

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Your Mission to Mars: A Junior Chemist's Mastery of Molar Ratios

Students synthesize complex stoichiometric data and analyze limiting reactants to fuel a simulated deep-space expedition using gravimetric and volumetric analysis.

---

**1. An aerospace engineer uses the combustion of hydrazine ( $\text{N}_2\text{H}_4 + \text{O}_2 \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$ ) to power a thruster. If 80.0 grams of hydrazine reacts with 128.0 grams of oxygen gas, which reagent is strictly responsible for halting the reaction?**

- A. Oxygen ( $\text{O}_2$ )
- B. Hydrazine ( $\text{N}_2\text{H}_4$ )
- C. Nitrogen ( $\text{N}_2$ )
- D. Both are consumed simultaneously

**2. To synthesize aspirin ( $\text{C}_9\text{H}_8\text{O}_4$ ), a chemist reacts 2.00 moles of salicylic acid with excess acetic anhydride. If the actual yield collected is 324.0 grams, the percentage yield of the reaction is \_\_\_\_\_ %.**

- A. 80%
- B. 100%
- C. 90%
- D. 75%

**3. In a closed system, the total mass of the reactants must always equal the total mass of the products, regardless of whether the reaction goes to 100% completion or which reactant is limiting.**

- A. True
- B. False

**4. When analyzing a hydrate of copper(II) sulfate ( $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$ ), a student heats 5.00g of the sample until only 3.20g of anhydrous salt remains. What is the value of 'x' in the chemical formula?**

- A. 2
- B. 3
- C. 5
- D. 7

**5. A balloon contains 48.0 grams of Ozone ( $\text{O}_3$ ) gas. The total number of oxygen ATOMS present in this balloon is \_\_\_\_\_ times Avogadro's number.**

- A. 1.0
- B. 6.0
- C. 3.0
- D. 1.5

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**6. Consider the Ostwald process:  $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$ . If you aim to produce 120 grams of NO, how many moles of  $\text{NH}_3$  must be consumed, assuming 100% efficiency?**

- A. 2.0 moles
- B. 4.0 moles
- C. 8.0 moles
- D. 1.0 moles

**7. The empirical formula of a compound represents the actual number of atoms of each element in a molecule, while the molecular formula refers to the simplest whole-number ratio.**

- A. True
- B. False

**8. A sample of a hydrocarbon is 80% Carbon and 20% Hydrogen by mass. If its molar mass is 30.07 g/mol, which of the following is its molecular formula?**

- A.  $\text{CH}_4$
- B.  $\text{C}_2\text{H}_6$
- C.  $\text{C}_3\text{H}_8$
- D.  $\text{C}_2\text{H}_4$

**9. In the precipitation reaction  $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$ , if 0.50 moles of  $\text{AgNO}_3$  react with 0.50 moles of  $\text{NaCl}$ , the mass of  $\text{AgCl}$  (molar mass  $\sim 143.3$  g/mol) produced is \_\_\_\_\_ grams.**

- A. 143.3
- B. 71.65
- C. 35.82
- D. 286.6

**10. The molar volume of any ideal gas at Standard Temperature and Pressure (STP) is 22.4 Liters per mole, which allows for direct stoichiometric conversions between gas volume and moles.**

- A. True
- B. False