

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

## Answer Key: Stoichiometry Alchemy: 11th Grade Quantitative Mastery Quiz

Limiting reactants, percent yield, and gas volume conversions — transition from theoretical formulas to predicting industrial chemical outcomes with precision.

---

**1. In the synthesis of alum from scrap aluminum, how many moles of H<sub>2</sub> gas are produced for every 2 moles of Al consumed according to the balanced equation:  $2\text{Al} + 2\text{KOH} + 6\text{H}_2\text{O} \rightarrow 2\text{KAl}(\text{OH})_4 + 3\text{H}_2$ ?**

**Answer:** C) 3.0 moles

Based on the stoichiometric coefficients in the balanced equation, the molar ratio of Al to H<sub>2</sub> is 2:3. Therefore, 2 moles of Al will yield exactly 3 moles of H<sub>2</sub> gas.

**2. The limiting reactant in a chemical process is always the substance present with the smallest initial mass.**

**Answer:** B) False

The limiting reactant is determined by the molar ratio and the amount of moles available, not mass. A substance with less mass might have more moles if it has a significantly lower molar mass.

**3. If the decomposition of 100g of calcium carbonate (CaCO<sub>3</sub>, molar mass 100 g/mol) theoretically produces 44g of CO<sub>2</sub>, but a student captures only 33g in the lab, the percent yield is \_\_\_\_\_.**

**Answer:** B) 75%

Percent yield is calculated as (Actual Yield / Theoretical Yield) × 100. Here, (33g / 44g) × 100 = 75%.

**4. What is the total number of atoms present in a 0.25 mole sample of pure silver (Ag)?**

**Answer:** A)  $1.506 \times 10^{23}$  atoms

Using Avogadro's number: 0.25 moles ×  $6.022 \times 10^{23}$  atoms/mole =  $1.5055 \times 10^{23}$  atoms.

**5. In the combustion of propane (C<sub>3</sub>H<sub>8</sub> + 5O<sub>2</sub> → 3CO<sub>2</sub> + 4H<sub>2</sub>O), the volume of oxygen gas required to react with 2.0L of propane at STP is \_\_\_\_\_.**

**Answer:** C) 10.0 L

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

According to Gay-Lussac's Law of Combining Volumes, for gases at the same temperature and pressure, the volume ratio is the same as the mole ratio (1:5). Thus,  $2.0\text{L} \times 5 = 10.0\text{L}$ .

**6. A empirical formula always represents the actual number of atoms of each element in a molecule of a compound.**

**Answer:** B) False

The empirical formula is the simplest integer ratio. The 'molecular formula' represents the actual number of atoms; for example, the empirical formula of benzene is CH, but its molecular formula is C<sub>6</sub>H<sub>6</sub>.

**7. If you are provided with 1 mole of Magnesium and 2 moles of Hydrochloric Acid (Mg + 2HCl → MgCl<sub>2</sub> + H<sub>2</sub>), which reagent is in excess if you add an additional 0.5 moles of Magnesium?**

**Answer:** B) Magnesium

The stoichiometry is 1:2. 1 mole of Mg needs exactly 2 moles of HCl. Adding more Mg (0.5 moles) makes it the excess reagent because there is no additional HCl to react with it.

**8. The molar mass of hydrated copper(II) sulfate (CuSO<sub>4</sub>·5H<sub>2</sub>O) is approximately \_\_\_\_\_ g/mol. (Atomic weights: Cu=63.5, S=32, O=16, H=1)**

**Answer:** C) 249.5 g/mol

$\text{CuSO}_4 = 63.5 + 32 + (16 \times 4) = 159.5$ . Then add 5 water molecules:  $5 \times (1 \times 2 + 16) = 90$ . Total =  $159.5 + 90 = 249.5$  g/mol.

**9. How many moles of solute are contained in 500 mL of a 0.10 M solution of Silver Nitrate (AgNO<sub>3</sub>)?**

**Answer:** A) 0.05 moles

Molarity = moles / Liters. Therefore, moles = Molarity × Liters =  $0.10 \text{ M} \times 0.500 \text{ L} = 0.05$  moles.

**10. In the reaction  $2\text{NaN}_3 \rightarrow 2\text{Na} + 3\text{N}_2$ , used in car airbags, the production of 3 moles of Nitrogen gas requires the decomposition of 130 grams of Sodium Azide (NaN<sub>3</sub> = 65 g/mol).**

**Answer:** A) True

The molar ratio of NaN<sub>3</sub> to N<sub>2</sub> is 2:3. To get 3 moles of N<sub>2</sub>, you need 2 moles of NaN<sub>3</sub>.  $2 \text{ moles} \times 65 \text{ g/mol} = 130$  grams.