CHEMICAL EDUCATION IN SECONDARY SCHOOL: CONTENTS OF COGNITIVE PROBLEMS

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INTRODUCTION

Currently, secondary school students are studying on different education profiles, only in three of which chemistry is a core among academic disciplines. The contents of basic level school textbooks of chemistry are not associated enough with life and with profile subjects. Many secondary school students who are studying chemistry at the basic level think that chemistry knowledge is not necessary. These students are exempt from control because they have not exam of chemistry. As a result, many students do not understand chemistry. Some of school-leavers, who was studied chemistry at the basic level, come to colleges, in which the curriculums in many professions contain an academic subject "Chemistry". In the absence of the basis of chemical knowledge, college course of chemistry remains unstudied.

THEORETICAL PART

Authors of textbooks have already begun work on the problem of teaching chemistry in humanities classes. O. Gabrielian believes that to overcoming the problems of teaching chemistry in classes of humanities disciplines teachers should: use techniques, methods and tutorial which are characteristic for the humanities sciences; demonstrate intersubject integration; disclose relation study material with future professional activities. [1, *167-171*]. He writes that in humanities classes, teachers should integrate chemical knowledge with literature, with art, with musical compositions, also should use humanities science methods [2, *18*]. E. Arshansky supposes that there is need to revise the contents, forms and methods of teaching chemistry for students in humanities classes with taking into account their individual psychological characteristics. These features, first of all, emotional-volitional characteristics, patterns of processes of perception and thinking, allow making the right choice of appropriate teaching methods [3]. In the humanities classes, where most students have a bright, imaginative vision of the world, the method of animation is efficient. For realization the method of animation we should endow inanimate objects the chemical world (elements, substances, materials, reaction) with traits of living objects [4, *19*]. Methods of chemistry training in other non-chemical profiles were not researched in detail.

PRACTICAL PART

In the senior classes of secondary schools of Russia, students are learning by 13 educational profiles (Table 1). To improve the results of teaching chemistry in each of the profiles we should realized interdisciplinary communications with profile disciplines.

The contents of chemistry course were described in the standard of school education. Variations can be achieved at the expense of contents of training problems. Consider what requirements should meet problems for chemistry training:

1) These problems should disclose the chemical side of a phenomenon at the level of requirements of the educational standard.
2) These problems should be integrated with disciplines which is studied by students on the profile level or with everyday life.
3) Problems should cause cognitive interest of students.

As the pedagogical experience shows, the using of such problems allows improving learning results of students.

Table 1

Profiles in the senior classes of secondary schools and profile subjects[1]

Profile	Main Subjects
Mathematical	Informatics, Mathematics, Physics
Biology-geographical	Mathematics, Geography, Biology
Socioeconomic	Mathematics, Geography, Social Studies, Economics, Law
Humanitarian	Social Science, History, Russian Language, Literature, Law
Philological	Literature, Russian language, foreign language, second foreign language
Information Technology	Mathematics, Informatics
Agrarian	Biology, Animal Husbandry, Agronomy, Farm machinery
Industrial	Physics, Technology
Art	Literature, Art
Physical culture	Physical training, Safety of life
Physical and chemical	Physics, Mathematics, Chemistry
Chemical	Mathematics, Chemistry
Chemical and Biological	Mathematics, Chemistry, Biology

EXAMPLES OF PRACTICAL SOLUTIONS

Mathematical profile

1) How many molecules are in the classroom under normal conditions? (Size of the classroom is $6\times10\times4$ m^3).

2) How many times the rate of chemical reaction should be increased at 25^0C in the presence of a catalyst, which reduces the activation energy of 20 kJ/mol? [5]

Biology-geographical profile

1) For healthy people, content of blood glucose in dependence on age should be between 3.3 to 6.6 mg/l. Taking the density of blood per 1 g/cm^3, calculate the mass fraction of glucose in the blood were normal.

2) Oil spill in the Gulf of Mexico, which was recognized the biggest in U.S. history, began on 22 April 2010 after an explosion at an oil platform owned by British Petroleum. Already by mid-May, according to expert evaluation to the ocean had flowed about 60000 barrels of oil. It is known that one ton of oil may cover an area of 12 km^2 on water surface. What proportion of the surface area of the Gulf of Mexico this oil can cover? For information: mass of 1 barrel of oil is 136.4 kg. The total area of the Gulf of Mexico is about 2.5 million km^2.

Socioeconomic profile

1) For ensuring the work within 1 year 1 lamp 100 watt requires energy, which can be obtained by burning 498 kg of wood, 490 kg of coal, 236 m^3 of natural gas. Energy-saving lamps can save up to 80% of electricity. Calculate what savings can be achieved for continuously working one energy-saving lamp during the year, in terms of firewood, coal, natural gas and electricity. Cost per ton of coal is 2100 rub., cost per 1 m^3 of wood is 800 rub., cost per 1 m^3 of natural gas is 3.1 rub., cost per 1 kWh of electricity is 3.4 rub., density of wood is 0.6 t/m^3.

2) The device GPC-D produces a concentrated solution of sodium hypochlorite by electrolysis of an aqueous solution of sodium chloride. Calculate the economic effect of the use of device GPC-D during the day, if the power consumption of installation is 1.2 kW, and productivity of active

[1] In various regions of Russia educational profiles in high school can differ

chlorine is 0.2 kg/h. Cost of 1 kWh of electricity is 3.4 rubles. 19% solution of sodium hypochlorite can be purchased at the price of 20 rubles for 1 kg.

Humanitarian profile

On that memorable day in 1811 a French scientist, Bernard Courtois, as usual, had breakfast at the table in his small chemical laboratory. Courtois' favorite tomcat was seated on his shoulder. On the table next to food two bottles stood, one of which was filled with an extract of marine algae in alcohol, the second bottle was filled with a mixture concentrated sulfuric acid with iron filings. Tomcat got tired to sit on his shoulder, and it jumped down, but awkward: the bottles rolled away to the floor and were broken. Liquids stored in these bottles were mixed, as a result of chemical reaction clubs violet vapor rose in the air. So iodine was discovered. Iodine has found application in medicine in the form of alcohol solution and Lugol solution.

Which rules for safe work in chemical laboratories B. Courtois had violated?

Which is the aggregate state of iodine under normal conditions?

How much iodine should be used to prepare 15 g of its 5% solution in alcohol?

Write the chemical equation, in which iodine was prepared in the laboratory Courtois.

Iodine is slightly soluble in water, but it is readily soluble in an aqueous solution of potassium iodide (Lugol solution). Write a chemical equation for explaining this property of iodine.

Philological profile

Students use the texts in a foreign language.

Industrial profile

1) Do you know that tennis balls have not inflated? Special substances have placed into these balls. These substances when heated decompose to gaseous products. In two blank hemispheres of the tennis balls which was smeared with glue are placed pill containing a mixture of sodium nitrite and ammonium chloride. Glued balls are placed in a form for vulcanization and heat. Write the chemical equation of sodium nitrite with ammonium chloride. Calculate the mass of tablet consisting of a stoichiometric mixture of sodium nitrite and ammonium chloride, which you must put into the ball, with the volume of 162 ml to achievement pressure inside the ball 1.2 bar. at 25^0C.

2) According to GOST 2874-54, after a 30-min contact chlorine with water at the output of sewage treatment plant, residual chlorine should be less than 0.5 mg / liter, and not less than 0.3 mg/l. n the most remote locations of water consumption, concentration of chlorine should be not less than 0.1 mg / liter. Calculate how much chlorine (at the normal condition) must be dissolved in 600 m^3 of purified water to obtain an initial concentration of chlorine 0.5 mg/liter.

Agrarian profile

1) We can use formaldehyde for the antifungal treatment of seed potato tubers. The working solution is prepared by diluting 40% aqueous solution of formaldehyde (formalin) with a water in the ratio 1:80. For the processing of 1 ton of potatoes we need 30 liters of working solution. How much of formalin we need for treatment of 2 sacks of potatoes (approximately 100 kg)? [6, *145*]

2) Allowable concentration of harmful gases in the pigsty is not more than: ammonia - 0.026%, hydrogen sulfide – 0.01%. We know that people feel the smell of ammonia at a concentration of 35 mg/m^3, and the smell of hydrogen sulphide - at a concentration of 1.4 -2.8 mg/m^3. Can we hope for our sense of smell for assessing air quality in a piggery? [6, *159*]

Physical and chemical

1) Halogen lamp - it is an incandescent lamp, in the flask of which was added iodine vapor. This increases the lifetime of the lamp up to 2000-4000 hours, and allows you to raise the temperature of the heating coil. Iodine reacts with evaporated tungsten atoms, forming tungsten iodide (II). Write the chemical equation of reaction tungsten with iodine. Explain how tungsten iodide (II) increases the lamp life?

2) As a result of a series of radioactive decays of uranium-235 transforms into lead-207. How many alpha-and beta-decays, includes this series of nuclear transformations? [5, *54*]

Chemical and Biological

1) MPC phenol in reservoir of water consumption is 0.001 mg / liter. Calculate in how many times the concentration of phenol will exceed MPC, if the reservoir with a capacity of 10^4 m^3 were dropped 47 kg of phenol.

2) Chlorine was the first chemical warfare agents. Germany has used chlorine April 22, 1915 at the valley Ypres against the French division. During gas attack 15 thousand people were poisoned, 5 thousand of them were died. How French could have prevented such large-scale poisoning, if they would know the chemical properties of chlorine?

Physical culture profile

Currently, we know several types of doping (Table 2).

Table 2

Effects and side effects of the main types of doping

Type of stimulant	Effects	Side effects
Anabolic steroid	increase of muscle mass, strength and endurance athlete	disrupting the functioning of the kidneys, may cause infertility and impotence
Diuretics	have diuretic effect, can applied for the rapid weight loss in sports with weight categories	disturb the metabolism, can cause dizziness, nausea, dehydration, damage kidneys
Beta-adrenoceptor antagonist	for reduce heart rate and tremor of hands	can lead to impaired cordial function, depression, sleep disorders, damage of sexual function
Peptide Hormones	increase of a level of red blood cells of athlete than increase strength and endurance of athlete	can lead to cardiac decompensation, diabetes, clotting of the blood (a heart attack, stroke)

Why doping have side-effects? Is it possible to develop drugs for athletes who do not have side effects? Argue your answer.

For all profiles

1) Find the weight of pure gold contained in the wedding ring made from white 14-carat gold (58.5%), decorated with 23 diamonds total weight 0.23 carats? Mass of ring is 3.8 grams (1 carat = 0.2 g).

2) Among the products of thermal decomposition of Teflon was detected a number of highly toxic compounds, most dangerous of which is considered oktafluoroisobuten (C_4F_8,) — extremely poisonous gas, which is more toxic than phosgene in 10 times. Write the structural formula of oktafluoroisobuten.

CONCLUSION

The using of training problems with intersubject content for teaching chemistry can improve learning interest and learning results of second school students

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ОБУЧЕНИЕ ХИМИИ В СТАРШЕЙ ШКОЛЕ: СОДЕРЖАНИЕ ПОЗНАВАТЕЛЬНЫХ ЗАДАЧ

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Summary

В настоящее время учащиеся старших классов общеобразовательных школ Российской Федерации обучаются в 13 общеобразовательных профилях, только в трёх из которых химия является профильной учебной дисциплиной. Практика показывает, что у школьников нехимических классов снижен интерес к изучению химии, к тому же эти учащиеся не сдают экзамен по химии и, как следствие, имеют низкие учебные результаты, не понимают химии, и не могут продолжать успешное изучение этой учебной дисциплины в вузах.

В наибольшей степени разработаны методы обучения химии в классах гуманитарного профиля. С рекомендациями по обучению химии в таких классах можно познакомиться в работах О.С. Габриеляна и Е.Я.Аршанского. Путём решения проблемы обучения химии в классах нехимических профилей может стать разработка учебных заданий, в которых химическое знание раскрывается на основе интеграции с учебными дисциплинами, изучаемых учащимися на повышенном уровне и с повседневной жизнью.

В статье приводятся примеры таких заданий для классов различных профилей. Например, для биолого-географического профиля предлагаются задания по химии связанные с содержанием глюкозы в крови и разливом нефти в Мексиканском заливе; для социально-экономического – с расчётами экономического эффекта при переходе на энергосберегающие лампы или при использовании установки для получения гипохлорита натрия в лечебном учреждении, для гуманитарного профиля – занимательная история открытия йода Бернаром Куртуа, для филологического профиля – задания на иностранном языке, для индустриального – задания связанные с производством теннисных мячей и расчётами при хлорировании питьевой воды, для аграрного профиля – с обработкой картофельных клубней и чистотой свинарников, для физико-химического – с физико-химическим механизмом увеличения продолжительности работы ламп накаливания и радиоактивным распадом, для химико-биологического – с ПДК и отравлением французских войск хлором в долине реки Ипр, для физкультурного – с классификацией и применением допингов и т.д. Применение подобных задач позволит развить познавательный интерес школьников к изучению химии и улучшить результаты обучения.

Ключевые слова: обучение химии в старшей школе, базовый уровень, межпредметное содержание учебных заданий.