# DIDACTIC SOURCES FOR FORMING KNOWLEDGE ON THE TOPIC OF "SOLUTIONS". (ON THE EXAMPLE OF THE HEAT OF FUSION OF SALTS)

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**Abstract :** *This article describes the didactic sources for the formation of knowledge on the topic of solutions, gives an example of theoretical knowledge about the heat of fusion of salts during the melting process and the heat of fusion of solutions, describes the methodology for performing it, and discusses the advantages of teaching using the example of experimental problems in the learning process.*

**Keywords:** *chemistry, methodology, practical training, solutions, heat of fusion, calorimetry, macroelement, microelement.*

Knowledge of solutions is closely related to many theoretical issues in chemistry. Since solutions are used in various fields, it is important to develop effective methods for teaching this topic. Another important aspect of this issue is that a significant share of tests in chemistry multiple-choice options falls on the topic of "Solutions".

The basic knowledge of solutions includes concepts and phenomena such as the mechanism of the melting process, the absorption of heat during the breakdown of the crystal lattice of a substance, which causes thermal phenomena during the melting of a substance, the release of heat during the binding of water molecules by dissolved particles, i.e. hydration, the formation of heat of fusion in their complexes, and solubility. The most convenient way to form them in the minds of students is to solve experimental and computational problems. The following is an example of the heat of fusion of salt solutions and the methodology for their implementation.

**Experimental problem.** Given an anhydrous salt of copper (II) sulfate, its crystalline hydrate, and a simple calorimetric apparatus, determine the heat of fusion of the anhydrous and water-retaining salts, as well as the heat of hydration of copper (II) sulfate.

Details of the experiment. The heat of fusion of salt is measured in a special calorimeter using a Beckman thermometer, as shown in the practical textbooks on physical chemistry for higher education institutions, but since conducting practical training in it takes too much time, a method for measuring the heat effect using a simple calorimeter has been developed. Since the results obtained in it are satisfactory in educational work, we believe that it can be recommended for practical training. A simple calorimetric device for conducting the experiment is assembled as follows.

It consists of an inner and outer beaker with a capacity of 100 and 150 ml. The small beaker is placed in the larger one with a little bandage wrapped around the top. Pieces of rubber are placed between the beaker to prevent the beaker from touching each other. A simple thermometer, funnel, and stirrer are placed in a cork stopper and placed in the inner calorimetric beaker. The stirrer is made of copper wire.

The teacher first prepares as many of these devices as possible (the mass of each calorimeter beaker will be determined) and numbers them.

**Determination of the heat of fusion of copper (II) sulfate.** Pour 50 ml of distilled water into a calorimetric beaker through a funnel and measure its temperature. Add 3.2 g of $CuSO_4$ salt to it, close the opening of the funnel with a rubber stopper and, while stirring, determine the highest temperature rise. Then, denote the temperature of the water by t1 and the highest temperature rise of the solution by t2, and calculate the temperature change. Calculate the heat of fusion first for 3.2 g of CuSO4, and then for 1 mol of it.

We calculate the heat of fusion according to the following equation:

$$Q_{erish} = (m_e + S_e + m_s + S_{sh})\cdot\Delta t$$

this equation :

$Q_{erish}$- copper (II)- sulfate salt melting heat ,

$m_e$— calorimetric in the glass solution mass depending on the condition of the matter according to = 50 + 3.2 = $m_e$ 53.2 g will be .

$S_e$- solution comparison heat capacity , it is 4.18 J/ gK , i.e of water comparison heat to capacity we assume that is equal , because in the water substance when melted of water heat capacity very less turns ;

$m_s$- calorimetric of the glass mass divided , it is equal to 45.4g .

$S_{sh}$- bottle comparison heat capacity is equal to 0.84 J/ gK .

In the experiment of water average temperature 20.3°C, melting in the process temperature average raised value is 25.4°C it has been .

Then $\Delta t = t_2 - t_1 = t_{solution} - t_{water}$ = 25.4-20.3 = 5.1° C It will be .

numerical values into the equation . to melt , to melt heat value we find :

$$Q_{erish\text{CuSO4}} = (m_e + S_e + m_s + S_{sh})\ \cdot\Delta t$$

Q = (53.2·4.18 + 45.4·0.84)·5.1 = 1328.7 j= 1.33 kj .

1 mole of $CuSO_4$ for when calculating :

$$\frac{3,2}{160} = \frac{1,33}{x}; x = \frac{160*1,33}{3,2} = 66,5\ kj/mol$$

**Determination of the heat of fusion of copper sulfate.** Pour 50 ml of water into a calorimeter beaker and determine its temperature. Add 5.2 g of crushed $CuSO_4\cdot 5H_2O$ salt to it. Cover the opening of the funnel with a stopper and, while stirring the solution, record the lowest temperature. In the experiment, the temperature of the water is 20.4°C, and the lowest temperature of the solution is 19.5°C, then Δt=20.4-19.5=0.9°C. Given that the mass of the calorimeter beaker is 45.8 g, we calculate the heat of fusion of copper sulfate:

$Q_{(CuSO4\cdot 5\ H2O)}$ = (55.2·4.18 + 45.8·0.84)·(-0.9) = 242 J = 0.242 kj .

For 1 mol $CuSO_4\cdot 5H_2O$ when calculating :

$$\frac{5,2}{250} = \frac{0,242}{x}; x = \frac{250*0,242}{5,2} = 11,6\ kj/mol$$

CuSO4 of hydration the heat calculation

$CuSO_4 \cdot 5H_2O$ in water when melted It is not hydrated . Therefore for 11.6 kj /mol of it melting is the heat . In that case :

$Q_{hydration (CuSO4)} = Q_{dissolution (CuSO4)} - Q_{dissolution (CuSO4 \cdot 5 H2O)} = 66.5 -(- 11.6) = 78.1$ kJ/ mol will be .

It is clear that in groups where students completed this task independently as a practical assignment, they have deeply mastered the basic knowledge of the topic.

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