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# System Of Tasks Aimed At Forming Skills Of Establishing Cause-And-Effect Relationships In Solving Problems In The Field Of Chemistry Education

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**Abstract:** This article examines the issues of identifying cause-and-effect relationships among students in the process of teaching chemistry, developing logical thinking, and gradually forming a system of chemical concepts. The author analyzes the role of integrative and interdisciplinary approaches in chemistry education, as well as the possibilities of shaping students' scientific worldview through the topic "Theory of Solutions." The significance of using inductive and deductive approaches in studying solutions, establishing cause-and-effect relationships between concepts, and revealing the essence of chemical processes is demonstrated.

**Keywords:** chemistry education, cause-and-effect relationships, theory of solutions, integrative approach, inductive and deductive thinking, methodological foundations, principle of scientific rigor, cognitive development.

# Kimyo Ta'limi Sohasidagi Muammolarini Yechishda Sabab-Oqibat Munosabatlarini O'rnatish Ko'nikmasini Shakllantirishga Yo'naltirilgan Vazifalar Tizimi

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**Annotatsiya:** Mazkur maqolada kimyo ta'limi jarayonida o'quvchilarda sabab-oqibat munosabatlarini aniqlash, mantiqiy fikrlashni rivojlantirish va kimyoviy tushunchalar tizimini bosqichma-bosqich shakllantirish masalalari yoritilgan. Muallif kimyo fanini o'qitishda integral va fanlararo yondashuvning o'rni hamda "Eritmalar nazariyasi" mavzusi orqali o'quvchilarda ilmiy dunyoqarashni shakllantirish imkoniyatlarini tahlil qiladi. Eritmalar mavzusida induktiv va deduktiv yondashuvlardan foydalanish, tushunchalar orasidagi sabab-oqibat bog'lanishlarini o'rnatish, kimyoviy jarayonlarning mohiyatini tushuntirishga xizmat qiluvchi metodologik asoslar ko'rsatib o'tiladi.

**Kalit so'zlar:** kimyo ta'limi, sabab-oqibat munosabatlari, eritmalar nazariyasi, integrativ yondashuv, induktiv va deduktiv fikrlash, metodologik asoslar, ilmiylik tamoyili, kognitiv rivojlanish.

# Система Заданий, Направленных На Формирование Навыков Установления Причинно-Следственных Связей При Решении Проблем В Области Химического Образования

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**Аннотация: в** данной статье рассматриваются вопросы выявления причинно-следственных связей у обучающихся в процессе преподавания химии, развития логического мышления и поэтапного формирования системы химических понятий. Автор анализирует роль интегрального и междисциплинарного подходов в обучении химии, а также возможности формирования научного мировоззрения учащихся на примере темы «Теория растворов». Показано значение использования индуктивного и дедуктивного подходов при изучении темы растворов, установления причинно-следственных связей между понятиями и раскрытия сущности химических процессов.

**Ключевые слова:** химическое образование, причинно-следственные связи, теория растворов, интегративный подход, индуктивное и дедуктивное мышление, методологические основы, принцип научности, когнитивное развитие.

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One of the main structural components of the methodological aspect in natural science education is the integrative approach, which is characterized by the connection of the studied object with nature. Its main task is to ensure the transition from associations focused on mastering the didactic elements of a lesson to a certain holistic complex system. This transition is carried out through intra-disciplinary and interdisciplinary integration, respectively, through intersubject connections [1]. The application of intra-disciplinary integration and the realization of cause-and-effect relationships can be analyzed in the school chemistry course through the study of the theory of solutions by defining the key concepts of the section. The theory of solutions is one of the fundamental doctrines of chemistry and is present not only in school chemistry curricula but also in the system of chemical disciplines in higher education. One of the important tasks of educational standards is to define the minimum requirements for the content of each educational topic. According to the chemistry curriculum, the study of such basic concepts as solutions, electrolytic dissociation, electrolytes and nonelectrolytes, and the conditions for reactions in solutions is mandatory.

In aqueous solutions, based on the theory of electrolytic dissociation, an integrative approach is applied to the topic of the main classes of inorganic substances in Grade 7 through the definition and differentiation of salts, acids, and bases. At the same time, experimental chemistry plays a special role in studying these topics, and practical lessons are given special attention in curricula and textbooks. In this section of chemistry, the main emphasis is placed on experiments based on reactions occurring in aqueous solutions. An analysis of chemistry curricula shows that, through the use of intertopic and interdisciplinary integration tools, the study of solution theory in higher education acquires additional content. According to the subject concept, the process of dissolution is explained not as a purely physical process, as emphasized in Grade 7, but as a physico-chemical process. This includes explaining the release or absorption of heat during dissolution without a change in the composition and formula of substances, factors affecting dissolution processes, the influence of temperature and pressure on solubility depending on the aggregate state of the solute, true and colloidal solutions, methods of expressing concentration, their interrelations, strong and weak electrolytes, the reaction medium of solutions, the hydrogen index (pH), and qualitative reactions [2].

One of the scientific and methodological features of the educational process, especially chemistry education, is related to the continuous formation and development of concepts and systems of concepts. As an example, one can consider the evolution of the concept of a "chemical element." Through the implementation of intertopic integration, this concept develops from "a certain type of atom" to "a type of atoms with the same nuclear charge." The concept of valency evolves from the definition "the ability of an atom of a given element to combine with a certain number of atoms of other elements" to "the ability of an atom of a given element to form a definite number of chemical bonds with other atoms." The first definition is temporary and serves to form an initial general understanding in the absence of sufficient concepts about chemical bonding (under conditions of a lack of deductive auxiliary concepts). After mastering concepts related to the structural organization of substances and chemical bonds, the first definition becomes insufficient and even reveals scientific inaccuracies (for example, the sulfur atom in sulfuric acid is bonded to four oxygen atoms; according to the first definition, it would appear tetravalent. However, it is bonded through six chemical bonds and therefore exhibits valency VI).

Chemistry is among the complex sciences, and its characteristics require not only the implementation of general didactic principles but also adherence to principles determined by the methodology of natural sciences. These include, first of all, the principles of scientific rigor, gradual complication, unity of logical and historical approaches, integrative teaching, environmental orientation, practice, and the use of experiments. The curriculum aligns the content of topics with a specific period of study. At the end of each instructional period, achieving and analyzing planned learning outcomes is envisaged. Typically, on the one hand, students master theoretical concepts and apply laws and theories through mathematical expressions; on the other hand, through structuring and reporting the processes carried out in practical lessons, functional chemical calculation literacy is formed.

The concept of "solutions" is introduced based on concepts such as complex substances, mixtures, and the properties of water. Solutions are homogeneous mixtures consisting of a solvent, dissolved substances, and the products of their interaction. The cause-and-effect relationships between the physical and chemical properties of solutions are clearly manifested in their scientific interpretation. A simple algorithm is developed showing the dependence of the properties of true solutions, colloidal solutions, and coarse dispersions on the

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size of dissolved particles. Here, the concepts of "homogeneous system" and "uniform system" are explained. The difference between solutions and other mixtures is emphasized by the uniform distribution of component particles and the identical composition in any microvolume of such a mixture. Although interactions between water and solutes are physico-chemical processes, dissolution and solution preparation are often viewed from the perspective of physical phenomena, whereas dissociation and hydrolysis are approached from the standpoint of chemical processes. On this basis, the concepts of dissociation, ion-exchange reactions, and hydrolysis are placed in a separate section and studied with a distinct cognitive load.

The main concepts of the topic "Solutions" most fully embody the principles of scientific clarity and vertical intertopic integrative approaches. This topic provides opportunities to introduce concepts of "pure substances and mixtures," primarily enabling an understanding of water and types and properties of natural mixtures. Solutions are homogeneous systems consisting of several components, and the quantitative ratios of these components can vary widely. Expressing these quantitative ratios allows the introduction of static chemical calculations. Unlike dynamic chemical calculations, static calculations do not involve chemical processes or reactions. It should be emphasized that this definition once again highlights the essence of solutions as mixtures and emphasizes two important characteristics: variable composition and homogeneity. In addition, the concepts of "solute" and "solvent" are introduced. The specific properties exhibited by solutions allow them to occupy an intermediate position between mechanical mixtures and chemical compounds. Using general educational methods such as classification and comparison, similarities and distinctive features of solutions relative to the above objects can be identified.

As the chemistry course concept develops, the concept of "solubility" is introduced based on previously acquired concepts. In turn, this concept is used to assess the properties of various substances (slightly soluble, highly soluble) and to express specific physical indicators (solubility coefficient).

Various approaches can be found in the sequence of presenting concepts related to solutions. Each approach reflects the place of the topic within the studied section and presents the order of introducing and explaining concepts differently. Before revealing the basic concepts of the above theory, it is necessary to construct a logical chain that more or less characterizes the studied objects. Then it becomes possible to determine what cause-and-effect relationships arise and which didactic principles should be prioritized. Not only the sequence of topics within a section but also the order of presenting topics from other sections that have related components must be taken into account. In the sequence of topics, concepts from previous topics serve as deductive material for subsequent ones (known and explained causes are used to explain effects). Didactics employs two types of logical approaches: inductive and deductive. In the inductive approach, the structure, properties of substances, and characteristics of phenomena are directed from the particular to the general, whereas in the deductive approach, they are directed from the general to the particular.

Mixtures, being structurally heterogeneous or homogeneous, are linked to solutions as homogeneous systems. At the same time, the study of the properties of gaseous substances such as oxygen and hydrogen, and concepts such as gas density and relative density, helps in learning how to calculate the density of solutions ($d = m/V$). Information about the solubility of gases in water also helps integrate this topic with the topics of solutions and solubility. The topic of water serves to logically connect the topics of oxygen and hydrogen with solutions. The concepts of solvent and solute link the topics of solubility and methods of expressing solution composition. Previously learned concepts such as relative molecular mass, amount of substance, and mole help in performing static chemical calculations related to percentage and molar concentrations of solutions.

Solutions are homogeneous systems formed by two or more components and their interactions, whose composition can be continuously varied within certain limits. As homogeneous mixtures, the most important property of solutions is homogeneity, meaning that the number of particles of the distributed (dissolved) substance is the same at any point in the solution volume.

The solute is a component of the solution, and during the process of dispersion, its ability to reassemble is not lost. If both components in their pure form are in the same physical state, the solvent is the one present in a larger quantity. The solute is usually present in a smaller amount compared to the solvent. Dissociation is a physico-chemical process of solution formation, which ends with the uniform distribution of particles of one substance among the particles of another and is accompanied by changes in thermal effects and sometimes color. Solubility is the ability of a substance to form a homogeneous system in a given solvent. There are no absolutely insoluble substances. With increasing temperature, the solubility of most solid substances increases.

With increasing temperature, the solubility of gases decreases, but it increases with increasing pressure. A solution containing the maximum amount of solute under given conditions (temperature, pressure) is called saturated; one containing less than this amount is called unsaturated. The composition of a solution is determined not only by the number of components but also by their qualitative composition, which in practice provides convenience in measuring and calculating the ratios of components.

As a set of such ratios, the concept of solution concentration is introduced. In Grade 7, it is sufficient to form an understanding of the mass fraction of a solute in a solution (unfortunately, in the new Grade 7 textbooks, 2022 edition, the central connecting topic “Solutions” has been removed from the Grade 7 chemistry course concept, yet the word “solution” is used 87 times without providing a definition) [3]. It should be noted that the ratio of an elemental component of a system (chemical substance, gas, solute) is expressed relative to a nominal quantity, while in complex substances, mixtures, and solutions, it is expressed relative to the sum of all quantities forming the system. That is, the essence of a fraction shows the contribution of an elemental component to the entire system. If the quantity is mass, the indicator is mass fraction; if the amount of substance per unit volume is considered, it is molar concentration. The use of induction and deduction methods should demonstrate that the mass fraction of a solution is one example of applying the concept of “concentration” in chemistry. At the same time, school students gain an understanding of the mass fraction of an element in a complex substance, which facilitates mastering the concept of the volumetric fraction of a gas in a mixture, and through the concept of gas density, understanding information about solution density becomes easier.

At the initial stage of chemistry education, simple information is provided about the solubility of acids, bases, and salts in water based on certain properties. For example, bases are divided into water-insoluble bases and water-soluble bases, i.e., alkalis. Later, more refined and systematized information is provided through solubility tables of acids, bases, and salts, enabling an assessment of substance solubility. In practice, more precise criteria are used: if more than 10 g of a substance dissolves in 100 g of water, it is considered “soluble”; from 1 g to 10 g, “slightly soluble”; less than 0.001 g, “practically insoluble.” In later stages of chemistry education, the solubility coefficient of substances as a function of temperature is used. As the essence of causes is explained, effects are clarified more precisely, and the level of scientific rigor is progressively increased.

For each section of chemistry, the classification of concepts requires knowledge not only of the scientific foundations of the content but also of the main principles of an integrative approach to learning. In chemistry, many concepts undergo qualitative and quantitative changes. Establishing these changes and the causes of influencing relationships, and implementing connections as the main tool of interdisciplinary integration, requires logical deduction. Thus, conditions are created for the methodological aspect of teaching chemistry. At the level of general secondary education, according to the content of the chemistry curriculum and the scientific logic of material presentation, solutions should be studied as a special case of systems. The study of dispersed systems corresponds to Grade 11, where the foundations of general chemistry are taught [4]. At this stage, solutions are considered as part of dispersed systems. The system of concepts related to “solutions” undergoes significant changes, supplementary concepts are introduced, and understanding rises to a new qualitative level.

At the new level of studying solutions, the introduction and expansion of additional concepts (equivalent for defining normal concentration, oxidation state for defining equivalence, dissociation, ion, hydrogen index, hydrolysis) are required. In true solutions, the degree of “disintegration” of a substance corresponds to the dimensions of molecules (ions); therefore, the surface of the solute disappears and the system becomes homogeneous. The stability of dispersed systems is another property, resulting from the particle size in dispersed systems. It should be noted that among all dispersed systems, true solutions are the most stable. After explaining the homogeneity and stability of true solutions, it is necessary to proceed to a logical comparison of their properties with mechanical mixtures and chemical compounds. Paying attention to the definition of solutions—namely, the possibility of changing their composition under certain conditions—shows that while qualitative composition remains unchanged and the solute and solution are expressed by the same chemical formula, the dissolution process approaches a physical phenomenon. However, changes in volume, color, and thermal effects indicate that solutions occupy an intermediate position between mechanical mixtures and chemical compounds. In Grade 11, with the transition to quantitative relationships, a new type of concentration is introduced in chemistry—normal concentration. This concept, in turn, requires a knowledge base related to equivalents and oxidation states.

Chemical concepts do not form randomly, singly, or in isolation. Each time, they require knowledge of scientific foundations, the role of a particular topic within a problem, or an understanding of a block of studied topics. To substantiate and select the necessary materials for working with the theoretical and terminological system of the discipline, it is necessary to adhere to the principles of scientific rigor, consistency, and progression from simple to complex. An integrative approach to learning and the establishment of cause-and-effect relationships enable the construction of a system of concepts, as well as the modification and complication of terminology with increasing cognitive load on students, leading them to a qualitatively and quantitatively new level of understanding [5].

**References**

1. Omonov, H. T. *Philosophical and Pedagogical Foundations of Chemical Education and Issues of Its Improvement.* Abstract of the dissertation for the degree of Doctor of Pedagogical Sciences. Tashkent, 1995.
2. Asqarov, I. R., To‘xtaboev, I. R., & G‘oipov, K. Y. *Chemistry, Grade 7.* Tashkent: Sharq Publishing House, 2017. 158 p.
3. Ismatov, I. Sh., & Azamatova, D. S. *Chemistry: Textbook for Grade 7 of General Secondary Education Schools.* Tashkent: Sharq Publishing House, 2022. 176 p.
4. Gabrielyan, O. S. *Chemistry: Grade 11. Textbook.* Moscow: Drofa Publishing House, 2016. 223 p.
5. Agton, R. T. *Cognitive Development and Achievement in Science through the Traditional and Inquiry Approaches of Teaching General Chemistry.* 1991.