

Name: _____ Date: _____

Feeling the Pressure? Conquer High-Stakes Physics Measurement (Grade 12)

Analyze dimensional consistency and error propagation in complex systems like relativistic momentum and thermodynamic gradients.

1. In a spectroscopic analysis, a researcher measures a wavelength of 589.3 nm. If the theoretical value is 589.0 nm and the instrument has a precision of ± 0.05 nm, how should the discrepancy be categorized?

- A. High precision, low accuracy due to systematic error
- B. Low precision, high accuracy due to human error
- C. High precision, high accuracy within tolerance
- D. Low precision, low accuracy due to random error

2. To ensure dimensional consistency in the equation for the Stefan-Boltzmann law ($P = \sigma AT^4$), the units for the Stefan-Boltzmann constant (σ) must be _____.

- A. $W \cdot m^2 \cdot K^{-4}$
- B. $W \cdot m^{-2} \cdot K^{-4}$
- C. $J \cdot s^{-1} \cdot m^2 \cdot K^4$
- D. $kg \cdot s^{-3} \cdot K^{-4}$

3. The 'candela' is an SI base unit defined by the luminous efficacy of monochromatic radiation of frequency 540×10^{12} hertz.

- A. True
- B. False

4. When calculating the density of a perfectly spherical planetoid where the radius has an uncertainty of 2% and the mass has an uncertainty of 1%, what is the resulting uncertainty in density?

- A. 3%
- B. 5%
- C. 7%
- D. 9%

5. In the context of the redefinition of SI units in 2019, the kilogram is now defined based on a fixed numerical value of the _____ constant.

- A. Avogadro
- B. Boltzmann
- C. Planck
- D. Gravitational

6. A measurement of 0.004050 meters possesses six significant figures.

- A. True
- B. False

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7. Which of the following derived units can be expressed in SI base units as $\text{kg}\cdot\text{m}^2\cdot\text{s}^{-3}\cdot\text{A}^{-2}$?

- A. Ohm (Ω)
- B. Tesla (T)
- C. Henry (H)
- D. Farad (F)

8. An experimenter using a Michelson interferometer observes a fringe shift corresponding to a distance of 150 'micro-inches'. To convert this to SI meters using scientific notation, the value is _____.

- A. 3.81×10^{-4} m
- B. 3.81×10^{-6} m
- C. 1.50×10^{-6} m
- D. 3.81×10^{-8} m

9. In fluid dynamics, the Reynolds number (Re) is calculated as $(\rho v d)/\mu$. Given that it is a dimensionless quantity, what does this imply about the units of the variables?

- A. The units of density and viscosity must cancel the units of velocity
- B. The units are irrelevant for dimensionless ratios
- C. The product of all units in the expression must simplify to 1
- D. The variable μ must have units of kg/m

10. Gaussian error distribution (the 'Bell Curve') assumes that measurements are equally likely to be slightly higher or slightly lower than the true value.

- A. True
- B. False