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Module 2: Introduction to Quantitative Chemistry — Topic 2.2: The Mole Concept

Development

1. Consider the following reaction:

$$2A + 3B \rightarrow 2C + 4D$$

How many moles of B is required to completely react with 2.50 moles of A?

(a) 2.50 mol
(b) 3.00 mol
(c) 3.75 mol
(d) 7.50 mol

2. For the same reaction in Question 1, if 5.00 moles of A is mixed with 6.00 moles of B, how many moles of C is produced?

(a) 4.00 mol
(b) 5.00 mol
(c) 6.00 mol
(d) 12.0 mol

3. Butanol burns in oxygen according to the following equation:

$$C_4H_9OH_{(l)} + 6\,O_{2(g)} \rightarrow 4\,CO_{2(g)} + 5\,H_2O_{(g)}$$

How many moles of carbon dioxide would form if exactly 12 moles of oxygen was consumed in this reaction?

(a) 2 mol
(b) 4 mol
(c) 8 mol
(d) 10 mol

4. Carbon monoxide can be oxidised according to the following equation:

$$2\,CO_{(g)} + O_{2(g)} \rightarrow 2\,CO_{2(g)}$$

How many moles of oxygen is required to combust 28 g of carbon monoxide?

(a) 0.40 mol
(b) 0.50 mol
(c) 0.60 mol
(d) 0.70 mol

5. Consider the following reaction:

$$2\,BiCl_{3(aq)} + 3\,H_2S_{(g)} \rightarrow Bi_2S_{3(s)} + 6\,HCl_{(aq)}$$

What volume of hydrogen sulfide gas at 25°C and 100 kPa is required to convert 0.600 moles of bismuth chloride into bismuth sulfide?

(a) 7.40 L
(b) 14.7 L
(c) 20.2 L
(d) 22.3 L

6. Aluminum can be extracted from aluminum oxide through the following electrolytic process:

$$2\,Al_2O_{3(s)} \rightarrow 4\,Al_{(s)} + 3\,O_{2(g)}$$

What mass of aluminum oxide needs to be electrolysed to produce 500.0 L of oxygen at 0°C and 100 kPa?

(a) 1020 g
(b) 1327 g
(c) 1497 g
(d) 2275 g

7. What volume of carbon dioxide gas is produced at 25°C and 100 kPa when 200.0 g of calcium carbonate is thermally decomposed?

(a) 22.20 L
(b) 24.50 L
(c) 44.42 L
(d) 49.54 L

8. What is the mass of calcium oxide produced when 25 g of calcium carbonate is thermally decomposed?

(a) 10 g
(b) 14 g
(c) 16 g
(d) 25 g

9. (a) Write a chemical equation for the reaction between magnesium and hydrochloric acid. **1**

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(b) Calculate the mass of hydrochloric acid that is required to completely dissolve 6.00 g of magnesium. **2**

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★ 18.0 g ★

10. (a) Write a chemical equation for the complete combustion of methane (CH_4) gas. **1**

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(b) Calculate the mass AND volume of oxygen gas at 0°C and 100 kPa required to completely combust 10.0 g of methane. **3**

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★ 39.9 g, 28.3 L ★

11. (a) Write a chemical equation for the reaction between aluminum and oxygen gas. **1**

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(b) Calculate the mass of the salt produced when 0.89 g of aluminum is reacted with excess oxygen gas. **2**

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★ 1.7 g ★

12. During a class demonstration, Mr Geerling mixed 1.50 g of sodium with excess sulfuric acid.

(a) Write a chemical equation for the reaction between sodium and sulfuric acid. **1**

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(b) Calculate the mass of the salt produced from this reaction. **2**

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(c) Calculate the volume of the gas produced from this reaction at 25°C and 100 kPa. **1**

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★ 4.63 g, 0.809 L ★

13. (a) Write a chemical equation for the reaction between nitric acid and barium hydroxide. **1**

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(b) Calculate the mass of the salt produced when 1.60 g of nitric acid is mixed with excess barium hydroxide. **2**

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★ 3.32 g ★

14. Calcium hypochlorite ($Ca(OCl)_2$) is often used to disinfect swimming pools. It can be prepared from calcium carbonate with the following series of reactions: **3**

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$$
$$CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)}$$
$$2\,Ca(OH)_{2(aq)} + 2\,Cl_{2(g)} \rightarrow Ca(OCl)_{2(aq)} + CaCl_{2(aq)} + 2\,H_2O_{(l)}$$

Calculate the mass of calcium hypochlorite that can be produced from 2.50 kg of calcium carbonate.

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★ 1790 g ★

15. (a) Write a chemical equation for the reaction between zinc and sulfuric acid. **1**

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(b) Calculate the volume of the gas produced at 25°C and 100 kPa when 1.50 g of zinc is reacted with 1.70 g of sulfuric acid. **3**

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★ 0.430 L ★

16. (a) Write a chemical equation for the reaction between potassium and oxygen. **1**

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(b) Calculate the mass of the salt produced when 5.00 g of potassium is reacted with 0.70 L of oxygen gas at 0°C and 100 kPa. **3**

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★ 5.8 g ★

17. Sodium carbonate can be used to neutralise acid spills. In a particular incident, a university student added 9.00 g of solid sodium carbonate to a spill containing 8.50 g of hydrochloric acid.

(a) Write a chemical equation for the reaction that occurs. **1**

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(b) Calculate the mass of the salt produced from this reaction. **3**

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(c) Calculate the volume of the gas produced from this reaction at 25°C and 100 kPa. **1**

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(d) Calculate the mass of the leftover reactant at the end of the reaction. **1**

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★ 9.92 g, 2.11 L, 2.31 g ★