:

- ○ A) $r(b) - r(a)$
- ○ B) $r(b) \cdot (b - a)$, always
- ○ C) $\int_a^b r(t)\,dt$
- ○ D) the derivative of r(t) at t = b

B9. A patient has a haemoglobin value with $z = +2.6$ with respect to the healthy population (approximately normal). This means that the value:

- ○ A) Lies 2.6 units above the mean
- ○ B) Lies inside the reference interval
- ○ C) Is 2.6 times the mean
- ○ D) Lies 2.6 standard deviations above the mean, outside the reference interval $\mu \pm 2\sigma$

B10. In a diagnostic test evaluated against a 2×2 table of true disease status (TP, FP, TN, FN), sensitivity is defined as:

- ○ A) TP / (TP + FN)
- ○ B) TN / (TN + FP)
- ○ C) TP / (TP + FP)
- ○ D) TN / (TN + FN)

B11. The sample size is multiplied by 4 while the SD stays the same. The standard error of the mean:

- ○ A) is multiplied by 4
- ○ B) is divided by 2
- ○ C) is divided by 4
- ○ D) does not change

ANSWER KEY

A1	FALSE	A5	TRUE	A9	FALSE	A13	TRUE
A2	TRUE	A6	FALSE	A10	FALSE	A14	TRUE
A3	TRUE	A7	TRUE	A11	TRUE	A15	FALSE
A4	TRUE	A8	FALSE	A12	FALSE		

B1	B	B4	C	B7	A	B10	A
B2	D	B5	B	B8	C	B11	B
B3	A	B6	D	B9	D		