

Mathematical Approaches to Solving Difficult Problems in Chemistry

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Annotation: The article presents simple ways to solve chemical problems using mathematical observation as part of a school chemistry course. Situations are also indicated, during which attention is drawn to the order of solving such problems, the sequence of their solution is noted, and examples of problems used in mathematical observations are given.

Keywords: chemical calculations, experimental problems, proportion, formulating equations.

In the educational sphere of our country, measures aimed at improving the professional competence of teachers of general education schools are being consistently implemented. Thus, educational institutions are being gradually equipped with the necessary material and technical base, modern software and teaching aids, the introduction of a wide range of pedagogical and information technologies into the educational process, the implementation of practical application, the organization of students' cognitive activity on the basis of independent and creative search. Institutes for retraining and advanced training of teachers of natural sciences, "Schools of professional excellence" have been created.

Under these conditions, the practical implementation of all professional competencies, skills and abilities is required, as well as the application of a competent approach to the organization of the educational process, including through the use of innovative methods and techniques. If theoretical knowledge, as a rule, is acquired through the use of various slides, handouts and teaching aids, then in the classroom for solving chemical problems, the methods for solving them are used, set out in the textbook or additional literature.

In this context, a special place is given to the mathematical approach, which, when solving problems in chemistry, allows a deeper understanding of the practical component of chemical concepts, theories and laws. As you know, the main goal of solving chemical problems is to teach students about chemical laws and rules, their application in the preparation of chemical formulas. Before you start solving problems, you should familiarize yourself with the necessary theoretical and tactical material.

There are different methods for solving chemical problems, and the choice of a particular method depends on the conditions and problem statement. To solve the problem, as a rule, a clear action plan (algorithm) is drawn up. In doing so, they focus on the following:

1. Identify the problem that needs to be solved through the same task;
2. Determine which substance, which element is involved in the condition of the question;
3. Determine the molar mass, relative molar mass, molar volume, element serial number, relative atomic mass and other quantities of substances involved in the task;
4. Find out which section of chemistry the problem belongs to;

5. When solving problems related to solutions, determine their percentage, mass fraction, molar, normal, equivalent concentration and, if a percentage concentration is given, its density according to the table (if density is given, determine the percentage concentration or mass fraction);
6. When solving problems related to redox reactions, the change in the oxidation states of the elements involved in the reaction is determined, the chemical reaction equations are compiled. An oxidizing element (atom) or a reducing element (atom or ions) is identified;
7. It is necessary to check the correctness of the formulated formula or reaction equations and their coefficients;
8. Proportion, ratio, formulas are used in solving calculation problems;
9. The coordinate system is used for graphical problem solving;
10. When writing the structural formulas of substances, the valencies of the elements included in this substance are determined;
11. When studying the structure of matter, the nuclear composition of simple substances, the state of electrons in atoms and the properties of simple substances, one should learn to use the periodic system of chemical elements of D.Ya. Mendeleev;
12. When solving experimental problems, it is necessary to follow the rules of work in chemical laboratories.

The main reasons for the mistakes that students make are:

1. Students in grades 5-6 do not pay enough attention to proportions, equations and related problems and examples.
2. Little attention is paid to calculations with fractions, one-sidedness in solving problems is manifested;
3. Grade 7 students do not pay enough attention to solving problems in physics;
4. Teachers of chemistry should pay more attention to highlighting the interdisciplinary connection of the profile discipline with mathematics and physics.

To eliminate the above shortcomings and fill the gap in the knowledge of students, it is necessary to pay attention to the following.

1. Ways to allow students to quickly remember the relative atomic masses of chemical elements. To do this, you can resort to entertaining mathematics, that is, challenge students to build an expression corresponding to relative atomic masses, using rational exponent levels.

This method helps to quickly memorize the relative atomic masses of chemical elements, makes the lesson interesting and meaningful, and helps to understand the relationship between chemistry and mathematics.

2. The correct formulation of the formula of a substance and the calculation of its molecular weight. During the lesson, it is convenient to explain to students through the following table:

	O ²⁻	OH ⁻	Cl ⁻	Br ⁻	I ⁻	NO ₃ ⁻	S ²⁻	SO ₃ ²⁻	SO ₄ ²⁻	CO ₃ ²⁻	PO ₄ ³⁻	SiO ₃ ²⁻
H ⁺		18	36,5	81	128	63	34	82	98	62	98	78
NH ₄ ⁺		35	53,5	98	145	80	68	116	132	96	149	112
Na ⁺	62	40	58,5	103	150	85	78	126	142	106	164	122
K ⁺	94	56	74,5	119	166	101	110	158	174	138	212	154
Ba ²⁺	153	171	208,0	197	391	261	169	217	233	197	601	213
Ca ²⁺	56	74	111,0	200	294	164	72	120	136	100	310	116
Mg ²⁺	40	58	95,0	184	278	148	56	104	120	84	262	100
Al ³⁺	102	78	133,5	267	408	213	150	294	342	234	122	282
Cr ³⁺	152	103	158,5	292	433	238	200	344	392	284	147	332
Fe ²⁺	72	90	127,0	216	310	180	88	136	152	116	358	132
Fe ³⁺	160	107	162,5	296	437	242	208	352	400	292	151	340
Mn ²⁺	71	89	126,0	215	309	179	87	135	151	115	355	131
Zn ²⁺	81	99	136,0	225	319	189	97	145	161	125	385	141
Cu ²⁺	80	98	135,0	224	318	188	96	144	160	124	382	140
Ag ⁺	232	125	143,5	188	235	170	248	296	312	276	419	292

	OH- 17	Cl- 35,5	Br- 80	S- 32	SO ₃ ⁻ 80	SO ₄ ⁻ 96	CO ₃ 60	NO ₃ ⁻ 62
H-1	H ₂ O 18	HCl 36,5	HBr 81	H ₂ S 34	H ₂ SO ₃ 84	H ₂ SO ₄ 98	H ₂ CO ₃ 62	HNO ₃ 63
K-39	KOH 56	KCl 74,5	KBr 119	K ₂ S 110	K ₂ SO ₃ 158	K ₂ SO ₄ 174	K ₂ CO ₃ 138	KNO ₃ 101
Na-23	NaOH 40	NaCl 58,5	NaBr	Na ₂ S	Na ₂ SO ₃	Na ₂ SO ₄	Na ₂ CO ₃	NaNO ₃
Cu-64								
Mg-24								
Ca-40								
Fe-56								
Al-27								

By completing this table, students will be able to correctly write the formula and find the molecular weight.

3. Determination of the amount (mol) by mass of the substance. To solve such problems, students must be able to calculate element atoms, relative atomic masses, molecular weights, and in many cases divide numbers as decimals. In this regard, one should pay attention to the mathematical solution of decimal fractions of the type 6.02; 22.4; 35.5; 63.5; 1.12; 0.224.

Also, students can be offered the following tables as a task to find the amount and volume of a substance:

Formula	K ₂ SO ₄	Na ₂ SO ₄	H ₂ O	NaCl	Mg(OH) ₂	CuO	CaCO ₃
Molecule, g weight	174	142	18	58,5	58	80	100
0,2 mole							
0,5 mole							
1,25 mole							
1,5 mole							
2,5 mole							
3 mole							
0,25 mole							

Determining the amount of a substance by its given mass

Formula	Al ₂ (SO ₄) ₃	NH ₄ OH	K ₂ CO ₃	BaSO ₄	Fe ₃ O ₄	NaNO ₃	Sn(OH) ₄
Molecular mass	342	35	138	233	232	85	186
weight	3,42 g	10,5 g	6,9 g	9,32 g	13,9 g	5,1 g	7,44 g
quantity							
weight	6 g						
quantity							
weight	6,4 g						
quantity							
weight	24,4 g						
quantity							

Finding the mass of a gas from its given volume

Name/volume	Carbon dioxide	Nitrogen	Air	Phosphine	Fox's tail	Methane	Phosgene
weight	44	28	29	34	46	16	99
2,24 l		2,8					
1,12 l			2,45				
3,36 l				5,1			
4,48 l					9,2		
5,6 l						4	
11,2 l							49,5

Methods for solving chemical problems are considered an important basis for teaching chemistry in secondary schools, academic lyceums and vocational schools. As a consequence, without the aid of a problem-solving methodology, chemistry cannot be expressed as a whole. Lessons organized according to this method increase students' interest in chemistry, mathematics and physics. Therefore, students should understand that these subjects are inextricably linked and, without mastering one of them, one should not try to master the other. The teacher, in

turn, controls the process of mastering the subject by each student and during the year organizes additional classes with weak students.

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