

Name: _____ Date: _____

Cosmic Scale Expedition: 12th Grade Metrology & Precision Quest

Navigate 10 complex scenarios requiring rigorous analysis of SI base units, dimensional consistency, and the fine line between uncertainty and accuracy in research.

1. During a high-energy particle physics experiment, a researcher calculates the vacuum permittivity but finds the final value is exactly 0.5% higher than the accepted physical constant. However, repeated trials yield the exact same displaced value every time. How should this data be categorized?

- A. Low accuracy and low precision
- B. High accuracy and low precision
- C. Low accuracy and high precision
- D. High accuracy and high precision

2. In the derivation of the Stefan-Boltzmann constant, which SI base unit is used to define the thermodynamic temperature and is independent of the properties of any specific substance?

- A. Celsius
- B. Rankine
- C. Kelvin
- D. Fahrenheit

3. The SI base unit for mass, the kilogram, is currently defined by a physical platinum-iridium cylinder stored in France known as 'Le Grand K'.

- A. True
- B. False

4. A theoretical physicist proposes a new equation: $E = (m * v^3) / r$. Using dimensional analysis, determine if this equation is consistent with the SI units for Energy (Joules).

- A. Consistent: Resulting units are $\text{kg}\cdot\text{m}^2/\text{s}^2$
- B. Inconsistent: Resulting units are $\text{kg}\cdot\text{m}^2/\text{s}^3$
- C. Inconsistent: Resulting units are $\text{kg}\cdot\text{m}/\text{s}^2$
- D. Consistent: Resulting units are $\text{kg}\cdot\text{m}/\text{s}$

5. When measuring the luminous intensity of a monochromatic radiation source at a frequency of 540×10^{12} hertz, the specific SI unit used is the _____.

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

6. In advanced stoichiometry, the mole is defined precisely as the number of atoms found in exactly 0.012 kilograms of Carbon-12.

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- A. True
- B. False

7. An electrical engineer measures a current of 450 milliamperes (mA) across a resistor. If she needs to convert this to the base unit to calculate power in Watts ($W = A * V$), which value must she use?

- A. 4.5×10^0 A
- B. 4.5×10^{-1} A
- C. 4.5×10^2 A
- D. 4.5×10^{-3} A

8. Which of the following derived units can be fully expressed using only the SI base units: kg, m, and s?

- A. Newton
- B. Volt
- C. Tesla
- D. Ohm

9. When reporting a measurement of 0.004050 meters, how many significant figures are present, and what is the uncertainty of the measurement assuming it is ± 1 in the last digit?

- A. 3 sig figs; ± 0.001
- B. 4 sig figs; ± 0.000001
- C. 4 sig figs; ± 0.00001
- D. 6 sig figs; ± 0.000001

10. A measurement can be highly accurate even if it has very low precision.

- A. True
- B. False