STUDY METHODOLOGY OF ANALYTICAL GROUP I CATIONS

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Abstract. The article analyses the necessary measures to be taken to modernize chemistry courses at universities. The basic principles of analysis and study of properties, the significance and application of K^+, Na^+, NH_4^+ cations of the analytical group I have been discussed.

The teaching process is carried out in the following 6 stages: The relation between the atom structure and the properties of the elements, their compounds; Their biological role; Use of metal cations of analytical group I in medicine; Particular identification reactions; Test task - analysis process of group I cations; Representation of the results of the analytical group particular reactions and the analysis of the mixture by the given schemes.

In order to achieve the goal, the student is involved in research-examination processes, is informed about the essence of research, determines the stages of research and deeply understands its results, at the same time explores its meaning, is given opportunity to understand, comprehend and interpret the information learned, develops skills in practical application of methods and strategies, in identification of risk factors related to experimental work, in selection and compilation of different types and complexity appropriate to the goal set

In the process of teaching analytical chemistry, such a methodical approach is important for effective management of practical work and ensuring a safe environment.

Keywords: *Cations, knowledge, teaching chemistry, methods, chemical analysis, reagent.*

According to the main educational goals of the National Curriculum, teaching-learning should promote the gradual formation of knowledge based on prior knowledge, the development of knowledge gained at school and the connection it with the next level of education, that is the main basis for cognition of natural sciences and is built on logical principle. The material mastered by the students through the school chemistry program is the basis for raising the level of chemical education.

In order to train a professional chemist, it is necessary to modernize chemistry courses at universities. This should be facilitated by the use of new teaching methods, new textbooks, including translations, scientific conferences with the participation of teachers, it is essential to regularly discuss the problems of teaching chemistry.

The teaching methodology is improved using modern technical means, by strengthening the aspects of the research component in the learning process. It became necessary to establish and refine distance learning programs. The ongoing education reform in Georgia requires the unification of teaching methods and the training of fundamentally different methodologist-teachers.

The main goal of teaching "Analytical Chemistry" is to study modern and classical methods of chemical analysis, to develop active and systemic thinking, to develop the ability of independent creative work, to deepen knowledge about the chemical properties of substances. The laboratory practicum develops the ability to conduct an experiment and assess the results, gives the experience of analyzing a specific object.

The paper discusses the basic principles of the analysis and the study of properties, importance and application of K^+, Na^+, NH_4^+ cations of analytical group I. These principles are formed on the basis of many years of experience in teaching chemistry [1, 8].

The teaching process is carried out in the following stages:

I. The relation between the atom structure and the properties of the elements, their compounds;
II. Their biological role;
III. Use of metal cations of analytical group I in medicine;
IV. Particular identification reactions;
V. Test task - analysis process of group I cations;
VI. Representation of the results of the analytical group particular reactions and the analysis of the mixture by the given schemes.

Stage I: The relation between the atom structure and the properties of the elements, their compounds;

Analytical classification of ions differs from the distribution of chemical elements in groups in the D.I. Mendeleev's periodic table, but it cannot be called artificial, since it is based on certain regularities related to the solubility of some compounds and the base-acid properties of oxides and hydroxides of the elements. Thus, the acid-base system of cation analysis is based on the dependence between metal cations and hydrochloric acid, sulfuric acid, alkalis, and therefore, it is represented by 6 analytical groups of cations and 3 analytical groups of anions.

Most of the salts of the analytical group I cations K^+, Na^+, NH_4^+ are well-soluble in water, they do not have a group reagent. Potassium and sodium are elements of the main subgroup of group I in the periodic table. They belong to the number of active metals. They have the ability to dissolve water even at room temperature by releasing hydrogen and producing the corresponding hydroxides. Alkali metal hydroxides are strong bases. They are completely ionized in aqueous solutions. Due to this, salts of potassium and sodium strong acids are not hydrolyzed and their salt solutions are of a neutral reaction ($pH = 7$). Salts of potassium and sodium weak acids are more or less fully hydrolyzed and their aqueous solutions have an alkaline reaction ($pH > 7$).

All cations are colorless in aqueous solution. These elements have a minimal value of ionization potential and form cations with spherical symmetry that determines their stability, weak polarization and the absence of colour. Their chemical properties are mainly determined by electrostatic interactions. Based on these data, students can explain the properties of substances and relate them to identification reactions [3].

Stage II. The use of metal cations of analytical group I in medicine:

Sodium and potassium. Sodium ions $Na^+$are mainly present in extracellular fluid ~50%, in bones and cartilage ~40%, less than 10% - in the inside a cell, while potassium ions K^+ are mainly present in intracellular fluid. [4]

The following are related to Na^+ ions:

- Osmotic pressure of liquids and its permanence;
- Consumption of large amounts of sodium ions leads to loss of potassium ions - they are antagonists;
- It affects the condition of the muscular and cardiovascular system;
- Water retention by tissues (15 grams of sodium chloride retains two liters of fluid in the human body);

- Maintaining the base-acid balance in the body ($NaHCO_3$ - blood alkaline reserve - is a component of the hydrocarbon buffer system);
- Transfer of amino acids and sugars to the cell membrane;
- It is contained in blood plasma, digestive fluids;
- Na^+ nd K^+ ions substantially affect the action of the central nervous system (CNS); Participate in the generation of nerve impulses, in the mechanism of short-term memory.
- An excess of Na^+ ions causes depression of the cerebral cortex, i.e. suppresses the action of the CNS;
- An excess of K^+ ions causes a manic state of the cerebral cortex, i.e. excites the action of the CNS.

K^+ ions participate in:

- Intracellular metabolism, regulation of heart contraction and water-electrolyte balance;
- Regulation of metabolism and osmotic pressure, in the process of action of the nervous system
- Normal functioning of the heart;
- Lack of potassium leads to disruption of normal cardiovascular function;
- Prolonged potassium deficiency can lead to cardiac arrest. Potassium is one of the body's most important electrolytes. Like sodium, it is important in the formation of buffer systems.

Stage III. Medicinal preparations of metal cations of the analytical group I:

- Sodium chloride NaCl. Isotonic (physiological) and hypertonic solutions are distinguished depending on its concentration. Isotonic is 0,9% NaCl solution because its osmotic pressure corresponds to the osmotic pressure of blood plasma (780,2 kPa). Isotonic solution is used as a plasma-replacement solution in the event of dehydration of the body, to dissolve medicinal substances, etc., hypertonic solution (mass fraction 3,5 and 10%) is used for external use in the form of compresses and sheets for the treatment of purulent wounds;
- Sodium bicarbonate $NaHCO_3$ (baking soda) - neutralizes hydrochloric acid in gastric juice, it is an antacid in case of increased acidity of gastric juice;
- Sodium sulfate decahydrate $Na_2SO_4 \cdot 10H_2O$ (Glauber's salt) - is a laxative;
- Sodium iodide NaI - is an iodine preparation for endemic goitre.
- Sodium tetraborate decahydrate $Na_2B_4O_7 \cdot 10H_2O$ is easily hydrolyzed in aqueous solution, the released boric acid is characterized by antiseptic action.

- Potassium chloride KCl - is used in the event of electrolyte imbalance in the body;
- Potassium iodide KI – is iodine-containing preparation for thyroid disease, cardiac arrhythmia
- Potassium permanganate $KMnO_4$ - is antiseptic for treating wounds, mouth and throat wash.

The student sees the purpose of the assignment, the practical aspects of these ions, the need for human health, and the connection to daily life. [5, 6]

Stage IV: Educational information transmitted using tables reduces the time it takes to form different types of views. A large amount of information is difficult to retain in the memory of students, systematization of information in the form of tables is better perceived by students and to a greater extent retained in long-term memory, they process a large amount of material, deepening and activating existing knowledge.

Particular identification reactions of cations of the analytical group I:

Table 1

Cation	Reaction number, reagent	The product of the reaction and its properties
K^+	1. $NH_4HC_4H_4O_6$ or 2. $Na_3[Co(NO_2)_6]$ 3. $Na_2Pb[Cu(NO_2)_6]$ 4. Flame staining reaction 5. Dipicrylamine (Poluektov's reaction)	$KHC_4H_4O_6$ – Cr. White, soluble in hot water, strong acids and alkalis. $K_2Na[Co(NO_2)_6]$ −Yellow precipitate, soluble in strong acid. $K_2Pb[Cu(NO_2)_6]$ − Black cube crystals, soluble in strong acids and alkalis. Violet $[C_6H_2(NO_2)_3]_6NK$ −Orange-red crystalline precipitate.
Na^+	1. $K_2H_2Sb_2O_7$ 2. $(NH_4)_2C_2O_4$ 3. $Zn(UO_2)_3(CH_3COO)_8$	$Na_2H_2Sb_2O_7$ − White crystalline precipitate, soluble in strong acids and alkalis. $Na_2C_2O_4$ − White crystalline precipitate. $NaZn(UO_2)_3(CH_3COO)_9 \cdot 9H_2O$ − Yellowish green tetrahedral or octahedral crystals, soluble in alkalis and

	4. Flame staining reaction	acids. Yellow.
NH_4^+	1. NaOH	$NH_3\uparrow$ − Phenolphthalein → Crimson
	2. $K_2[HgI_4] + KOH$ (Nesler Reagent)	$[HgO \cdot HgNH_2]^+ + Hg \downarrow$ − Black $[NH_4Hg_2O]I \downarrow$ −Brown red precipitate.
	3. $Na_3[Co(NO_2)_6]$	$(NH_4)_2Na[Co(NO_2)_6]$
	4. $H_2C_4H_4O_6 + CH_3COO^-$	$\downarrow$ −Yellow crystalline residue.
	5. KH_2SbO_4	$NH_4HC_4H_4O_6$ − White crystalline precipitate.
	6. Dissolution of ammonium salts by dry method	$HSbO_3$ −White amorphous precipitate. $NH_3\uparrow, HCl\uparrow$

Ammonium alkali is a weak base. Solutions of strong ammonium acid salts are characterized by an acid reaction($pH < 7$). K^+ and NH_4^+ are closest to each other in terms of analytical properties. They generate:

Hardly soluble, white hydrotartrates $-NH_4HC_4H_4O_6$, $KHC_4H_4O_6$;

Yellow chloroplatinates $-(NH_4)_2[PtCl_6]$, $K_2[PtCl_6]$;

Hexanitrocobalts $-(NH_4)_3[Co(NO_2)_6]$, $K_3[Co(NO_2)_6]$.

Using this table makes it easier for the student to carry out the research procedure, record data, conduct experiment, work out, analyze and evaluate the obtained data,

The table below is entered by students in workbooks, which they complete according to the results of the experiment:

Private reactions of cations I analytical group

Table 2

1	2	3	4	5	6
Number	Reagent	Cation reaction equation	Reaction equation	Conditions for the reaction	Characterization of the product obtained

The test task allows the student to transfer the learned material to a new situation, i.e. to use ideas and concepts to solve problems. [1, 7]

Stage V: Analysis process of group I cations

Purpose of the work: Detection of group I cations in the research solution.

Assignment: Determine group I cations in the research solution.

The student can determine the subject of research and the stages of research:

1. **NH_4^+ is first studied in the research solution**, the detection of which is not prevented by Na^+ and K^+ ions. Therefore, if NH_4^+, Na^+ and K^+ ions are present in the research solution, NH_4^+ must be removed from the reaction area prior to detection. In case of a negative reaction on the Nessler's reagent, the presence of Na^+ and K^+will be checked.
2. **Detection of** K^+. With $Na_2Pb[Cu(NO_2)_6]$ (precipitate is observed under a microscope) or with freshly prepared $Na_3[Co(NO_2)_6]$ solution.
3. **Detection of** Na^+**.** a) with $K_2H_2Sb_2O_7$ solution b) Ammonium oxalate solution with ethanol; c) with uranilacetate under a microscope.

Stage VI: A scheme is proposed for students to understand the sequence of work performed, which allows them to better master the systemic analysis process. The results of the individual reactions of the analytical group and the analysis of the mixture are represented according to the following tables:

Analysis of a mixture of cations of the analytical group

Table 3

1	2	3	4	5	6	7
Sample number	Research ion	Reagent	What did we see?	Conclusion	Sediment composition	Solution composition

In the final part of the lesson there is a discussion and testing around the topic.

Thus, in order to achieve the goal, the student is involved in research-examination processes, is informed about the essence of research, determines the stages of research and deeply understands its results, at the same time explores its meaning, is given opportunity to understand, comprehend and interpret the information learned, develops skills in practical application of methods and strategies, in identification of risk factors related to experimental work, in selection and compilation of experimental work of different types and complexity appropriate to the goal set. [2, 8]

In the process of teaching analytical chemistry, such a methodical approach is important for effective management of practical work and ensuring a safe environment. After finishing

the laboratory work, the student completes a workbook, summarizes the experiment results, masters the techniques of conducting experiments, practical skills in the use of tools, follows the stages of the research cycle, seeks to solve problems by manipulating chemical reagents – detects the cations in the research solution individually assigned for him/her - that helps him/her in the gradual construction of knowledge.

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აბსტრაქტი. ნაშრომში განხილულია ქიმიის სწავლების მრავალწლიანი გამოცდილების საფუძველზე ჩამოყალიბებული I ანალიზური ჯგუფის კატიონების K^+, Na^+, NH_4^+ ანალიზის, თვისებების, მნიშვნელობისა და გამოყენების შესწავლის ძირითადი მეთოდები და პრინციპები, რომლებიც უნდა განხორციელდეს უნივერსიტეტებში ქიმიის კურსის მოდერნიზაციისათვის.

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