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Some aspects of creation of problem situations and decisions of problems

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Abstract

One of innovations in education technique is the method of problem-based learning which is directed on development of pupils independence, which plays a big role for stimulation of creativity and formation of research activity of them during training. The main idea of this approach is construction of educational activity by the solution of cognitive educational problems or tasks having blank places, insufficient conditions for getting the answer. A problem task is a form of an organization of teaching material with present conditions and unknown data. Search of these data assumes active cognitive activity, analysis of facts, finding-out of reasons of the objects origin and the skills of constructing cause and effect relationships. The solution of such problems can be in a form of a verbal reasoning, mathematical calculations and laboratory research work.

Keywords

Problem-based learning, innovation technology, problematic situation, challenging task, laboratorial searching task.

Introduction

In biology and chemistry problem training can be organized on miscellaneous: these are theoretical questions, various experimental and calculation tasks with the problem contents. During the solution of new problems and performance of new experiments, including with problem contents application of heuristic forms of work will be pertinent with the purpose of development of students' scientific thinking and interest to science. In chemistry school course of pupils from various classes get acquainted with a theme "Metals" including "Iron and its compounds". In the program the experiments based on description of chemical properties of metals, included iron and some of its compounds. However, in many modern books some models of interaction of metals with solutions of acids are not completely represented. The mechanisms of interaction of metals with solutions of salts which also contain atoms of metals with variable valence for example iron, chrome etc. are not considered in detail.

Investigation of iron metabolism disturbance is important in medicine and refers to the actual questions because of participation of iron in vital functions of organism.

Iron is included in a group of essential (vital) microelements, but his relative content in organism is high (4.0-4.5 grams in adult human body).

Problem Situation 1.

Why iron refers to the microelements?

Answer: Formerly it was attributed to the macroelements. However, 75-80 % of iron is concentrated in the blood hemoglobin, and approximately 20 % of the iron is stored in the liver and spleen. In the other tissues, its concentration is comparable with microelements.

Problem situation 2.

What is the biological role of iron?

Answer: iron provides oxygen transport (contained in hemoglobin), provides the transport of electrons in redox reactions of the organism (contained in cytochromes and iron proteids), and participates in the formation of active centers of redox enzymes.

Iron (II) characterized by an octahedral coordination, i.e. communicates with the six ligands. Four of them are manifested with nitrogen atoms of the porphyrin ring located on the same plane. Two other coordinated positions lie on an axis perpendicular to the plane of the porphyrin. One of them is involved with nitrogen of the histidine residues in the 93 position of the polypeptide chain. Hemoglobin in the lungs at a high oxygen partial pressure is coupled with it, forming oxyhemoglobin. In this case oxygen combines with heme, heme iron joining the sixth coordination bond.

Problem situation 3. By which communication connects the non-polar molecule of oxygen with the atom of iron (II) and what is the structure of the resulting complex.

Answer of this question requires serious research, and necessary to disassemble the question in the form of project (project learning).

On the same connection joins also the carbon monoxide entering with oxygen in the "competitive struggle" for the relationship with hemoglobin to form carboxyhemoglobin.

Problem situation 4. Why in this fight wins carbon monoxide (II).

Communication of carbon monoxide with the hemoglobin is more resistant than with oxygen. Therefore, a portion of hemoglobin, forming a complex with carbon monoxide, is not participate in the transport of oxygen. Normally, in human body is formed 1.2 % carboxyhemoglobin. Its elevated levels can lead to death.

Sometimes reactions of metals with solutions of acids and salts interactions of are described by one example: "The metals which in the row of electrochemical intensity of metals are on left from hydrogen, replace hydrogen from solutions of acids"; or "Interaction of a solution of copper (II) sulfate with iron" is considered. However, in chemical practice there are many examples of interactions of metals with solutions of salts which cannot be explained from this point of view and consequently many aspects of this question remain unexplored and not clear for pupils. Unlike traditionally questioning let's consider a problem in interaction of copper with a solution of iron (III) chloride.

In literature there are known works[1] in which reactions of interaction of salts of iron (III) with metals of various activities are described. However, the reasons of iron (III) salts and solutions of inactive metals interaction are not considered in detail. In this work we shall try to prove theoretically opportunities of course of these reactions, combining it with some calculation problems.

Problem 1: The copper plate with mass 50g was added to the solution of iron (III) chloride. After that the plate was removed and weighed. The mass of the plate was equal to 43,6g. How much salt (in grams) is there in solution?

To make sure that the problem is correct, corresponding experiment can be carried out: in a test tube with the solution of iron (III) chloride some amount of copper powder is added. The reaction between copper and iron (III) chloride takes place very quickly at ordinary conditions: after a couple of minutes the solution of iron (III) chloride changes the color from pale yellow to green. This proves that the reaction has taken place.

The problem situation is created. The problem is that in opinion of pupils copper as poorly active metal cannot enter chemical interaction with solutions of salts of iron. They know about an opportunity of course of other reaction, namely – replacement of copper from solutions of its salts by iron. However the condition of a problem, and also experiment observed by them, testify completely about another. Naturally, some questions arise:

1. What is the reason of color change of iron (III) chloride solution after adding to it a copper plate?
2. Why copper reacts with a solution of iron (III) chloride?
3. How to determine the direction of chemical reaction?, etc.

Pupils know that by chemical activity metals are organized in a row named ***a row of standard electrode potentials***, or a row of intensity of metals. In this row metals are located according to increase in standard electrode potentials. ***However***, alongside with known conclusions following from this, concerning

1 "Role of Strategic Training and Development in Organizational Success", StudyMode, available at: http://www.studymode.com/essays/Role-Of-Strategic-Training-And-Development-234586.html

chemical properties of metals, it is necessary to pay attention that the algebraic value of standard electrode potential of metal characterizes simultaneously reductive ability of its atoms and oxidizing ability of its ions. The less algebraic value of standard electrode potential of metal, the more its chemical activity, i.e. more its reductive ability is. Increase of values of standard electrode potentials corresponds to increase in force of oxidizers and decrease in force of reducers.

Standard electrode potentials give representation about probable direction of oxidation-reduction reactions, allow to choose suitable oxidizers and reducers, and also to solve other questions.

At a combination of two oxidation-reduction pairs, the one of them with bigger standard electrode potential should play a role of an oxidizer, i.e. to take away an electron from a reducer. Thus it is necessary to consider, the fact: the more a difference of standard electrode potentials is, faster a process of oxidation – reduction takes place. That is why at comparison of values of standard electrode potentials of systems Fe^{2+}/FeO (E^0 = –0,44 eV) and Cu^{2+}/CuO (E^o = +0,34 eV), it can easily be convinced, that system Cu^{2+}/CuO possessing great value of standard electrode potential, during chemical reaction will be an oxidizer, i.e. will take away electrons from stronger reducer (Fe^0). According to it reaction between this pair is: $Cu^{2+} + Fe^0 \rightarrow Cu^0 + Fe^{2+}$.

However as against above-stated ($Fe^{2+} + 2e \rightarrow Fe^0$), other direction of oxidation-reduction process, namely $Fe^{3+} + e \rightarrow Fe^{2+}$, is also enough possible, with the high value of electrode potential equals E^o Fe^{2+}/Fe^0 = +0,77 eV.

Except Fe^{2+}/Fe^0 system iron participates in other oxidation-reduction processes, namely $Fe^{3+} + e \rightarrow Fe^{2+}$, and the value of standard electrode potential of this system is high enough too and equals E^o Fe^{2+}/Fe^0 = +0,77.

Hence, value of standard electrode potential of this system is much greater than that of pair Cu^{2+}/CuO (E^o = +0,34 v). It proves that electron affinity of Fe^{3+} is much more, than that of Cu^{2+}, therefore the system Fe^{3+}/Fe^{2+} compared to Cu^{2+}/CuO acts as an oxidizer and Fe^{3+} oxidizes Cu^0 up to Cu^{2+}, is reduced itself up to Fe^{2+} : $Fe^{3+} + Cu^0 \rightarrow Cu^{2+} + Fe^{2+}$.

It's already rather clear, why copper plate in a solution of iron (III) chloride after a while pale yellow color of a solution changes into blue, which is typical for hydrated ions of copper (II).

After such theoretical justification of the problem solution there are no any difficulties. It is clear, that change of weight of a copper plate is caused by amount of copper which was passed into the solution, i.e. in reaction with iron (III) chloride 50 – 43,6 = 6,4 g copper has reacted which makes 0,1 mole. From the equation of reaction it is visible, that during reaction it is formed the same amount (0,1 mole) of copper chloride and twice more (0,2 moles) of iron (II) chloride which weights are accordingly equal:

m (CuCl2) = 0,1 mole x 135 g/mole = 13,5 g;

m (FeCl2) = 0,2 moles x 127 g/mole = 25,4 g.

Problems for the self-dependent solution are suggested:

Problem 2. A copper plate in weight 29,57g was added to a 200g 20 % solution of iron (III) sulfate . After a while, when in the solution mass fractions of iron (III) sulfate and the copper (II) sulfate (formed during reaction) became equal, a plate was taken out, dried up and weighed. What did weight of a copper plate become? The answer: 25 g.

Problem 3. A nickel plate with weight 25,9 g was added to a 555 g 10 % solution of iron (III)sulfate. After a while, when in the solution mass fractions of iron (III) sulfate and nickel (II) sulfate formed during reaction became equal the plate was taken out, dried up and weighed. What did weight of a nickel plate become? The answer: 20g.

Let's consider another example which also allows creating of a problem situation and on the relevance of the question posed is not inferior to the previous. Again we shall consider behavior and properties of metals proceeding from their arrangement in a row of standard electrode potentials. The problem situation can be created as follows:

If into solution of silver nitrate powder of copper is poured, or copper plate is put after a while the plate is covered by a silver-white film of silver. Rather logically, in a row of standard electrode potentials copper is located more to the left of silver and replaces it from solutions of its salts. And if we put the plate which is covered with silver coating in a solution of iron (III) chloride after a while silver completely will dissolve and leaves the plate. This happens also if after carrying out of qualitative reaction to aldehydes in test tube which is applied with "silver mirror" some small amount of solution of iron (III) chloride is added. Full dissolving of silver is observed. In this connection we shall make a problem with the problem contents.

Problem 4. In a test tube with "a silver mirror" **25 g 20 %** solution of iron

(III) chloride was flowed. After a while the silver coating from walls of a test tube has disappeared, and the weight of a solution in a test tube has increased for 2,16. How many grams of iron (III) chloride does the received solution contain?

There was a problem situation. The fact that copper replaces silver from a solution of its salt, it is rather logical and is explained by the arrangement of these metals in a row of standard electrode potentials. The problem is that in opinion of pupils silver as poorly active metal cannot enter chemical interaction with solutions of salts of iron and be dissolved in it. Besides they know about an opportunity of course of other reaction, namely – replacement of silver from solutions of its salts by iron. However, as at the solution of the first problem, again the condition of set problem, and also experiment observed by them testify completely other. And it is natural, a number of typical questions for the given problem situation arise, namely:

1. What did cause dissolving of "a silver mirror" under action of Iron (III) chloride?

2. Why does silver interact with a solution of iron (III) chloride?

3. What did cause controversy between values of standard electrode potentials and behavior of these systems?

4. What argument determines a direction of proceeding chemical reaction?, etc.

As it was already marked, at oxidation-reduction processes the course and a direction of these reactions is caused by values of standard electrode potentials and the more their difference is, the more intensively a process of oxidation – reduction takes place.

However unlike previous, by comparison of values of standard electrode potentials of systems Fe^{3+}/Fe^{2+} (E^0 = +0,77 eV) and Ag^+/Ag^o (E^o = +0,8 eV) it will easily be convinced, that at a combination of these two systems reaction between them should not go on, and if it does, the system Ag^+/Ag^0 possessing rather great value should be an oxidizer and oxidize Fe^{2+} up to Fe^{3+}, that contradicts a condition of a problem. The reason of occurrence of a problem situation is that in the muriatic environment due to formation of not enough soluble precipitate AgCl, concentration of Ag^+ ions is strongly reduced. In this connection arises a new system, namely $AgCl/Ag^o$ which is characterized with considerably low value of standard electrode potential which is equal +0,22 eV. At such combination of two oxidation-reduction systems, namely Fe^{3+}/Fe^{2+} (E^o = +0,77 eV) and $AgCl/Ag^o$ (E^o = +0,22 eV) it is natural, that Fe^{3+} should oxidize silver up to a free condition: $Fe^{3+} + Ag^{o} \rightarrow Ag^{+} + Fe^{2+}$.

And therefore there is a dissolving of "a silver mirror".

Hence, the solution of a problem can be carried out as follows: it is rather logical, that the increase in weight of a solution is caused by amount of the silver dissolved during reaction, i.e. in reaction with iron (III) chloride 2,16 g silver has entered which makes 0,02 mole. From the equation of reaction it is visible, that during reaction the same amount (0,02 moles) of iron (III) chloride was used and 0,02 moles of iron (II) chloride was formed which weights are accordingly equal:

m ($FeCl_3$) = 0,02 mole x 162,5 g/mole = 3,25 g;

m ($FeCl_2$) = 0,02 mole x 127 g/mole = 2,54 g.

At the beginning of reaction in solution of iron (III) chloride 5 g salts was contained (25 x 20 : 100 = 5).

During the reaction amount of 3,25 grams from have been used, hence in a solution 5 – 3,25 = 1,75 g of iron (III) chloride was remained.

Conclusion

Apparently dissolving of "a silver mirror" promotes other circumstance also, namely: as salts of iron (III) in water solutions strongly hydrolyze creating environment with low pH. In the literature[2] dissolving of silver chloride in muriatic solutions is described due to formation of complex compound H [$AgCl_2$]. In this connection concentration of ions of silver is strongly reduced and the equilibrium of reaction shifts to the side of its formations. Apparently it is possible to explain that fact, that during the reaction between a solution of iron (III) chloride and silver, silver is actually dissolved in a solution of iron (III) chloride, but formation of a precipitate is not observed.

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Некоторые аспекты создания проблемных ситуаций и решения задач

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Аннотация

Данная статья рассматривает одну из разновидностей инновационной методики в образовании – проблемное обучение, которое направлено на раз-

витие самостоятельности студентов и играет большую роль для стимуляции творческой и развития исследовательской деятельности учащихся в процессе обучения.

Ключевые слова

Проблемное обучение, инновационная технологиа, проблемная ситуация, проблемная задача, поисковая лабораторная задача.

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