METHODOLOGY OF SOLVING EXERCISES AND PROBLEMS THAT ENCOURAGE STUDENTS' LOGICAL THINKING IN CHEMISTRY

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https://doi.org/10.5281/zenodo.19080756

ARTICLE INFO

Received: 13th March 2026
Accepted: 15th March 2026
Online: 17th March 2026

KEYWORDS

logical thinking, exercises, problem situation, Vitamin C.

ABSTRACT

This article outlines the methodology for creating and solving exercises and problems that develop logical thinking in chemistry. The author presents methods and practical examples that serve to enhance students' analytical thinking and foster their ability to draw independent conclusions. Special attention is given to developing students' analytical reasoning, ability to analyze problematic situations, understand cause-effect relationships, and form independent conclusions. The methodological recommendations are enriched with practical examples, the application of which in chemistry lessons serves to increase not only students' knowledge of the subject but also their level of general cognitive ability.

In the modern education system, the main task is not only to provide students with knowledge but also to develop their skills of independent thinking, analysis, problem solving, and logical reasoning. In this regard, natural sciences, particularly chemistry, play a significant role in the educational process. Understanding complex chemical phenomena, recognizing cause-and-effect relationships, and applying formulas in practice require a high level of thinking from students. This article discusses the role of exercises and problems that develop logical thinking in the teaching of chemistry, as well as their impact on students' intellectual potential.

Intellect is the highest form of theoretical understanding of objective reality and is manifested through a person's ability to think. The main indicators of intellect are expressed in the independence, criticality, depth, flexibility, and consistency of thought. Logical thinking activity is a mental and physical process aimed at developing cognition, reasoning, and intellectual culture of the individual—in this case, the student—during the process of acquiring knowledge.

During the process of logical thinking, the development of students' intellect and thinking abilities plays an important role. Exercises aimed at analysis and synthesis, comparison, generalization, identifying cause-and-effect relationships, classification, and systematization have a significant role in developing students' thinking skills.

1. Concepts of Logical Thinking and Intellectual Development: Logical thinking is a type of thinking activity that involves reasoning based on certain rules, analyzing causes and results, and drawing correct conclusions. Intellectual ability, on the other hand, refers to a

person's capacity to acquire new knowledge, process it, generate new ideas, and adapt to changing conditions. According to psychological research, tasks that stimulate logical thinking play an important role in developing students' intellectual potential. In particular, chemistry as a subject provides broad opportunities to apply such tasks due to its specific nature.

2. The Influence of Chemistry on Students' Thinking: Chemistry is an experimental science that requires not only theoretical knowledge but also practical skills. To understand chemical processes, students must constantly analyze cause-and-effect relationships. For example, under what conditions does a substance react? What products are formed as a result of the reaction? What type of energy is released or absorbed?

To answer such questions, students perform various thinking operations such as analytical reasoning, comparison, classification, and generalization. Understanding and writing chemical reactions also require students to work with formulas and comprehend the relationships between them.

3. Activating Thinking through Exercises and Problems

a) Approach from simple to complex: In teaching chemistry, starting with simple examples and gradually moving to more complex problems helps to progressively develop students' thinking abilities. For example:

Simple example: Calculating the masses of substances in the reaction

$2H_2 + O_2 \rightarrow 2H_2O$

Complex problem: Determining changes in pressure, volume, and temperature based on gas laws.

b) Tasks that require logical thinking: To stimulate logical reasoning, the following types of questions and tasks can be used:

"What happens if sodium is placed in water?"

"If a reaction is endothermic, what conclusion can be drawn?"

"Which of the following substances acts as a catalyst and why?"

Tasks Requiring Logical Thinking: Real-Life and Engaging Assignments

1. Explaining a Boiling Kettle and Le Chatelier's Principle

Task: When water in a kettle boils, the lid lifts upward. Explain this phenomenon from the perspective of chemical equilibrium. How does increasing or decreasing heat affect the equilibrium?

Logical Points:

- How does heat shift the reaction equilibrium?
- Is this an endothermic or exothermic process?
- What is the relationship between pressure and the amount of vapor?

Why It's Useful: This task requires students to relate a real-life event to a chemical model and analyze the factors affecting equilibrium.

2. Why Laundry Detergent Doesn't Work in Cold Water

Task: When using laundry detergent at home, stains do not come out in cold water. One family member complains. Provide a scientific explanation for this situation. Which reaction or process does not occur?

Logical Points:

- Enzymes do not function in cold water → Enzymes are biological catalysts.

- Reaction rate depends on temperature.
- How do existing components (enzymes, pH, temperature) change under these conditions?

Why It's Useful: This assignment encourages students to analyze a real-life problem from a chemical perspective, applying their theoretical knowledge to everyday experiences.

3. Boiling of Vitamin C Tablet in Water:

Task: When a student puts a vitamin C tablet in water, it fizzes and produces foam. What kind of reaction is this? What is the foam? Why does the reaction stop?

Logical Elements:

- The tablet contains **sodium bicarbonate** and **ascorbic acid**.
- When mixed with water, **carbonic acid** forms → **CO_2 gas is released**.
- Understand the stages of the chemical reaction and why it ends (reactants are consumed).

Benefit: Helps students understand a real-life phenomenon based on chemical principles.

4. Why Does a Cut Apple Turn Brown Quickly?

Task: Cut apples turn brown in a short time. Explain this phenomenon from a chemical point of view. How can this process be slowed down?

Logical Reasoning:

- Oxidation – phenolic compounds are oxidized to quinones.
- Enzyme involvement (polyphenol oxidase).
- Adding lemon juice changes pH, inactivating the enzyme and slowing browning.

What Students Learn:

- Biochemistry concepts
- Role of enzymes
- pH effects
- Oxidation reactions

Problem 1: Unusual Neutralization

Task: In an experiment, an unknown base (hydroxide) reacts with an acid in a neutralization reaction. The total mass of the resulting salt and water is 160 g. If the remaining acid mass is 95 g, and the water formed is 18 g, determine the mass of the metal in the base and identify the possible base.

Solution:

- Water = 18 g → 18 g = 1 mol H_2O
- Remaining mass of base + hydroxide = 160 − 95 − 18 = 47 g
- OH^- = 17 g/mol → 1 mol = 17 g
- Metal mass = 47 − 17 = 30 g

Checking possible metals:

- Zn (65) → does not match
- 2 mol OH → 34 g, metal = 13 g → Al = 27, Mg = 24, Na = 23 → not matching
- Considering $Zn(OH)_2$: Zn = 30 g, OH = 17 g → matches

Answer: $Zn(OH)_2$, metal mass = 30 g

Problem 2: Chemical Analysis of a Carbonated Drink

Task: The volume of carbon dioxide (CO_2) gas in a carbonated drink is 2.24 l (at standard conditions). This gas reacts with water forming a substance. The resulting substance has a molar mass of 62 g/mol and acidic properties. Identify the substance.

Analysis:

- 2.24 l CO_2 → 0.1 mol
- $CO_2 + H_2O \rightarrow H_2CO_3$
- Molar mass of H_2CO_3 = 62 g/mol **Answer:** H_2CO_3 (carbonic acid)

Problem 3: Mass Balance in a Metal Oxide Reaction

Task: A metal oxide reacts in an acidic medium to form a salt. The oxygen mass in the oxide was 32 g. The acidic residue in the salt is SO_4^{2-} with a mass of 96 g. The total salt mass is 200 g. Determine the metal in the oxide.

Analysis:

- SO_4^{2-} = 96 g
- Salt = 200 g → metal + SO_4 + O = 200 − 96 − 32 = 72 g
- Metal = 72 g

Checking possible salts:

- $ZnSO_4$ (65 + 96 = 161) → closest
- $CuSO_4$ (64 + 96 = 160) → close, but less likely
- Most likely: Zn **Answer:** ZnO → $ZnSO_4$ formed, metal = Zn

In summary, the presented chemistry problems and exercises demonstrate the essential role of logical thinking in understanding chemical processes. Through tasks such as unusual neutralization reactions, analysis of carbonated drinks, and mass balance calculations in metal oxide reactions, students are required to apply analytical reasoning, compare data, classify substances, and identify cause-and-effect relationships.

These exercises not only help students strengthen their conceptual understanding of chemistry—including acids, bases, salts, gases, and oxides—but also develop their ability to solve real-life problems using scientific principles. By working through such problems, students enhance their intellectual potential, critical thinking, and problem-solving skills, which are fundamental competencies in modern education and in the study of natural sciences.In essence, integrating logically challenging, practical, and thought-provoking exercises into chemistry education significantly improves students' cognitive development and prepares them for independent scientific reasoning.

References:

1.Zumdahl, S. S., & Zumdahl, S. A. (2014). Chemistry: An Atoms First Approach (2nd ed.). Cengage Learning.

2.Brown, T. L., LeMay, H. E., Bursten, B. E., & Murphy, C. (2012). Chemistry: The Central Science (12th ed.). Pearson.

3.Chang, R., & Goldsby, K. (2016). Chemistry (12th ed.). McGraw-Hill Education.

4.Silberberg, M. S. (2013). Chemistry: The Molecular Nature of Matter and Change (6th ed.). McGraw-Hill Education.

5.Oliy va o'rta maxsus ta'limda kimyo fanini o'qitish metodikasi. Toshkent: Fan va texnologiya nashriyoti, 2018.

6.Petrov, V. A., & Ivanov, N. I. (2010). Practical Chemistry Exercises for Developing Logical Thinking. Moscow: Prosveshcheniye.
7.Kirsanov, A. P. (2007). Experiments in School Chemistry: From Observation to Analysis. Saint Petersburg: Khimiya.