Name: _____ **Date:** _____

Answer Key: The Metric Sabotage: A 10th Grade Measurement Mission

Calculate derived units and evaluate dimensional consistency to repair a simulated laboratory's data stream before the experiment fails.

---

1. A theoretical propulsion system is measured to produce 450 Newtons of force. Which of the following represents the correct decomposition of this derived SI unit into its fundamental base units?

Answer: C) kgåm/s²

Force is defined by Newton's Second Law (F=ma). Mass is measured in kilograms (kg) and acceleration in meters per second squared (m/s²), making the Newton kgåm/s².

2. In a high-precision vacuum experiment, a measurement of 0.0004050 moles of a noble gas contains exactly four significant figures.

Answer: A) True

Leading zeros are never significant, but captive zeros and trailing zeros after a decimal point are significant. Therefore, 4, 0, 5, and 0 are all significant.

3. An astrophysicist calculates the energy of a photon to be 3.2 x 10^-19 Joules. If this value must be expressed in terms of the Planck constant (h) and frequency (f) where E=hf, what are the derived units of the Planck constant?

Answer: B) kgåm²/s

Since E (Joules) is kgåm²/s² and frequency is 1/s, dividing Energy by frequency results in kgåm²/s (or Joule-seconds).

4. A surveyor measures a tectonic shift as 14.50 mm/year. If this must be converted to the SI base unit for velocity for a global geophysical model, what is the value in m/s?

Answer: A) 4.59 x 10^-10 m/s

Convert mm to m (divide by 1000) and years to seconds (365.25 * 24 * 3600). 0.0145 / 31,557,600 ≈ 4.59 x 10^-10 m/s.

5. You are calibrating a laser with a wavelength of 632.8 nanometers. In scientific notation, how many meters does this represent?

Answer: A) 6.328 x 10^-7 m

Name: _____ **Date:** _____

Nano denotes 10^-9. 632.8 x 10^-9 m is mathematically equivalent to 6.328 x 10^-7 m in standard scientific notation.

6. A digital balance indicates a mass of 5.00g for a 5g calibration weight five times in a row. This instrument can be described as both precise and accurate.

Answer: A) True

It is accurate because it hits the target value (5g) and precise because the results are consistent across multiple trials.

7. Which of these expressions is dimensionally inconsistent (incorrect) regarding the relationship between displacement (d), velocity (v), acceleration (a), and time (t)?

Answer: D) $v = at^2$

Velocity has units of m/s. Acceleration times time squared (at^2) results in (m/s^2) * s^2 = meters. Therefore, $v = at^2$ is dimensionally inconsistent.

8. A resistor has a conductance of 0.025 Siemens (S). Siemens is the SI unit for the reciprocal of electrical resistance (1/Ω). If resistance is measured in Ohms, defined as kgÅ²åsÅ³Å⁻², what is the base unit representation of the Siemen?

Answer: A) $kg^{-1}Å^{-2}åsÅ^2$

Conductance is the reciprocal of resistance. Taking the reciprocal of the Ohm's base units flips the signs of all the exponents.

9. The Candela (cd) is a unique SI base unit because it is the only one based on human perception (luminous efficacy) rather than a purely physical constant of the universe.

Answer: A) True

The candela measures perceived brightness by the human eye, incorporating a weighting function based on visual sensitivity to different wavelengths.

10. A volumetric analysis requires 0.50 Liters of a solution. How many cubic centimeters (cm^3) does this equate to, and why is this relevant in laboratory measurements?

Answer: C) 500 cm^3; because 1 mL is equivalent to 1 cm^3.

1 Liter equals 1000 mL, and since 1 mL = 1 cm^3, 0.50 Liters is exactly 500 cm^3.