METHODS FOR DEVELOPING STUDENTS' CREATIVE THINKING IN SOLVING CHEMISTRY PROBLEMS

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Annotation. *This article discusses the development of students' science-related competencies in solving problems during chemistry lessons, as well as methods for fostering students' creative thinking in solving chemistry problems.*

Keywords: *chemistry, competency, chemical problem, method, tool.*

In the process of the development of pedagogical technologies and their penetration into the educational process, as well as the rapid exchange and improvement of information technologies, each teacher is required to strengthen his professional training, skills. The rapid development of modern pedagogical technologies creates fundamental changes in the educational process. This in turn requires teachers to constantly learn, adapt to innovations and improve their professional skills. Students, on the other hand, should be able to work with textbooks and additional literature in the process of mastering topics, be able to draw up chemical reaction equations, correctly select coefficients, be able to issue solutions to issues, apply acquired knowledge, formulate skills and qualifications on the ability to learn a matter in itself. In the process of learning on the basis of modern pedagogical technologies, there are several interconnected invasions of knowledge acquisition, such as the transmission of ready-made knowledge to the minds of students, memorization, storage in memory, recollection, eloquence, written expression, representing the level of cognition, understanding [42, 43].

Below we will consider in detail one of the practical classes aimed at developing the creative thinking of students by solving issues in chemistry. In the process of learning on the basis of ach

By proposing to solve the same issue in several ways, students can be taught to think creatively. For example, to show solution attainment through molar mass, mass share, or ratios when solving stoichiometric problems. Organic matter contains carbon (mass fraction 84.21%) and hydrogen (mass fraction 15.79%). The density of matter vapor relative to air is 3.93.y proposing to solve the same issue in several ways, students can be taught to think creatively. For example, to show solution attainment through molar mass, mass share, or ratios when solving stoichiometric problems. Organic matter contains carbon (mass fraction 84.21%) and hydrogen (mass fraction 15.79%). The density of matter vapor relative to air is 3.93. Determine the formula of this substance. Solution: method 1. The formula of the substance is CxHy in appearance. For calculations, we take a sample of a substance with a mass of 100 g. We determine the mass and amount of matter of carbon and hydrogen in the same sample

$$m(C) = m(substance) * \omega(C) = 100*0,8421g = 84,21\ g.$$

$$m(H) = m(substance) * \omega(H) = 100*0,1579g = 15,79\ g.$$

$$n(C) = \frac{m(C)}{M(C)};\quad n(C) = \frac{84,21}{12}\,mol = 7,02\ mol.$$

$$n(H) = \frac{m(H)}{M(H)};\quad n(H) = \frac{15,79}{1}\,mol = 15,79\ mol.$$

We find the ratio of the amount of hydrogen and carbon substances that make up the compound:

$$\frac{n(H)}{n(C)} = \frac{15,79}{7,02} = 2,25.$$

This ratio is equal to the ratio of the coefficients y and x:

$$\frac{n(H)}{n(C)} = \frac{y}{x} \qquad \frac{y}{x} = 2,25. \quad \text{(a)}$$

Knowing the vapor density of the hydrocarbon relative to air, we calculate its molar mass:

M(CxHy) = 29 Dx; M(CxHy) = 29*3,93 g/mol = 114 g/mol.

The molar mass can also be shown in the following way:

M(CxHy) = M(C) * x + M(H) * y; M(CxHy) = 12x + y.

we obtain the following:

12x + y = 114. (b)

solving the system of Equations (A) and (b), We Find x=8, y=18, that is, the formula of the hydrocarbon C8H18, this octane.

Method 2. Assuming that the formula of the substance is CxHy in appearance, a ratio of carbon to hydrogen moles is found based on the given percentages.

$$n(C) = \frac{m(C)}{M(C)};\quad n(C) = \frac{84,21}{12}\,mol = 7,02\ mol.$$

$$n(H) = \frac{m(H)}{M(H)};\quad n(H) = \frac{15,79}{1}\,mol = 15,79\ mol.$$

We find the smallest ratio of the amount of hydrogen and carbon in the substance.

So, the molecule of the substance has eight carbon eighteen hydrogen atoms.

I. The use of practical and vital issues To interest students and connect them with real life, chemical issues can be linked on the basis of situations found in everyday life. For example:

1. "How much milk is needed to produce a ton of lactic acid? So, the molecule of the substance has eight carbon eighteen hydrogen atoms.

II. The use of practical and vital issues To interest students and connect them with real life, chemical issues can be linked on the basis of situations found in everyday life.

For example: 1. "How much milk is needed to produce a ton of lactic acid?" Solution: the amount of milk needed to produce a ton of lactic acid is determined by the following factors: Formation of lactic acid: lactic acid is usually extracted from fat and proteins present in milk. In the process of its formation, cream and other components are released from milk, so how much acid is obtained from milk depends on the composition of the milk and the effectiveness of the process. Composition of milk: usually milk contains 3-4% fat, which is important in determining the amount of acid.ormation of lactic acid: lactic acid is usually extracted from fat and proteins present in milk. In the process of its formation, cream and other components are released from milk, so how much acid is obtained from milk depends on the composition of the milk and the effectiveness of the process. Composition of milk: usually milk contains 3-4% fat, which is important in determining the amount of acid. In general, 10-15 tons of milk may be needed to obtain a ton of lactic acid, which may vary depending on the composition of the milk and the effectiveness of the process. 2. “How to calculate the exact concentration of vinegar solution in your kitchen?” Life issues like this help connect students ' knowledge in science with life and develop their creative thinking.

III. Analyzing issues and asking problematic questions Instead of a ready-made solution, let the readers analyze the main part of the issue themselves. For example, in explaining the reaction mechanism: 1. “How to calculate the exact concentration of vinegar solution in your kitchen?” Life issues like this help connect students ' knowledge in science with life and develop their creative thinking.

III. Analyzing issues and asking problematic questions Instead of a ready-made solution, let the readers analyze the main part of the issue themselves. For example, in explaining the reaction mechanism:

1. “What changes will happen if a catalyst is added to this reaction?”
2. “Why does this substance dissolve well in water, but the other does not dissolve?”

IV. Group work and creative discussions A creative approach develops when issues are addressed in groups and each group is required to defend their solution. With this, students not only understand science, but also develop communication and problem-solving skills.

For example: 1. It is possible to determine with what reagent which of the three numbered test tubes contains potassium chloride, nitric acid, corrosive potassium. 2.or example:

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For example: 1. It is possible to determine with what reagent which of the three numbered test tubes contains potassium chloride, nitric acid, corrosive potassium. 2. A solution of kitchen vinegar (acetate acid, CH_3COOH) has a concentration of 5%. What result will come out if you take 200 ml of vinegar and calculate how many grams of acetate acid is contained in it? When solving such issues, students not only repeat relevant topics, but also study the effect of these substances on indicators in practice.

V. Analyzing problems with graphs and diagrams Especially in Inorganic Chemistry, Reactions and structures can help to understand them well if represented graphically. For example, drawing an electronic balance scheme for oxidation-reduction reactions. For example

$3Me + bHNO_3 \rightarrow 3Me(NO_3)_n + xNO\uparrow + dH_2O$ in the reaction, the oxidizer is 6e-derived. 33.6 liters of 400 g of nitric acid (. n.sh.) determine the reaction yield (%) if the gas is formed.

We write the electron-balance equation for the reaction:

$Me^0 \xrightarrow{-ne^-} Me^{+n}$ n 3 Me – returner

a n HNO_3 – oxidizer

$N^{+5} \xrightarrow{+3e^-} N^{+2}$

a) We determine the oxidation state of the metal by the number of electrons received by the oxidizing agent:

$3n = 6$

$n = 2$

Hence, a formula Me(NO3)2was formed in which the oxidation state of the metal is +2. a) we write the reaction equation:

$n = 2$ from this $x = 2$; $b = 8$ va $d = 4$ origin.

a) a) We calculate the mass of acid consumed (g) by making a proportion:

504 g HNO3 □□□ 44,8 litr NO

x g HNO3 □□□□ 33,6 litr NO

$504\ g\ HNO_3$ ——— 44,8 litr NO

$x\ g\ HNO_3$ ——— 33,6 litr NO

$$x = \frac{33.6 \cdot 504}{44.8} = 378\ g\ HNO_3$$

b) b) Calculate the reaction yield (%).

$400\ g\ HNO_3$ ——— 100%

$378\ g\ HNO_3$ ——— x%

$$x = \frac{378 \cdot 100\%}{400} = 94{,}5\%$$

VI. Making matters difficult and creating new situations It is possible to give students a simple matter and then make it difficult. For example, in the initial matter, the data is given exactly, and then asked what solution can be found in the context of certain data deficits. For example:

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$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

$$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$$

Given that 102 l of oxygen is spent under normal conditions for the combustion of gases, a third algebraic equation is induced based on the reaction equations:

$$(S)=\begin{cases} x+y+Z=42{,}4 & (1)\\ x+2y+2Z=68{,}8 & (2)\\ 2x+3{,}5y+2{,}5z=102 & (3)\end{cases}$$

(S) the variable x is lost from Equation 2 and 3 of the system:

$$(S_1)=\begin{cases} x+y+z=42{,}4 & (1)\\ \quad y+z=26{,}4 & (2)\\ \quad 1{,}5y+0{,}5z=17{,}2 & (3)\end{cases}$$

(S1) multiplying the 2nd equation of the system by the opposite signal of the number in front of y in Equation 3, adding (S1) to the 3rd equation of the system, one obtains the following system in which the variable y is lost from Equation 3:

$$(S_2)=\begin{cases} x+y+z=42{,}4\\ \quad y+z=26{,}4\\ \quad -z=-22{,}4\end{cases}$$

It is not difficult to calculate the values of y and x in such a system:

z= 22,4; y= 26,4-22,4=4; x=42,4 - y-z=42,4-4-22,4 = 16

VII. Using the scientific-verification method Students can be taught to think independently by asking questions about the results of the experiment. For example:

1. “If the temperature increases during a chemical reaction, how does the reaction rate change?”

2. “When the pH of the solution is 5, what substance should be added to bring it to 7?”

3.II. Using the scientific-verification method Students can be taught to think independently by asking questions about the results of the experiment.

For example:

1. “If the temperature increases during a chemical reaction, how does the reaction rate change?”

2. “When the pH of the solution is 5, what substance should be added to bring it to 7?”

3. The yard water barrel is planned to be disinfected with calcium hydroxide ($Ca(OH)_2$). If there is 500 liters of water in the barrel and it is necessary to add 0.01 M $Ca(OH)_2$ to kill the bacteria in the water, how many grams $Ca(OH)_2$ will it take? In conclusion, solving issues with a different approach, giving life and practical examples, giving problematic issues and working in a group will greatly help develop the creative thinking of students. Also, the use of visual tools and step-by-step difficulty of issues will give an effective result.

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