Name: _____ **Date:** _____

Dissect Cosmic Constants: A College Calculus-Based Measurement Quiz

Evaluate dimensional homogeneity and relativistic corrections across non-Euclidean frameworks where standard SI derivations face extreme astrophysical constraints.

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1. When deriving the Planck length contextually, which synthesis of fundamental constants (G, ħ, and c) maintains dimensional consistency for L?

A. sqrt($G\hbar/c^3$)
B. $G\hbar/c^2$
C. sqrt($G\hbar/c^5$)
D. $G^2/\hbar c$

2. Regarding the 2019 redefinition of SI base units, the value of the _____ is now fixed by defining the numerical value of the Boltzmann constant (k).

A. Mole
B. Kelvin
C. Ampere
D. Candela

3. In a non-inertial reference frame, the measured 'proper time' between two events is a Lorentz invariant and remains unchanged regardless of the observer's velocity.

A. True
B. False

4. A Josephson Junction is primarily utilized in metrology to realize the SI volt by relating it to which two fundamental physical constants?

A. Permeability of free space and the Electron mass
B. The Fine-structure constant and the Rydberg constant
C. The Elementary charge and the Planck constant
D. Avogadro's number and the Faraday constant

5. When examining the systematic error in a high-precision interferometer, the 'Type B' evaluation of uncertainty is based on _____.

A. Statistical analysis of series of observations
B. The square root of the variance
C. Non-statistical scientific judgment and calibration data
D. The Poisson distribution of photon counts

6. Calculate the radiant flux (Watts) of a blackbody source if its luminous intensity is 683 candelas at a frequency of 540 x 10^{12} Hz, assuming monochromatic emission.

A. 683 W

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B. 1 W
C. 1/683 W
D. 4π W

7. The SI base unit for mass is no longer determined by a physical artifact (the 'Le Grand K') but is instead realized via the Kibble balance and Planck's constant.

A. True
B. False

8. In fluid dynamics, the Reynolds number is a dimensionless quantity. Which ratio of units correctly yields a dimensionless result for Re = (ρvd)/μ?

A. $(kg/m^3)(m/s)(m) / (kg/(m \cdot s))$
B. $(g/cm^2)(cm/s)(cm) / (Poise)$
C. $(kg \cdot m)(m/s^2) / (Pascals)$
D. $(m^2/s)(kg) / (Newton \cdot s)$

9. For a Quantum Hall Effect experiment measuring Resistance (R_H), the Von Klitzing constant (R_k) equates the unit 'Ohm' to the ratio _____.

A. h / e^2
B. e^2 / h
C. mc / e
D. $\hbar / 2e$

10. Even if a measurement is perfectly precise (zero variance), it can still possess high systematic error if the instrument is poorly calibrated.

A. True
B. False