Name: _____ **Date:** _____

Shatter the Scale: Advanced Metrology Challenge for 11th Grade

Probe beyond simple conversions by modeling multidimensional dimensional analysis and quantifying the propagation of uncertainty in complex laboratory environments.

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1. A researcher measures the resistivity of a new alloy using the formula ρ = RA/L. If the uncertainty in resistance (R) is 2% and the uncertainty in the dimensions (A and L) is 1% each, what is the total propagated percentage uncertainty in resistivity?

A. 2%
B. 3%
C. 4%
D. 5%

2. In the derivation of fundamental constants, the _____ is the only SI base unit defined by fixing the numerical value of the Planck constant (h) to exactly $6.62607015 \times 10^{-34}$ $kg \cdot m^2 \cdot s^{-1}$.

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

3. Systematic errors can be significantly reduced by calculating the mean of a very large set of repeated trials.

A. True
B. False

4. Evaluate the following calculation to the correct number of significant figures: (12.55 × 3.00) / 0.01201.

A. 3134.887
B. 3135
C. 3130
D. 3.13e3

5. Which derived unit is used to express the frequency of a periodic signal in terms of base SI units (s^{-1})?

A. Newton
B. Hertz
C. Pascal
D. Joule

6. The luminous intensity (candela) is the only SI base unit that accounts for the human eye's perception of light brightness.

A. True
B. False

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7. If a theoretical equation for velocity is given as v = sqrt(2GM/r), what must be the SI base units of the gravitational constant (G)?

A. $m^3 kg^{-1} s^{-2}$
B. $m^2 kg^{-2} s^{-1}$
C. $m kg s^{-2}$
D. $m^2 s^{-2} kg^{-1}$

8. The SI base unit for thermodynamic temperature, the Kelvin, is defined by fixing the numerical value of the _____ to 1.380649×10^{-23} $J K^{-1}$.

A. Avogadro constant
B. Boltzmann constant
C. Ideal gas constant
D. Stefan-Boltzmann constant

9. A student measures the thickness of a wire using a micrometer screw gauge with a zero error of -0.02 mm. The observed reading is 1.45 mm. What is the corrected measurement?

A. 1.43 mm
B. 1.45 mm
C. 1.47 mm
D. 1.470 mm

10. Dimensions and units are synonymous; if two quantities share the same dimensions (e.g., L^2), they must be expressed in the same SI units.

A. True
B. False