

12.2 CHEMICAL CALCULATIONS

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Section Review

Objectives

- Construct mole ratios from balanced chemical equations and apply these ratios in mole-mole stoichiometric calculations
- Calculate stoichiometric quantities from balanced chemical equations, using units of moles, mass, representative particles, and volumes of gases at STP

Key Equations

- mole-mole relationship used in every stoichiometric calculation:

$$aG \rightarrow bW$$

$$\frac{\text{(given quantity)}}{a \text{ mol } G} \times \frac{b \text{ mol } W}{1 \text{ mol } G} = \frac{x \text{ mol } W}{1 \text{ mol } G}$$

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

- Mole ratios from balanced equations may be used to solve problems with other units such as numbers of 1 and 2 of gases at STP. The 3 from the balanced equation are used to write conversion factors called 4. These conversion factors are used to calculate the numbers of moles of 5 from a given number of moles of 6. In mass-mass calculations, the molar mass is used to convert mass to 7.

atoms, moles, particles

- representative particles
- volumes
- coefficients
- mole ratios
- product
- reactant
- moles

product of switched is fine

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- AT 8. In mass-mass calculations, the molar mass is used to convert mass to moles.
- NT 9. The mole ratio 2 mol HF/1 mol SnF₂ can be used to determine the mass of SnF₂ produced according to the equation: $\text{Sn}(s) + 2\text{HF}(g) \rightarrow \text{SnF}_2(s) + \text{H}_2(g)$

should be switched

- AT 10. In a volume-volume problem, the 22.4 L/mol factors always cancel out.
- AT/ST 11. In stoichiometric problems, volume is expressed in terms of liters.
- NT 12. For a mass-mole problem, the first conversion from mass to moles is skipped.
- NT 13. For a mass-mass problem, the first conversion is from moles to mass.
- AT 14. Because mole ratios from balanced equations are exact numbers, they do not enter into the determination of significant figures.

It's mass to moles

Part C Matching

Match each conversion problem in Column A to the correct solution in Column B.

Column A

- C 15. moles O₂ → grams O₂
- b 16. liters SO₂ → grams SO₂ at STP
- d 17. molecules He → liters He(g) at STP
- e 18. grams Sn → molecules Sn
- a 19. molecules H₂O → grams H₂O

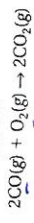
Column B

- a. molecules $\times \frac{6.02 \times 10^{23} \text{ molecules}}{\text{mol}} \times \frac{18.0 \text{ g}}{\text{mol}}$
- b. liters $\times \frac{\text{mol}}{22.4 \text{ L}} \times \frac{64.1 \text{ g}}{\text{mol}}$
- c. mol $\times \frac{32.0 \text{ g}}{\text{mol}}$
- d. molecules $\times \frac{\text{mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{22.4 \text{ L}}{\text{mol}}$
- e. grams $\times \frac{\text{mol}}{119 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{\text{mol}}$

Part D Questions and Problems

Answer the following questions in the space provided.

20. How many liters of carbon monoxide (at STP) are needed to react with 4.8 g of oxygen gas to produce carbon dioxide?



$$\frac{4.8 \text{ g O}_2}{1} \cdot \frac{1 \text{ mol O}_2}{32.00 \text{ g O}_2} \cdot \frac{2 \text{ mol CO}_2}{1 \text{ mol O}_2} \cdot \frac{22.4 \text{ L CO}_2}{1 \text{ mol CO}_2} = 6.7 \text{ L CO}$$

21. What mass of ammonia, NH₃, is necessary to react with 2.1 × 10²⁴ molecules of oxygen in the following reaction?



$$\frac{2.1 \times 10^{24} \text{ molecules O}_2}{1} \cdot \frac{1 \text{ mol O}_2}{6.02 \times 10^{23} \text{ molecules O}_2} \cdot \frac{4 \text{ mol NH}_3}{7 \text{ mol O}_2} \cdot \frac{17.04 \text{ g NH}_3}{1 \text{ mol NH}_3} = 33.966 \text{ g NH}_3$$