

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

## Shatter the Limits of Stoichiometric Synthesis for Collegiate Chemists

Limiting reagents, theoretical yield, and percent atom economy — simulate high-stakes industrial chemical manufacturing across 10 rigorous scenario-based problems.

---

**1. A research team is synthesizing cisplatin  $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$  from  $\text{K}_2\text{PtCl}_4$  and  $\text{NH}_3$ . If the starting material contains 15.0 g of  $\text{K}_2\text{PtCl}_4$  (MW: 415.1 g/mol) and an excess of ammonia, but the process yields only 9.20 g of cisplatin (MW: 300.0 g/mol), what is the percent yield and the primary stoichiometric bottleneck?**

- A. 84.9% yield; Theoretical yield is 10.84 g
- B. 72.4% yield; Theoretical yield is 12.71 g
- C. 91.3% yield; Theoretical yield is 10.08 g
- D. 61.3% yield; Theoretical yield is 15.00 g

**2. In the combustion of a 1.500 g sample of an unknown hydrocarbon ( $\text{C}_x\text{H}_y$ ), 4.714 g of  $\text{CO}_2$  and 1.285 g of  $\text{H}_2\text{O}$  are produced. Determine the whole-number coefficient of 'x' in the empirical formula.**

- A. 3
- B. 4
- C. 2
- D. 1

**3. True or False: In a system where the reaction  $3\text{A} + 2\text{B} \rightarrow \text{C}$  occurs, if you start with equal masses of A and B, and the molar mass of A is exactly 1.5 times the molar mass of B, then B must be the limiting reactant.**

- A. True
- B. False

**4. A 2.50 g sample of a mixture containing  $\text{NaHCO}_3$  and  $\text{Na}_2\text{CO}_3$  was heated, yielding 0.310 g of  $\text{CO}_2$  according to the decomposition of  $\text{NaHCO}_3$  ( $2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$ ). What is the mass percentage of  $\text{NaHCO}_3$  in the original mixture?**

- A. 24.8%
- B. 47.3%
- C. 59.2%
- D. 36.6%

**5. Consider the reaction:  $\text{P}_4 + 6\text{Cl}_2 \rightarrow 4\text{PCl}_3$ . If 2.0 mol of Phosphorus reacts with 9.0 mol of Chlorine, how many moles of the excess reactant remain after the reaction reaches completion?**

- A. 0.50 mol
- B. 1.50 mol
- C. 0.25 mol
- D. 3.00 mol

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

**6. True or False: The concept of 'Atom Economy' in green chemistry is equivalent to 'Percent Yield' because both measure the efficiency of a chemical processes converting reactants to products.**

- A. True
- B. False

**7. A sample of an unknown metal oxide ( $M_2O_3$ ) with a mass of 1.52 g is reduced to 1.04 g of pure metal. Identify the metal M.**

- A. Iron (Fe)
- B. Aluminum (Al)
- C. Chromium (Cr)
- D. Gallium (Ga)

**8. Determine the molarity of a solution prepared by dissolving 25.0 g of  $BaCl_2$  (MW: 208.2 g/mol) into enough water to make 450 mL of solution. The value is \_\_\_\_ M.**

- A. 0.120
- B. 0.267
- C. 0.555
- D. 0.450

**9. True or False: In the combustion of any pure liquid alcohol ( $C_nH_{2n+1}OH$ ), the number of moles of water produced will always be greater than the number of moles of carbon dioxide produced.**

- A. True
- B. False

**10. What is the total number of ions present in 50.0 mL of a 0.150 M solution of Aluminum Sulfate  $[Al_2(SO_4)_3]$ ?**

- A.  $2.26 \times 10^{22}$
- B.  $4.52 \times 10^{21}$
- C.  $7.50 \times 10^{-3}$
- D.  $1.35 \times 10^{23}$