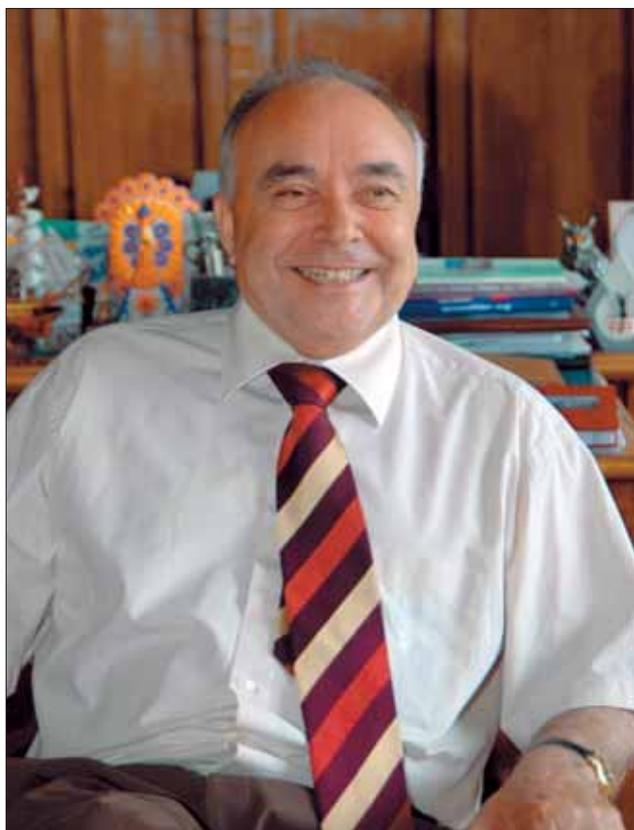




Chemistry  
Department  
of Moscow  
State University





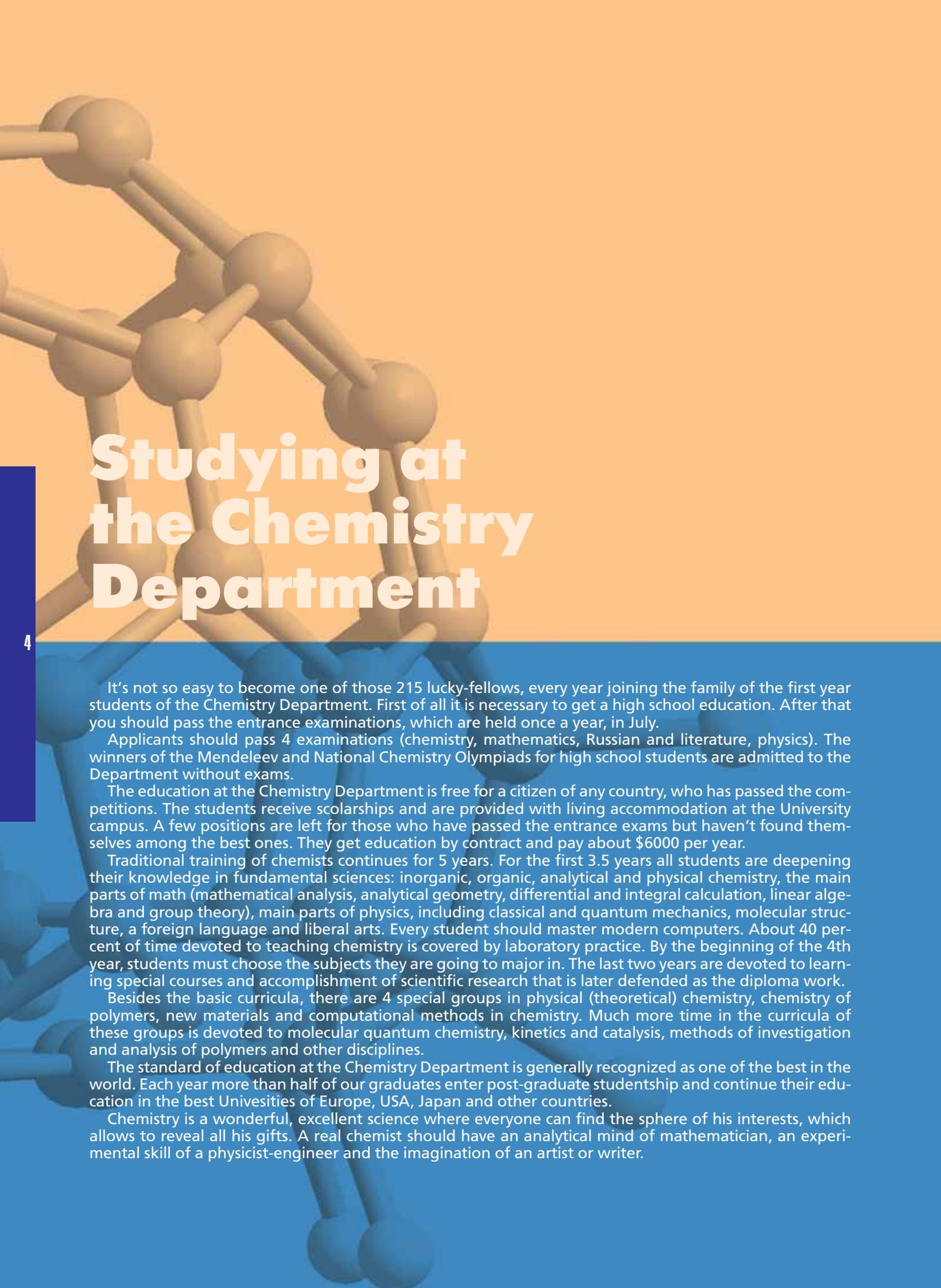
Dean of the Chemistry Department,  
Academician  
of Russian Academy of Sciences,  
Professor V.V. Lunin

## Dear friends!

I invite you to the Chemistry Department of the Moscow State University named after M.V. Lomonosov. All my life is closely connected with this educational and research science centre: once I studied here and now I work here for many years. I like my Department and every time I enter it, I do it with deep emotion.

Chemistry occupies an exceptionally important, central position among other natural sciences. The sphere of modern chemists' interests is extremely broad. They create new materials possessing unique properties, new sources of energy, new medicines, plant protectants and fertilizers. They penetrate into the mystery of a living cell, which is the most perfect and complex chemical reactor to use the obtained knowledge for creating safe and wasteless technologies on the principles of living nature. While studying the transformation of chemical compounds in atmosphere, water and soil, chemists find means of protection and ways of preservation all the environment's richness and variety. So a considerable amount of chemical knowledge becomes an indispensable element of culture for anyone in our society.

The Chemistry Department of the Moscow State University is the most advanced and oldest chemistry school in Russia. Many generations of outstanding chemists whose merits are universally recognized were educated at our Department. Our doors are always open for gifted young people from all over the world, for everyone who is willing to devote himself to splendid and fascinating chemistry science full of mysteries. You are welcome to the Chemistry Department.



# Studying at the Chemistry Department

4

It's not so easy to become one of those 215 lucky-fellows, every year joining the family of the first year students of the Chemistry Department. First of all it is necessary to get a high school education. After that you should pass the entrance examinations, which are held once a year, in July.

Applicants should pass 4 examinations (chemistry, mathematics, Russian and literature, physics). The winners of the Mendeleev and National Chemistry Olympiads for high school students are admitted to the Department without exams.

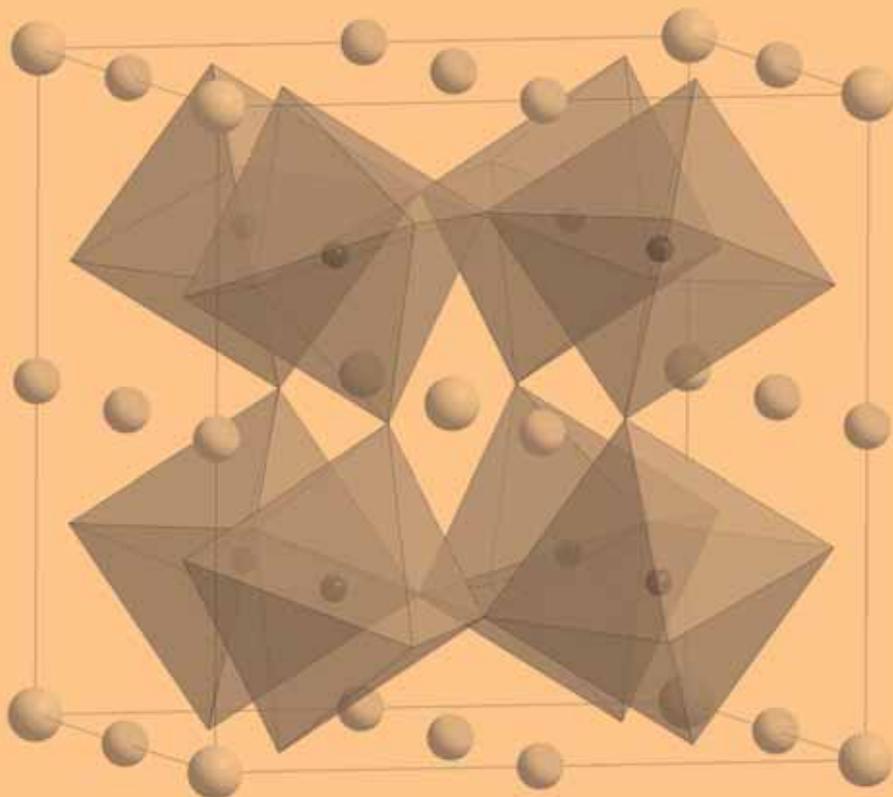
The education at the Chemistry Department is free for a citizen of any country, who has passed the competitions. The students receive scholarships and are provided with living accommodation at the University campus. A few positions are left for those who have passed the entrance exams but haven't found themselves among the best ones. They get education by contract and pay about \$6000 per year.

Traditional training of chemists continues for 5 years. For the first 3.5 years all students are deepening their knowledge in fundamental sciences: inorganic, organic, analytical and physical chemistry, the main parts of math (mathematical analysis, analytical geometry, differential and integral calculation, linear algebra and group theory), main parts of physics, including classical and quantum mechanics, molecular structure, a foreign language and liberal arts. Every student should master modern computers. About 40 percent of time devoted to teaching chemistry is covered by laboratory practice. By the beginning of the 4th year, students must choose the subjects they are going to major in. The last two years are devoted to learning special courses and accomplishment of scientific research that is later defended as the diploma work.

Besides the basic curricula, there are 4 special groups in physical (theoretical) chemistry, chemistry of polymers, new materials and computational methods in chemistry. Much more time in the curricula of these groups is devoted to molecular quantum chemistry, kinetics and catalysis, methods of investigation and analysis of polymers and other disciplines.

The standard of education at the Chemistry Department is generally recognized as one of the best in the world. Each year more than half of our graduates enter post-graduate studentship and continue their education in the best Universities of Europe, USA, Japan and other countries.

Chemistry is a wonderful, excellent science where everyone can find the sphere of his interests, which allows to reveal all his gifts. A real chemist should have an analytical mind of mathematician, an experimental skill of a physicist-engineer and the imagination of an artist or writer.



# HISTORY

Moscow State University was founded on January 25, 1755. The initiative of its foundation belongs to an outstanding scientist and poet Mikhail V. Lomonosov. Chemists of Russia are familiar with M.V. Lomonosov due to his experiments in generating multicoloured glasses and his interesting concepts on the combustion process and nature of heat energy. The first building of the Moscow University (not survived) was located near the Kremlin on Red Square, opposite to the St. Basil's Cathedral. Already in that building there was a small chemical laboratory where students performed simple experiments, e.g. prepared tinctures out of amber or obtained sulphur through the reaction of turpentine with concentrated sulphuric acid. During that time, the most labour consuming chemical task was getting phosphorus from urine.

At the end of the 18th century Moscow University moved to a new marvelous building constructed not far from the Kremlin on the order of Empress Catherine the Great. Soon a drugstore was joined to it where a new chemical laboratory was accommodated. However, for a long period of time only medical staff that did not succeed in setting up a chemical school at the University was teaching there. By 1870s, the situation with teaching chemistry became critical. Lectures on the subject were not delivered, the laboratory was in a wretched state, and laboratory assistants were engaged in preparing before the holidays a few buckets of vodka brewed on herbs for the University authorities.

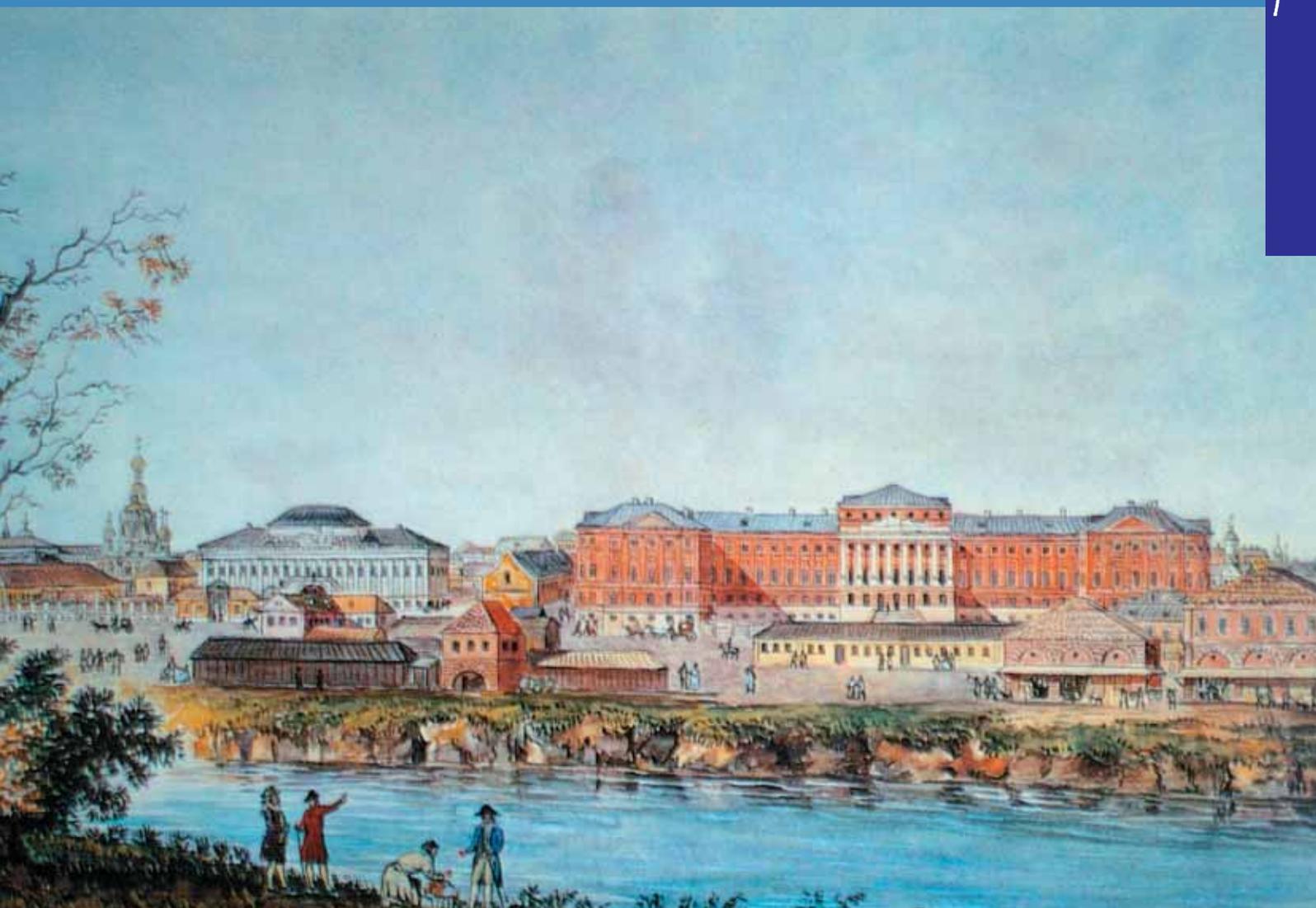
Catherine II in the Laboratory of M.V. Lomonosov. Artist A. Kivshenko





Drugstore Building on Red Square (on the left),  
where the Moscow University was opened

Mokhovaya Street in the late 18th century.  
Building of the Moscow University



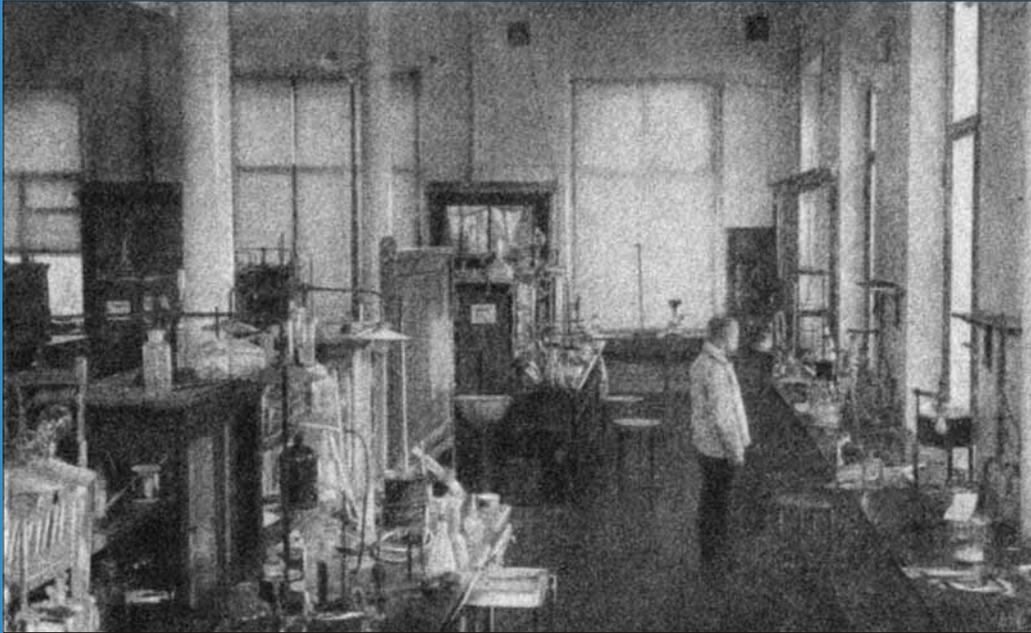


Professor  
V.V. Markovnikov

In 1873, professor Vladimir V. Markovnikov (1837–1904) started to teach chemistry in the Moscow University. He was a representative of the Kazan school, well known by that time for his works in the field of organic chemistry. Being a remarkable personality, he worked wonders. Years of his hard and persistent work resulted in establishing stable full-fledged chemistry teaching at the Moscow University, set up of a laboratory of European standards and systematic research work with the students' participation. At the same time, V.V. Markovnikov didn't indulge students and trained them to be self-dependent. He used to repeat, "one should never... put fried pigeons into the mouth." With his coming, a number of students who chose chemistry for studying grew continuously as well as an amount of scientific papers published on the subject.

A considerable part of those publications was dedicated to the examination of oil composition. V.V. Markovnikov and his disciples found a new class of compounds – naphthenes (alicycles) and called them "chemical corpses" due to their low reacting capability. Experiments in classical organic chemistry were also performed. Thus, Y.V. Lermontova, one of the first Russian women-chemists, synthesized glutaric acid in the University laboratory.

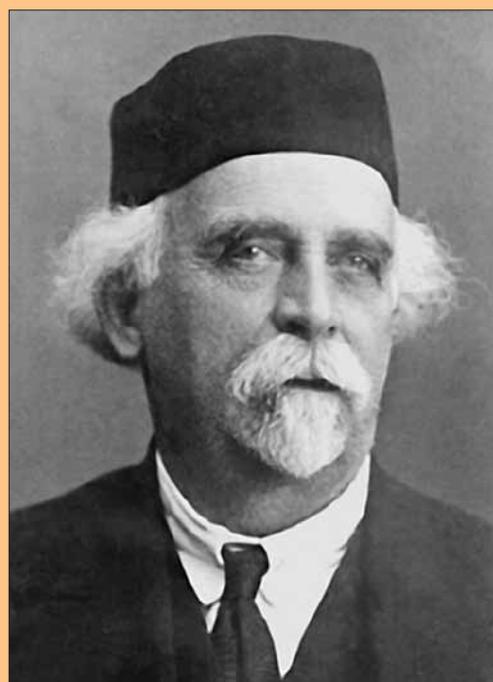
Once V.V. Markovnikov had to conduct a unique for that time research in chemistry: to prove that an image of Christ on the icon in one of Moscow hospitals did not have a divine origin. V.V. Markovnikov's disciples who were going to dedicate themselves to science continued to work in the laboratory of the Moscow University, some of them later left for other universities and higher educational institutions or found employment at the factories. That is how a celebrated Markovnikov school had been taking shape – the first school of chemists at the Moscow University.



Laboratory in the "Red Building"



The Moscow University. Artist K. Yuon



Professor  
N.D. Zelinsky

In 1893, a position of the Chemistry Division's head passed to Nikolai D. Zelinsky (1861–1953). He continued to research into oils and found a method of "reviving chemical corpses" – a reaction of cyclohexane hydrocarbons' dehydrogenation to aromatic compounds on platinum catalyst. With N.D. Zelinsky, the chemical laboratory of the University was considerably expanded due to the construction of an extension to the old building. The new structure was faced with red brick and got the name of a "Red Building".

In 1911, N.D. Zelinsky together with 130 other professors left the Moscow University in protest to the authorities' actions when police was brought to the University to stop students' disturbances (that was strictly prohibited by the Charter of the University). N.D. Zelinsky came back only in 1917, after the Revolution and Bolsheviks' power establishment. He was one of the few professors who did not leave abroad in those days. N.D. Zelinsky attempted to put the work in order in the new environment. That was a challenge in the conditions of total ruin and devastation that reigned in the country after the civil war. There was no heating in the chemical laboratory, salaries were not paid, and most professors had to sell the family funds to avoid starvation. N.D. Zelinsky's wife then composed this song:

No tea and no bear,  
No sugar, no wine,  
Now I understand, my dear,  
That I am a chemist's wife.



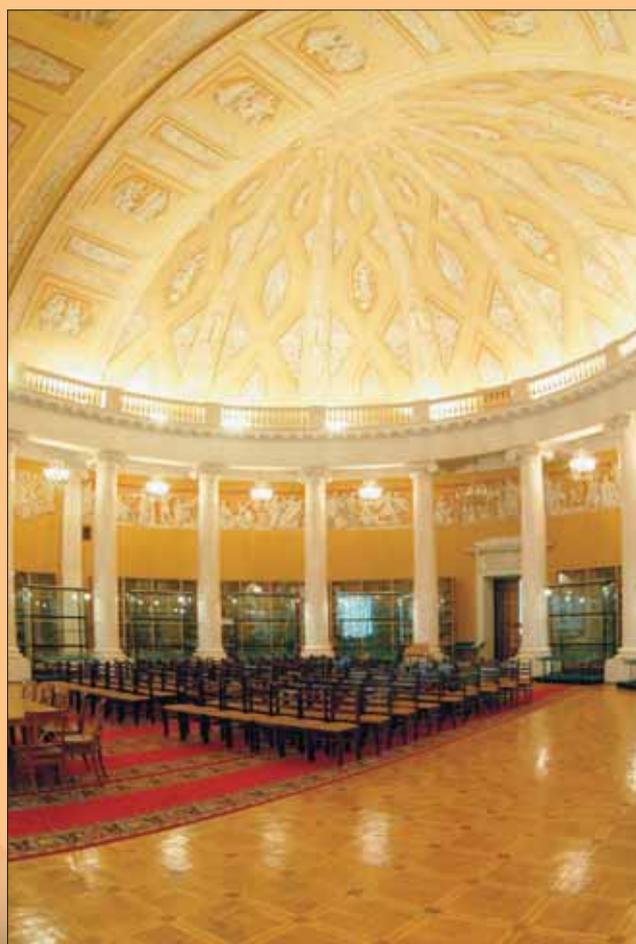
N.D. Zelinsky in Chemical Laboratory

"White Building" at Mokhovaya Street





The University's  
Assembly Hall



Nevertheless, even under those conditions research work continued in the chemical laboratory by the efforts of the people tremendously devoted to science, its results were published in papers. Scholars of other countries reading afterwards those publications were surprised that many experiments were conducted under  $8^{\circ}\text{C}$  temperature. Obviously, that was the "room temperature" in the premises (scientists had to work in the smocks put over the warm overcoats).

In the mid-1920s, with the establishment of the Soviet Union a campaign started on launching a powerful chemical industry in the country that required specialists in the chemical area. The number of students specializing in chemistry grew considerably, that required setup of a separate Chemistry Department. The formation of the Chemistry Department started in 1926, though it was formally opened only on October 29, 1929. The Department obtained the building of the former anatomical theatre where medical students studied earlier. The building was painted white, and therefore it got the name of the "White Building". All students of the Chemistry Department moved to it, except those engaged in the organic chemistry, they stayed in the "Red Building".

It is interesting that the first Dean of the Chemistry Department was Evgeny P. Troitsky, a soil scientist, and the second – Vasily V. Potyomkin, a politician and physician (on some accounts, he was one of Stalin's personal physicians). Only the third Dean, Adam V. Rakovsky, who originated from a Polish family, was a "classical" chemist, a specialist in the area of chemical thermodynamics.

In the late 1920s and mid-1930s, chemists of the Moscow University made a number of significant discoveries. Thus, P.A. Rebinder discovered an effect of mechanical decrease of solids' strength because of a reversible environment's physical and chemical impact. A.A. Nesmeyanov proposed a diazo method of synthesis of organometallic compounds. A.N. Frumkin established a link between the rate of electrochemical reaction and the structure of the electrode/solution's division border. Yu. K. Yuriev discovered reactions of mutual catalytic conversion of pyrrole, thiophene and furan.

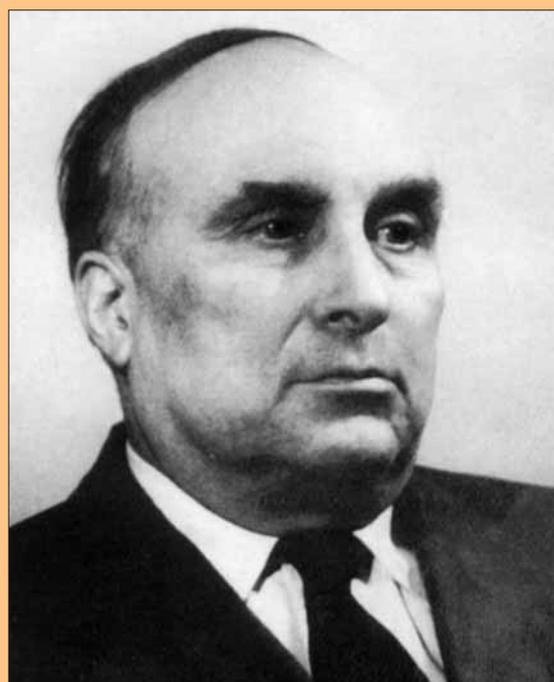


Memorial to the Chemists Perished during the Great Patriotic War of 1941–1945

Unfortunately, this period in the Department's history as well as a subsequent decade were overshadowed by the repressions of the teaching staff and students during the time of Stalin purges. Thus in 1929, Evgeny I. Shpitalsky, one of the most talented University professors, the author of research in catalysis and electrochemistry and a Corresponding Member of the USSR Academy of Sciences was arrested on a false charge. He was sentenced to many years of compulsory labour and died in confinement. In 1949, Alexey A. Balandin, an Academician and an author of the multiplet catalysis theory, was arrested (for the second time) and sentenced to exile. Irrespective of the renowned chemists' petitions on release of the Academician, he could return to the University only after a number of years.

By 1940s, a constellation of students and young scientists was formed at the Department that belonged to the after-revolution generation and many of them sincerely believed that it was possible to build a "bright communist future." They were going to work vigorously "for the benefit of Soviet science." However, the Great Patriotic War started in 1941 ruined striking plans of the young scientists. The devastating war wrecked normal course of life at the Chemistry Department and took lives of its many students, post-graduates, and employees. Thus in 1941, L.E. Agronomov, a young gifted post-graduate, the author of three research works on boranes' structure theory, left for the front and was killed. In his last letter, he describes their attempt to break out from the encirclement, "We move slowly... Food is running out. We count the last crusts of bread. The Commissar treated me to a tiny piece of cheese and said, "Remember the taste of cheese"...

During the war a part of the Department was evacuated, though some employees stayed in Moscow. Here under the guidance of Nikolay V. Kostin works for the defense potential were going on: methods of detecting toxic substances were developed and synthesis of sulfamide medications set up. At the period from 1943 to 1945, the evacuated part of the Department returned to Moscow.



Academician  
A.N. Nesmeyanov

After the war, Alexander N. Nesmeyanov, an outstanding chemist, was appointed Dean of the Chemistry Department. Works were developed at the Department on chemistry of elementorganic substances and later on research of sandwich compounds of the ferrocene's type and its analogues. Incidentally, in those days Russian public was totally unaware of the word "sandwich," that is why ferrocene and its analogues were called in Russian "bread-and-butter compounds" that did not precisely reflect their structure. It is noteworthy that A.N. Nesmeyanov initiated works on development synthetic food, including protein-based black caviar that appeared on sale in the shops.

In 1951, there happened an unpleasant episode in the scientific biography of A.N. Nesmeyanov and other scientists engaged in organic chemistry. It was connected with the criticism of the "resonance theory" by a well-known American chemist Linus Pauling. This theory was proclaimed "idealistic" and "bourgeois," and its supporters were subjected to attacks by a group of little known chemists and public figures. In one of his research papers A.N. Nesmeyanov explained the difference of reacting capability of mercury containing chlorvinyl compounds by a "resonance" between their covalent and ionic structures, however, during the described debate on the "resonance theory" he had to abandon the concept. Fortunately, none of Russian chemists suffered any harm physically, as it happened in other fields of science, though Pauling's theory was removed from all Soviet textbooks in organic chemistry for long.



Construction of the Main MSU Building. 1950

Besides being a talented scientist, Alexander N. Nesmeyanov was an outstanding organizer of science. In 1948, he became Rector of the Moscow University. It was specifically on his initiative that a construction of the new huge complex of the Moscow University on Vorobjovy Gory (then Leninskiye Gory) started. In 1953, the construction was practically completed and the Chemistry Department got an accommodation in a separate building, which area exceeded the area of its previous buildings in 40 times. The major part of the Chemistry Department is still located there, though some laboratories and divisions are located in separate buildings. A.N. Nesmeyanov and A.V. Novosyolova, the Dean of the Chemistry Department (an Academician of the USSR Academy of Sciences from 1970) were at the head of the transfer from the old building to the new one. They took an active part in developing designs of the Chemical Department's laboratories, selecting devices, equipment, visual aids, furniture, and even pictures decorating the rooms and corridors. It is interesting that there were plans to engrave on the building several quotations from the works of outstanding chemists and speeches of the communist leaders of the country. For this purpose special niches were made on the building. Later the plan was abandoned, though the niches survived to present day.



Academician  
N.N. Semyonov

The relocation to the new Chemistry Department's building did not take place at once, it took about a year, therefore it caused certain complications to the scientific experimental work. Thus in 1954, the compressed air was not provided to the building on Vorobjovy Gory and employees had to use a vacuum cleaner to unsolder ampoules or blew into the burners themselves. Finally, all the communications were set up and high quality equipment purchased. Models, layouts, training films and other materials were prepared for the learning purposes.

A transfer to the building on Vorobjovy Gory marked a very significant milestone not only for the development of the Department, but also for the chemical education and science in the country. A considerable extension of the floor space, a good quality equipment and increase in the number of employees enabled to achieve an extremely high level of educational and scientific work. In the 1950s, two new divisions were inaugurated at once – of high-molecular compounds and radiochemistry. An award of Nobel Prize to Professor Nikolai N. Semyonov (together with British scientist C. Hinshelwood), the head of the Chemical Kinetics' Division, for his papers on chemical reactions' mechanism was a great event at the Department. It is interesting that in the Soviet Union a branching chain reaction theory by N.N. Semyonov was first attacked in the early 1950s, exactly the way the "resonance theory" had been accused. However, the Nobel Prize terminated those attacks and radically changed the attitude to N.N. Semyonov in the governmental circles. Nikolai Nikolayevich Semyonov is the only Nobel Prize winner in chemistry among Russian scientists.



The Chemistry Department today



Lecture of Academician A.N. Nesmeyanov in the Big Chemical Auditorium (1st September, 1953)



Throughout 1960s – 1980s, research was carried out at the Chemistry Department practically in all major areas of chemical science. Gifted chemists that became academicians started or continued their productive activity at the University: Victor I. Spitsyn, Ivan P. Alimarin, Oleg A. Reutov, Nikolai M. Emanuel, Leonid F. Vereschagin, Valentin A. Kargin, Semen I. Vol'fkovich, Alexei A. Balandin, Petr A. Rebinder, Alexander N. Frumkin, Nikolai N. Semenov, Alexandra V. Novoselova, Alexander N. Nesmeyanov, Boris A. Kazanskii, Valery A. Legasov, Irina P. Beletskaya, Nikolai S. Zefirov, Victor A. Kabanov, Nikolai A. Plate, Nikolai F. Bakeyev, Valery V. Lunin, Yurii A. Zolotov, Alexei A. Bogdanov, Yurii D. Tret'yakov, Anatolii L. Buchachenko. During those years, Soviet science became less dependant on the authoritative guidelines, and, overall, the conditions for research work were quite favourable. Certain "distractive aspects" were linked with the specifics of the socialist system's management and revealed themselves in mandatory participation of students and the Department's employees in agricultural works. One – two times a year they had to go to the vegetables' store cellars to sort out vegetables. For sophomores the trips to the country to harvest potatoes in the fields were mandatory during the whole September. Here is a typical quotation from the Department's wallpaper in 1975, "In 1975, the students harvested 4.8 thousand tonnes of potatoes and root vegetables from the area of 316 hectares and fulfilled the plan for 126,4%".

These mandatory agricultural works were abolished only in the early 1990s, when economic reforms started to be vigorously carried out. These years were quite difficult for the Department, as well as for the majority of scientific and educational institutions in the country. A transition to the market economy along with preserving a traditional system of free education resulted in a sharp reduce in financing the teaching staff and research work. The circumstances concerned gave impetus to an increased outflow of employees abroad. This phenomenon acquired such a huge scale that a special term was coined to designate it – "brain drain." What is interesting, letters with admiration of those employees' level of knowledge and freshness of thinking started to come from the leading professors of Western universities who accepted the former staff of the Moscow University's Chemistry Department in their laboratories.



Academician V.V. Lunin – the first elected Dean of the Chemistry Department

An emergence of democracy elements in the administrative system was one of the positive aspects of the early 1990s' difficult period. Thus, the Dean position became elective, and in 1992, for the first time in the history of the Department the elections based on alternative vote were held (there were four nominees for the position). Professor Valery V. Lunin (from 2000, an Academician of the Russian Academy of Sciences) was elected Dean. He heads the Department at present.

Valery Vasilievich was born in 1940 in the remote village Red Horn of Bryansk region. In the seventh grade he heard a song on the radio about a "great and majestic Moscow University" and made up his mind to enter it. This child's dream came true. V.V. Lunin graduated from the Chemistry Department of the Moscow University in 1967 and worked at the Division of Oil Chemistry and Organic Catalysis and later at the Physical Chemistry's Division where he organized works on researching an impact of non-conventional types of energy on solids' properties, and ozone chemistry.

Valery Vasilievich is whole-heartedly committed to the Chemistry Department and works consistently on improvement of the chemical education in the country. In the beginning of 1990s, V.V. Lunin managed to revive and maintain all stages of the secondary schools' Chemistry Olympiads (contests) and inaugurate a branch of the Chemistry Department in a small town Chernogolovka in the Moscow region. For these accomplishments, he was awarded with a prize of the President of the Russian Federation.

By the late 1990s and early 2000s, the situation with scientific research work in the country improved considerably. The workers of the Department are provided with vast opportunities for international cooperation in science. Gradually a system of grants for scientific research work has developed. Presently the Chemistry Department is one of the best departments of the Moscow University and Russia's largest centre of chemical education and science.



M.V. Lomonosov – the first Russian chemist, founder of Moscow University

# CHEMIST'S OATH

Receiving with sincere appreciation the knowledge bestowed on me  
And attempting to perceive the mysteries of chemical science,  
I swear by the names of Mikhail Vasilievich Lomonosov,  
Dmitry Ivanovich Mendeleev,  
Alexandr Mikhailovich Butlerov  
And by the names of all our Teachers:  
not to cast a shadow on the honour of the chemical brotherhood that I  
now embark upon throughout my entire life.

*I do swear!*

I will reckon Disciples of Him who taught me equally dear to me as my  
brothers and sisters, and impart my knowledge and that of the Teacher's  
to the offsprings, augmenting it selflessly.

*I do swear!*

I will abstain from using my knowledge for whatever is deleterious to  
a Human Being, Nature, the Fatherland, and the Alma mater that had  
nurtured me. I will not be engaged in preparation or sale of clandestine  
substances and give no deadly or prohibited remedies to anyone,  
if asked.

*I do swear!*

I promise to keep this Oath unreservedly.  
May it be granted to me to enjoy life and the practice of my work  
and respect in all times!  
Should one violate this Oath, or swear falsely, may he/she be rejected by  
our entire community and consigned to oblivion for all times.

*I swear! I swear! I swear!*



*The Ceremony is being held at Chemistry Departments  
of Classical Universities since 2000.*

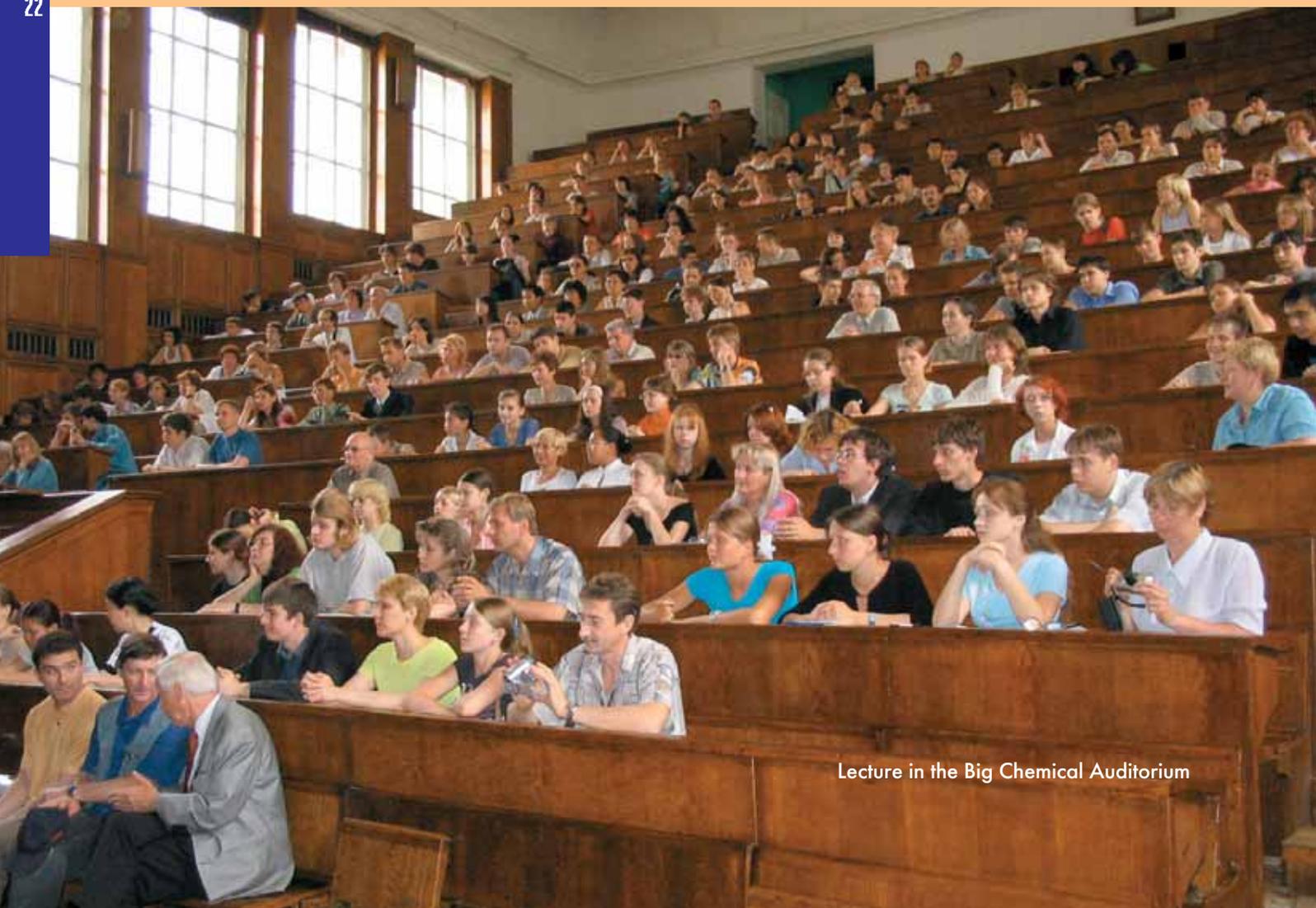
# EDUCATION

The Chemistry Department of the Moscow State University is the best and one of the biggest chemistry schools of Russia. A number of generations of remarkable chemists whose names have been written in the history of Russian and world science were trained here. The doors of the Chemistry Department are always widely open for talented young people from all over the world, for all those who seek knowledge, who is not afraid of difficulties and is ready to contribute to remarkable, fascinating and full of secrets chemistry science.

Educational and scientific process at the Department is marked by the broad scope of scientific objectives, their deep research and sustainable connection of fundamental research and its practical application. At present the team of the Chemistry Department has more than 1800 employees, among them there are 270 professors, senior lecturers, senior teachers, assistants, 850 scientific researchers, 675 engineers, technicians, laboratory workers and administrative and management personnel. Among teachers and researchers there are 230 doctors of science and more than 750 candidates of science.

Over 1100 students and 275 post-graduates are trained at the Department. Post-graduate students specialize in more than 20 fields of chemistry, physics and chemistry, biology and pedagogical sciences.

High educational and scientific potential of MSU Chemistry Department enjoys wide recognition all over the world. The largest scientific institutions and companies are interested in and highly appreciate specialists who graduated from the MSU's Chemistry Department.



Lecture in the Big Chemical Auditorium



Rector of MSU V.A. Sadovnichy with a Student of the Chemistry Department

# Curricula

## The 1st year First half-year (18 weeks)

Subject	Hours			
	Lectures	Seminars	Labs	Total
Inorganic chemistry	72	36	144	252
Mathematical analysis	54	54	–	108
Computers and programming	18	18	18	54
Professional training	18	–	–	18
Analytical geometry	18	36	–	54
History of Motherland and native culture	36	36	–	72
Foreign language	–	72	–	72
Sports and physical training	–	–	72	72

## Second half-year (16 weeks)

Subject	Hours			
	Lectures	Seminars	Labs	Total
Inorganic chemistry	64	32	96	192
Mathematical analysis	48	32	–	80
Computers and programming	–	16	32	48
Linear algebra	16	32	–	48
Mechanics and electrostatics	32	32	32	96
History of Motherland and native culture	8	32	–	40
Foreign language	–	64	–	64
Sports and physical training	–	–	64	64
Research project in inorganic chemistry	10 weeks			

## Additional subjects for specialized groups

### 110. Chemistry of polymers

1. Introduction to polymer chemistry (first half-year, lectures (36 h)).
2. Macromolecules in the surrounding world (second half-year, lectures (16 h)).

### 112. Chemistry of new materials

1. Inorganic materials (first half-year, lectures (18 h) and seminars (18 h)).

2. Elements of statistical physics (first half-year, lectures (36 h) and seminars (18 h)).

3. Solid state physics (second half-year, lectures (32 h) and seminars (32 h)).

### 113. Computational methods in chemistry

1. Quantum mechanics and structure of matter (first half-year, lectures (72 h) and seminars (54 h)).

2. Mathematical methods in chemistry (all year, lectures (68 h) and seminars (52 h)).

## Lecture courses on main subjects INORGANIC CHEMISTRY

### First half-year

1. Introduction to inorganic chemistry. First Law of thermodynamics
- 2-3. Second Law of thermodynamics
4. Chemical equilibrium
5. Phase equilibria, phase diagrams
- 6-7. Solutions
8. Bases of chemical kinetics
9. Electronic structure of an atom
- 10-11. Chemical bonding
12. Periodic Law
13. Hydrogen 14-16. Halogens
- 17-18. Elements of 16 (VIA) group
- 19-21. Elements of 15 (VA) group
- 22-23. Elements of 14 (IVA) group
24. Boron
25. Noble gases
26. General properties of non-metals
27. General properties of metals. Zone theory

### Second half-year

28. Alkaline and alkaline-earth metals
29. Aluminium and elements of 13 (IIIA) group
30. Complexes. The method of valence bonds.
31. Complexes. Crystal field theory
32. Complexes. MO method
33. Elements of 4 (IVB) group
34. Elements of 5 (VB) group
- 35-36. Elements of 6 (VIB) group
37. Elements of 7 (VIIB) group
38. Iron, cobalt, and nickel
39. Methods of structure determination of inorganic substances
40. Platinum elements
41. Elements of 11 (IB) group
42. Elements of 12 (IIB) group
43. General properties of J-elements
44. Solid state chemistry
45. Elements of 3 (IIIB) group and lanthanides
46. Chemistry of *f*-elements
47. Bio-inorganic chemistry



## MATHEMATICAL ANALYSIS

### First half-year

1. Separability axiom. Upper and lower bounds.
  2. Collapsing segments.
  3. Limit points.
  4. Limit of a sequence, limit of a function.
- Infinitesimals. Arithmetic properties of a limit.
5. Limits in inequalities. Calculation of

$$\text{Calculation of } \lim_{x \rightarrow 0} \frac{\sin x}{x}.$$

6. Limit of a monotonous bounded function.
7.  $e$  number.
8. Cauchy criterion for the existence of a limit of a sequence, a limit of a function.
9. Continuity. Points of discontinuity. Properties of continuous functions.
10. Continuity of elementary functions.
11. Comparison of functions. Calculation of limits

$$\lim_{x \rightarrow 0} \frac{\ln(1+x)}{x}, \lim_{x \rightarrow 0} \frac{a^x - 1}{x}, \lim_{x \rightarrow 0} \frac{(1+x)^u - 1}{x}.$$

12. Intermediate values of a function which is continuous on a segment.
13. Boundedness of a function which is continuous on a segment.
14. Uniform continuity. Cantor's theorem.
15. Derivative, its main properties.
16. Differential. Invariance of a form of a first differential.
17. Derivatives and differentials of higher orders.
18. Ferma and Roll's theorems. Necessary conditions for the extremum of a function.
19. Lagrange's and Cauchy theorems.
20. Taylor's formulas.
21. Taylor's expansions of functions  $e^x$ ,  $\sin x$ ,  $\cos x$ ,  $\ln(1+x)$ ,  $(1+x)^u$ .
22. Lopital's rules.
23. Monotony of a function. Sufficient conditions for extremum.
24. Convexity of a function graph.

### Second half-year

25. Antiderivative. Indefinite integral and its properties.
26. Integration of rational functions.
27. Integration of expressions containing radicals.
28. Integration of trigonometric functions.
29. Definite integral, its geometrical interpretation. Necessary condition of integrability.
30. Darboux sums and their properties.
31. Criterion of integrability.
32. Integrability of continuous and monotonic functions.
33. Properties of an integral. Theorem about an average value.
34. Integral with variable upper limit. Newton-Leibniz formula.
35. Area of a figure in rectangular and polar coordinates.
36. Length of an arc.
37. Volume of a body. Area of a surface of revolution.

38. Improper integrals. Convergence of integrals

$$\int_a^{+\infty} \frac{dx}{x^p}, a > 0, \int_a^b \frac{dx}{(x-a)^q},$$

39. Absolute convergence of integrals.
40. Partial derivatives. Differentiability of a function of many variables. Sufficient condition for differentiability.
41. Derivatives of a composite function. Mixed derivatives. Differential of the  $n$ -th order.
42. Directional derivative, gradient.
43. Tangential plane and normal to surface. Surface of level.
44. Taylor formula for a function of many variables.
45. Extremum. Necessary condition for an extremum.
46. Sufficient conditions for an extremum of function of two variables.
47. Implicit function and its derivatives.
48. Conditional extremum.

## COMPUTERS AND PROGRAMMING

1. Computer as a universal tool for information processing.
2. Operational systems.
3. Text processing.
4. Spreadsheets.
5. Relational databases.
6. Computer networks.
7. Electronic presentations.
8. Programming languages.
9. Programming language Pascal.
10. Computational methods in chemistry: summation, integration, regression.
11. Computational methods in chemistry: solving algebraic and differential equations.



## The 2nd year

### First half-year (18 weeks)

Subject	Hours			
	Lectures	Seminars	Labs	Total
Analytical chemistry	36	36	126	198
Mathematical analysis	36	36	–	72
Probability theory	36	36	–	72
Oscillations. Optics	36	36	72	144
Philosophy	36	36	–	72
Foreign language	–	72	–	72
Sports and physical training	–	–	72	72

### Second half-year (16 weeks)

Subject	Hours			
	Lectures	Seminars	Labs	Total
Analytical chemistry	32	32	96	160
Mathematical analysis	32	32	–	64
Equations of mathematical physics	16	32	–	48
Elementary quantum mechanics	16	32	–	48
Theoretical mechanics	16	32	–	48
Philosophy	32	32	–	64
History of MSU Chemistry Dept.	32	–	–	32
Foreign language	–	64	–	64
Sports and physical training	–	–	64	64
Special training	–	128	–	128
Research project in inorganic chemistry	10 weeks			

### Additional subjects for specialized groups

#### 210. Chemistry of polymers

1. Radiochemistry and radioecology (first half-year, lectures (36 h) and labs (36 h)).
2. Numerical methods in polymer chemistry (all year, lectures (68 h) and seminars (32 h)).

#### 211. Physical (theoretical) chemistry

1. Differential equations (first half-year, lectures (36 h) and seminars (36 h)).
2. Classical mechanics and field theory (second half-year, lectures (48 h) and seminars (48 h)).

#### 212. Chemistry of new materials

1. Differential equations (first half-year, lectures (36 h) and seminars (18 h)).
2. Theoretical and quantum mechanics (second half-year, lectures (16 h) and seminars (32 h)).
3. Solid state structure (second half-year, lectures (16 h) and seminars (32 h)).

#### 213. Computational methods in chemistry

1. Computational and programming methods (all year, lectures (34 h), seminars (16 h) and labs (18 h)).

## Lecture courses on main subjects

### ANALYTICAL CHEMISTRY

1. Introduction to analytical chemistry.
2. Metrological bases of chemical analysis.
3. Sampling and sample preparation.
4. Main types of chemical reactions and processes in analytical chemistry: acid-base reactions, complexation, redox reactions, precipitation.
5. Methods of detection and identification.
6. Methods of isolation, separation, and concentration.
7. Chromatography.
8. Gravimetry.
9. Titration methods of analysis.
10. Kinetic methods of analysis.
11. Electrochemical methods of analysis: potentiometry, coulometry, voltammetry.
12. Spectroscopic methods of analysis.
13. Atomic optical spectroscopy.
14. Molecular optical spectroscopy.
15. X-ray spectroscopy.
16. Other physical methods: mass-spectrometry, ESR, NMR, Mossbauer spectroscopy.
17. Automation of analysis and use of computers in analytical chemistry.
18. Main objects of analysis.

### MATHEMATICAL ANALYSIS

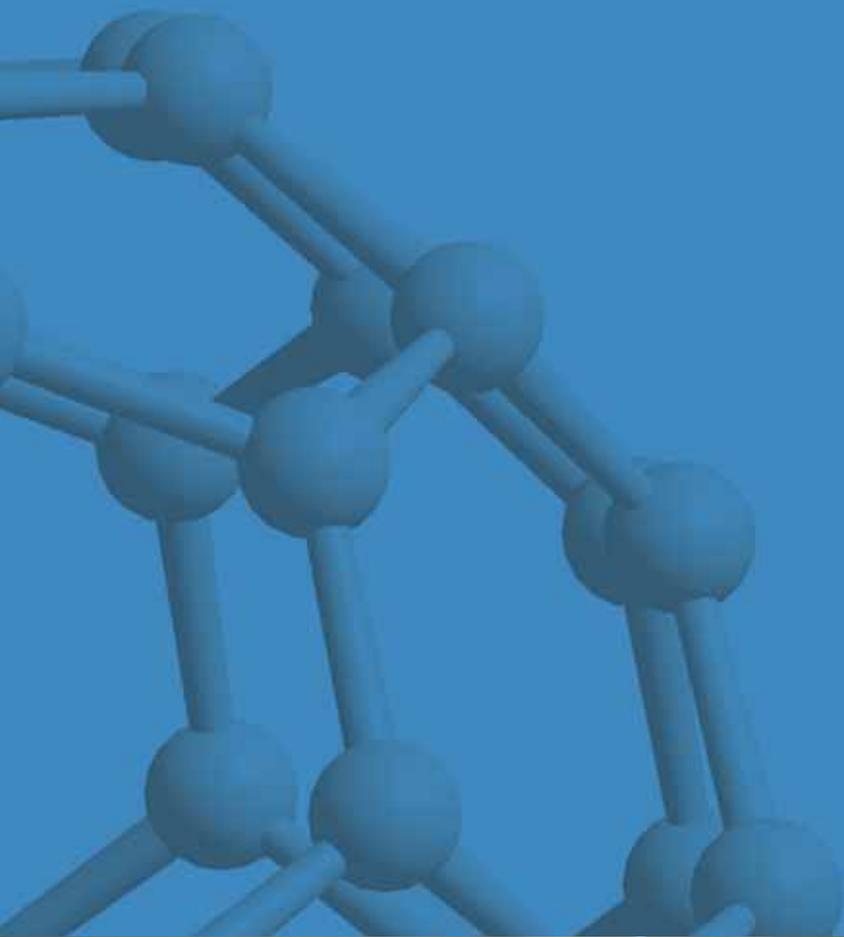
#### First half-year

1. Number series. Cauchy criterion for their convergence. Properties of converging series.
2. Series with non-negative members. Comparison theorems. Tests of D'Alambert, Cauchy and Gauss (without proof).
3. Integral test of convergence. Convergence of the series  $\sum_{n=1}^{\infty} \frac{1}{n^p}$ .
4. Absolute convergence. Properties of absolutely converging series.
5. Conditional convergence. Leibniz theorem.
6. Uniform convergence of a functional series. The Weierstrass test for uniform convergence of a series.
7. Continuity of a sum of uniformly converging series of continuous functions. Termwise differentiation and integration.
8. Power series. Radius of convergence. Continuity of a sum. Termwise differentiation and integration.
9. Power series expansions of elementary functions.
10. Orthonormalized sets of functions. Generalised Fourier series. Convergence theorem (without proof).
11. Differential equations of first order. Equation  $y' = f(x, y)$ . Theorem of existence and uniqueness for a solution of the Cauchy problem (formulation only). Equations with separable variables. Equations of the form  $y' = f(ax+by+c/kx+ly+m)$ .
12. Linear differential equations of first order.
13. Differential equations of the  $n$ -th order. Cauchy problem for an equation  $y^{(n)} = f(x, y, y', \dots, y^{(n-1)})$ . Lowering the order of the differential equation.
14. Linear differential equations of the  $n$ -th order. Properties of linear homogeneous differential equations.
15. Linear dependence of functions. Wronsky determinant.

16. Fundamental set of solutions for linear homogeneous equation.
17. Linear inhomogeneous equation. Superposition principle.
18. Method of variation of constants.
19. Linear homogeneous differential equation with constant coefficients. Characteristic equation. General solution.
20. Method of undetermined coefficients for the particular solution of linear inhomogeneous differential equation with constant coefficients.

#### Second half-year

21. Double integral. Its main properties and applications.
22. Calculation of double integral.
23. Double integral in polar coordinates.  
Calculation of the integral  $\int_0^{\infty} e^{-x^2} dx$ .
24. Triple integral, its main properties and applications. Calculation of triple integral.
25. Triple integral in cylindrical and spherical coordinates.
26. Path integral of the first order.
27. Path integral of the second order.
28. Green's formula.
29. Conditions at which path integral is independent on path.
30. Test for total differential on plane.
31. Surface area.
32. Surface integrals of the first and the second orders.
33. Ostrogradsky's formula, its vector expression.
34. Stokes formula, its vector expression.
35. Scalar and vector fields. Definitions and main properties of *grad*, *div*, *rot*, and flow of a vector field.
36. Solenoidal field. Vector tube in a solenoidal field.
37. Potential field.



## The 3rd year

### First half-year (18 weeks)

Subject	Hours			
	Lectures	Seminars	Labs	Total
Organic chemistry	72	36	144	252
Structure of molecules	54	18	–	72
Chemical basics of biological processes	72	–	–	72
Radiochemistry	–	–	36	36
Foreign language	–	72	–	72
Economics	36	36	–	72
Special training	–	–	144	144

### Second half-year (16 weeks)

Subject	Hours			
	Lectures	Seminars	Labs	Total
Organic chemistry	64	–	128	192
Physical chemistry	64	32	64	160
Structure of matter	32	–	–	32
Economics	32	32	–	64
Professional training	8	–	–	8
Special training	–	–	96	96
Research project in organic chemistry	10 weeks			

### Additional subjects for specialized groups

#### 310. Chemistry of polymers

1. Quantum mechanics and structure of matter (first half-year, lectures (72 h) and seminars (54 h)).

#### 311. Physical (theoretical) chemistry

1. Quantum mechanics (first half-year, lectures (36 h) and seminars (36 h)).  
2. Quantum chemistry (second half-year, lectures (32 h) and seminars (32 h)).

#### 312. Chemistry of new materials

1. Inorganic materials (First half-year, lectures (18 h) and seminars (18 h)).  
2. Elements of statistical physics (first half-year, lectures (36 h) and seminars (18 h)).  
3. Solid state physics (second half-year, lectures (32 h) and seminars (32 h)).

#### 313. Computational methods in chemistry

1. Quantum mechanics and structure of matter (first half-year, lectures (72 h) and seminars (54 h)).  
2. Mathematical methods in chemistry (all year, lectures (68 h) and seminars (52 h)).

## Lecture courses on main chemical subjects

### ORGANIC CHEMISTRY

#### First half-year

1. Introduction to organic chemistry.
2. The bases of organic nomenclature.
3. Main types of chemical bonds. Intermediates in organic reactions. Electronic effects. Acids and bases.
4. Stereochemistry.
5. Alkanes.
6. Alkenes.
7. Alkynes.
8. Alkadienes.
9. Nucleophilic substitution at the saturated carbon atom.
10. Alcohols and ethers.
11. Elimination reactions.
12. Organometal compounds.
13. Aldehydes and ketones.

#### Second half-year

14. Carboxylic acids and their derivatives.
15. Aromaticity. Aromatic hydrocarbons.
16. Electrophilic substitution in aromatic compounds.
17. Nucleophilic aromatic substitution.
18. Nitrocompounds.
19. Amines.
20. Diazo compounds.
21. Phenols.
22. Alicyclic compounds. Cycloalkanes and their derivatives.
23. Heterocyclic compounds.
24. Amino acids, peptides and proteins.
25. Carbohydrates.
26. Physical methods of structure determination in organic chemistry.

### STRUCTURE OF MOLECULES

1. Hamiltonian and Schrodinger equation for a free molecule. Adiabatic approximation.
2. Potential surfaces. Equilibrium configurations of molecules.
3. Symmetry properties of molecular systems.
4. Electronic wave equation and its approximate solutions. Hartree-Fock method.
5. Semiempirical methods for the solution of electronic equation.
6. Symmetry of atomic orbitals. Crystal field theory.
7. Chemical bonding.
8. Molecular vibrations.
9. Electronic-vibrational coupling. Jahn-Teller effect.
10. Rotation of molecules.
11. Electric and magnetic properties of molecules.
12. Interaction of molecules with radiation: emission, absorption, and scattering. Dipole approximation. Einstein coefficients. Selection rules.
13. Electronic, vibrational, and rotational states of molecules.
14. Rotational states of di- and polyatomic molecules.
15. Vibrational states of diatomic molecules. Vibrational-rotational spectra.

16. Electronic-vibrational spectra of diatomic molecules. Franck-Condon principle. Intensity distribution in absorption spectra.
17. Classical theory of molecular structure.
18. Molecular mechanics and molecular dynamics.
19. Intermolecular interactions.

### CHEMICAL BASICS OF BIOLOGICAL PROCESSES

#### Part I. Introduction

1. Role of chemistry in studying vital functions. What is life?
2. Protein structure.
3. Biological membranes. Cell wall.
4. Bioenergetics.
5. Structure of nucleic acids.
6. Mechanisms of transfer and realization of genetic information.

7. Protein biosynthesis (translation).

8. Regulation of gene expression.

9. Extrachromosomal genetic elements.

10. Genetic engineering.

#### Part II. Chemistry of enzymes

11. Sources and diversity of enzymes. Enzymes as catalysts of chemical reactions.
12. Enzymatic kinetics
13. Molecular mechanisms of enzymatic reactions.
14. Receptors and systems of signal transmission.
15. Basics of medical chemistry.
16. Cell populations and cell growth.
17. Engineering enzymology.
18. Ecobiocatalysis.

### PHYSICAL CHEMISTRY

#### Part 1. Chemical thermodynamics

1. Introduction. Physical chemistry as the basis of theoretical chemistry.
2. Equations of state.
3. The First Law of thermodynamics.
4. The First Law in chemistry.
5. The Second Law of thermodynamics. Entropy.
6. Thermodynamic potentials. Gibbs fundamental equation.
7. Chemical potential.
8. Chemical equilibrium.
9. Phase and membrane equilibrium. First-order and second-order phase transitions.
10. Thermodynamics of ideal and real solutions.
11. Phase equilibrium in two component systems.
12. Chemical equilibrium in liquid solutions.
13. Statistical thermodynamics: concepts.
14. Statistical thermodynamics: microcanonical and canonical ensembles.
15. How to calculate the thermodynamic functions of ideal gases from the molecular partition functions.
16. Configurational integral for the real gases and liquids.
17. Elements of linear thermodynamics of irreversible processes.

## The 4th year

### First half-year (18 weeks)

Subject	Hours			
	Lectures	Seminars	Labs	Total
Physical chemistry	72	36	72	180
Polymer chemistry	36	36	–	72
Colloid chemistry	36	36	72	144
Special subject (depends on the division)	54	–	–	54
Sociology	18	36	–	54
The basics of law	36	–	–	36
Special training	–	–	144	144
Research project in physical chemistry	10 weeks			

### Second half-year (15 weeks)

Subject	Hours			
	Lectures	Seminars	Labs	Total
Polymer chemistry	15	–	60	75
Chemical technology	60	–	60	120
Special subjects (depends on the division)	60	–	120	180
Liberal arts (by choice)	30	–	–	30
Special training	–	–	120	120

### Additional subjects for specialized groups

#### 410. Chemistry of polymers

1. Chemistry and technology of monomers (first half-year, lectures (18 h)).
2. Technology of polymer preparation (first half-year, lectures (36 h)).
3. Structure, properties, and functions of biopolymers (second half-year, lectures (30 h)).

#### 411. Physical (theoretical) chemistry

1. Structure of molecules (first half-year, lectures (36 h) and seminars (36 h)).

2. Statistical thermodynamics (first half-year, lectures (72 h)).

3. Special problems of physical chemistry (first half-year, lectures (36 h))
4. Physical methods of structure determination (first half-year, lectures (72 h))

413. Computational methods in chemistry 1. Mathematical methods in chemistry (first half-year, lectures (18 h) and seminars (18 h)).

## Lecture courses on main chemical subjects

### PHYSICAL CHEMISTRY

#### Part 2. Chemical kinetics

1. Introduction to chemical kinetics. Main concepts and postulates. Reactions of the integer order.
2. Determination of reaction order. Temperature dependence of rate constant. Arrhenius equation. Activation energy.
3. Irreversible consecutive reaction. Steady-state principle. Reversible and concurrent reactions.
4. Chain reactions. Kinetics of branched and unbranched chain reactions. Semenov's partial steady-state principle.
5. Collision theory for bimolecular reactions.
6. Collision theory for unimolecular reactions.
7. Transition state theory, statistical version.
8. Transition state theory, thermodynamic version.
9. Photochemistry. Quantum yield. Kinetic description. Stern-Volmer scheme.
10. Homogeneous catalysis. Acid-base catalysis. Correlation relations and acidity function.
11. Enzymatic catalysis. Michaelis-Menten equation. Inhibition.
12. Heterogeneous catalysis. Langmuir-Hinshelwood and Alley-Riedel mechanisms for reactions on uniform surfaces.
13. Ion-dipole interaction in solutions of electrolytes. Energies of crystal lattice and ion solvation. Ion-ionic interactions. Debye-Huckel theory.
14. Electric conductivity of solutions of electrolytes. Specific, equivalent, and molar conductivity. Onsager equation. Conductometry.
15. Electrochemical circuits. Nernst equation. Thermodynamics of galvanic cells. Determination of activity coefficients, pH, and transport numbers by measurement of electromotive force.
16. Electrocapillary phenomena. Lippmann equations. Adsorption of cations and anions on electrodes. Models of double electric layer.
17. Kinetics of electrode processes. Polarization of electrodes. Various types of overvoltage. Tafel formula. Butler-Volmer equation. The influence of double layer on the rate of discharge reaction.

#### CRYSTAL CHEMISTRY

1. Introduction to crystal chemistry. Crystal structure and its models.
2. The basics of X-ray diffraction analysis.
3. Other diffraction methods of crystal structure determination.
4. Symmetry groups and structural classes.
5. General crystal chemistry.
6. Specific problems of crystal chemistry.

#### COLLOID CHEMISTRY

1. Main notions of colloid chemistry. Classification of disperse systems.
2. Thermodynamics of surface phenomena.

3. Wetting and capillary phenomena. Laplace's law. The law of Thomson-Kelvin. Measurement of surface tension.

4. Adsorption of surfactants from aqueous solutions. Derivation of Gibbs equation. Two-dimensional pressure.

5. The structure of adsorption layers on various phase boundaries. Frumkin-Volmer equation. Adsorption of surfactants on solid surfaces.

6. Adsorption from electrolyte solutions on solid surfaces. Models of double layer.

7. Electrokinetic equations: electrophoresis, electroosmosis.

8. Liophilic disperse systems. Micelle formation in surfactant solutions. Microemulsions, conditions of formation.

9. Preparation of liophilic disperse systems. Thermodynamics of homogeneous and heterogeneous formation of nucleus.

10. Molecular kinetic and optical properties of disperse systems. Sediment and aggregation stability of disperse systems. Railey's law.

11. Disjoining pressure and its components.

12. Factors determining the stability of sols, foams, emulsions, and aerosols.

13. Sol coagulation by electrolytes. DLFO theory.

14. Structure formation in disperse systems. The basics of rheology.

15. The basics of physico-chemical mechanics. Physico-chemical phenomena during deformation and destruction of solids.

16. Classification of surfactants and mechanisms of their behavior.

17. The role of colloid chemistry in science, technology, and environment protection.

#### POLYMER CHEMISTRY

1. Introduction.
2. Polymers classification
3. Macromolecules and their behavior in solutions.
4. Polymer bodies.
5. Chemical properties and chemical transformations of polymers.
6. Polymers synthesis.

#### CHEMICAL TECHNOLOGY

1. General problems of chemical technology.
2. Theoretical bases of chemical technology.
3. Structure and analysis of technological schemes of main chemical industrial processes.
4. Structure of ammonia production from natural gas.
5. Technological scheme of nitric acid production.
6. Processing the phosphorus-containing raw materials.
7. Catalytic processes in petroleum industry.
8. Technology of organic synthesis.
9. Technology of polymer materials. Chemical fibres.
10. Chemical technology and material science.

## The 5th year

### First half-year (18 weeks)

Subject	Hours			
	Lectures	Seminars	Labs	Total
Environment protection	36	18	–	54
History of chemistry	36	–	–	36
Liberal arts (by choice)	36	–	–	36
Special subjects (depends on the division)	72	–	144	216

### Second half-year (16 weeks)

Research project – diploma work



Presentation of a diploma work

# The Chemistry Department.

## Courses and Degrees

The Chemistry Department prepares **SPECIALISTS in Chemistry**

**The term of study:** 5 years, full-time.

**Specializations:** Analytical Chemistry; Bioorganic Chemistry; Biochemical Technology; Colloid Chemistry; Cryochemistry; Medicinal Chemistry; Inorganic Chemistry; Petrochemistry; Organic Chemistry; Radiochemistry; Physical Chemistry; Chemical Kinetics and Catalysis; Chemical Technology; Chemical Enzymology; Chemical Material Science; Polymer Chemistry; Chemistry of Organoelement Compounds

### Bachelor and Master degrees

#### Bachelor Degree

**The term of study:** 4 years, full-time

**Direction:** Chemistry

To get the Bachelor degree, during 7th and 8th semesters, students attend to special courses on the chosen specialization in addition to general courses.

#### Master Degree

**The term of study:** 2 years, full-time

**Direction:** Chemistry

Training for Master degree combines theoretical courses with practical and research laboratory work. At the end of their term of study students prepare a Master's thesis.

**Programs:** Analytical Chemistry; Inorganic Chemistry; Organic Chemistry; Physical Chemistry; Bioorganic Chemistry; Polymer Chemistry; Colloid Chemistry

### PhD Honors Degree in Chemistry

**The term of study:** 3-4 years, full-time

**Specializations:** Inorganic Chemistry; Analytical Chemistry; Organic Chemistry; Physical Chemistry; Electrochemistry; Polymer Chemistry; Chemistry of Organoelement Compounds; Bioorganic

Chemistry; Colloid Chemistry, Physical and Chemical Mechanics; Petrochemistry; Radiochemistry; Catalysis; Mathematical and Quantum Chemistry; Solid State Chemistry; Biotechnology; Biochemistry

### Doctor of Science Honors Degree in Chemistry

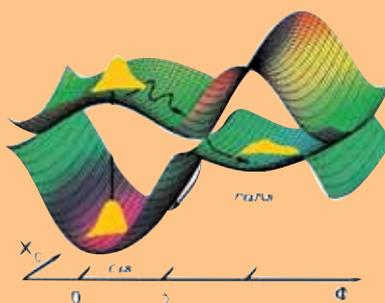
**The term of study:** 3-4 years, full-time

**Specializations:** Inorganic Chemistry; Analytical Chemistry; Organic Chemistry; Physical Chemistry; Electrochemistry; Polymer Chemistry; Chemistry of Organoelement Compounds; Bioorganic

Chemistry ; Colloid Chemistry, Physical and Chemical Mechanics; Petrochemistry; Radiochemistry; Catalysis; Mathematical and Quantum Chemistry; Solid State Chemistry; Biotechnology; Biochemistry

# RESEARCH

Scientists of the Chemistry Department carry out scientific research practically in all areas of modern chemistry. The researches of the Department create new semiconductors and high temperature superconductors, synthesize thousands of new complex organic and organoelemental compounds and develop new pharmaceutical products, high-performance catalysts and polymers with wide range of properties. Scientists of the Chemistry Department make an important contribution to the development of modern theory of catalysis, creation of new concepts of nanotechnology, electrochemistry and chemistry of colloidal systems.



## The Chemistry Department includes 16 divisions consisting of more than 80 laboratories

*Today, priority directions of research work in the Department are:*

- Development of new technologies in extraction, concentration and detection of trace amounts of organic and inorganic substances from the environment, food products and biochemicals;
- Current problems of chemistry and properties of high molecular compounds;
- Physicochemical mechanics of solids and colloidal systems, molecular mechanisms of the Rebinder effect, medium influence on dispersed particles interaction and self-organization;
- Study of laser-induced physicochemical processes;
- Inorganic chemistry as a fundamental basis for creating new generations of functional materials;
- Modern methods of physical and chemical analyses for studying multicomponent system constitutional diagrams;
- New approaches to a problem of hydrocarbon raw materials efficient application;
- Structural and functional analyses of protein and proteino-nucleic complexes as a foundation for creation of gene expression synthetic regulators and medical products of new generation;
- Kinetics and mechanism of photochemical, cryochemical and catalytic processes and development of new materials and technologies based on molecular-organized systems;
- New energy-saving technologies and materials that ensure protection and reliability;
- Chemical enzymology;
- Electrochemistry;
- Radiation chemistry of organic systems;
- Design of organic structures and organic reactions, target search, synthesis and testing of new organic compounds;
- Organoelemental compounds that act as reactants and catalytic agents in synthesis of organic and organometallic compounds;
- Radiochemistry as a foundation for synthesis of radio nuclides and tagged compounds, radionuclide diagnostics and study of environmental radioactivity;
- Structure and dynamics of atomic-molecular systems;
- Chemical thermodynamics;
- Catalysis and physical chemistry of the surface;
- Physico-chemical principles of separation methods and fine purification of substances and isotopes.



## Research Directions and Achievements of the Chemistry Department's Divisions

### Analytical Chemistry Division (<http://analyt.chem.msu.ru/eng/default.htm>)

Since the Moscow State University foundation a special emphasis was made on carrying out chemical analysis. Before the revolution of 1917, many outstanding chemists: **Vladimir V. Markovnikov**, **Mikhail M. Kononov**, **Ivan A. Kablukov**, **Nikolay M. Kizhner**, **Nikolay A. Shilov**, **Nikolay D. Zelinsky** delivered lectures on analytical chemistry at Moscow State University. After 1917, lots of efforts went for making analysis of chemicals, since their production in the Soviet Union increased. Chemists frequently used physico-chemical and physical methods like conductometry, potentiometry, colorimetry and spectroscopy.

Today, the Analytical Chemistry Division consists of a laboratory for students training and 5 scientific laboratories: Laboratory of Concentration, Laboratory of Spectroscopic Analysis, Laboratory of Kinetic Analysis and Laboratory of Chromatographic and Electrochemical Analysis.

The Division specializes in the development of new technologies in extraction, concentration and detection of trace amounts of organic and inorganic substances from the environment, food products and biochemicals.

Among scientific achievements of the Division is development of analytical methods based on liquid chromatography and capillary electrophoresis. These methods are used in diagnostics of nucleoside composition change in blood, for therapeutic monitoring of pharmaceutical substances.

Scientists of the Division develop new methods of rapid analysis of environment and pharmaceutical products. An innovation firm "MedEcoTest" was created in the framework of the program "Start" in order to introduce new technologies of rapid analysis.

Staff of the division works on use of gas chromatography and mass spectrometry for analysis of complex organic mixtures and on detection of trace amounts of toxins.

## Division of High Molecular Compounds (<http://www.chem.msu.ru/eng/chairs2/polymer/welcome.html>)

A branch of science that nowadays is called "High Molecular Compounds" appeared at the beginning of the 20th century in the context of three sciences little connected with each other at that time: organic chemistry (synthesis), colloidal chemistry (study of solutions and dispersions of high molecular compounds) and physics (study of structure and mechanical properties of polymeric compounds).

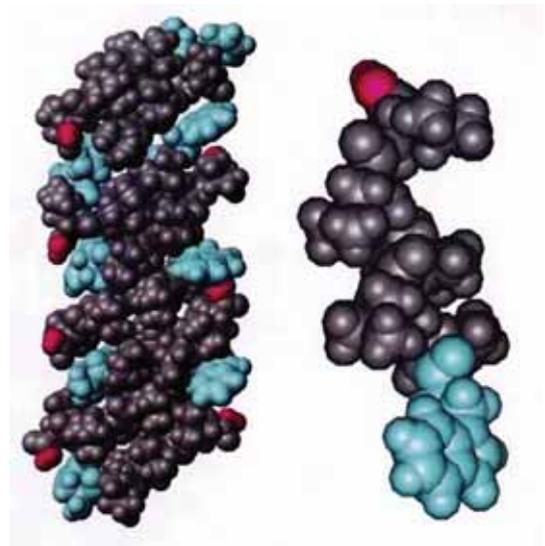
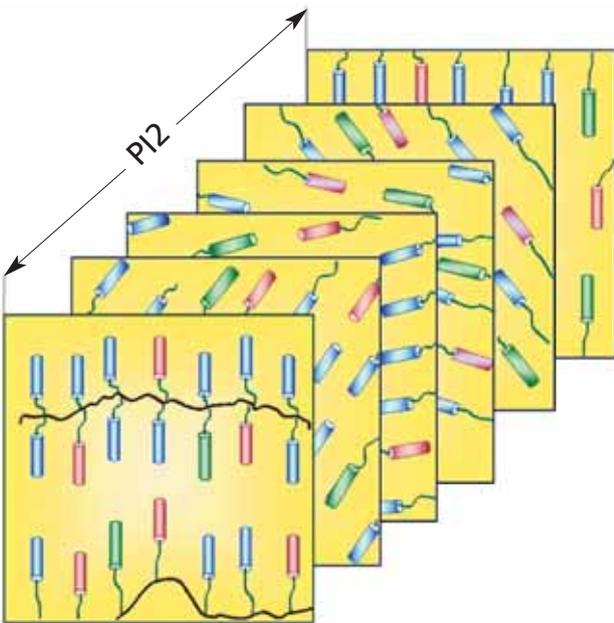
The Division was founded in the middle of the 20 century by Academician Valentin A. Kargin who played a major role in formation of polymer science. His research of mechanical properties of polymers in broad interval of temperatures led to fundamentally important finding about connection between structure and physico-mechanical properties of polymers. This is one of the corner stones in modern polymer science.

Today, the Division of High Molecular Compounds consists of a laboratory for students training and 6 scientific laboratories: Laboratory of Polymerizing Processes, Laboratory of Chemical Transformations of Polymers, Laboratory of Polymeric Electrolytes and Biopolymers, Laboratory of Macromolecules for Medicine and Biotechnology, Laboratory of Polymer Structure and Laboratory of Physics and Mechanics of Polymers.

Scientific research directions of the Division are:

1. Synthesis of polymers, control of macromolecule formation reactions and regulation of macromolecular structures.
2. Synthesis and study of bio- and medical polymeric materials and macromolecular systems which serve as model systems for biopolymers.
3. Synthesis and properties of polyelectrolytes, reactions between polyelectrolytes, structure and properties of electrolytic complexes.
4. Liquid-crystal state of polymers and research for new liquid-crystal state polymeric substances.
5. Structure and properties of amorphous and crystalline polymers and multicomponent heterophase systems.

The existence of "superfine oriented state of polymers" that are characterized by a complex of unknown before properties was established by the staff of the Division. Scientists of the Division worked out universal methods of polymeric sorbents synthesis, polymeric separating membranes, new types of multicomponent polymeric mixtures, nonflammable polymeric materials, conducting polymeric materials, metal-organic polymers and some other materials. A new scientific direction that appeared recently and successfully develops is connected with research of fundamental foundations of system deformation (hard surface with soft foundation). A typical example of these systems could be polymeric films with thin solid covering. The systems are promising for creation of new types of liquid-crystalline displays.



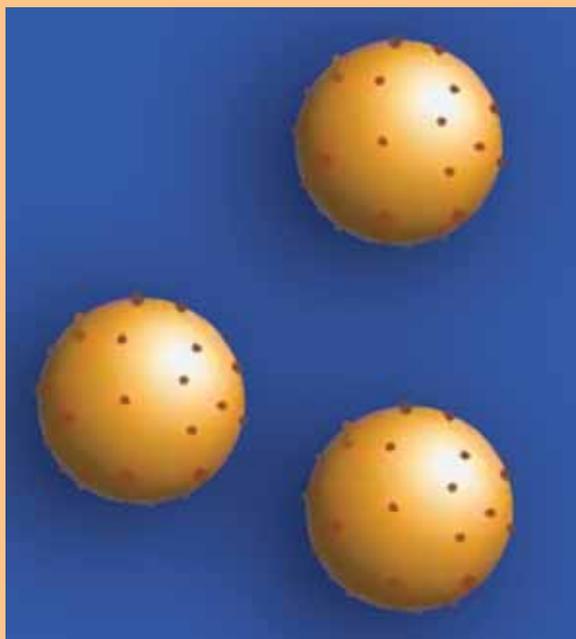
## Division of Colloid Chemistry

(<http://www.chem.msu.ru/eng/chairs2/colloid/welcome.html>)

In 1923, professor Vladimir A. Naumov started to deliver colloid chemistry course in Moscow University. 10 years later, the Division of Colloid Chemistry was founded at Chemistry Department.

Today, the Division of Colloid Chemistry consists of a laboratory for students training and 2 scientific laboratories: Laboratory of Physicochemical Mechanics of Solids and Laboratory of Colloid Chemistry.

The Division specializes in physicochemical mechanics of solids and dispersed systems, molecular mechanisms of the Rebinder effect, medium influence on dispersed particles interaction and structural organization. The Division is engaged in solving problems of foam stability and emulsions, and develops new methods of experimental study and computer modelling of structure and processes of break-up of foams and emulsions. The role of adsorption layer mobility in kinetics of dispersed foam-like system outflow and principles of foam formation are being analyzed. High emphasis is placed on study of surface phenomena role in deformation and destruction processes of different solids (metals and alloys, ionic crystals and rocks). The researchers of the Division are interested in wetting and surface modification of solids by solutions of surfactants, processes of micelle systems formation and synthesis of nanoparticles in reversed microemulsions.



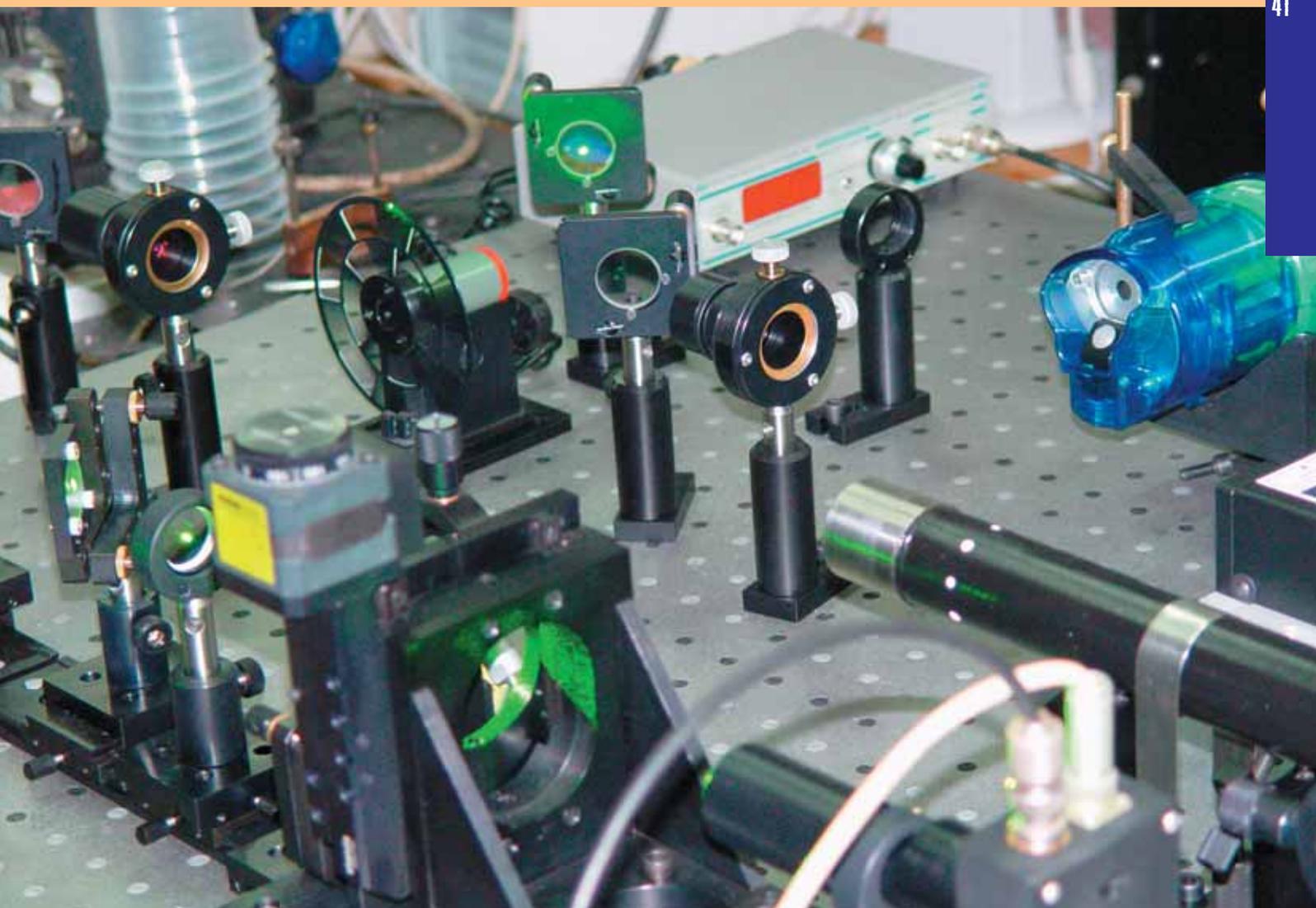
## Division of Laser Chemistry

(<http://www.chem.msu.ru/eng/chairs2/laser/welcome.html>)

The Division of Laser Chemistry was founded in 1988. One of the major fields of research is laser-induced physicochemical processes. Today, the Division consists of 3 laboratories: Laboratory of Laser Synthesis, Laboratory of Laser Spectroscopy and Laboratory of Laser Diagnostics.

Using laser beam technology scientists create sensors of gaseous toxic substances (like hydrogen sulphides, carbohydrates and alcohols), that considerably exceed in sensitivity all existent world analogues.

The Division worked out methods for atomic absorptive determination of gold, silver and also platinum metals in secondary raw materials using preliminary separation and by means of matrix modification by ammonia water solution.



## Division of Inorganic Chemistry ([www.inorg.chem.msu.ru](http://www.inorg.chem.msu.ru))

The Division of General and Inorganic Chemistry was one of the five divisions constituting the Chemistry Department at the time when it was founded in Moscow State University in 1929. Until 1936, it was headed by professors Yaroslav S. Przheborovsky and Eduard F. Krause. The members of the Division were responsible for teaching inorganic and general chemistry not only at the Chemistry Department, but also at other departments of Moscow State University.

Academician Nikolay S. Kurnakov played a special role in the formation and development of the Division's scientific preferences. He was invited to head the Division of General and Inorganic Chemistry in 1936. After Academician Kurnakov took this position, the Division of General and Inorganic Chemistry was divided into two independent divisions: Division of Inorganic Chemistry headed by Academician Kurnakov and Division of General Chemistry headed by Professor Krause. From 1988, a new direction of scientific research – chemistry of high-temperature superconductors – started to develop rapidly. The Division takes great pride in discovery made by Eugene V. Antipov and Sergey N. Putilin of new generation of high-temperature superconductors on the basis of Hg-containing compositions.

Today, the Division consists of 6 laboratories: Laboratory of Inorganic Crystal Chemistry, Laboratory of Coordination Compounds Chemistry, Laboratory of Semiconducting Materials, Laboratory of Directional Inorganic Synthesis, Laboratory of Inorganic Materials Science and Laboratory of Inorganic Materials Diagnostics.

The Division developed a new method for vapor deposition of quasi-one-dimensional (diameter 50-80 nm, length 20-50  $\mu\text{m}$ ) metal oxide crystals. The possibility of using them as active elements of chemical sensors was proved.

The Division developed unique principles of photonic crystal films with structure of inverted opal and different composition synthesis.

New materials for gas sensors were created and systematically studied. Scientists created materials with selective sensitivity to a range of toxic and highly explosive molecules.

A new method for preparation of functional (magnetic, sensory, optically and catalytically active) nanocomposite materials was proposed and successfully realized. The method is based on solid-phase nanoreactors like mesoporous silicon oxide and aluminosilicates, zeolites, porous alumina and layered double hydroxides.

New class of solid supramolecular complexes based on three-dimensional cationic Hg-containing frameworks was synthesized. The researchers of the Division proposed a new thermodynamic model and theory of epitaxial stabilization. This discovery enabled to obtain and analyze thin films of complex oxides. Also the staff is working on the development of novel biocompatible materials which can be used as bone implants.





### **Division of General Chemistry**

(<http://www.chem.msu.ru/eng/chairs2/general/welcome.html>)

The Division of General Chemistry consists of laboratory for students training and five scientific laboratories: Laboratory of Physicochemical Analysis, Laboratory of Metallochemistry, Laboratory of Ecological Chemistry, Laboratory of Structural Chemistry and Laboratory of Theory and Methods of Chemical Education.

The major fields of research at the Division are modern methods of physicochemical analysis for studying state diagrams of multicomponent systems and development of the most effective methods for teaching chemistry and other natural sciences.

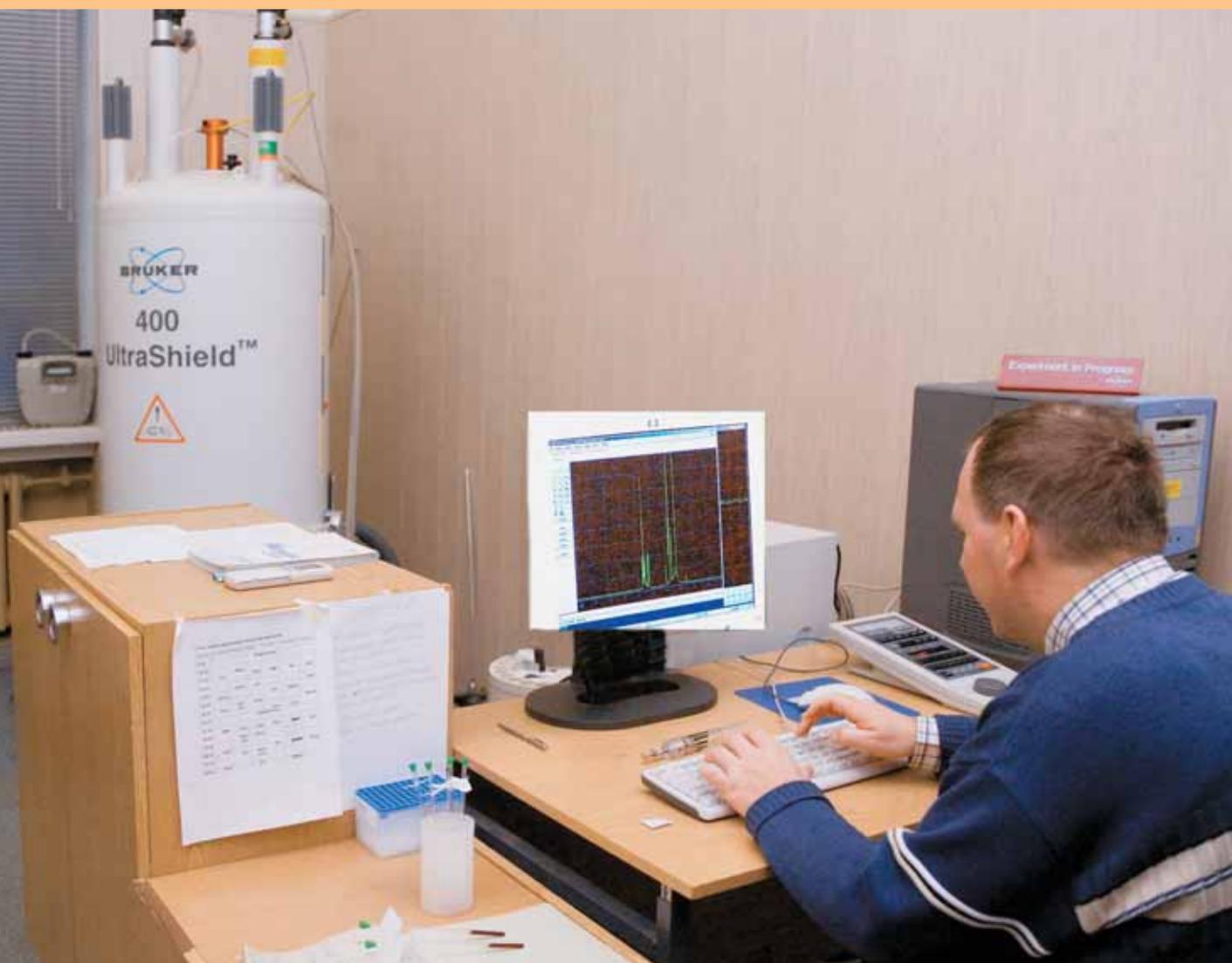
Scientists are currently working in the following priority directions: development of theoretical methods for analysis of multicomponent state diagrams; electrocatalysis, metals protection, ionic liquids as catalytic media and electrolytes, ecologically pure catalytic processes, electroactivation of heterogeneous catalysts; X-ray structural analysis of organic and inorganic compounds; development of new fundamental approaches to theoretical and practical issues in rontgenography; chemical education; search for new educational methods and approaches; study of methods for control and evaluation of students knowledge; application of pedagogic, didactic and private techniques to teaching general chemistry course in the middle and high schools.

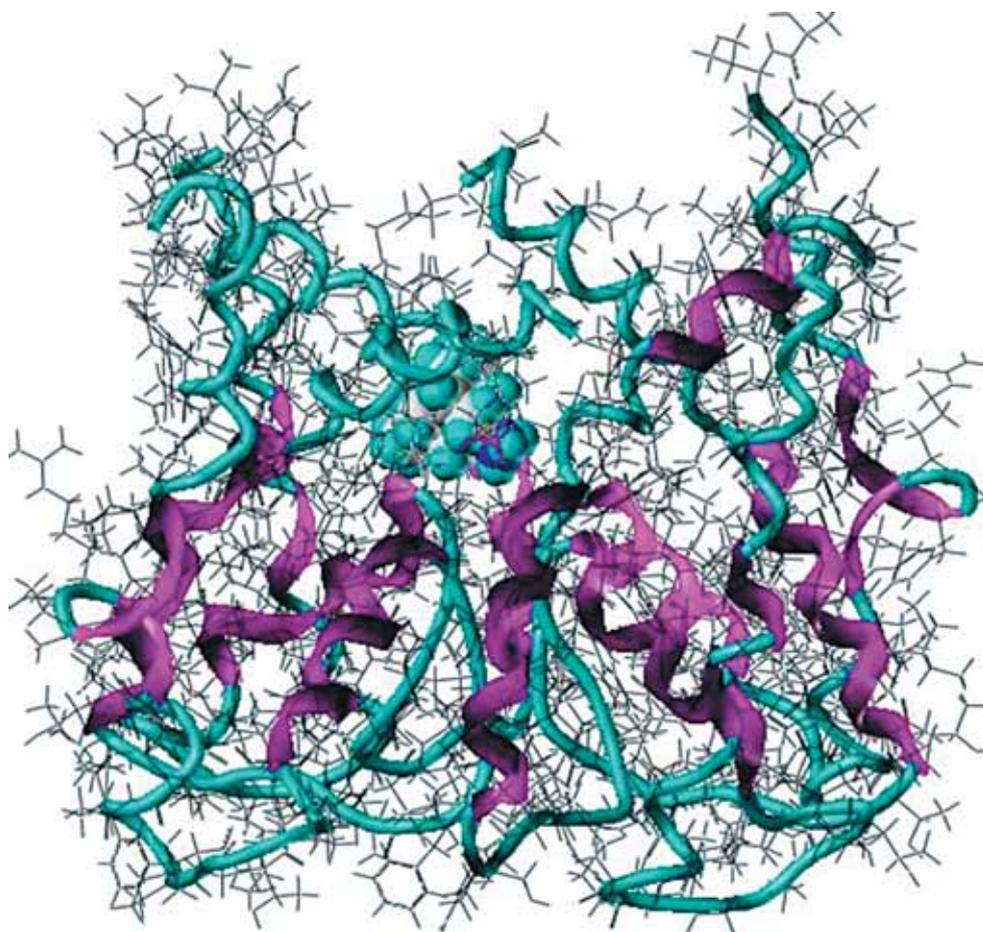
To date, more than hundred new triple intermetallic compounds containing rare-earth elements and platinum metals were synthesized and characterized at the Division of General Chemistry. Also, researchers developed a new method of modeling of crystal packing effect on spatial and electronic structure of anthraquinone- and azo-type organic dyes and pigments, including their spectral properties in crystalline state.

## Division of Organic Chemistry (<http://www.chem.msu.ru/eng/chairs2/organic/welcome.html>)

The Division of Organic Chemistry headed by academician N.D. Zelinsky was among first five divisions constituting the Chemistry Department of Moscow State University in 1929. At present, the Division of Organic Chemistry is one of the best centers of education and research in organic chemistry in our country. The Division delivers the general undergraduate course of organic chemistry including lectures, seminars and extensive laboratory works. The graduates work in two main fields: medicinal chemistry or drug-design and chemistry of organoelemental compounds.

The Division consists of eight laboratories: Laboratory of Organic Synthesis, Laboratory of Physical Organic Chemistry, Laboratory of Organoelemental Compounds, Laboratory of Coordinating Organometallic Compounds, Laboratory of Bioactive Organic Compounds, Laboratory of Nuclear Magnetic Resonance, Laboratory of Organic Reagents, Laboratory of Organic Analysis, and Laboratory for students training.





The major field of research at the Division of Organic Chemistry are synthesis and study of highly strained polycyclic structures of the triangulane type, the bridgehead compounds; design of new reagents for electrophilic selenation and nitrosation; fine organic synthesis with the use of metal complexes as catalysts; synthesis of new types of organometallic compounds, especially the organic derivatives of lanthanides and transition metals. The members of the Division systematically investigate the family of ferrocene derivatives with the properties of liquid crystals and unusually wide temperature interval of crystallinity. A number of works was devoted to the application of physical methods for structure determination. Thus, mass-spectrometry was used to determine the structure of peptides in complex biological mixtures.

Since the end of 1990s the Division actively participates in the design of new organic compounds possessing anti-cancer, neuroprotective, antiviral and other types of physiological activity. Some of the designed substances undergo clinical trials in medical laboratories.

## Division of Radiochemistry

(<http://www.chem.msu.ru/eng/chairs2/radio/welcome.html>)

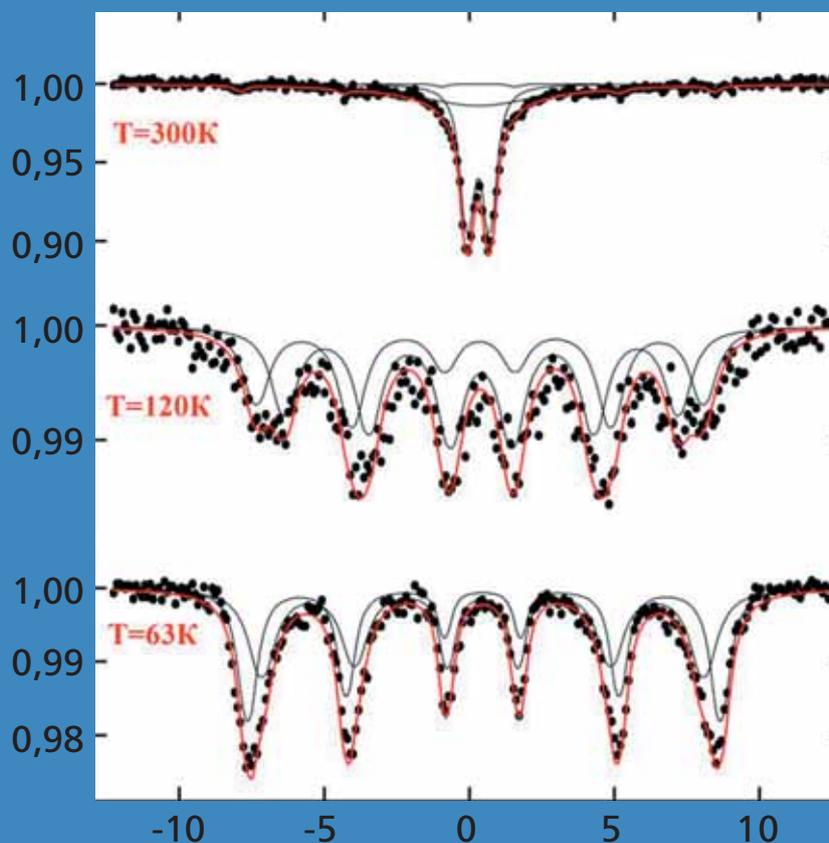
The Division was founded in 1959 by Corresponding Member of USSR Academy of Sciences Andrey N. Nesmeyanov, who headed the Division until 1983.

The modern Division of Radiochemistry consists of the Laboratory for students training, the Group of Ecological Radiochemistry and five scientific laboratories: Laboratory of Heterogeneous Processes, Laboratory of Dosimetry and Environmental Radioactivity, Laboratory of Mossbauer Spectroscopy and Radiochemical Methods, Laboratory of Radio Nuclides and Tagged Compounds, and Laboratory of Chemonuclear Methods.

The major fields of research at the Division are: development of new radio nuclides and tagged compounds preparation techniques, radionuclide diagnostics of chemical processes and conditions of an environment, dosimetry of ionizing radiation and environmental radioactivity.

The members of the Division developed a method of chemical purification of radiation-contaminated soils using acidic solutions of potassium ferrocyanide. Also, laws of plutonium and neptunium migration in the underground ecosystems were established. Furthermore, researchers developed a complex of scientifically-proved methods of preparation of compounds with predicted biological activity. The conditions of synthesis of superfine metastable modification of calcium carbonate were investigated, also a mechanism of formation of nanostructures on its basis with improved sorption ability was studied.

In the framework of the project on the development of experimental approaches to therapy of malignant tumors with the use of solid sonosensitizing effect a variety of new therapeutic combinations were obtained and their efficiency was confirmed by in vivo experiments.





### Division of Electrochemistry

(<http://www.chem.msu.ru/eng/chairs2/electrochem/welcome.html>)

At the Chemistry Department of Moscow State University the Division of Electrochemistry was founded in 1933 on the basis of the Laboratory of Electrochemistry headed by Alexander N. Frumkin. The laboratory was a part of the Division of Physical Chemistry since 1929.

Today, the Division of Electrochemistry consists of five laboratories: Laboratory of Double Layer and Electrochemical Kinetics, Laboratory of Electrocatalysis and Corrosion, Laboratory of Electrochemical Energetics, Laboratory of Radiation Chemistry, and Laboratory of Aluminum Problems. The staff of the Division work on preparation of high-performance catalysts and development of theoretical aspects of kinetics and mechanisms of processes running in electrochemical current sources. The electrochemical methods of catalysts synthesis containing microquantity of the platinum group metals and approaches for regulation of quantities of deposited metal and its dispersity were developed. Researchers succeeded in electrocatalytic reduction of carbon dioxide on the dispersed palladium under soft conditions. And currently, methods of intensification of this reaction, which is very important for ecology, are searched for. The staff of the Division developed a general approach to the investigation and modeling of viscosity effects and determination of the degree of adiabaticity. They also considered possible nonlinear and nonmonotonic dependences in the framework of the modeling of kinetics of adiabatic and nonadiabatic electrode processes. Now scientists study kinetics of the various adiabatic electrode processes in water-sucrose and water-glucose mixtures characterized by different type of the dielectric relaxation spectra.

The researchers of the Division of Electrochemistry developed methods of immobilization of copper and nickel binuclear complexes with Robson-type ligands in polyphenol films and carbon layers. They also carried out electrocatalytic reduction of hydrogen peroxide on optimized electrodes of this type.

## Division of Physical Chemistry

(<http://www.chem.msu.ru/eng/chairs2/phys/welcome.html>)

The Division of Physical Chemistry was formed in 1929 at one time with foundation of the Chemistry Department. It was based on the laboratory of inorganic and physical chemistry headed by prof. Ivan A. Kablukov at the Research Institute of Chemistry. Today, the Division consists of thirteen laboratories: Laboratory of Chemical Thermodynamics, Laboratory of Thermochemistry, Laboratory of Molecular Spectroscopy, Laboratory of Molecular Structure and Quantum Mechanics, Laboratory of Electron Diffraction Analysis, Laboratory of Kinetics and Catalysis, Laboratory of Catalysis and Gas Electrochemistry, Laboratory of Stable Isotopes, Laboratory of Solutions, Laboratory of Crystal Chemistry, Laboratory of Molecular Beams, Laboratory of Adsorption and Gas Chromatography and Laboratory of Chemical Cybernetics.

The major fields of research at the Division are structure and dynamics of atomic-molecular systems, chemical thermodynamics, catalysis, physical chemistry of the surface, physico-chemical principles of separation methods and fine purification of substances and isotopes.

The achievements of the Division noticeably contributed to the elaboration of hydrogen chemistry. Thus, researchers showed the ability to use complexes of aromatic compounds with nickel for the development of hydrogen storage systems under soft conditions. They developed efficient catalysts based on the zirconium oxide for application in multiphase polychlorobenzene hydrodechlorination were developed. Scientists suggested a new method of ethylcyclohexylbenzenes synthesis using benzene and ethylbenzene hydroalkylation on metalcontaining zeolite catalysts. They also found optimum conditions for selective ethylcyclohexylbenzenes synthesis. The catalysts for benzene and ethylbenzene hydroalkylation based on Beta zeolite containing Ru and Ni and guaranteeing ethylcyclohexylbenzene yield of 28% with selectivity of 45% and conversion of 63% were developed at the division. The oscillation (Infrared and Raman) and electronic spectra of the wide range of C60 and C70 fullerenes derivatives were studied. Researchers constructed a general theory of nonequilibrium fluctuations considering internal variables in different dimension. They also established new methods of solution structure investigation including distant molecules correlation and supramolecular aggregates.





## Division of Petroleum Chemistry and Organic Catalysis (<http://www.chem.msu.ru/eng/chairs2/oil/welcome.html>)

In 1929-1930 Professor N.D. Zelinsky took the initiative to organize two laboratories at the Division of Organic Chemistry: Laboratory of Petroleum Chemistry and Laboratory of Organic Catalysis. Subsequently, these laboratories were transformed into the Division of Petroleum Chemistry (1938) and the Division of Organic Catalysis (1940) which were united into one division in 1968.

Today, the Division consists of four laboratories: Laboratory of Petrochemical Synthesis, Laboratory of Chemistry of Petroleum Hydrocarbons, Laboratory of Organic Catalysis, and Laboratory of Microcyclic Receptors.

The research work at the Division develops in traditional directions founded by professor N.D. Zelinsky, B.A. Kazansky and A.A. Balandin. The major field of research is development of fundamental issues concerning the nature of catalysis.

The staff of the Division is working on the development of the perspective processes of oil refining, metallocomplex supramolecular catalysis, preparation of macrocomplex catalysts with the function of molecular recognition, chemistry of the grafted surface compounds, chemistry of polycarbon substances, evolutionary catalysis, chemistry of acyclic and framework compounds, and chemistry of organic sulphur-containing compounds.

Scientists developed a method of two-stage synthesis of  $ZrO_2$ -based mesoporous materials which are considered as potential components of acidic and bifunctional catalysts of hydrocarbon isomerization and alkylation. They also devised techniques of chemical surface modification of magnesium and tin oxides by organosilicon and organophosphorous compounds. The obtained results can be used to protect magnesium-containing materials from environmental influence and produce selective semiconducting sensors. Researchers showed possibility of directed chemical surface modification of diamond nanomaterials in order to control their properties and place different grafted compounds on their surface. For the first time, the data on nanodiamonds influence on growth and viability of living cells of oligotrophic bacteria was obtained.

## Division of Chemistry of Natural Compounds (<http://www.chem.msu.ru/eng/chairs2/natural/welcome.html>)

The Division of Chemistry of Natural Compounds was founded in 1965 by professor Mikhail A. Prokofiyev on the basis of Laboratory of Protein Chemistry at the Division of Organic Chemistry. The division consists of three laboratories: Laboratory of Protein Chemistry, Laboratory of Chemistry of Nucleic Acids, and Laboratory of Nucleoproteins.

The major fields of research at the Division are organic chemistry of double-stranded acids and NK-protein complexes, study of the structure and functions of ribonucleoproteins using chemical approaches. Thus, new efficient methods of DNA fragments synthesis containing amino acid residues in 2'-site of carbohydrate fragment were developed. It was revealed that short single-stranded oligonucleotides, containing hydrophobic groups, function as efficient inhibitors of HIV-1 integrase. Researchers carried out the reconstruction of functional RNA-polymerase. They also studied influence of carcinogen – the benzopyrene residue – on DNA methylation. Scientists developed a method of analysis of mutagenic pinpoint DNA damage based on chronopotentiometric measurement of purine bases at the graphite electrode.

Moreover, the staff of the Division performed a synthesis of series of biologically active peptide derivatives of certain antibiotics macrolides (for example, tylosin) for their application as probes to study topography of growing polypeptide chain in ribosome tunnel.





### Division of Chemical Kinetics

(<http://www.chem.msu.ru/eng/chairs2/chemkin/welcome.html>)

The Division was founded in 1944 and it was headed by Nobel Prize winner in Chemistry Nikolay N. Semenov for more than 40 years. There are five laboratories within the division: Laboratory of Photonics of Laser Media, Laboratory of Cryochemistry, Laboratory of Chemical Kinetics, Laboratory of Photochemistry, and Laboratory of Homogeneous Catalysis.

The major fields of research at the Division are kinetics and mechanism of photochemical, cryochemical and catalytic processes, and development of new materials and technologies based on molecular-organized systems.

To date, the researchers of the Division determined laws of functioning of photochemical lasers on dyes, as well as selection criteria of acid-base systems and systems with energy transfer for this type of lasers. New photochemical lasers based on proton phototransfer and energy transfer were developed. Scientists worked on several projects on photochemistry and photophysics of chromoionophores and fluoroinophores and their complexes with metal cations. As a result, a new reaction of adiabatic metal ion photorecoordination in complexes of cationic dyes containing crown ether fragment was discovered. Investigation of photonics of new thermally irreversible photochromic systems of naphthacene quinines, diaryl ethylenes and fulgides has shown that they can be used as working systems in fundamentally new data medium – tree-dimensional optical-electronic memory. Researchers revealed an unusually high catalytic activity of Cu, Ni and Pd nanoparticles ensembles in reactions of olefins and aromatic hydrocarbons hydration. They also developed a technique of structure control of low-temperature metal condensates. Furthermore, the staff of the Division determined main types of photochemical reactions of cation-radicals of different classes together with quantitative characteristics of reactivity of their excited states.

## **Division of Chemical Technology and New Materials** (<http://www.chem.msu.ru/eng/chairs2/technology/welcome.html>)

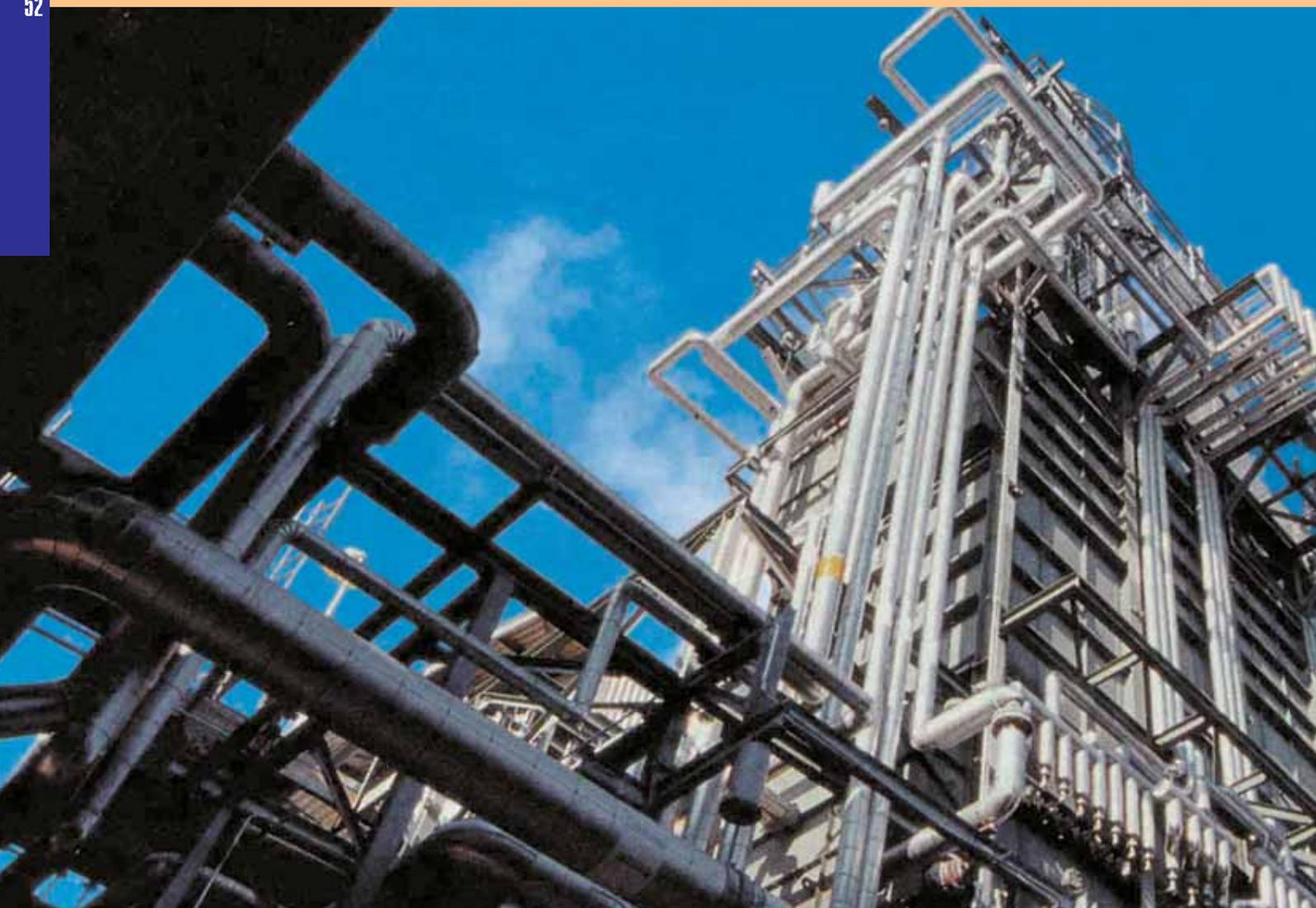
The Division of Chemical Technology and New Materials was founded in 2004 on the basis of the Division of Chemical Technology and the Division of Chemistry and Physics of High Pressures.

There are six laboratories within the Division: Laboratory of Chemistry of High Pressures, Laboratory of Power-Consuming and Catalytically Active Substances, Laboratory of Chemical Production Safety, Laboratory of Chemistry of Carbon Materials, Laboratory of Fundamentals of Chemical Technology, and Laboratory of Technology of Functional Materials.

The major field of research at the Division of Applied Chemistry and New Materials are design of perspective technological systems of chemical materials processing based on the concept of safe development of technosphere, chemistry of high pressures, chemistry of power-consuming and coal-graphite materials.

The staff of the Division synthesized new superconductors based on lithium, sodium, potassium, rubidium and cesium heterofullerides. Researchers developed methods of synthesis of new family of chelating mono and polydentate achiral ligands in the row of amino-bis (1,1-diphenylethanol) titanium and zirconium chlorides. They also tested the catalytic activity in homogeneous ethylene polymerization reaction of all synthesized complexes.

Scientists continue their research for the national key industries in the area of ecological aspects of environmental problems. For example, work on the project "Mercury in the megapolis: monitoring and influence on health" was completed. Researchers developed the algorithm for ecological risks evaluation in the specific region. They also collected a data base on professional risk evaluation and analyzed gas-main pipeline exploitation technogenic risk.





### Division of Chemical Enzymology

(<http://www.chem.msu.ru/eng/chairs2/enzim/welcome.html>)

The Division was founded in 1974 on the basis of the group of scientists studying kinetics of enzymes activity at the Division of Chemical Kinetics and the group from the Department of Biokinetics of Belozersky Research Institute of Molecular Biology and Bioorganic Chemistry.

The Division consists of seven laboratories: Laboratory of Enzyme Engineering, Laboratory of Kinetics and Mechanism of Enzymatic Processes, Laboratory of Micellar Enzymology, Laboratory of Physico-Chemical Basis for Energetic Bio-Conversion, Laboratory of Physico-Chemistry of Enzymatic Polymer Conversion, Laboratory of Ecobiocatalysis and Laboratory of New Chemical Technologies for Medicine.

The major field of study at the Division is chemical enzymology. Researchers performed laboratory tests and optimization of carbohydrases application in processes of textile materials treatment to improve their custom properties, as well as to berries and fruits to increase yield and improve juices quality, and also as additives to formula feed for agricultural animals and birds. Scientists developed an express method of determination of aromatic compounds of toluene type and a sensitive method of bisphenol A determination using two schemes of immunoenzymatic analysis. They also prepared a biocatalyst for lipids biodegradation in manufacturing waters of food industry.

The staff of the Division studied an operating stability of hydrogen electrode, based on hydrogenases, in microbe culture and tolerance to oxygen presence in media for application in fuel cells. A new method for overall antioxidant activity of foods was developed at the division. Researchers also suggested new approaches to preparation of disperse systems of protein delivery. These protein delivery systems show significant advantages compared to native proteins as it was proved by *in vitro* and *in vivo* experiments. Scientists developed an extremely sensitive express-method of bioluminescent determination of the total microbial air pollution. Moreover, for the first time in the world, genes of two plant forms of formiate hydrogenases were cloned and expressed in *E.coli* cells in active and soluble forms.



# SPORT

54

The Chemistry Department has long-standing traditions in sports. Sport and physical fitness are inseparable from the research work and career of many chemists and became a major component of their life style.

Sport and science share much in common. Primarily, it is an ultimate concentration of mind and body efforts at critical moments, creative non-standard solutions, and capability to overcome difficulties. Gifted people reveal talents along the line, therefore many well-known chemists achieve great success at the sports grounds.

The Chemistry Department has always been one of the most keen on sports in the MSU. Its team many times won MSU championships held annually since 1947. Since this year, a Department's annual championship (Spartakiad) in ten sport events has started. This competition enjoys wide popularity at the Department. The evidence of it is that since the 1960s, the Chemical Department's soccer championship has taken place at the bigger MSU's playing ground, i.e. many laboratories of the Department have full-fledged soccer teams.

It is specifically with soccer that the greatest success in sports of MSU chemists is connected. For many years an all-department team was headed by A.N. Rykov, a talented soccer-player who in his youth was one of the favourite disciples of a celebrated Soviet coach K.N. Beskov. He was meant for a promising career in sports, however, when it was time to decide between soccer and chemistry, Anatoly Nikolayevich gave preference to science. Owing to this, the Chemistry Department was unrivalled for years not only at the bigger soccer ground but also at the small grounds for mini-soccer (that is tenderly called "dyr-dyr" meaning "a short pass").

The MSU chemists have always been strong in team games (it should not be ruled out that it is a reflection of a specific corporate character of chemists). Along with soccer players, volleyball players have been making their fans happy throughout many years already. The Department's team, having achieved a professional level, since 2007, plays in the Moscow Championship, and not just plays, it wins. "The MSU Chemistry Department" team is Moscow 2007 champion!

Besides the team kinds of sports, chemists give preference to intellectual sports, among which chess holds the first place. Professor N.E. Kuzmenko who is in charge of the educational process at the Chemistry Department is one of the best MSU's chess-players. Tennis is another popular kind of sport that experienced people call "a chess game at the tennis court." The chemists play a prominent role in the MSU's Tennis Club: its head (Yu.D. Perfilyev) and the Club's No.1 racket" (V.V. Eryomin) are professors of the Chemistry Department.



Professor V.P. Zlomanov,  
a 12-times winner  
of the forty-event competition  
(Sorokoborje)

## Legend

There is a legendary competition organized at the Chemistry Department known to everyone.

In 1960, some chemists, enthusiasts of sports, decided to inaugurate the Department's forty-event sport competition (Spartakiad in Sorokoborje).

It must be said, that in those years a brilliant generation of athletes studied and worked at the Department. They were real amateur sportsmen. Sports and physical culture were of paramount importance for their life style and inseparable from their research work and career.

## They say, all that started after a plain dispute

Friends started to argue who was the most versatile athlete among them. Then an organic chemist Igor I. Grandberg proposed to arrange an all-around competition.

The forty-event competition (Sorokoborje) continues throughout the year.

Here is a list of the forty kinds of sports: eight distances in swimming (among them fin swimming and swimming with a board), 30 km bicycle race and 10 km cycle cross, rifle shooting, sixteen kinds of track and field athletics, skating (two distances), four ski races, table tennis. There are several contests in general fitness. The participants of the forty-event competition (Sorokoborje) do bar pull-ups, push-ups on the floor, squat on one leg, press and push weight. Famous "foot race on the rail" is arranged on a railway branch line near the University. One has to walk several kilometres for time. In the middle of the distance a u-turn is done, and the athlete moves in the opposite direction. Each dismount from the rail is penalized by half a minute.

The participants believe that tactics determines a lot in this kind of sport. On a dry rail it is possible almost to run. If a train passed shortly before the start, the rail gets slip-

pery from oil, and it is better to lower the speed in order to reduce the number of dismounts. The rules of the forty-events competition (Sorokoborje) are worked out and recorded by the participants themselves. The winner in each kind receives one score. The second best athlete gets two scores, etc. However, non-participation in any kind of sport is penalized by ten scores and also, in compliance with the rules, by "2 roubles penalty (about 1 dollar) that go to the corporate treasury."

On March 7, the day of summing up, the winner of the sports competition is announced; it is the athlete who received the lowest amount of scores in the forty events. It is explicit that with this plain system of calculations it is impossible to win the whole competition at the expense of the sports, in which one is the strongest. For instance, it is possible by far to outstrip all in the hardest ski race and then lose the advantage on a skating rink or doing pull-ups. Only the most versatile athlete can achieve an overall victory.

Ten scores, "baranka" is considered a serious failure; therefore the participants of the forty-event competition (Sorokoborje) try to fulfil the entire program by all means. There happened an incident when one participant nearly drowned. Swimming was his weak point, but he toed the starting line for all the distances in the swimming pool and received his point-count. Traditionally from six to eight persons take part in the competition. The same people also act as judges. Strangers are not admitted to the competition. The winner is not awarded with any prize.

It is interesting that participants of the forty-event competition (Sorokoborje) do not take into account an age difference of the athletes, though it happens that one participant may be 25 years older the other! Participants of the forty-event competition (Sorokoborje) are well known at the University. Sports grounds and facilities are readily provided for them, though their competition is informal and an amateur one. It is not scheduled in any calendars. Currently already the 46th traditional forty-event competition (Sorokoborje) is underway.

In conclusion let's have a look at the records of the forty-event competitions (Sorokoborje), which are strictly followed and recorded: Push-ups, 2 minutes – 96 times; Cycle cross, 10 km – 19.02; Race 1500 m – 4.41.6; Squats on one leg, 2+2 minutes – 110 times.

# OPERA AND BALLET



One of the first concert pieces of the Theatre of Ancient Music. Valery Kreisberg is the third to the left

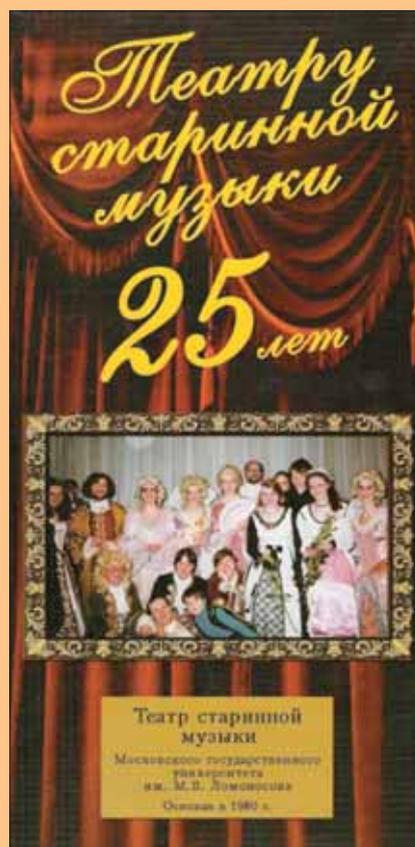
A few odd fellows in powdered wigs and camisoles and gorgeous ladies in flamboyant skirts came to the theatre and raised a lot of clamour. They climbed the stage and demanded handbills. A quick-tempered Gascon cavalier is about to stab the box keeper. Scandal! But nobody screams. The point is that the scandal is sung. It is a masterly interlude by Lully and Moliere performed by the Theatre of Ancient Music of the Moscow University.

Quite a few groups of art lovers were set up at the Chemistry Department at various times. It is here that a well-known "Russian Souvenir" folklore group was inaugurated. A drama theatre and a pantomime studio performed at the Department as well. The first actors of the Ancient Music Theatre were the best voices of the huge Department's choir (over 100 persons!).

It is assumed that there cannot be an amateur opera. This genre demands special professionalism. Who would listen to the "Carmen" opera performed by amateurs? However, some two hundred years ago opera music was a more accessible genre. Common arias were sung in the streets. Young girls and boys from Russian noble families learned to sing. In Russia there were many "noble amateurs" who staged home opera performances.

New "noble amateurs" were ten students-chemists who first played a small concert piece in public. They sang a few uncomplicated pieces a capella and performed a minuet dance. Spectators were amused with their costumes: camisoles, wigs, corsets, and white stockings on gentlemen.

In two years the first performance was produced. It was a Russian comic opera of the 18th century "Fedoul with Children." Its music was absolutely forgotten, its genre – half-forgotten and the time that had long passed.



It was rumoured that Russian empress Catherine the Great wrote the "Fedoul's" libretto. It consisted of musical pieces and short intervals between. During each interval a Russian proverb matching the content of the last piece was pronounced from the stage. That's how Catherine the Great devised it. In the Department's Theatre performance the intervals were extended and theatrical sideshows developed with participation of all characters, the conductor and musicians of the orchestra. There emerged a live performance that was fun to watch. The opening night of the "Fedoul with Children" opera took place in March of 1983 with the full house of the University Palace of Culture. The performance turned out to be a lucky one. "Fedoul" sustained over 50 runs (for an amateur play it is an enormous number!), was on at many stages, performed in English as well, received many prizes and was shown to the guests of the Youth World Festival in 1986.

In those years Sunday concerts used to be arranged in Moscow for teenagers. Their organizers, professional musicians, willingly included "Fedoul" into the program, since it was a rare example of the "revitalized" 18th century Russian art.

Valery Abramovich Kreisberg, an employee of the Chemistry Department, created the Theatre of Ancient Music. Valery is an outstanding and unique personality. Besides being endowed with a great musical talent, he possesses a rare gift of bringing any undertaking to a conclusion. V.A. Kreisberg can do everything: he is the Musical Director, conductor, tenor singer and Director of the Theatre! The history of staging the "Gallant Europe" opera-ballet by French composer Campra is an evidence of it. In Russia only scholars engaged in music history were familiar with this opera from the books. It was never staged in the Russian theatres and there was no single copy of its score in the country. Valery ordered the score of the opera in Paris through the State Public Library. To a surprise of many, the sheet music from France arrived to the then isolated "Soviet" Moscow in a few months. Then the music had to be adapted for the theatre's orchestra and learned by musicians and singers. There are complex ballet pieces in the "Gallant Europe." They had to be devised and staged in their turn. Designs of the costumes had to be done and ordered in the workshop and money found to pay the order. Actors quarrelled, failed to attend rehearsals, were annoyed by the complexity of the opera and criticized directors. It was impossible to produce the performance in such environment. But Kreisberg managed to make it. A lucky premiere of the "Gallant Europe" took place in the spring of 1985.

Recently the Theatre of Ancient Music marked its 25th anniversary. Let's ask for a jubilee handbill!

There are 13 operas listed in it. Throughout these years, 46 soprano singers performed in the company and totally – over 200 people. They are chemists, students, employees of other University departments and also ordinary Muscovites. French singers and a Swedish singer performed at the theatre at different times. It turns out that around there are lots of people who can sing and love to sing!



Soprano singer Elena Malitskaya in the "Vivat" performance

# TRADITION



On the second Saturday in May the Chemistry Department celebrates the Day of Chemist. At 11 o'clock in the morning a theatrical performance begins on the steps between the monuments to Mendeleev and Butlerov. The Dean comes up to the microphone. Behind him on the Department's facade a huge Mendeleev's Periodic Table is put up. Every year one cell on it is highlighted. This element is a current hero of the fest. There was one wit at the Chemistry Department who inaugurated a tradition to mark a day of one chemical element from the Mendeleev's Table every year and gradually move across the Table.

The first holiday, the Day of Hydrogen, was marked May 10, 1966. It was set up with an extraordinary grandeur and inspired the entire Department. That day the fireworks were arranged and in the evening students with torchlights processed around the University building.

The second Saturday in May, bird cherry trees and lilac blossom in the square between the Departments of Chemistry and Physics. The Day of Chemist is a traditional reunion day of the Department's graduates. The crowd of people moves between the steps and the square. Former students pass from one circle to another looking for their fellow-students and watch the performance with one eye. Since nobody watches the whole street performance, it is split into separate

bright costume scenes, musical pieces and tricks. Once three motorcycles drove on to the steps with a roar. Many times a body fell down on the steps from the window of the Administrative Office (located in the centre of the second floor). A brilliant trick was performed on the Day of Magnesium in 1977. The host in a cylinder and tailcoat announced: "Cockroaches of Zone "B"...welcome participants of the fest!" At that very moment above the zone "B" hostel's tower where students of the Chemistry Department live a brown "cloud of cockroaches" emerged! It flew out of the window on the 24th floor and could be visible on the ground from afar. This sophisticated trick was performed without preliminary rehearsals.

The thing is that the dormitory of students-chemists is located 300 metres from the steps of the Chemistry Department. An observer was watching the performance at the steps through a binocular from the window above. Two signals with a white cloth were given from the steps unnoticed by the viewers – and "cockroaches" took off in time! Why did cockroaches welcome the Day of Chemist? Alas, there were quite a few cockroaches in the dormitory at that time. Throughout many years they were the subject of students' jokes and therefore were animated during the performance. Other popular heroes of the show were: a cheat sheet, a strict professor, a careless student, a students' canteen where food was tasteless, American spies and a hydra snake. The small "Phlogiston-Rectificate" humorous theatre played short scenes from "the lives of renowned chemists and physicists" at some celebrations. During the performance chemist Sheele discovered hydrocyanic acid on stage, tasted it and made records in the laboratory's log. Italian physicist Marconi invented radio in the house where it was already roaring and disturbed him while he worked. "The Small Theatre" was almost a perfect piece. The performances: funny costume "chemical" scenes lasting a minute or two captivated the whole crowd.

Already several generations of jokes replaced each other in the performances on the steps. The jokes laughed at on the Day of Beryllium are not funny today. And, probably, the opposite. The participants of the Nitrogen or Phosphorus Days turned into professors now and themselves are being portrayed at the steps. Only monuments to Mendeleev and Butlerov stay the same. Though... "on numerous observations, Mendeleev and Butlerov every Day of Chemist turn their heads by one grade to the steps of the Chemistry.





Department, thus, by the Day of Thorium they will be able not only listen but also view the event..." (a joke of the Day of Neon in 1975).

The performance ends at one o'clock in the afternoon. Now it is time to enter the Department's building. There are posters, humorous slogans and greetings on the walls. In the Big Chemical Auditorium a festive auction takes place. It is possible to buy here, say, a lucky exam paper. Once, special banknotes with the portraits of the Department's heads were issued for the auction. Also on sale is a traditional Chemist's Day badge with an image of the holiday's hero element. The history of the badge began with the Day of Carbon. It was then invented and issued for the first time. Badges with the elements in the beginning of the Table (hydrogen, lithium, beryllium) were produced much later and are particularly valued by collectors. There are no badges for the Days of Helium and Nitrogen until now. Presently, every year the whole series of badges of different colour and design are produced and one special – for members of the fest's Organizing Committee. A badge for the Organizing Committee is usually a humorous one. For the Day of Chrome, for instance, it depicted... a boot (in Russian "boots of box calf" sounds as "boots made of chromium").

There is a tradition at the Chemistry Department: teachers present their students with the badges of the holiday held in the year a student was born. Presently, some girls study at the Department who may be presented with the badges of the Days of Vanadium, Chrome and even Manganese.

Following the auction, the crowd leaves for the stadium to watch a traditional soccer game between a combined team of professors and combined team of students. Every year the sports program for the Day of Chemist is being extended – currently, it includes tennis and volleyball games, as well as a "Beer Race."

It is still a long way until the evening. Picnics are starting to be arranged on the lawns around the University. Companies of people sit on the grass and drink wine and beer. People who haven't seen each other over a year, two years, and twenty years talk between themselves.

Graduates of the Chemistry Department come for the holiday from all over Russia.

Many romantic stories commence every year on the Day of Chemist, pairs find each other, and people who had been in love before meet again.

When it's getting dark, people start to dance at the steps. Popular groups are playing music. Traditional Chemical fireworks are arranged in the evening.

Sometimes chemists are asked a question: "What are you going to do when all the known elements will expire?" Here is a possible answer: "Then we'll proceed to the isotopes." If to take into account that only hydrogen's seven isotopes are known, at least some several hundreds Chemist's Days more are guaranteed.

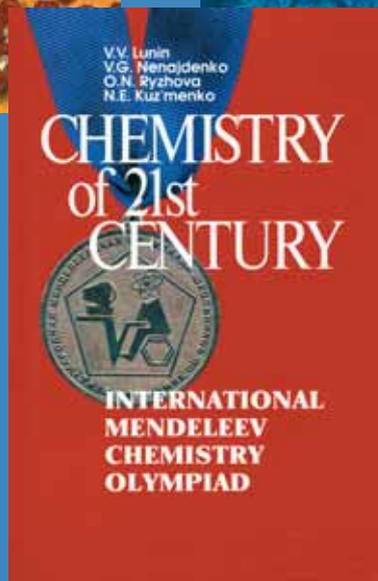
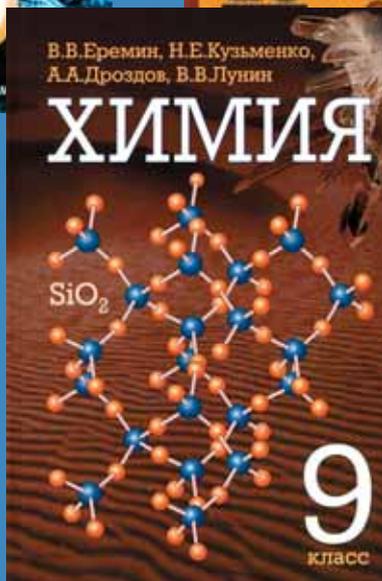
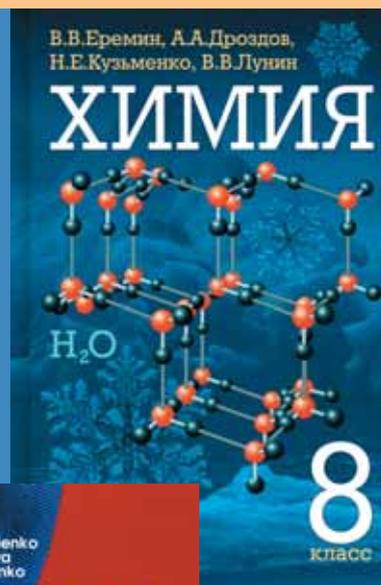
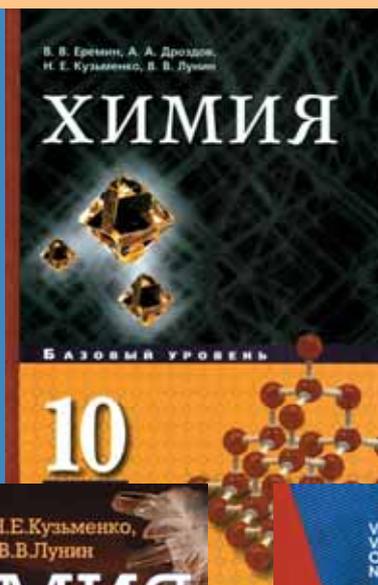
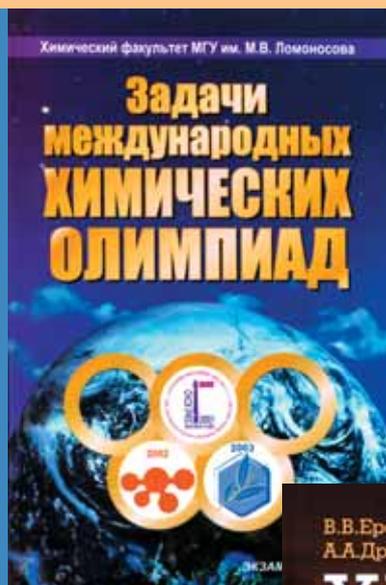
# High school chemistry, chemistry olympiads

One of the oldest Department's traditions is work with high schoolers and dissemination of chemical knowledge. Many students before entering the Chemistry Department were engaged in the chemical hobby circles where they could "really get acquainted with Substance and understand that chemistry is much more interesting and versatile than one could have imagined from the school's course."

Right after the war, at the end of the 1940s, there operated over 100 chemical hobby circles at high schools headed by the University students. Every year students of the Chemistry Department came to various Moscow secondary schools, made reports on chemistry, told about the Chemistry Department and conducted studies at the schools' societies in chemistry.

In 1970, an evening School of Young Chemist was inaugurated under the Chemistry Department where classes in theory and practical experiments in chemistry were arranged. This School is successfully operating to present day and covers schoolers of all grades. In recent years, classes in mathematics and physics were added to chemistry that helps school graduates to prepare for the MSU entrance exams.

Chemistry today is not that popular in our society as it used to be. A school curriculum in chemistry was reduced manifold and a number of hobby circles decreased considerably. Nevertheless, the Chemistry Department is trying to maintain a high level of school education in Russia. One of the most significant recent projects is creation of a textbooks' set compiled by the Department's employees that helps high schoolers to get familiar with actual but not "paper" chemistry and understand that it is not only useful but also fascinating science.



The Chemistry Department has always been at the head of Olympiads in Chemistry in our country. The Moscow City Olympiad is held in the laboratories and auditoriums of the Chemistry Department. The employees of the Department head the preparation and organization of the Olympiad that has been officially held since 1965. When in 1991, the Soviet Union was dissolved, only chemists managed to unite the former republics of the USSR and maintain the All-Union Olympiad that from 1992 is called the Mendeleev Olympiad. V.V. Lunin, the Dean of the Chemistry Department, is a permanent head of this Olympiad. According to the legislation of Russia, the winners of the high level Olympiads enter Universities without exams and the majority of them choose the Moscow University to continue their education.



Announcement on the 1949 Olympiad in Chemistry

The Chemistry Department is in charge of the Russian team preparation for the International Chemical Olympiad (ICHO). Every year in June, 15 best young chemists of Russia, the winners of the All-Russia Olympiad come to Moscow for training, during which the best four are identified to represent Russia at the international level. Due to a thorough preparation on the MSU base, the team of Russia is very successful at the IChO. In 2004 and 2005, a Russian high schooler Alexey Zeifman achieved unique result – he won the first prize at the IChO two years in succession.

Winners of the All-Russia Olympiad in Chemistry in 2007





The Olympiads, competitions of high schoolers in chemistry, that are to identify the most gifted students hold a special place in Russia's chemical education. The first Olympiad was held at the Chemistry Department in 1939, and took place in the "Red Building" of the old University. Besides the calculation tasks, the participants had to recognize famous chemists by the presented portraits, design schemes of devices for obtaining various substances, as well as perform experimental tasks, e.g. to collect gas into the glass jar from the gazometer and examine it.

The Chemistry Department's participation in the IChO is not limited to the All-Russia team's preparation. The Chemistry Department hosted the IChO three times, in 1972, 1996 and 2007. If in 1972, only 7 countries participated in the Olympiad, in 35 years there were already 68 countries-participants. During these years, the IChO turned into a competition of a great scale – the world's forum of young chemists. Olympiad 2007 was conducted under the "Chemistry: art, science, fun" slogan and its task was to show to the participants that chemistry is not only science, but primarily – art of high degree.

Working with high schoolers at all levels – from schools' hobby circles to the international Olympiads the Chemistry Department attracts gifted young people dedicated to science and ready to pass this dedication to the following generations.



Closing Ceremony of the IChO-2007



Dean of the Chemistry Department  
V.V. Lunin with the IChO's Challenge Banner



Nobel Prize Winner Professor Lee is awarding  
Alexey Zeifman with the IChO- 2005 1st Prize



IChO's "Founding Fathers" –  
Anton Sirota (Slovakia) (on the left)  
and Sergey Churanov (Russia)



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