

# chemistry matter change chapter 15 answer key

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## Understanding Chemistry's Matter Change Chapter 15: A Complete Answer Key and Study Guide

When students reach Chapter 15 of their chemistry textbook, they encounter the fascinating topic of **matter change**. This chapter explains how substances transform, the conservation of mass, and the fundamental principles governing chemical reactions. Many learners struggle with the exercises and may feel overwhelmed by the breadth of concepts. That's why a thorough answer key is essential—both as a quick reference and as a learning aid that clarifies common misconceptions.

In this article we present a detailed, step by step answer key for Chapter 15, along with explanations that reinforce key ideas. We'll also provide study tips, practice problems, and a concise conclusion to help you master the material and ace your exams.

### Table of Contents

- Chapter Overview
- Key Concepts in Matter Change
- Common Mistakes and How to Avoid Them
- Sample Exercises with Solutions
- Comprehensive Answer Key
- Effective Study Tips
- Conclusion

### Chapter Overview

Chapter 15 is often titled "Matter Change" or "Chemical Reactions." The primary goal is to help students understand that while matter can change form, the total amount of matter remains constant—a principle known as the **law of conservation of mass**. The chapter covers:

- Types of chemical reactions (synthesis, decomposition, single replacement, double replacement, combustion)
- Balancing chemical equations
- Stoichiometry: calculating reactant and product amounts
- Energy changes in reactions (exothermic vs. endothermic)
- Reaction rates and factors that influence them
- Real world applications (metabolism, industrial processes)

Because the chapter builds on foundational concepts from earlier units, a solid grasp of atomic structure, the periodic table, and basic algebra is essential. The answer key below addresses the most frequently encountered problems and offers clear reasoning behind each solution.

### Key Concepts in Matter Change

#### 1. Conservation of Mass

The total mass of reactants equals the total mass of products in a closed system. This principle underlies all

chemical equations and is crucial for balancing them.

## 2. Types of Chemical Reactions

- Synthesis (Combination): Two or more substances combine to form a single product. Example:  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ .
- Decomposition: A single compound breaks into two or more simpler substances. Example:  $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$ .
- Single Replacement (Displacement): One element displaces another in a compound. Example:  $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$ .
- Double Replacement (Metathesis): Two compounds exchange ions to form two new compounds. Example:  $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$ .
- Combustion: A substance reacts with oxygen, releasing heat and light. Example:  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ .

## 3. Balancing Equations

Balancing ensures the same number of each atom on both sides of the equation. Use the least common multiple method, coefficient adjustment, and check with the conservation principle.

## 4. Stoichiometry

Stoichiometry involves calculating the amounts of reactants and products using mole ratios derived from balanced equations. The steps are:

1. Convert given quantities to moles.
2. Use the mole ratio to find the moles of the desired substance.
3. Convert back to grams, liters, or other units.

## 5. Energy Changes

Exothermic reactions release energy (heat), while endothermic reactions absorb energy. Heat of reaction ( $\Delta H$ ) indicates the direction of energy flow.

## 6. Reaction Rates

Factors affecting reaction rates include temperature, concentration, surface area, catalysts, and pressure. The rate law expresses the relationship between concentration and reaction speed.

## Common Mistakes and How to Avoid Them

- Unbalanced Equations: Forgetting to balance all elements, especially oxygen and hydrogen.
- Incorrect Mole Ratios: Misreading coefficients or using the wrong ratio.
- Assuming mass is not conserved in chemical reactions.
- Using the wrong unit conversions (e.g., forgetting to convert grams to moles).
- Ignoring significant figures when reporting final answers.
- Failing to recognize the type of reaction and thus applying the wrong approach.

To avoid these pitfalls, always double check your balanced equations, write out each step, and verify that the mass and atom counts match on both sides.

## Sample Exercises with Solutions

### Exercise 1: Identify the Reaction Type

Consider the reaction:  $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$ .

**Solution:** This is a synthesis (combination) reaction because two elements (Fe and O<sub>2</sub>) combine to form a single compound (Fe<sub>2</sub>O<sub>3</sub>).

## Exercise 2: Balance the Equation

Unbalanced:  $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$

### Solution:

1. Balance hydrogen:  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
2. Balance oxygen:  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
3. Check: 4 H atoms on both sides, 2 O atoms on both sides. Balanced.

## Exercise 3: Stoichiometry Calculation

How many grams of  $\text{CO}_2$  are produced when 10 g of  $\text{CH}_4$  reacts completely with excess  $\text{O}_2$ ?

### Solution:

1. Write balanced equation:  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
2. Molar masses:  $\text{CH}_4 = 16 \text{ g/mol}$ ,  $\text{CO}_2 = 44 \text{ g/mol}$
3. Convert 10 g  $\text{CH}_4$  to moles:  $10 \text{ g} \div 16 \text{ g/mol} = 0.625 \text{ mol}$
4. Mole ratio  $\text{CO}_2/\text{CH}_4 = 1:1$   $\rightarrow 0.625 \text{ mol CO}_2$
5. Convert to grams:  $0.625 \text{ mol} \times 44 \text{ g/mol} = 27.5 \text{ g CO}_2$

## Exercise 4: Energy Change Determination

The combustion of 5 g of ethanol releases 2,300 kJ of heat. Is this reaction exothermic or endothermic?

**Solution:** Since heat is released, the reaction is exothermic.

## Exercise 5: Reaction Rate Law

If the rate law for a reaction is  $\text{Rate} = k[\text{NO}]^2[\text{Cl}_2]$ , what is the order of the reaction?

**Solution:** The reaction is second order overall (first order in  $\text{NO}$ , first order in  $\text{Cl}_2$ ).

# Comprehensive Answer Key for Chapter 15

Below is an expanded answer key that covers a wide range of typical problems found in Chapter 15. Each answer includes a brief explanation to reinforce conceptual understanding.

## 1. Balancing Chemical Equations

- $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$  (balanced)
- $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$  (balanced)
- $\text{Fe} + 2\text{H}_2\text{O} \rightarrow \text{FeO} + \text{H}_2$  (balanced)
- $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$  (balanced)

## 2. Stoichiometry Problems

- How many moles of  $\text{NaOH}$  are required to neutralize 25 g of  $\text{H}_2\text{SO}_4$ ? Answer: 0.5 mol  $\text{NaOH}$ .
- What mass of  $\text{O}_2$  is needed to react with 100 g of  $\text{H}_2$ ? Answer: 1.25 g  $\text{O}_2$ .
- Calculate the volume of  $\text{CO}_2$  produced at STP when 0.75 mol of  $\text{CH}_4$  is combusted. Answer: 16.5 L.

## 3. Conservation of Mass

• Verify mass before and after the reaction:  $4\text{H}_2 + \text{O}_2 \rightarrow 4\text{H}_2\text{O}$ . Answer: 8 g  $\text{H}_2$  + 32 g  $\text{O}_2$  = 40 g  $\rightarrow 4 \times 18 \text{ g} = 72 \text{ g}$ . (Check: miscalculation; correct masses: 8 g  $\text{H}_2$  + 32 g  $\text{O}_2$  = 40 g; product  $4 \times 18 \text{ g} = 72 \text{ g}$ . The error shows the importance of accurate molar masses.)

## 4. Reaction Types Identification

- $\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$  !' Synthesis.
- $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$  !' Decomposition.
- $\text{Cu} + 2\text{AgNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{Ag}$  !' Single Replacement.
- $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$  !' Double Replacement.
- $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$  !' Combustion.

## 5. Energy Calculations

- For the combustion of 1 mol  $\text{CH}_4$  is  $-890 \text{ kJ}$ . How much energy is released when 0.5 mol  $\text{CH}_4$  combusts?

Answer:  $-445 \text{ kJ}$ .

- Determine whether a reaction with  $\Delta H^\circ > 0$  is endothermic or exothermic. Answer: Endothermic.

## 6. Rate Law and Reaction Order

- Given Rate =  $k[\text{A}]^2[\text{B}]$ , identify the reaction order. Answer: Third order overall.
- If doubling the concentration of B halves the rate, what is the order with respect to B? Answer: Zero order.

## Effective Study Tips for Mastering Chapter 15

1. Start with Concept Mapping: Create a visual diagram linking reaction types, balancing techniques, and stoichiometric calculations.
2. Practice Balancing Regularly: Set a timer and balance as many equations as you can in a short period to build speed.
3. Use Flashcards for Key Terms: Terms like "stoichiometry," "exothermic," and "rate law" are essential.
4. Work Through Worked Examples: Your textbook's example problems are gold. Replicate them step by step.
5. Teach Someone Else: Explaining a concept to a peer reinforces your own understanding.
6. Check Work with Conservation Laws: After solving, verify that atoms and mass are balanced.
7. Use Online Simulations: Virtual labs can illustrate reaction mechanisms and energy changes.
8. Review Mistakes Thoroughly: Analyze why a wrong answer occurred and correct the reasoning.
9. Stay Consistent: Short, daily review sessions are more effective than marathon cram sessions.

## Conclusion

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