Name: _____ **Date:** _____

Metrology Mastery: A High-Stakes Senior Science Seminar

Can you navigate the nuances of dimensional analysis and error propagation? Defend your data through 10 advanced measurement evaluation scenarios.

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1. A research team measuring the Planck constant reports a high degree of precision but realizes the cryostat thermometer was improperly calibrated by 0.5 K. Which statement best evaluates their data's validity?

A. The data is valid because precision automatically implies accuracy in quantum metrology.
B. The results are precise but inaccurate due to a systematic error in the instrumentation.
C. The results are both imprecise and inaccurate because of thermal fluctuations.
D. The error is negligible because SI units are based on universal constants.

2. In the context of the 2019 SI redefinition, the kilogram is no longer defined by a physical artifact but is instead derived from the fixed numerical value of the _____.

A. Boltzmann constant
B. Avogadro constant
C. Planck constant
D. Speed of light

3. Dimensional analysis can be used to prove that a derived physical equation is definitively correct in its description of reality.

A. True
B. False

4. When calculating the volume of a cylinder ($V = \pi r^2 h$) where the radius r has a 2% uncertainty and the height h has a 1% uncertainty, what is the total propagated percentage uncertainty in the volume?

A. 3%
B. 5%
C. 4%
D. 1.4%

5. A fundamental unit that measures the luminous intensity in a given direction is the _____, which uniquely depends on the human eye's sensitivity.

A. Lumen
B. Lux
C. Candela
D. Watt

6. A measurement of 0.005060 meters contains exactly four significant figures.

A. True

B. False

7. Which of the following is considered a derived unit rather than a base unit in the SI system?

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

8. In high-precision particle physics, the term _____ describes the scatter of the data and is often quantified using the standard deviation of the mean.

A. Accuracy
B. Random error
C. Systematic bias
D. Linearity

9. The radian and steradian are mathematically considered dimensionless derived units in the SI system.

A. True
B. False

10. An astrophysicist calculates the age of a star to be 10.2 Gigayears. Express this value in SI base units using proper scientific notation.

A. 1.02 x 10^10 s
B. 3.22 x 10^17 s
C. 1.02 x 10^9 s
D. 3.22 x 10^14 s