Владимирский государственный университет

ХИМИЯ

Учебно-практическое пособие по обучению чтению на английском языке

Владимир 2024

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имени Александра Григорьевича и Николая Григорьевича Столетовых»

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PREFACE

Учебно-практическое пособие построено по тематическому принципу и включает тексты, содержание которых соответствует темам, предусмотренным учебным планам и рабочей программой дисциплины: «История химии», «Химические теории и законы», «Вещества и соединения» и др.

Учебно-практическое пособие имеет чёткую структуру и состоит из девяти модулей, включающих тексты для изучающего и ознакомительного чтения: два текста А – для изучающего чтения, два текста В – для ознакомительного чтения. Каждый модуль предваряет тематический список слов для активного усвоения и понимания текста А; предтекстовые и послетекстовые упражнения предусматривают работу с терминологическим словарём пособия, а также проверку понимания прочитанного. Тексты В также снабжены упражнениями, способствующими выработке навыка обобщения и компрессии текста. В пособии также представлены тексты для дополнительного чтения.

Unit I
FROM THE HISTORY OF CHEMISTRY

I. Remember the following words and words combinations from the text:

1. to stick things – прикреплять материалы
2. notion of atomic structure – понятие атомной структуры
3. to form a rational philosophy – сформировать рациональную философию
4. urgent implications of atomic power sources – неотложные последствия источников атомной энергии
5. to attack any course – воздействовать на любое направление
6. web of concepts and attitudes – сеть концепций и взглядов
7. scaffolding of empirical facts – подкрепление эмпирических фактов
8. to gain knowledge – приобрести (получить) знания
9. acquisition of culture materials – приобретение культурного материала
10. to sink materials below the level of recall – опустить материал ниже уровня запоминания
11. to develop skills – развивать навыки
12. reference literature – справочная литература
13. unique value – уникальная ценность
14. to lean the structure and behaviour of the mater – изучить структуру и поведение вещества
15. off-hand knowledge – импровизированные экспромтом, без подготовки знания
16. to call up – вызывать в памяти
17. edifice – система взглядов

II. Give the Russian equivalents for the following:

notion of atomic structure, unique value, empirical facts, behaviour of the matter, level of recall, complex of attitudes and ideas, to use after graduation, to be of primary importance, off-hand knowledge, a good deal of knowledge.

III. Give the English for the following:

сформулировать рациональную философию, воздействовать на любое направление, уровень запоминания, подкрепление эмпирических фактов, развивать навыки, справочная литература, изучать структуру и поведение вещества, значение образования, не импровизированная информация, приобретение культурного материала.

IV. Translate the following sentences into Russian:

1. The notion of atomic structure is of prime importance in chemistry.
2. The meaning of education lies in the web of concepts and attitudes about the reality.
3. A man has a million facts in his head.
4. In the course of chemistry students learn the structures and behaviour of matter.
5. The course of chemistry helps understand scaffolding of empirical facts.

V. Translate the following sentences into English:

1. Знания химии можно использовать на практике в науке и в технике, а также в искусстве и литературе.
2. Несмотря на знания химии, полученные в университете, студенты также должны пользоваться справочной литературой.
3. В основе рациональной философии современного образования лежит понимание последствий использования источников атомной энергии.
4. Импровизированные знания являются источником дополнительной информации для студентов.
5. Можно легко восстановить знания, находящиеся вне уровня запоминая, изучая химию.

VI. Translate the following sentences, paying attention to Perfect Tenses:

1. We have called education the complex of attitudes and ideas.
2. The student who has had one year of chemistry remembers no detail after a few months.
3. The edifice we call education has been erected quite recently.
4. Material which has sunk below the level of recall may be easily relearned.
5. The edifice we call education has been erected due to study of chemistry.

VII. Read the text bellow and find out information about the history of chemistry.

Text 1A

Why Study Chemistry?

Certainly, the student who has had one year of chemistry remembers virtually no detail after a few months. The things that stick will generally include some notion of atomic structure, and this information will be of some help to the individual in forming a rational philosophy and in understanding the very urgent implications of atomic power sources; but if this is to be all the student gains we may well be troubled.

It is easy to attack any specific course as contributing little or nothing that the student will use after graduation. However, the huge reality and meaning of education lie precisely in that web of concepts and attitudes which have no meaning without factual detail. It is of no importance that the scaffolding of empirical facts disappear after the edifice we call education has been erected.

It is not wise to press the analogy too far. Besides this complex of attitudes and ideas we have called philosophy, or education, there is necessarily gained by the student a good deal of knowledge which might be characterized as off-hand knowledge in the sense that it is immediately present and usable whenever called up. Such is the knowledge the engineer uses in the practice of engineering and his information in the arts and literature which he may use in ordinary conversation. This immediately available information is tool and culture material and its acquisition is defensible.

But what of that information which has been lost unused, is other than scaffolding? The answer is that it has not been lost. Material which has sunk below the level of recall may be much more easily relearned and understood than brand-new material. The foundations have been built and lie in readiness for the possible time when a particular skill is to be developed. This non-recall information is thus not useless, even though a great part of it be unused. It might be pointed out that even tool information is largely sunk below the level of recall. Especially in chemistry, though a man has a million facts in his head, he still needs the reference literature.

The unique value of a course in chemistry is that it is the only course taken by the great majority of students in which they learn the structure and behaviour of the matter of which their environment is composed. Each knowledge is of primary importance in the development of any realistic philosophy or the understanding of nature.

VIII. Answer the following questions about the text:

1. Does the student remember everything he lerans?
2. What may any specific course be criticized for?
3. What kind of knowledge does the student gain?
4. What may be the example of off-hand knowledge?
5. What is the use of information which seems to be lost?
6. What is the unique feature of a course in chemistry?

IX. Fill in the blanks which information taken from the text:

1. The things that stick will generally include some ________.
2. It is easy ________ that the student will use after graduation.
3. The meaning of education lies in _________.
4. A good deal of knowledge may be characterized as _________.
5. A particular skill in _________ is developed.

X. Read the text, try to get it as a whole.

Text 1B
The History of Chemistry

There are five periods in the history of chemistry. The ancient period comprising the older civilizations of China, India, Greece, and their contemporaries to 350 A. D. developed practical arts as in Egypt, and a philosophical approach to the study of matter as in Greece, where a theory of numbers, an atomic theory, and a theory of five elements, earth, air, fire, water and the quintessence were proposed.

The alchemical period (350-1500), of which the principal goals were an elixir of life and the philosopher's stone by which base metals could be changed to gold, introduced pure substance and improved techniques.

Iatrochemists (1500-1650) devoted their chemical pursuits to alleviation of disease. During the phlogiston period (1650-1774) men postulated a hypothetical matter whose presence was required for combustion and calcination. Gain in weight by calcination of metals led to a search for a very light material and subsequent discovery of gases, one of which was oxygen, and the answer to the problem. This is the date when modern chemistry begins.

When qualitative and quantitative analysis had identified enough pure substances, inorganic chemistry grew in scope. Organic chemistry was little understood until 1828 when synthesis of urea by Friederich Wöhler (1800-1828), a German chemist, proved that the "vital force" which was considered imperative to produce compounds that occurred in living matter was not needed.

Meanwhile reliable physical and chemical measurement began with the laws of Boyle (1660), Charles (1785), Gay-Lussac (1808) and Dalton (1807). Dalton's atomic theory (1807), postulated after the laws of the conservation of mass and definite proportions were tacitly assumed, stimulated the 19th-century effort to determine accurate atomic weights, ideas for combination as expressed in valence, and the studies of molecular structure until the three-dimentional models appeared.

Gradual determination of physical properties of the elements indicated a periodicity of property expressed by the periodic law which has withstood the onslaught of the discovery of the subatomic particles which make up the nucleus and outer electrons of the atom.

XI. Find answers to the following questions in the text:

1. How many periods are there in the history of chemistry?
2. What are these periods?
3. What do you know about the ancient period?
4. What were the principal goals of the alchemist period?
5. What was the period of iatrochemistry devoted to?
6. Why is the period between 1650 and 1774 called the phlogiston period?
7. When does modern chemistry begin?
8. What stimulated the development of chemistry in the 19^{th} century?
9. What investigations led to the discovery of the Periodic Law?

XII. Find sentences characterizing the following:

1. alchemists devoted their efforts to a search for the philosopher's stone;
2. the first period of the development of chemistry is the ancient period (until 350 A. D.);
3. characteristics of the phlogiston period;
4. the period of beginning modern chemistry;
5. molecular structure period.

Text 2A

The World's Greatest Chemist

I. Remember the following words and words combinations from the text:

1. history-making contribution – вклад в историю
2. characteristic feature – характерная черта

3. to develop into different directions – развиваться в разных направлениях

4. to predict in advance – предсказать заранее

5. undiscovered elements – неоткрытые элементы

6. to owe to smth – быть обязанным

7. fission of uranium nucleus – деление ядра урана

8. to obtain elements – получить элементы

9. to bear the name – носить имя

10. to lay the foundation – заложить фундамент

11. to draw special attention to – обратить особое внимание на

12. to retain key capacity – сохранить ключевой потенциал

13. to commemorate – почтить память

14. underwater ridge – подводный хребет

15. explorer of nature – исследователь природы

16. immortality – бессмертие

17. lasting heritage – прочное наследие

18. to serve society – служить обществу

19. to do one's best – стараться изо всех сил (сделать всё возможное)

20. dreams have come true – мечты осуществились

21. to intensity the development of – идентифицировать развитие науки, техники и промышленности

22. to deal with the problem – справиться с проблемой

II. Give the Russian equivalents for the following:

the greatest chemist, the periodic system of the elements, to predict in advance, to lay the foundation of smth, to deal with the problem, to do one's best, the structure of matter, to devote efforts to teaching, spread of knowledge, to draw special attention to.

III. Give the English for the following:

изучение природы, мечты осуществились, обращать внимание на что-либо, носить имя кого-либо, разрушаться со временем, основы изучения веществ и их состава; всероссийский институт, заниматься астрономией, исследователь природы, экономическое и промышленное развитие России.

IV. Translate the following sentences into Russian:

1. This century has seen great changes in science and life of people.
2. The all-Russian Chemical Society bears the name of Mendeleyev.
3. Mendeleyev tried to do his best for the economic and industrial progress of Russia.
4. Mendeleyev successfully dealt with the problems in mathematics, astronomy, meteorology, philosophy, economics and art.
5. Since its discovery the periodic system of chemical elements has long served as greatest contribution to the study of nature.

V. Translate the following sentences into English:

1. Периодическая система Д.И. Менделеева стала известна в 1869 году.
2. Она позволила заранее предсказать существование и свойства нескольких элементов.
3. Д.И. Менделеев – основатель современной химии и, в значительной степени, современной физики.
4. Он посвятил себя изучению природы.
5. В настоящее время периодическая таблица сильно отличается от периодической таблицы 1869 года.

VI. Translate the following sentences into Russian and Define the Tenses.

1. Mendeleyev places work as an explorer of nature at the first place.
2. He also devoted much of his effort to teaching.
3. The Mendeleyev system has served for almost 100 years as a key to discovering new elements.
4. Mendeleyev drew his colleagues special attention to uranium (No. 92) which at that time had closed his periodic table.
5. The ideas of many outstanding researches originate from the periodic law.

VII. Read the text bellow and find out information about Mendeleyev and his discovery.

Text 2A

The World's Greatest Chemist

The periodic system of the chemical elements by Mendeleyev has long since served as the greatest history-making contribution to the study of nature. As any work of genius it shows two characteristic features: it adds more to the present knowledge, and it fruitfully develops along different directions in future.

It allowed to predict in advance the existence and properties of yet undiscovered elements. Many outstanding researchers owe to it, to a considerable degree, the ideas of their experiments, calculations, hypotheses and theories. Take, for example, the German Otto Hahn, who discovered the fission of the uranium nucleus. Or the American Glenn Seaborg who led a group of researchers that obtained, in laboratory conditions, a number of elements, including mendelevium, named in honour of Mendeleyev. That element bears the name of the great Russian scientist not only because Mendeleyev laid the foundation of the modern science of atom, but also because he drew his colleagues' special attention to uranium (No. 92), which at the time had closed his periodic table. A long train of transuraniums followed the once "final" uranium.

"The Mendeleyev system has served for almost 100 years as a key to discovering new elements," Seaborg wrote in 1955. It has retained its key capacity until now.

To commemorate Mendeleyev himself, the Soviet researchers named many newly discovered things on the earth or in the outer space after him: a crater on the "back" side of the Moon, an underwater ridge in the Arctic Ocean and the mineral mendeleyevite. Villages, streets and establishments such as the Moscow Institute of Chemical Technology, the Tobolsk Pedagogical Institute, the All-Russian Institute of Meteorology, the Museum of the St. Petersburg University building (where the scientist lived), the All-Russian Chemical Society, etc. have got Mendeleyev's name.

Mendeleyev, the explorer of nature, has found real immortality in his lasting heritage. The periodic system hasn't crumbled with time; on the contrary, its structure has expanded. At present it is the basis of modern teaching on substances, the structure of matter, atoms and nuclear energy.

“The greatest chemist of the world” this is Mendeleyev's fame among modern chemists. Yes, he, the founder of modern chemistry and, to a large degree, of modern physics, considered physical chemistry his main subject, while he successfully dealt with problems in different areas, from mathematics and astronomy to meteorology, from philosophy to economics, from technology to art. “He has penetrated everywhere”, the great Russian poet Alexander Blok once said.

Mendeleyev's notes on “three services to the Motherland” are quite interesting. He places work as an explorer of nature at the first place. He devoted himself to it. He tried to make his experimental and theoretical results serve society. He also devoted much of his effort to teaching, to the spread of knowledge. Finally, the third important task in Mendeleyev's life was to do his best for the economic and industrial progress of Russia.

Mendeleyev's dreams have come true. As long as seventy years ago the British magazine Nature (of February 24, 1934) wrote that in Russia scientists like Mendeleyev are valued and their works help to intensify the development of science, technology and industry.

VIII. Answer the following questions about the text:

1. Why is the periodic system by Mendeleyev valued so much?
2. Why does the element No. 101 bear Mendeleyev’s name?
3. Has the periodic table changed with time? In what way has it changed?
4. What information is it possible to get from the periodic table of elements?
5. What does the periodic law state?
6. Was Mendeleyev a man of wide interests? Prove it.

IX. Fill in the blanks with the information from the text:

1. D.I. Mendeleyev laid the foundation _________.

2. He _________ of chemists to uranium.

3. Mendeleyev devoted much of his efforts to _________.

4. There are many _________ in Russia which have got Mendeleyev's name.

5. Mendeleyev _________ which problems in different areas from mathematics and astronomy to meteorology, from philosophy to economics, from technology to art.

X. Read the text, try to get it as a whole.

Text 2B

The History of the Periodic Table

The final and most important step in the development of the periodic table was taken in 1869, when the Russian chemist Dmitry Ivanovich Mendeleyev (1834-1907) made a thorough study of the relation between the atomic weights of the elements and their physical and chemical properties, with special attention to valence. Mendeleyev proposed a periodic table containing seventeen columns, resembling in a general way the present periodic table without the noble gases. In 1871 Mendeleyev revised this table and placed a number of elements in different positions, corresponding to revised values of their atomic weights.

The "zero" group was added to the periodic table after the discovery of helium, neon, argon, krypton and xenon by Lord Rayleigh and Sir William Ramsay in 1894 and the following years.

The periodic law was accepted immediately after its proposal by Mendeleyev because of its success in making predictions with its use which were afterward verified by experiment. In 1871 Mendeleyev found that by changing seventeen elements from the positions indicated by the atomic weights which had been accepted for them into new positions, their properties could be better correlated with the properties of the other elements.

Most of the elements occur in the periodic table in the order of increasing atomic weights. There still remain, however, four pairs of elements in the inverted order of atomic weight; argon and potassium (the atomic numbers of argon and potassium are 18 and 19, respectively, whereas their atomic weights are 39.948 and 39.098), cobalt and nickel, tellurium and iodine, and protactinium and thorium. The nature of the isotopes of these elements is such that the atomic weight of the naturally occurring mixture of isotopes is greater for the element of the lower atomic number in each of these pairs than for the element of higher atomic number; thus, argon consists almost entirely (99.6%) of the isotope with mass number 40 (18 protons, 22 neutrons), whereas potassium consists largely (93.4%) of the isotope with mass number 39 (19 protons, 20 neutrons). This inversion of the order in the periodic system, as indicated by the chemical properties of the elements, from that of atomic weight caused much concern before the atomic numbers of the elements were discovered, but has now been recognized as having little significance.

A very striking application of the periodic law was made by Mendeleyev. He predicted the existence of six elements which had not yet been discovered, corresponding to vacant places in his table. Three of these elements were soon discovered (they were named scandium, gallium, and germanium by their discoverers), and it was found that their properties and the properties of their compounds are very close to those predicted by Mendeleyev.

After helium and argon had been discovered, the existence of neon, krypton, xenon, and radon was clearly indicated by the periodic law, and the search for those elements in air led to the discovery of the first three of them; radon was then discovered during the investigation of the properties of radium and other radioactive substances.

XI. Find answers to the following questions in the text:

1. When did Mendeleyev present his periodic system?
2. Were there noble gases in his periodic table?
3. Why did Mendeleyev revise the table?
4. What elements are there in Group “O”?
5. How are the elements arranged in the system?
6. Why are there elements in the inverted order of atomic weight?

7. What was the striking application of the Periodic Law made by Mendeleyev?

8. What discoveries verified Mendeleyev's predictions?

9. Is the Periodic Law widely applied by chemists? Prove it.

XII. Find sentences characterizing the following:

1. Mendeleyev made a thorough study of the relation between the atomic weight of the elements and their physical and chemical properties;

2. Mendeleyev revised his table;

3. the date of the acceptance of the periodic law;

4. arrangement of elements in the periodic table;

5. four pats of elements arranged in the inverted order of atomic weights.

Unit II
THEORIES AND LAWS

I. Remember the following words and words combinations from the text:

1. to explain facts – объяснять факты
2. to correlate facts – соотносить факты
3. to subject hypothesis to tests – подвергать гипотезу проверке
4. to agree with the results of experiment – согласовываться с результатами эксперимента
5. to involve some idea – включать идею
6. summarizing statement – заключительное утверждение
7. the law of the constancy of the angles – закон постоянства углов
8. faces of crystals – грани кристалла
9. to measure the angles – измерять углы
10. pure substance – чистое вещество
11. to have the same value – иметь одинаковы значения
12. to be in a regular order – располагаться в определённом порядке
13. sense – значение
14. to verify a hypothesis – подтверждать гипотезу
15. systematic body of knowledge – основная часть знаний
16. to compound facts – соединять факты
17. to interpret – интерпретировать (толковать)
18. in terms of – на основе, исходя из
19. properties of substance – свойства веществ
20. atomic structure – атомная структура

II. Give the Russian equivalents for the following:

to verify a hypothesis, to compound facts, to correlate a number of facts, summarizing statement, a law of the constancy of angles, pure substance, to have the same value, a body of knowledge, to explain facts, atomic theory of crystal

III. Give the English for the following:

ряд экспериментов, экспериментальное подтверждение, включать в себя, вселенная, угол между гранями кристалла, на основе, измерять грани кристалла, состоять из атомов, различные вещества, согласовываться с результатами

IV. Translate the following sentences into Russian:

1. A theory usually involved some ideas about the nature of some part of the Universe.
2. The periodic law represents a summarizing statement about the properties of the elements.
3. The atomic theory explains and interprets the facts of terms of atoms.
4. The scientists verified the hypothesis and it became a theory.
5. A hypothesis usually explains or correlates a number of facts.

V. Translate the following sentences into English:

1. Закон – это такое утверждение, которое суммирует наблюдаемые экспериментальные факты.
2. Теория даёт экспериментально подтверждённые объяснения фактов.
3. Когда эксперименты действительно подтверждают какую-либо гипотезу, мы обычно называем её «теорией».
4. Ученые знают много гипотез, которые стали теориями или законами.
5. Химики широко пользуются атомной теорией.

VI. Translate the following sentences, paying attention to the Model Verbs:

1. We can subject hypothesis to further tests.
2. Chemists may find explanation of structure of substance in the atomic theory.
3. We must explain the properties of substances in terms of their atomic structure.

4. Atomic theory can be regarded as the main one in chemistry.

5. In the anomic theory scientists describe facts that can be explained in terms of atoms.

VII. Read the text bellow and find out information about the theories and laws in chemistry.

Text 3A

Hypothesis, Theories and Laws

When we find that an idea explains or correlates a number of facts, we call this idea a hypothesis. We can subject it to further tests and to experimental checking of deductions. If the hypothesis continues to agree with the results of experiment, we call it a theory or a law.

A theory, such as the atomic theory, usually involves some idea about the nature of some part of the Universe, a law represents a summarizing statement about observed experimental facts. For example, there is a law of the constancy of the angles between the faces of crystals. The law states that whenever we measure the angles between corresponding faces of various crystals of a pure substance, they will have the same value. It does not explain the fact. We find an explanation of the fact in the atomic theory of crystals, the theory that in crystals the atoms are in a regular order.

Chemists and other scientists use the word “theory” in two different senses. The first meaning of the word is the meaning described above. namely, a hypothesis that has been verified. The second use of the word “theory” is to represent a systematic body of knowledge, compounded of facts, laws, theories, deductive arguments and so on.

Thus, by the atomic theory we mean not only the idea that substances consist of atoms, but also all the facts about substances that can be explained and interpreted in terms of atoms and the arguments that explain the properties of substances in terms of their atomic structure.

VIII. Answer the following questions about the text:

1. What is a hypothesis?

2. Do you know what a law is?
3. What is a theory?
4. What theories do chemists use in their work?
5. What do we mean by atomic theory?
6. When did you hear about the atomic theory for the first time?

IX. Fill in the blanks with the information from the text:

1. A hypothesis usually explains or correlates _________.
2. _________ we mean that substances consist of atoms.
3. If a hypothesis _________ with the results of experiments we call a theory as a law.
4. A law represents a _________ about observed experimental facts.
5. There is a law of _________ between the faces of crystals.

X. Read the text, try to get it as a whole.

Text 3B

The Atomic Theory of Democritus and Dalton

The Greek philosopher Democritus (about 460-370 B.C.) who had adopted some of his ideas from earlier philosophers, stated that the Universe is composed of void (vacuum) and atoms. The atoms were considered to be everlasting and indivisible - absolutely small, so small that their size could not be diminished. The atoms of different substances, such as water and iron, were considered by him to be fundamentally the same, but to differ in some superficial way; atoms of water, being smooth and round, could roll over one another, whereas atoms of iron, being rough and jagged, would cling together to form a solid body. The atomic theory of Democritus was pure speculation, and was much too general to be useful. Dalton's atomic theory, however, was a hypothesis that explained many facts in a simple and reasonable way.

Dalton stated the hypothesis that elements consist of atoms, all of the atoms of one element being identical, and that compounds result from the combination of atoms of two or more elements, each in definite number. In this way, he could give a simple explanation of the law of conservation of mass and of the law of constant proportions.

XI. Find answers to the following questions in the text:

1. When did Democritus live?
2. What did he state?
3. Did he consider water and iron to be the same?
4. In what way do they differ?
5. What was the Democritus atomic theory in general?
6. What about Dalton's theory?
7. What kind of hypothesis did Dalton state?
8. What do compounds result from according to Dalton's theory?
9. What laws did he explain?

XII. Find sentences characterizing the following:

1. the characteristics of atoms made by Democritus;
2. his opinion about different substances;
3. properties of water and iron;
4. the use of Democritus atomic theory;
5. a simple explanation of the law of conservation of mass.

Text 4A
Atomic Theory

I. Remember the following words and words combinations from the text:

1. to put forward the hypothesis – выдвинуть гипотезу
2. indivisible – неделимый
3. to give a simple explanation – дать простое объяснение
4. to take part in chemical reactions – участвовать в химической реакции
5. increase of our knowledge about atoms – повышение знаний об атомах
6. to aggregate – собираться в одно целое

7. to have priceless value – быть бесценным
8. coordination of knowledge – координация знаний
9. to abandon – отказаться
10. to be in favour of – быть сторонником чего-либо (выступать за)
11. distinguished chemists – выдающиеся химики
12. to await fate – ожидать судьбу
13. predecessors – предки
14. precise knowledge – точные знания
15. no longer – уже не

II. Give the Russian equivalents for the following:

to put forward a hypothesis, according to atomic theory, to give an explanation, previously observed relations, by further work, rapid progress, imaginary units, replace a hypothesis by a theory, to be in favour of smth, no longer.

III. Give the English for the following:

дать простое объяснение, принять участие в реакции, выдающийся учёный, доводы в пользу гипотезы, увеличение радиоактивности, быстрое развитие, согласно теории, точные знания, больше не может рассматриваться, быть бесценным для химиков, координация знаний.

IV. Translate the following sentences into Russian:

1. According to the atomic theory a molecule is considered as being composed of atoms.
2. All substances may be regarded as soluble in water.
3. All substances are usually defined as having a definite composition.
4. Dalton’s hypothesis was later proved to be true.
5. The atomic theory is of priceless value to chemists.

V. Translate the following sentences into English:

1. Джон Дальтон был химиком и физиком.

2. Он жил в Англии с 1766 по 1844 год.

3. Современная наука располагает точными знаниями о структуре и свойствах атомов и молекул.

4. Теперь никто больше не может утверждать, что структура и состав атомов неизвестен.

5. Современные исследования способствуют дальнейшему развитию атомной теории.

VI. Translate the following sentences paying attention to the Complex Subject:

1. Fundamental particles are no longer considered to be non-existent.
2. Chlorine is stated to have been discovered in 1774.
3. Mendeleyev is known to have been born in Tobolsk.
4. Solid carbon is usually said to exist in three modifications.
5. Atoms and molecules can no longer be considered “imaginary”.

VII. Read the text below carefully and find out information about the development of atomic theory.

Text 4A

The Atomic Theory

In 1805 the English chemist and physicist John Dalton (1766-1844) put forward the hypothesis according to which all substances were stated to consist of small particles of matter, of several different kinds, corresponding to the different elements. He called these particles atoms, from the Greek word *atomos*, meaning “indivisible”. This hypothesis gave a simple explanation or picture of previously observed but unsatisfactorily explained relations among the weights of substances taking part in chemical reactions with one another. As it was verified by further work in chemistry and physics, Dalton's atomic hypothesis became the atomic theory.

The rapid progress of science during the twentieth century is well illustrated by the increase in our knowledge about atoms. In a popular textbook of chemistry written in the early years of the twentieth century, atoms were defined to be the “imaginary units” of which bodies are aggregates. The article in “Atom” in the 11th edition of the *Encyclopaedia Britannica*, published in 1910, ends with the words "The atomic theory has been of priceless value to chemists, but it has more than once happened in the history of science that a hypothesis, after having been useful in the discovery and the coordination of knowledge, has been abandoned and replaced by one more in harmony with later discoveries. Some distinguished chemists thought that this fate may be awaiting the atomic theory... But modern discoveries in radioactivity are in favour of the existence of the atom, although they lead to the belief that the atom is likely to be not so eternal and unchangeable a thing as Dalton and his predecessors had imagined".

Only half a century later, scientists had precise knowledge of the structure and properties of atoms and molecules. Atoms and molecules can no longer be considered “imaginary”.

VIII. Answer the following questions about the text:

1. When was Dalton’s atomic hypothesis put forward?
2. What was the main idea of this hypothesis?
3. In what way was the hypothesis verified?
4. What does sometimes happen to a hypothesis in the course of history?
5. What do modern scientists think about Dalton’s theory?

IX. Fill in the blanks with the information from the text:

1. John Dalton _________ according to which all substances consist of atoms.
2. _________ became the atomic theory.
3. Some distinguished chemist thought that this fate _________.
4. Only have a century later, scientists, had _________ of the structure and properties of atoms and molecules.
5. The atomic theory has been of __________ to chemists.

X. Read the text, try to get it as a whole.

Text 4B

The Born Theory of the Hydrogen Atom

Most our knowledge of the electronic structure of atoms has been obtained by the study of the light given out by atoms when they are excited by high temperature or by an electric arc or spark. The light that is emitted by atoms of a given substance can be refracted or diffracted into a distinctive pattern of lines of certain frequencies; such a distinctive pattern of lines is said to be the line spectrum of the atom.

The careful study of line spectra began about 1880. Early investigators made some progress in the interpretation of spectra, in recognizing regularities in the frequencies of the lines: the frequencies of the spectral lines of the hydrogen atom, for example, show an especially simple relationship with one another. It was not until 1913, however, that the interpretation of the spectrum of hydrogen in terms of the electronic structure of the hydrogen atom was achieved. In that year, the Danish physicist Niels Bohr (1885-1962) successfully applied the quantum theory to this problem, and laid the basis for the extraordinary advance in our understanding of the nature of matter that has been made since then.

XI. Answer the following questions about the text:

1. How has the knowledge of the electronic structure of atoms been obtained?
2. When did the careful study of line spectra begin?
3. When was interpretation of hydrogen atom achieved?
4. What did Niels Bohr do?
5. What will happen with the light emitted by atoms?
6. What is called the spectrum of the atoms?
7. What do frequencies of spectral lines of hydrogen atom show?
8. Who laid the basis for the extraordinary advance in our understanding of the nature of matter?
9. Who discovered the regularities in frequency of spectral lines of hydrogen atom?

XII. Find sentences characterizing the following:

1. the method of obtaining knowledge of the electronic structure of atoms;

2. the modification of light emitted by atoms of a given substance;

3. the investigator made progress in interpretation of spectra of hydrogen atom;

4. the date of determining the spectrum of hydrogen atom in terms of electronic structure;

5. the role of Niels Bohr in quantum theory.

Unit III
ATOMS AND MOLECULES

I. Remember the following words and words combinations from the text:

1. solid matter – твёрдое вещество
2. continues matter – целостное вещество
3. no matter – независимо от того
4. continuous surface – сплошная поверхность
5. to turn up magnification – вызвать увеличение
6. to argue – спорить
7. to inquire minds – исследовать умы
8. to perceive – воспринимать
9. to be not sound – быть нездоровым
10. varieties of matter – разновидности веществ
11. to bring about – осуществлять
12. coupling – связь
13. uncuttable = indivisible – неделимый
14. to be astonishing – быть удивительным
15. to be confirmed – подтверждать
16. to be composed of – состоять из
17. to systematize the facts – систематизировать факты
18. to hold jointly – удерживать вместе
19. ultimate sense of the argument – окончательный смысл аргумента (договора)

II. Give the Russian equivalents for the following:

during the course of history, unlimited magnification, a sound argument, fundamental property, in the outer shells, to be composed of particles, knowledge about the structure of atom, to hold together, ultimate sense of the argument, to couple together two kinds of particles.

III. Give the English for the following:

твердое вещество, отдельные частицы, столкнуться с фактом, много различных видов, полностью подтвердить, состоять из молекул, электронное строение атомов, систематизировать факты, удерживать вместе, целостное вещество.

IV. Translate the following sentences into Russian:

1. An atom was considered by the ancients to be an indivisible particle.
2. The new results are likely to be widely discussed.
3. There are known to exist several modifications of phosphorus.
4. Bromine happened to be prepared in 1826.
5. At first the discovery did not seem to be very important.

V. Translate the following sentences into English:

1. Древние учёные считали, что основное свойство атомов – неделимость.
2. Оказалось, что их предположение подтвердилось.
3. Сегодня признают, что атомы состоят из мельчайших частиц.
4. Открытые структуры атома, вероятно, являлось одним из важнейших открытий науки.
5. Безусловно, что знание строения атома сыграло важную роль в развитии химии.

VI. Translate the following sentences paying attention to the Complex Object:

1. We know chemistry to be very important science.
2. They want this experiment to be made at once.
3. They saw her make the experiment in the laboratory.
4. Chemists consider all substance to be composed of atoms.
5. Scientists believed indivisibility to be the fundamental property of atoms.

VII. Read the text below carefully and find out what the atoms are.

Text 5A

The Idea of the Atom

Many times during the course of history men believed that the solid matter, of which the different things in the world are made, was really continuous matter. They thought that if you could look at the surface of a stone with magnification unlimited, you would always see a continuous surface, no matter how much you turned up the magnification. They believed that you would not find individual particles like atoms and electrons. They argued that if you had a magic knife by which you could cut the stone into smaller and smaller pieces, you could continue cutting it up indefinitely and could make the pieces as small as you like a trillion, quadrillion, quintillion times smaller or even infinitely small. But some twenty-five hundred years ago, there lived in Greece a group of men with inquiring minds, who perceived that this argument for continuous matter was not sound. Facing the fact that the world contains so many different kinds of matter-stones, metals, vegetables matter, animal matter, solids and liquids of so many forms-they argued that it was more logical to believe that all these varieties of matter are brought about by coupling together a relatively few kinds of particles, which could not be cut up any further. Because the indivisibility was taken to be the fundamental property of these particles, they gave them the name atom, or atom which in Greek means uncuttable. It is astonishing that this purely philosophical guess turned to be confirmed so completely two thousand five hundred years later. Of course, today all atoms are cuttable into smaller particles, such as the electrons in the outer shells and the fundamental particles in the inside of the nucleus; but the truly fundamental particles of which atoms are made, are sure to be uncuttable and they are true building blocks of all matter.

During the period of fourteen years beginning with 1897, it was discovered that atoms are composed of smaller particles. The discovery of the components of atoms and the investigation of the structure of atoms is likely to be one of the most interesting stories in the history of science.

Moreover, knowledge about the electronic structure of atoms has made it possible to systematize the facts of chemistry in a striking way, making the subject easier to understand and to remember: it has been discovered that the bonds that hold atoms together in molecules, consist of pairs of electrons held jointly by two atoms. So those ancient Greeks were right in the ultimate sense of the argument.

VIII. Answer the following questions about the text:

1. What did the ancients think about the composition of matter?
2. What particles were considered to be the building blocks of matter?
3. What does the word "atom" mean?
4. What was known about the structure of the atom at the beginning of the 20th century?
5. What do we call fundamental particles now?

IX. Fill in the blanks with the information from the text:

1. Knowledge about the electronic structure of atoms has made it possible _________.
2. Atom mean _________ in Greek.
3. _________ is one of the most interesting stories in the history of chemistry.
4. During the period of fourteen years beginning with 1897, it was discovered that atoms _________ of smaller particles.
5. Ancient Greek were right in _________.

X. Read the text try to get it as whole.

Text 5B

Dalton's Atomic Theory

One of the foundations of modern chemistry is Dalton's atomic theory developed between 1801 and 1808. When the atomic hypothesis appeared, there was no direct evidence of the existence of atoms. But as time passed, scientists found that the assumption of their existence and other assumptions concerning their properties and behaviour explain more and more of the accumulating experimentally determined facts of chemistry, and also predict other facts successfully. The hypothesis, therefore, gained the status of a theory.

There were revolutionary changes in chemistry in the last fifty years. Chemists found that atoms are not indivisible particles as Dalton thought, but consist of much smaller particles which form the structure of atoms. They established their sizes, weights and the arrangement of their parts with high accuracy, as well as the sizes and shapes of molecules and the internal structure of crystals. As a result, atoms and molecules are now as real as test-tubes. Chemistry has achieved not only a new look, but a major breakthrough to a deeper level of understanding. It is now possible to explain most of the properties of elements and their compounds in terms of their electronic, atomic and molecular structures. It is also possible to predict new properties successfully. Chemistry is no longer a collection of more or less unrelated facts, but a mature science founded on scientific principles which arrange facts in an orderly system.

XI. Answer the following questions about the text:

1. What is one of the foundations of modern chemistry?
2. When was it developed?
3. When did the existence of atoms appear?
4. Were there any revolutionary changes in chemistry it the last fifty years?
5. What were they?
6. When have atoms and molecules become real?
7. What has chemistry achieved?
8. What is it possible to explain now?
9. What is chemistry now?

X. Find sentence characterizing the following:

1. the evidence of the existence of atoms;
2. the first change in chemistry during the last fifty years;
3. the second one;

4. chemistry a major breakthrough to a deeper level of understanding;
5. chemistry a nature science now.

Text 6A

The Study of the Structure of Molecules

I. Remember the following words and word combinations from the text:

1. structure of molecules – структура молекул
2. to carry on the study – продолжить исследование
3. brilliant postulate – верный постулат (условие положение)
4. tetrahedral orientation – тетраэдрическая ориентация
5. the theory of stereochemistry – теория стереохимии
6. valence bond – валентная связь
7. to express in a concise way – выразиться в сжатой форме
8. qualitative significance – качественная значимость
9. with regard to – относительно, чего касается
10. to make attempts – предпринимать попытки
11. to culminate – достигать высшей точки (кульминировать)
12. electronic theory of valence – электронная теория эквивалентности
13. stable shells – стабильные обломки
14. covalent bond – ковалентная связь
15. to emphasize the importance – подчеркнуть важность
16. pairing unshared electrons – спаривание неподвижных электронов
17. to clarify the facts – прояснять факты
18. to suggest – предлагать
19. to incorporate suggestion into the present theory – включить предложение в настоящую теорию
20. to discard suggestion – отказаться от предложения

II. Give the Russian equivalence for the following:

to carry on the study, essentially chemical in nature, to take part in a reaction, formulate the theory of valance, tetrahedral orientation of the bonds to have qualitative significance, with regard to molecular structure, to form the basis of a theory, to share the electrons between the atoms, the features of the detailed theory.

III. Give the English equivalence for the following:

изучение структуры молекул, методы исследования, химический состав, многочисленные попытки, развить теорию, образование химической связи, подчеркнуть значение чего-либо, ковалентная связь, теория стереохимии, предложить теорию.

IV. Translate the following sentences into Russian:

1. The discovery of the electron stimulated the development of an electronic theory.
2. The study of the structure of molecules has been carried out by the scientists since early dimes.
3. Numerous attempts were made to develop an electronic theory of valence.
4. Early studies confined some suggestions that were discarded later.
5. The substance taking part in the reaction must be pure.

V. Translate the following sentences into English:

1. Проблема структуры молекул давно интересовала химиков.
2. Структурная формула – это формула, которая показывает, как сгруппированы элементы, как распространяются связи в молекуле.
3. Скорость реакции часто зависит от температуры.
4. Электронная теория химических связей была создана после открытия электрона.
5. Первые исследования ученых превратились в настоящую теорию.

VI. Translate the following sentences paying attention to use of Participles I, II:

1. The study of the structure of molecules was originally carried on by chemistry using different methods of investigation.
2. In the nineteenth century the valence bond was represented by a line drawn between the symbols of two chemical elements.
3. The modern electronic theory of valence discussed not only the formation of ions but also the formation of a chemical bond, now called the covalent bond.
4. Many of the features of the detailed theory were suggested in the papers of Langmuir written in the decades following 1961.
5. Particular attention must be paid to the reaction regarding the conditions of synthesis.

VII. Read the text below and find out information about the structure of molecules.

Text 6A

The Study of the Structure of Molecules

The study of the structure of molecules was originally carried on by chemists using methods of investigation that were essentially chemical in nature, relating to the chemical composition of a substance, the existence of isomers, the nature of the chemical reactions in which a substance takes part and so on. From the consideration of facts of this kind Frankland, Kekulé, Couper and Butlerov were led a century ago to formulate the theory of valence and to write the first structural formulas for molecules, van't Hoff and le Bel were led to bring classical organic stereochemistry into its final form by their brilliant postulate of the tetrahedral orientation of the four-valence bonds of the carbon atom, and Werner was led to his development of the theory of the stereo- chemistry of complex inorganic substances.

In the nineteenth century the valence bond was represented by a line drawn between the symbols of two chemical elements, which expressed in a concise way many chemical facts, but which had only qualitative significance with regard to molecular structure. The nature of the bond was completely unknown. After the discovery of the electron, numerous attempts were made to develop an electronic theory of the chemical bond. These culminated in the work of Lewis, who in his 1916 paper, which forms the basis of the modern electronic theory of valence, discussed not only the formation of ions by the completion of stable shells of electrons but also the formation of a chemical bond, now called the covalent bond, by the sharing of the two electrons between two atoms. Lewis further emphasized the importance of the phenomena of the pairing of unshared as well as of shared electrons and of the stability of the group of eight electrons (shared or unshared) about the lighter atoms. These ideas were then further developed by many investigators; the work of Langmuir was especially valuable in showing the great extent to which the facts of chemistry could be coordinated and clarified by the application of the new ideas. Many of the features of the detailed theory that is discussed were suggested in the papers of Langmuir and others written in the decade following 1916, or in the book *Valence and Structure of Atoms and Molecule*s written by Lewis in 1923.

All of these early studies, however, contained, in addition to suggestion that have since been incorporated into the present theory, many others that have been discarded.

VIII. Answer the following questions about the text:

1. What methods were used in the first investigations of the structure of molecules?
2. What do you know about isomers?
3. Who formulated the theory of valence?
4. In what way was the valence bond represented?
5. How did the discovery of the electron affect the development of an electronic theory?

IX. Fill in the blanks with the information from the text:

1. In the 19^{th} century _________ was represent by a line of symbols of two chemical elements.
2. In 1916 Lewis formed the basis of _________.

3. The study of _________ was originally carried on by chemists using natural methods of investigation.

4. After the discovery of the electron _________ were made to develop an electronic theory of the chemical bond.

5. Many of the features of the detailed theory ________ in the papers of Langmuir.

X. Read the text try to get it as whole.

Text 6B

Molecular Composition and Size

Molecules are chemical units composed of one or more atoms. The simplest molecules contain one atom each; for example, helium atoms (one atom per molecule) are identical with helium molecules. Oxygen molecules (O_2) are composed of two atoms, and ozone (O_3) of three. Molecules may contain several different sorts of atoms. Water (H_2O) contains two different kinds, hydrogen and oxygen, and dimethyl amine ($(CH_3)_2NH$) has three kinds. Molecules of many common gases (hydrogen H_2, oxygen O_2, nitrogen N_2, and chlorine Cl_2) consist of two atoms each.

Not all molecules are molecular in structure. Some are atomic and many are ionic. Molecular substances are characterized by low boiling points and poor conductivity of electricity when dissolved or melted. Gases are generally molecular, and so are many liquids, and some solids. All compounds of hydrogen and non-metallic oxides are molecular. These compounds are considered to be bonded by a force called a covalent bond (or bonds) which consists of one or more shared electron pairs.

The size of molecules, especially of the smaller ones, is so tiny that to make a meaningful comparison is rather difficult. Let us assume that the water molecules in a cup of water are dyed so that they can be identified. If this cup had been thrown into the ocean 2,000 years ago, these molecules would have become distributed evenly in all bodies of water on the earth.

A cup of water taken at random from your nearest supply, would give you at least one hundred of the original dyed molecules. The exceedingly large number of molecules of water in a cup is, of course, directly related to the fact that each molecule is exceedingly small. Molecules are too small to be visible in ordinary light. The most powerful and best illuminated optical microscope has failed to reveal molecules by direct vision, although it is claimed that they have been resolved in the electron microscope.

XI. Answer the following questions about the text:

1. What do the simplest molecules contain?
2. What are molecules of oxygen composed of?
3. What can you say about the composition of many common gases?
4. What are molecular substances characterized by?
5. What is the composition of compounds of hydrogen?
6. What is the size of molecules?
7. What is the member of molecules in a cup of water?
8. Can we see molecules in ordinary light?
9. Is it possible to reveal molecules through the most powerful microscope?

XII. Find the sentences characterizing the following:

1. composition of molecule of water;
2. characteristics of molecular substance;
3. covalent bond in compounds
4. the size of molecules in a cup of water;
5. the possibility of seeing molecules.

Unit IV
SUBSTANCES AND COMPOUNDS

I. Remember the following words and word combinations from the text:

1. to share credit – приписывать заслугу
2. amateur scientist – учёный-любитель
3. pharmacist – фармацевт
4. to escape religious persecution – избежать религиозных преследований
5. to heat various compounds – нагревать различные соединения
6. mercuric oxide – оксид ртути
7. to delay publications – отложить публикацию
8. account – упоминание (сообщение)
9. to play important role in combustion – играть важную роль в процессе горения
10. ardent adherent – ярый приверженец
11. phlogiston theory of combustion – флогистонная теория сгорания
12. dephlogisticated air – дефлогистированный воздух
13. to establish the modern concept – создать современную концепцию (понятие)
14. to yield products – производить продукцию
15. acidic solutions – кислотные растворы
16. “acid former” – «образующий кислоты»
17. to occur in a free state – встречаться в свободном состоянии
18. pure water – чистая вода
19. earth’s crust – земная кора
20. multitude of compounds – множество соединений
21. estimated extent – предполагаемый размер (степень)

II. Give the Russian equivalence for the following:

to heat various compounds, to yield products, phlogiston theory of compounds, amateur scientist, to establish the modern concept, mercuric oxide, to share credit, to find evidence, an acid solution, to delay publication.

III. Give the English equivalence for the following:

путём нагревания, реагировать с различными соединениями, фармацевт, встречаться в атмосфере, около 90% по весу, чистая вода, кислотные растворы, играть важную роль в процессе горения, множество соединений, на основе экспериментальных результатов.

IV. Translate the following sentences into Russian:

1. Oxygen was obtained by heating mercuric oxide.
2. Evidence was found that this gas is a component of the atmosphere.
3. The theory of phlogiston is not much spoken about nowadays.
4. Substances such as phosphorus and sulphur are known as non-metals.
5. Much attention has been given recently to the study of this group of oxides.

V. Translate the following sentences into English:

1. Современное понятие горения было установлено Лавуазье в 1777 году.
2. Кислород был найден в земной коре в виде соединений.
3. Работа Пристли была опубликована в 1774 году.
4. Кислород был открыт и описан во второй половине XIII века.
5. Такие вещества, как калий, известны как очень активные металлы.

VI. Translate the following sentences paying attention to the Passive Voice:

1. Gold is unaffected by oxygen.
2. Attempts were made to obtain pure oxygen.
3. When a substance is attracted by oxygen, it forms an oxide or a number of oxides.
4. Oxygen was obtained by heating mercuric oxide.
5. The yield of the reaction is greatly affected by temperature.

VII. Read the text below to find out information about oxygen.

Text 7A
Oxygen: History and Occurrence

Credit for the discovery of oxygen is shared by two men, Joseph Priestley, an English clergyman and amateur scientist, who later moved to the United States to escape religious persecution, and Carl Wilhelm Scheele, a Swedish pharmacist. Working independently, these two men both obtained the gas which we know as oxygen by heating various compounds of the element, particularly mercuric oxide. They also found evidence that this gas is a component of the atmosphere. Priestley's work was published in 1774, but although Scheele's experiments had probably been performed even earlier, their publication was delayed and no account of them appeared until 1777. Though Priestley recognized that the gas which he had discovered plays an important role in combustion, he remained, along with Scheele, an ardent adherent of the phlogiston theory of combustion; in fact, he called the gas “dephlogisticated air”.

On the basis of the experimental results of Priestley, Scheele, and others, as well as some very fine experimental work of his own, in 1777 the brilliant French chemist Lavoisier established the modern concept that the combustion of a substance consists in its combination with the new gas which Priestley and Scheele had described, and which Lavoisier found an important constituent of the atmosphere. Since the combustion of many substances (now known as non-metals) such as phosphorus and sulphur yields products which react with water and give acidic solutions, Lavoisier named this gas oxygen, derived from Greek words meaning “acid former”.

Oxygen occurs in the free state as the second most abundant component of the atmosphere; about one-fifth of the air by volume is oxygen. In the combined state it makes up 88.81% by weight of pure water, and, on the average, 85.79% of sea water. It occurs in the earth's crust, in the form of a multitude of compounds, to the estimated extent of 46.43%.

VIII. Answer the following questions about the text:

1. What famous scientists worked on the discovery of oxygen?
2. Who was the first to obtain this gas?
3. What was the method of obtaining oxygen?
4. What did the French chemist Lavoisier establish?
5. Where does oxygen occur and in what state?

IX. Fill in the blanks with the information from the text:

1. Priestly recognized that the gas obtained _________ in combustion.
2. Oxygen _________ in a free state in the atmosphere.
3. _________ were made to obtain pure oxygen.
4. In 1777 the brilliant French chemist Lavoisier established _________ of combustion.
5. Lavoisier named this gas oxygen, derived from Greek worlds meaning _________.

X. Read the text, try to get it as a whole.

Text 7B
Modern Uses of Oxygen

Although oxygen has been used in industry for more than 100 years, gas for several there has been interest in this colourless, odourless, tasteless hundred years. Its presence as an active element in the air was suspected as long ago as 1500 A. D., but only in 1777 Antoine Lavoisier, a French chemist, named oxygen and described its properties.

The actual development of the industrial application of oxygen for the next hundred years was extremely slow. Then, at the turn of the twentieth century, two factors greatly speeded progress. One was a method for economically producing oxygen of high purity from the air, and the other was a method for producing calcium carbide on a commercial scale.

Probably 95 per cent of the huge volume of oxygen used today is obtained from the air by a process which was developed by Dr. Carl von Linde in Germany in 1895 and 1902. This method is based upon the liquefaction of air and its fractional distillation. Technically, the process is complicated, as more than it requires one of the lowest temperatures used industrially 300°F below zero (-194.4°C). The liquid air is a very cold mixture of liquid oxygen and liquid nitrogen. Oxygen is then separated by rectification. Most oxygen produced for industrial purposes is purer than 99 per cent.

Calcium carbide treated with water produces acetylene, a gas which burns in air with a brilliant white light. When the two gases, oxygen and acetylene are mixed in proper proportions and burned, their combustion produces the hottest flame known more than 5400°F (≈ 3000°C). This flame for the past 100 years has formed the basis for the oxy-acetylene process for welding and cutting metals.

Today there is practically no industry which does not use the process. Broadly speaking, applications are divided into two fields - repair and production. The repair field is perhaps the better known, for practically every garage uses the oxy-acetylene process for repairing automobile parts. In industry, there is not a factory which does not use the process in many different ways for repairing the equipment.

Another process where acetylene is used, is called "hard-facing" Extremely hard alloys are applied to the surfaces of metal parts, increasing the life of the parts many times.

Certain industries have developed mostly due to welding. This is true in the manufacture of airplanes, automobiles, refrigerators, railway roads.

But the greatest amount of oxygen is used in cutting iron and steel one of the most spectacular applications of oxygen in industry. This simple process has literally revolutionized the metalworking industries. It was found that any cuts were made quite easily.

One of the most recent applications of the oxy-acetylene process is for removing surface defects from steel. In this way, larger amounts of cleaner and better steel are made possible at lower cost.

Although by far the greatest volume of oxygen – amounting to several billion cubic feet a year – is used for industrial purposes, an ever increasing amount of oxygen is being used in medicine, the treatment of diseases, such as pneumonia or heart diseases. It has saved many lives. Besides, while breathing oxygen, aircraft pilots operate at altitudes otherwise impractical without it.

It may be said that oxygen is men's best friend – both in industry and for human health.

XI. Find answers to the following questions in the text:

1. Who gave the name of oxygen? When?
2. What can you say about the industrial applications of oxygen in the nineteenth century?
3. What factors speeded the process of producing oxygen at the turn of the twentieth century?
4. What method is used today for 95% production of oxygen?
5. What product is formed by the combination of oxygen and acetylene?
6. What industrial application of oxygen is known best of all?
7. What fields of industry is the oxy-acetylene process used in?
8. What is oxygen used in medicine for?
9. Why is oxygen called men’s best friend?

XII. Find sentence characterizing the following:

1. interest in oxygen for several hundred years;
2. the progress in industrial applications of oxygen;
3. evolution in methods of obtaining oxygen;
4. use of oxygen in repair field as the better known;
5. what industries have development mostly due the welding.

Text 8A
Selenium

I. Remember the following words and words combinations from the text:

1. to receive scant attention – получить мало внимания
2. to be of little importance commercially – иметь небольшое промышленное значение
3. to be worth studying – стоит того, чтобы изучить

4. abundant element – распространённый элемент
5. sister element – распространённый элемент
6. as compared with – по сравнению с
7. several allotropic forms – несколько аллотропных форм
8. to be alike = to be similar to – быть похожим
9. to be brittle – быть хрупким
10. silver-grey coating – серебристо-серое покрытие
11. to be odourless – быть без запаха
12. to be tasteless – быть безвкусным
13. to burn readily – легко гореть
14. reddish-blue flame – красновато-синее пламя
15. to vary in electrical conductivity – различаться по электропроводности
16. nonconductor – непроводник
17. hydrazine hydrate – гидразин гидрат
18. to keep below the boiling point – поддерживать температуру ниже точки кипения
19. to prolong the life – продлить жизнь
20. colloidal suspension – коллоидная суспензия

II. Give the Russian equivalence for the following:

curious property of selenium, electrical conductivity, selenium dioxide, nonconductor, to be less active, amorphous selenium, rather hard, silver-grey coating, under proper condition, to prolong the life.

III. Give the English equivalence for the following:

иметь большое промышленное значение, по сравнению с, такая же валентность, проводник электричества, однопроцентный раствор, атомный вес, интересный элемент среди химиков, тёмный цвет, элемент родственный сере, несколько аллотропных форм.

IV. Translate the following sentences into Russian:

1. Selenium is both odourless and tasteless.

2. The characteristic property of selenium is silver-grey coating on its surface.

3. Selenium is a nonconductor.

4. The element is found in various ores.

5. It burns readily with a reddish-blue flame.

V. Translate the following sentences into English:

1. Селен не имеет большого промышленного значения.

2. Сера и селен очень похожи и потому реакции серы похожи на реакции селена.

3. Хотя селен не очень широко распространён, его можно найти в различных рудах.

4. Из его положения в периодической таблице мы можем сделать вывод, что селен должен быть менее активным, чем сера.

5. Селен без запаха и без вкуса, но может иметь несколько вариаций по цвету.

VI. Translate the following sentences paying attention to the Passive Voice:

1. One curious property of selenium should be mentioned.

2. Under proper conditions selenium can form colloid.

3. We must remember to keep selenium below the boiling point.

4. From the facts that the atomic weight is more, we may infer that selenium should be less active than sulphur.

5. Selenium can be found in several allotropic forms.

VII. Read the text below to find out information about the element selenium.

Text 8A
Selenium

The element selenium usually receives scant attention in elementary textbooks, probably because it is of little importance commercially. Nevertheless, it is an interesting substance and well worth studying.

Selenium was discovered by the Swedish giant among chemists, Berzelius.

The element is not abundant, but it is to be found in various ores.

Selenium is the sister element of sulphur, forming with tellurium the elements occurring in Group VI. It has an atomic weight of 78.96 as compared with 32 for sulphur. From the fact that the atomic weight is more, we may infer that selenium should be less active than sulphur. Its valences are: +2, +4, and +6, the same as those of sulphur. It can be found in several allotropic forms, just as sulphur does. It will be helpful to remember that the two elements are very much alike in their chemical properties and so the reactions of sulphur are similar to those of selenium.

A piece of amorphous selenium is rather hard and quite brittle, just as sulphur is. The dark colour of the element, the silver-grey coating on its surface are characteristic. Another variety of the element is red.

The element is both odourless and tasteless. It burns as readily as sulphur does, with a reddish-blue flame and the peculiar odour. In working with selenium, beware of the odour of its hydrogen compound; it is worse than that of hydrogen sulphide.

One curious property of selenium should be mentioned. The substance varies in its electrical conductivity according to the amount of light that falls upon it. We should remember that sulphur is a nonconductor. An experiment shows that selenium differs in this respect.

Under proper conditions selenium can form a colloid. One gram of selenium dioxide is dissolved in 500 ml of water. To 50 ml of this solution we add, after heating, 10 ml of a one-percent solution of gelatin, and then, drop by drop, 60 ml of hydrazine hydrate (1:2,000 of water). We must remember to keep it just below the boiling point for 16 minutes. The beautiful peach-pink colour of the colloid is to be observed. The colloid can be made without gelatin, but the protective colloid serves to prolong the life of the colloidal suspension.

VIII. Answer the following questions about the text:

1. Why is there only little information about selenium in elementary textbooks?
2. Why are properties and selenium and sulphur alike?
3. What are the physical properties of selenium?
4. What can you say about electrical conductivity of selenium and sulphur?
5. In what way can we prepare a colloid with selenium?

IX. Fill in the blanks with the information from the text:

1. Selenium can _________ in several allotropic forms.
2. _________ selenium can form a colloid.
3. Selenium is the _________ of sulphur.
4. Selenium and sulphur _________ in their chemical properties.
5. The reaction of selenium _________ to those of sulphur.

X. Read the text, try to get it as a whole.

Text 8B
Selenium Compounds

The element (selenium) can combine with the metals, just as sulphur can, forming selenides. Let us grind some selenium to powder in a mortar. After that, we should take 10 grams of this powder and grind it with 7 grams of iron dust, a proportion of 80 and 56, the approximate atomic weight ratio of the two elements. Then, we must pour the well-mixed material into a dry test-tube and heat it. Ferrous selenide is formed, the action proceeds somewhat less vigorously than that between iron and sulphur. When the tube has cooled somewhat, we can break it open and remove a grey-black product which much resembles ferrous sulphide. Selenium will unite similarly with zinc and with other metals such as and lead.

Selenium dioxide may be formed by the combustion of the element. The dioxide is white and can dissolve readily in water to form selenious acid just as sulphur dioxide dissolves to form sulphurous acid:

$H_2O + SeO_2 \rightarrow H_2SeO_3$.

When selenious acid is treated with chlorine or potassium permanganate, selenic acid is produced; the process, of course, can be called oxidation, the reaction proceeds just as it does with sulphurous acid. Small lumps of ferrous selenide are transferred to a small flask connected to a train of bottles containing solutions of a number of different metallic salts, for example, those of cadmium, cobalt, nickel, arsenic, and antimony. Any excess of gas which may escape is led into the flue. Add some hydrochloric or sulphuric acid to the material in the flask, and presently hydrogen selenide forms and bubbles into the liquids in the various bottles. Various selenides can be formed.

XI. Find answers to the following questions in the text:

1. When are selenides formed?
2. Will you describe the procedure?
3. In what way can selenium dioxide formed?
4. What are physical and chemical properties of the dioxide?
5. How is ferrous selenide formed?
6. When is selenic acid produce?
7. Is the reaction the same as with sulphorous acid?
8. Will you describe the process?
9. What substances will selenium unite similarly?

XII. Find sentence characterizing the following:

1. the process of forming selenides;
2. the method of forming ferrous selenide;
3. the process of formation selenium dioxide;
4. physical and chemical properties of selenide dioxide;
5. the method of preparation of sulphuric acid.

Unit V
STRUCTURE OF MATTER

I. Remember the following words and word combinations from the text:

1. to enter into chemical reaction – вступать в химическую реакцию
2. to occur – встречаться (происходить)
3. bear definite relationships – иметь определённые отношения
4. to undergo disruption – подвергаться разрушению
5. rearrangement – перераспределение
6. aggregates – совокупность (общее количество)
7. to unite with each other – соединяться друг с другом
8. elemental molecule – молекула элемента
9. compound molecule – молекула соединения
10. to be exemplified – быть примером
11. to give full account of properties – дать полную информацию о свойствах
12. to exhibit in full – выставлять полностью
13. to be packed together – быть упакованным вместе
14. to redistribute – перераспределять
15. to account for – отчитываться за что-либо

II. Give the Russian equivalence for the following:

to enter into a chemical reaction, definite relationships, to form definite aggregates, to exhibit a property, to depend on the mass, to be of great practical importance, to undergo rearrangements, to contain two or more molecules, to exist as diatomic molecules, to pack the molecules together.

III. Give the English equivalence for the following:

состоять из нескольких видов атомов, электрически нейтральный, молекула хлора, молекула соединения, образец данного вещества, плотность (удельный вес) вещества, одноатомная молекула, определение молекулы, проявлять физические свойства, отличаться от.

IV. Translate the following sentences into Russian:

1. To give a short definition of a molecule is not very easy.
2. Chemical reactions occur when atoms of different kinds unite to each other and form groups.
3. Compound molecules are composed of two or more kinds of atoms and are exemplified by the water molecule.
4. An element molecule may contain only one atom, or it may contain two or more.
5. The definition does not give a full account of the properties of a molecule.

V. Translate the following sentences into English:

1. Атомы каждого элемента отличаются от атомов других элементов.
2. Химическая реакция происходит, когда атомы взаимодействуют друг с другом и образуют новые соединения.
3. Дать определение молекулы – значит сказать о её составе и свойствах.
4. Молекулы, как известно, электрически нейтральны.
5. Если атомы имеют одинаковые свойства, то они принадлежат одному элементу.

VI. Translate the following sentences paying attention to the forms and functions of the Infinitive:

1. To give a short definition of a molecule is not to give a more or less full account of properties.
2. Some elements have atoms that unite with others of their own kind to form molecules.
3. To analyse the substance means to define its components.
4. To think about ordinary conditions of a reaction means to think about room temperature and 1-atm. pressure.
5. To know the atomic structure is to understand this phenomenon.

VII. Read the text below to find out information about the molecules.

Text 9A
Molecules

To the modern chemist, the atom is the smallest particle of an element that can enter into a chemical reaction. Thus, each element has atoms that are peculiar to itself and different from those of each of the other elements. Chemical reactions occur when atoms of different kinds unite to form groups in which they bear definite relationships to each other or when these groups undergo disruption or rearrangement. Chemical unions are of two general types.

In one type of union, atoms become bonded together to form definite aggregates that exist as independent, electrically neutral particles and are known as molecules (Latin "little mass"). Some elements have atoms that unite with others of their own kind to form molecules. These are known as elemental molecules and are exemplified by the chlorine molecule which is made up of two chlorine atoms. Compound molecules are composed of two or more kinds of atoms and are exemplified by the water molecule, which contains two atoms of hydrogen and one of oxygen.

To give a short definition of a molecule is not to give a more or less full account of properties.

Molecules are regarded as the smallest particles or elementary substances that can have independent existence. They account for the chemical properties and at least some of the physical properties of the substance they constitute. A single molecule does not exhibit in full the physical properties commonly associated with its particular variety of matter. These properties arise both within the molecule itself and within the aggregates of like molecules that constitute a sample of the given substance. The density of water depends not only on the mass and volume of individual molecules but also on the manner in which the molecules are packed together. Since the chemist works with the aggregates, their properties are of great practical importance.

A molecule of a compound contains, of necessity, at least two different atoms. An element molecule may contain only one atom, or it may contain two or more. Helium has monoatomic molecules; chlorine and hydrogen each exist as diatomic molecules; and sulphur molecules contain eight atoms. During reactions the atoms of elemental molecules usually are separated and individually redistributed in new combinations.

VIII. Answer the following questions about the text:

1. What is a chemical reaction?
2. What types of chemical unions do you know?
3. What is an elemental molecule?
4. What determines the properties of a molecules?
5. What composition may an elemental molecule have?

IX. Fill in the blanks with the information from the text:

1. The smallest particle of an element that can _________ a chemical reaction is an atom.
2. Since the chemist works with aggregates, their properties _________.
3. The sulphur molecules _________ eight atoms.
4. In one type of union, atoms become _________ to form definite aggregates.
5. Molecules are regarded as the smallest particles of _________ that can have independent existence.

X. Read the text, try to get it as a whole.

Text 9B

Molecules in Solids

Having their own shape is a characteristic feature of solids since they have their own shape rather than that of the container (as for liquids and gases) and generally do not flow, the extent of molecular motion in a solid is even more limited than that in a liquid. True solids are crystalline, bounded by plane surfaces that meet in a definite dihedral angle, and have a characteristic melting point. The molecules in a solid have the same temperature, and if they are molecules of the same substance, they are moving at the same average velocity, the motion of molecules in a solid must be confined, and, probably, it is a vibration or oscillation about a fixed point.

Crystals composed of molecules may evaporate in a manner similar to that of liquids. This phenomenon is called sublimation, and it may be noticed in solid carbon dioxide (dry ice), paradichlorobenzene, camphor, and many odorous solids. Non-molecular solids show little tendency to sublime. The Van der Waals force between the particles in molecular solids is, apparently, less in general than the coulomb forces between ions in non-molecular solids. As with liquids, solids vary greatly in their tendency to sublime, and the rate of sublimation varies with the temperature and inversely with the pressure. In some solids the crystal is composed of molecules in a pattern that repeats.

XI. Find answers to the following questions in the text:

1. What is a characteristic feature of solids?
2. What are the physical properties of solids?
3. What do you know about molecular motion in solids?
4. How can crystals evaporate?
5. How is this phenomenon called?
6. Can non-molecular solids sublime?
7. What is the rate of sublimation of solids as compared with liquids?
8. What can you say about the Van der Waals forces between the particles in molecular solids?
9. What is the difference in properties between crystalline and non-crystalline solids?

XII. Find sentence characterizing the following:

1. characteristic feature of solids as compared with liquids or gases;
2. physical properties of solids;
3. kinds of molecules motion in a solid;
4. the essence the properties of sublimation;
5. variations of sublimation in solids.

Text 10A

The Nature of a liquid

I. Remember the following words and word combinations from the text:

1. iodine crystals – кристаллы йода
2. to form liquid iodine – образовывать жидкий йод
3. melting point – точка плавления
4. freezing point – точка замерзания
5. to differ from – отличаться от
6. to have a definite volume – иметь определённый объём
7. to have a definite shape – иметь определённую форму
8. from the molecular point of view – с молекулярной точки зрения
9. to agitate – перемешивать
10. thermal agitation – термическое перемешивание
11. to stay close together – оставаться рядом
12. to retain a regular fixed arrangement – сохранять обычное фиксированное расположение
13. close packing of the crystal – плотная упаковка кристалла
14. condensed phase – конденсированная фаза
15. to be piled closely together – быть сложенным вплотную друг к другу
16. randomness of structure – беспорядочность структуры
17. fluidity – текучесть

II. Give the Russian equivalence for the following:

to be in equilibrium, the tendency for crystals to melt, differ in properties, to have a definite volume, stay close together, a random structure, the density of a liquid, like a solid, from the molecular point of view, to move vigorously.

III. Give the English equivalence for the following:

точка плавления вещества, изменить местоположение, группировка молекул вокруг, плотная упаковка, каждая молекула йода, в отличие от газа, характеризоваться чем-либо, произвольное расположение молекул, нагреть до, находиться в равновесии.

IV. Translate the following sentences into Russian:

1. That solid, liquid and gas are the three main states of a substance is a matter of common knowledge.
2. As a crystal is heated, its molecules are agitated.
3. At the melting point the agitation finally becomes so great that it causes the molecules to change.
4. A liquid, like crystal is a condensed form of matter.
5. The density of a liquid is less than that of the corresponding crystal because of the randomness of its structure.

V. Translate the following sentences into English:

1. Каждое вещество имеет свою определённую точку плавления при одинаковом давлении.
2. Точка плавления твёрдого вещества – это в то же время точка замерзания жидкости.
3. Известно, что жидкость принимает форму сосуда, в котором она содержится.
4. В отличие от газа, у кристаллов и жидкостей молекулы располагаются довольно близко друг к другу.
5. Структура жидкости произвольна, поэтому плотность жидкости несколько меньше, чем у кристалла.

VI. Translate the following sentences paying attention to the ing-forms:

1. Crystals melt forming liquid iodine.
2. The temperature at which the crystals and the liquid are in equilibrium is called the melting point.
3. Freezing of a liquid is very interesting to observe.
4. The grouping of molecules around a given molecule changes by raising the temperature.

5. From the molecular point of view the process of melting can be described in the following way.

VII. Read the text below to find out information about the nature of liquid.

Text 10A

The Nature of a Liquid

When iodine crystals are heated to 114°C, they melt forming liquid iodine. The temperature at which the crystals and the liquid are in equilibrium - that is, at which crystals have no tendency to melt or the liquid has no tendency to freeze – is called the *melting point* of the crystals, and the freezing point of the liquid. This temperature is 114°C for iodine.

Liquid iodine differs from solid iodine (crystals) mainly in its fluidity. Like the solid, and unlike the gas, it has a definite volume (1 g occupies about 0.2 cm^3), but it does not have a definite shape: instead, it fits itself to the shape of the bottom part of its container.

From the molecular viewpoint the process of melting can be described in the following way. As a crystal is heated, its molecules are increasingly agitated, and move about more and more vigorously, but at lower temperature, this thermal agitation does not carry any one molecule any significant distance away from the position fixed for it by the arrangement of its neighbours in the crystal. At the melting point the agitation finally becomes so great that it causes the molecules to slip by one another and to change somewhat their location relative to one another. They continue to stay close together, but do not continue to retain a regular fixed arrangement. Instead, the grouping of molecules around a given molecule changes continually, sometimes being much like the close packing of the crystal, in which each iodine molecule has twelve near neighbours, and sometimes considerably different, the molecule has only ten or nine or eight near neighbours. Thus, a liquid, like a crystal, is a condensed phase, as contrasted with a gas, the molecules being piled rather closely together; but whereas a crystal is characterized by regularity of atomic or molecular arrangement, a liquid is characterized by randomness of structure. The randomness of structure is usually the reason why the density of a liquid is somewhat less than that of the corresponding crystal.

VIII. Answer the following questions about the text:

1. What temperature is called the melting point?
2. How does liquid iodine differ from solid iodine?
3. In what way is it possible to explain the change from the solid to the liquid?
4. What is the principal difference between solid and liquid from the structural point of view?
5. How are molecules in a liquid arrange?

IX. Fill in the blanks with the information from the text:

1. Crystals of iodin _________ when they are heated to 114°C.
2. Liquid iodine differs from solid iodine by its _________.
3. The liquid is characterized by _________.
4. As a crystal _________ the molecules are increasingly agitated.
5. A liquid has a definite volume bat no definite _________.

X. Read the text, try to get it as a whole.

Text 10B

The Nature of a Gas

That the molecules of a gas are not held together, but are moving freely in a volume rather large compared with the volumes of the molecules themselves is the characteristic feature of a gas. The Van der Waals attractive forces between the molecules still operate whenever two molecules come close together, but usually these forces are negligibly small because the molecules are far apart. Because of this freedom of molecular motion, a specimen of a gas does not have either definite shape or definite size. A gas shapes itself to its container.

Gases at ordinary pressure are very dilute: the molecules themselves constitute only about one-thousandth of the total volume of the gas, the rest being empty space. Thus, 1 g of solid iodine has a volume of about 0.2 cm^3 (its density is 4.93 g/cm^3), whereas 1 g of iodine gas at 1-atm pressure and at the temperature of 184°C (its boiling point) has a volume of 148 cm^3, over 700 times greater. The volume of all the molecules in gas at ordinary pressure is accordingly small compared with the volume of the gas itself. On the other hand, the diameter of a gas molecule is not extremely small compared with the distance between molecules; in a gas at room temperature and 1-atm pressure the average distance from a molecule to its nearest neighbours is about ten times its molecular diameter.

XI. Find answers to the following questions in the text:

1. What is the characteristic feature of a gas?
2. Why are Van der Waals attractive forces small in a gas?
3. What can you say about the shape and size of a gas?
4. What kind of substances are gases at ordinary pressure?
5. What is the volume of all the molecules in a gas at ordinary pressure?
6. What is a diameter of the gas molecules?
7. Is the distance between the molecules of a gas at 1-atm pressure greater than diameter of the molecule itself?
8. How do molecules move in a volume of a container?
9. Are the molecules of a gas rather close together at ordinary pressure?

XII. Find sentence characterizing the following:

1. the movement of molecules in a gas;
2. Van der Waals attractive forces in a gas;
3. the volume of a gas at ordinary pressure;
4. the volume of iodine gas at 1-atm pressure;
5. the diameter of a gas molecule.

Unit VI
THE ARRHENIUS THEORY OF ACIDS AND BASES

I. Remember the following words and words combinations from the text:

1. class of equilibria – класс равновесий
2. acid-base reaction – кислотно-основная реакция
3. to involve (to include) – включать
4. nomenclature of acids and bases – номенклатура кислот и оснований
5. to suggest – предлагать
6. sour taste – кислый вкус
7. alkalis – щелочи
8. to neutralize the action of acids – нейтрализовать действие кислот
9. to have different strengths – иметь разные сопротивления
10. degree of dissociation – степень диссоциации
11. hydroxyl ion – гидроксильный ион
12. to be responsible for – быть ответственным за
13. to concern the nature – касаться природы
14. aqueous solution – водный раствор
15. to be capable of acting as bases – быть способным действовать в качестве оснований
16. dissociation – разложение

II. Give the Russian equivalents for the following:

acid-base reaction, ionic dissociation theory, to neutralize the action of acids, necessary constituent, hydroxyl ion, advance in chemical theory, nomenclature of acids and bases, basic properties, aqueous solution, acidic properties.

III. Give the English for the following:

действовать как основание, классификация кислот и оснований, кислый вкус, электропроводность, степень диссоциации, определение трудности, необходимый компонент кислот, быть ответственным за, класс равновесий, соляная кислота.

IV. Translate the following sentences into Russian:

1. There is a perhaps no other class of equilibria as important as that involving acids and bases.
2. The classification of "acid-base reaction" includes a vast number of chemical changes.
3. Arrhenius ionic dissociation theory was developed between 1880 and 1890.
4. The proton was responsible for acidic properties.
5. The theory of ionic dissociation has played a great role in the development of chemistry.

V. Translate the following sentences into English:

1. Полагают, что кислота должна содержать водород как необходимый компонент.
2. Классификация веществ на кислоты была обусловлена их кислым вкусом.
3. За щелочи принимали вещества, которые могли нейтрализовать действия кислот.
4. В 1810 г. Дэви показал, что соляная кислота содержит только водород и хлор.
5. Существовало мнение о том, что все кислоты имеют водород как основной компонент.

VI. Translate the following sentences. Define the types of Subordinate Clauses:

1. Alkalis were taken as substances that could neutralize the action of acids.
2. It was thought also that an acid must have, as necessary constituent, the element oxygen.
3. An experiment of why acids had different strengths was one of the important results of the Arrhenius ionic dissociation theory.

4. While this point of view was a considerable advance in chemical theory, it led to certain difficulties.

5. A similar scheme applied to the behaviour of bases which were all thought to produce the hydroxyl ion in solution.

VII. Read the text below and find out information about states of matter.

Text 11A

The Arrhenius Theory of Acids and Bases

There is perhaps no other class of equilibria as important as that involving acids and bases. As we continue the study of chemistry, we shall find that the classification "acid-base reaction" includes a vast number of chemical changes, so that the principles and practical points are of very general use. Now we must devote some time to a nomenclature and classification of acids and bases.

The classification of substances as acids was at first suggested by their sour taste, and alkalis were taken as those substances that could reverse or neutralize the action of acids. It was thought also that an acid must have, as necessary constituent, the element oxygen, but in 1810 Davy demonstrated that hydrochloric acid contained only hydrogen and chlorine. Shortly thereafter the view was taken that all acids had hydrogen as an essential constituent.

An explanation of why acids had differing strengths was one of the important results of the Arrhenius ionic dissociation theory, developed between 1880 and 1890. The chemical activity and electrical conductivity of solutions of acids were taken to be consequences of their reversible dissociation into ions, one of which was H^+:

$HCI = H^+ + Cl^-$.

The fact that different acids had different strengths was explained as a result of a variation of the degree of dissociation. A similar scheme applied to the behaviour of bases, which were all thought to produce the hydroxyl ion in solution:

$NaOH(s) = Na^{+}(aq) + OH^{-}(aq)$.

Thus, the proton was responsible for acidic properties, and the hydroxyl ion was responsible for basic properties.

While this point of view was a considerable advance in chemical theory, it led to certain difficulties. The first of these concerned the nature of the proton in aqueous solution, and the second had to do with the fact that substances which did not contain hydroxyl ion were capable of acting as bases.

VIII. Answer the following questions about the text:

1. What are the characteristic properties of acids?
2. What was the classification of substances as acids at first suggested by?
3. What did Davy demonstrate in 1810?
4. What was one of the most important result of the Arrhenius ionic dissociation explained?
5. How was the fact that different acids had different strengths explained?

IX. Fill in the blanks which information taken from the text:

1. The proton ________ for acidic properties.
2. In 1810 Davy demonstrated that ________ contained only hydrogen and chlorine.
3. The fact that different acids had different strengths was explained as a result of a variation of the _________.
4. While this point of view was a considerable _________, it led to certain difficulties.
5. The chemical activity and _________ of solutions of acids were taken to be consequences of their dissociation into ions.

X. Read the text, try to get it as a whole.

Text 11B
A Kinetic Theory of Liquids

In a liquid, molecules are close to each other, and consequently the forces exerted on one molecule by its neighbours are substantial. Thus, the problem of analyzing the motion of a single molecule is exceedingly difficult, for each is constantly in “collision”, subject to the forces for as many as twelve nearest neighbours. What then can we say about molecular motion in liquids? One of the most revealing observations in this respect was made by the botanist Robert Brown in 1827. Brown discovered that very tiny particles (10^{-4} cm diameter) suspended in a liquid undergo incessant randomly directed motion. These motions occur without any apparent external cause such as stirring or convection, and are evidently associated with an intrinsic property of all liquids. A wealth of experimental observation has confirmed the idea of this Brownian motion being a direct manifestation of the thermal motion of molecules. When it is suspended in a liquid, a very small particle constantly experiences collisions with all the molecules surrounding it. If the particle is small enough, so few molecules will be able to collide with it, that at any particular instant the number striking it from one side may be different from the number striking it from the other sides; consequently, the particle will be displaced. Subsequently, another unbalance of collisional forces may occur, this time displacing the particle in a different direction. The great majority of these displacements are so small that they cannot be detected individually, but the motion which is observed is a result of many of the smaller random displacements. In essence, a Brownian particle is a “molecule” thought to be large enough to be observable, but small enough to execute observable random thermal motion.

Analysis of the motion of Brownian particles shows that their kinetic energy is $^3/_2$ kT. Since each particle is to be considered as one of the molecules of the liquid we can conclude that the average kinetic energy of a molecule in a liquid is also $^3/_2$ kT – exactly the same as the kinetic energy of a gaseous molecule at the same temperature.

XI. Find answers to the following questions in the text:

1. How are molecules arranged in a liquid?
2. The problem of analyzing the motion of a single molecule is difficult, isn't it? And why?
3. What did botanist Robert Brown discover in 1827?
4. What has a wealth of experimental observation confirmed?
5. What is Brownian motion now?
6. When may another unbalance occur?
7. Can displacement in the motion of molecules be detected individually?
8. What is the average kinetic energy of a molecule in a liquid?
9. In what way do liquids resemble solids?

XII. Find sentences characterizing the following:

1. arrangement of molecules in a liquid;
2. the problem of analyzing the motion of a single molecule;
3. the discovery made by the botanist Robert Brown in 1827;
4. Brownian motion is a direct manifestation of the thermal motion of molecules;
5. kinetic energy due to analysis of the Brownian particles.

Text 12A

Molecules in Gases and Liquids

I. Remember the following words and words combinations from the text:

1. equal volumes of gases – равные объемы газов
2. regardless of composition – независимо от состава
3. the same temperature and pressure – одинаковые температура и давление
4. to calculate by different methods – рассчитать разными методами

5. increasing refinement – возросшее уточнение
6. to move at the same rate – двигаться с той же скоростью
7. to flow in a stream – течь потоком
8. extent of motion – протяженность (пространство) движения
9. to give evidence – давать доказательства
10. the force of cohesion – сила сцепления
11. to occupy space – занимать пространство
12. to have effect on – оказывать влияние на
13. to be adjacent – быть рядом
14. to move at the same velocity – двигаться с той же скоростью
15. force of attraction- сила притяжения
16. to overcome the cohesive force – преодолеть силу сцепления
17. vapour pressure – давление пара
18. to leave the surface – оставить поверхность
19. evaporation – испарение
20. the act of boiling – процесс кипячения
21. to be accomplished – быть достигнутым
22. to raise the temperature – повышать температуру
23. to reduce the pressure – понижать температуру

II. Give the Russian equivalents for the following:

a gram-molecular weight, to calculate by different methods, to move at the same rate, the force of cohesion, below the surface layer, throughout the liquid, to accomplish the boiling, to reduce pressure, to occupy the volume, the extent of motion.

III. Give the English for the following:

независимо от состава, одинаковое число молекул, под давлением в одну атмосферу, нагревание жидкости, двигаться с большой скоростью, при данной температуре, в отличии от, тенденция к испарению, достичь атмосферного давления, оказывать влияние на.

IV. Translate the following sentences into Russian:

1. Molecules of a liquid move at the same rate as those in a gas at equal temperatures.

2. Some of the more rapidly moving molecules overcome the cohesive force of their neighbor and leave the surface.

3. The tendency to evaporate varies from liquid to liquid.

4. According to Avogadro's principle, equal volumes of gases contain the same number of molecules at the same temperature and pressure.

5. Heating liquids, as a rule, results in their expansion.

V. Translate the following sentences into English:

1. При одинаковой температуре средние скорости движения молекул жидкости и газа одинаковы.

2. Тенденция к испарению увеличивается, когда повышается температура.

3. Точка кипения жидкости определяется температурой и давлением.

4. Нагревание тела, как правило, приводит к увеличению его объема.

5. Нельзя сказать, что все жидкости испаряются с одинаковой скоростью.

VI. Translate the following sentences into Russian. Define the Types of Subordinate Clauses.

1. It is argued that molecules in a liquid are adjacent, close enough to flow in a continuous stream.

2. The tendency to evaporate increases when the temperature is raised.

3. As a rule, there is a tendency of the molecules to occupy more space when they move at a faster rate.

4. In general, vapour pressure increases when the temperature rises.

5. As the hydrides of the alkali decompose in water, hydrogen is being released.

VII. Read the text below and find out information about molecules in gases and liquids.

Text 12A

Molecules in Gases and Liquids

According to Avogadro's principle, equal volumes of gases regardless of composition, contain the same number of molecules at the same temperature and pressure. As a consequence of the principle, the gram-molecular weight of any gaseous substance occupies 22.4 litres at standard temperature (0°C) and pressure (760 mm of mercury). The number of molecules per gram-mole has been calculated by different methods of increasing refinement through the years, and is now considered to be 6.023×10^{23} atoms per gram-atom, or molecules per gram-mole, and it is accurate within 0.1%. For example, one mole of ammonia gas (NH_3 – weighs 17.073 grams, occupies a volume of 22.4 litre at standard temperature and pressure, and contains 6.023×10^{23} molecules).

At the same temperature, molecules of a liquid move at the same rate as those in a gas. In a liquid, however, the extent of motion must be more restricted. Liquids flow as a stream and tend to form drops to a greater or less extent, thus giving evidence of the importance of the force of cohesion between the molecules in a liquid. Heating liquids, as a rule, results in their expansion, an effect explained by the tendency of the molecules to occupy more space when they move at a faster rate. Also, increase in pressure has but slight effect on the volume compressible. From this evidence it is argued that molecules in a liquid are ajacent, close enough to flow in a continuous stream.

The molecules in a liquid, like those in a gas, are not all moving at the same velocity, but at the same average velocity at a given temperature. The molecules at the surface of a liquid, unlike those below the surface layer, have no force of attraction from molecules above. Some of the more rapidly moving molecules overcome the cohesive force of their neighbour and leave the surface. The tendency to leave the surface or to evaporate varies from liquid to liquid, and it increases when the temperature is raised. The pressure caused by the evaporation of molecules from a liquid, measured at equilibrium with the returning molecules at a given temperature, is called the vapour pressure. In general, vapour pressure increases when the temperature rises. With continued addition of heat the vapour pressure rises still more until the vapour pressure reaches the vapour pressure of the atmosphere above the liquid. The evaporation goes on throughout the liquid, and the liquid is boiling. Obviously, the act of boiling can be accomplished either by raising the temperature of the liquid or by reducing the pressure of the atmosphere above the liquid.

VIII. Answer the following questions about the text:

1. What does Avogadro's principle state?
2. In what way can the number of molecules per mole be determined?
3. What forces act between the molecules in a gas and in a liquid?
4. What affects the molecular motion?
5. What process is called evaporation?

IX. Fill in the blanks which information taken from the text:

1. At the same temperature molecules of a liquid move ________ as those of gas.
2. The molecules of a liquid are not moving ________at a given temperature.
3. Some of the more rapidly moving molecules _________ of their neighbor and leave the surface.
4. The tendency to _________varies from liquid to liquid.
5. The pressure caused by evaporation of molecules from liquid is called _________.

X. Read the text, try to get it as a whole

Text 12B

Liquids and Solutions

Solids and gases represent the extreme states of behaviour in which some of the properties found in either solids or gases are molecules. The liquid state can be thought of as an intermediate condition displayed. Liquids, like gases are isotropic and flow readily under applied stress, but like solids, they are dense, relatively incompressible, and have properties that are largely determined by the nature and strength of intermolecular forces. With respect to molecular order, liquids are substances considered to be intermediate between solids and gases. The fact that liquids are isotropic tells us immediately that they do not have the extended lattice structure and long-range order of solids. Yet, the density of a liquid is generally only 10% less than that of its solid phase; this must mean that the molecules in a liquid are packed together with some regularity, and do not exhibit the complete chaos associated with molecules in the gas phase.

One of the most important properties of liquids is their ability of acting as solvents. In the first place, liquid solutions provide an extremely convenient means of bringing together carefully measured amounts of reagents and of allowing them to react in a controlled manner. Second, the nature of the reactions which proceed and the speed at which they occur can be greatly influenced by the properties of the liquid solvent medium. Finally, the physical properties of solutions are interesting and important, because they can be used to determine molecular weights of dissolved substances and to study the nature and strength of forces between solvent and solute molecules.

One of the most engaging and absorbing features of the study of chemistry is the attempt to explain the behaviour of bulk matter in terms of molecular properties. Therefore, it is important to outline a molecular picture which will help us to understand and relate phenomena associated with the liquid state.

XI. Answer the following questions about the text:

1. What are the main states of matter?
2. How can the liquid state be thought?
3. Is there any difference in the density of solids, liquids or gases?
4. Why are liquids usually thought of as solvents?
5. What can you say about the physical properties of solutions?
6. What position do liquids occupy?
7. What are the main properties of liquid?
8. What is one of the most important features of the study of chemistry?
9. What will help us understand the phenomena associated with the liquid state?

XII. Find sentences characterizing the following:

1. the volume of gases;
2. the calculation of number of molecules per gram-mole;
3. movement of molecules of a liquid;
4. the effect of heating the liquid;
5. the tendency of molecules to evaporate.

Unit VII
TEMPERATURE SCALES

I. Remember the following words and words combinations from the text:

1. temperature scales – температурные шкалы
2. to place in contact – разместить в контакте
3. to determine the direction – определить направление
4. to measure temperature – измерять температуру
5. ordinary mercury thermometer – обычный ртутный термометр
6. glass tube – пробирка
7. centigrade of Celsius scale – стоградусная или шкала Цельсия
8. to saturate – насыщать
9. Fahrenheit scale – шкала Фаренгейта
10. the freezing point of water – точка замерзания воды
11. to be devised – быть разработанным
12. to invent the mercury thermometer – изобрести ртутный термометр
13. zero point of the scale – нулевая точка шкалы
14. to mix equal quantities – смешивать равное количество
15. to have a slight fever – иметь небольшую лихорадку
16. to convert temperature from one scale to another – переводить температуру из одной шкалы в другую
17. Rankin scale – шкала Рэнкина

II. Give the Russian equivalents for the following:

ammonium chloride, to calibrate the thermometer, centigrade scale, ordinary mercury thermometer, a Swedish professor of astronomy, temperature of freezing water, the zero point on the scale, to convert temperature, absolute zero, object at lower temperature.

III. Give the English for the following:

получить соединение нагреванием, тепловая энергия, измерять температуру, стеклянная трубка, насыщать воздухом, изобрести ртутный термометр, смешивание разных количеств, температурная шкала, градус по Фаренгейту, температурная шкала Рэнкина.

IV. Translate the following sentences into Russian:

1. Temperature determines the direction in which thermal energy flows when the two objects are in contact.
2. Thermal energy flows when the two objects are in contact.
3. Fahrenheit devised alcohol thermometer.
4. Only the Fahrenheit scale is used in the English-speaking countries.
5. The temperature of the boiling point is 100 degrees centigrade.

V. Translate the following sentences into English:

1. Температура – это качество, которое определяет направление прохождения тепловой энергии от одного объекта к другому.
2. Обычно температура измеряется термометром.
3. Температурная шкала была введена Цельсием, шведским профессором астрономии.
4. Точка замерзания воды на шкале фаренгейта равна 32°.
5. Иногда в англоязычных странах используется температура шкалы Рэнкина.

VI. Translate the following sentences, paying attention to Participle I or II:

1. Temperature is usually measured by ordinary mercury thermometer, consisting of a quantity of mercury in a glass tube.
2. The temperature scale used by scientists is centigrade or Celsius scale.
3. On this scale the temperature of freezing water saturated with air is 0°C.
4. On the Fahrenheit scale used in everyday life in English-speaking countries, the freezing point of water is 32°F.
5. While calibrating his thermometer Fahrenheit had a slight fever.

VII. Read the text below to find out information about the temperature scales.

Text 13A

Temperature Scales

If two objects are placed in contact with one another, thermal energy may flow from one object to the other one. *Temperature* is the quality that determines the direction in which thermal energy flows – it flows from the object at higher temperature to the object at lower temperature.

Temperatures are ordinarily measured by means of a thermometer, such as the ordinary mercury thermometer, consisting of a quantity of mercury in a glass tube. The temperature scale used by scientists is the *centigrade* or *Celsius scale*; it was introduced by Anders Celsius (1701 – 1744), a Swedish professor of astronomy, in 1742. On this scale the temperature of freezing water saturated with air is 0°C and the temperature of boiling water is 100°C at 1-atm pressure.

On the *Fahrenheit scale*, used in everyday life in English-speaking countries, the freezing point of water is 32°F and the boiling point of water is 212°F. On this scale the freezing point and the boiling point differ by 180°, rather than 100° of the centigrade scale. The Fahrenheit scale was devised by Gabriel Fahrenheit (1686-1736), a natural philosopher who was born in Danzig and settled in Holland. He invented the mercury thermometer in 1714; before then, alcohol had been used as the liquid in thermometers. As the zero point on his scale he took the lowest temperature he could obtain, produced by mixing equal quantities of snow and ammonium chloride. His choice of 212° for the boiling point of water was made in order that the temperature of his body should be 100°F. The normal temperature of the human body is 98.6°F; perhaps Fahrenheit had a slight fever while he was calibrating his thermometer.

To convert temperatures from one scale to another, you need only remember that the Fahrenheit degree is $^{100}/_{180}$ or $^{5}/_{9}$ of the centigrade degree, and that 0°C is the same temperature as 32°F.

Another absolute scale, the *Rankine scale*, is sometimes used in engineering work in the English-speaking countries. It uses the Fahrenheit degree, and has 0°R as the absolute zero.

VIII. Answer the following questions about the text:

1. What is temperature?
2. In what way can the temperature be determined?
3. Who introduced the centigrade scale?
4. What scale is now used in English-speaking counties?
5. What is the difference between centigrade scale and Fahrenheit one?

IX. Fill in the blanks which information taken from the text:

1. The Fahrenheit scale was devised by ________ a natural philosopher.
2. Temperatures ________ by thermometers.
3. The temperature of the _________ is 100 degrees centigrade.
4. The normal temperature of the _________ on the Fahrenheit scale is 98,6°F.
5. Another absolute scale _________ is sometimes used in English-speaking countries.

X. Read the text, try to get it as a whole.

Text 13B

Celsius versus Centigrade

The Ninth General Conference on Weights and Measures, held in October, 1948, adopted the name “Celsius” for the scale of temperature which had more commonly been called “centigrade”. This action, which had not been proposed in advance of the Conference, arose from a question regarding preferred usage in French, the sole official language of the Conference. The decision might be considered as applying strictly only to hat language. In the interest of eventual uniformity of practice the use of

"Celsius" appeared desirable, but it was not practicable to impose this term on those who preferred "centigrade".

In preparation for the General Conference the National Bureau of Standard submitted a revised text defining the International Temperature Scale to supersede that adopted in 1927. The proposed text was drafted in English and, in accordance with common English practice as well as the official French text adopted in 1927, it used the name "centigrade". This name was carried over into the French translation prepared for consideration by the Advisory Committee on Thermometry in May, 1948. However, in the printed report of that meeting, the term "centigrade" had, in most cases, been changed to "centesimal", the term that was used in the French law governing weights and measurements. When it was asked to choose between the two, the International Committee on Weights and the General Conference voted to substitute "Celsius".

With regard to the merits of the decision it might be remarked that Celsius (abbreviated C) was analogous to the names *Kelvin*, *Fahrenheit*, *Reaumur*, and *Rankine*, used for other temperature scales, that it had previously been used considerably in some countries, and occasionally in America. It might also be argued that "centigrade" was logically ambiguous, since the absolute *Kelvin scale*, as well as the *centigrade scale* has 100 degrees between the ice point and the boiling point of water. On the other hand, the name "centigrade" was thoroughly established in English-speaking countries, the need for choosing between that name and "centesimal" arose only in French, and the decision on a term in the official French language of the Conference might not be considered as controlling the terms to be used in translating into other tongues.

XI. Find answers to the following questions in the text:

1. What problems were discussed at the conference in 1948?
2. What name was adopted for choosing a single name for the scale?
3. What was the reason for choosing a single name for the scale?
4. Why was the name «Celsius» considered preferable?
5. What other name for this scale do you know?
6. What other temperature scales do you know?

7. What scale was established in English-speaking countries?

8. What is the similarity between absolute Kelvin scale and centigrade one?

9. What temperature scales are used in Russia?

XII. Find sentences characterizing the following:

1. conference on weights and measures held in October, 1948;
2. the name for temperature scale adopted at the conference;
3. the temperature scale used in English-speaking countries;
4. the absolute Kelvin scale and centigrade scale have 100 degrees between the ice point and boiling point of water;
5. Celsius was analogous to the names established in English-speaking countries.

Text 14A

The Kelvin Temperature Scale and Modern Means of Meaning the Temperature

I. Remember the following words and words combinations from the text:

1. to notice – замечать
2. a sample of a gas – образец газа
3. to cool a gas – охлаждать газ
4. to develop a concept – разрабатывать концепцию
5. to decrease in volume – уменьшиться в объёме
6. absolute zero – абсолютный ноль
7. law of thermodynamics – закон термодинамики
8. triple point of water – тройная точка воды
9. to be in equilibrium – находиться в равновесии
10. to determine thermodynamic temperature at a fixed point – определить термодинамическую температуру в фиксированной точке
11. highly accurate measurements – очень точные измерения
12. convenience of instruments – удобство приборов
13. resistance thermometer – термометр сопротивления

14. mercury thermometer – ртутный термометр
15. thermocouple – термопара
16. to feel the need – чувствовать необходимость
17. gas thermometer – газовый термометр

II. Give the Russian equivalents for the following:

sample of a gas, the law of thermodynamics, to be in equilibrium, triple point of water, one-atmosphere pressure, highly accurate measurement, resistance thermometer thermocouples, to decrease the volume, to become zero.

III. Give the English for the following:

разработать концепцию, точно измерять температуру, знаменитый Британский физик, выражать в простой форме, аналогичный метод, новая температурная шкала, определение градуса, создание международной температурной шкалы, термодинамическая температура, находиться в равновесии.

IV. Translate the following sentences into Russian:

1. Temperature does not depend on how much matter is present.
2. It is necessary that the temperature should be kept constant.
3. Thermodynamic temperatures of the fixed point must be determined with as much accurate as possible.
4. The device was needed that measures essentially the thermodynamic temperature.
5. Gas thermometer is quite enough to carry out such measurements.

V. Translate the following sentences into English:

1. Сто лет тому назад, ученые заметили зависимость между температурой и объёмом газа.
2. Температура, при которой объем образца газа был бы равен нулю, назвали абсолютным нулем.
3. На международной шкале стандартов абсолютный ноль равен 0°.

4. Газовый термометр используется для обычных измерений.

5. Легко подсчитать температуру на шкале Цельсия.

VI. Translate the following sentences into Russian. Define the Tenses:

1. The International standard temperature scale is the Kelvin scale with a new definition of the degree.
2. About 200 years ago scientists noticed that a sample of a gas decreases in volume.
3. The establishment of the International Temperature Scale has required the thermodynamic temperature to be accurately determined.
4. I think it would be right to study existing temperature scales first.
5. The device that has filled the need of making accurate thermodynamic measurements is the gas thermometer.

VII. Read the text below to find out information about the Kelvin Temperature Scale.

Text 14A

The Kelvin Temperature Scale and Modern Means of Meaning the Temperature

About 200 years ago scientists noticed that a sample of gas that is cooled decreases in volume in a regular way, and they saw that if the volume were to continue to decrease in the same way, it would become zero at about -273°C. The concept was developed that this temperature -273°C (more accurately -273.15°C) is the minimum temperature, the *absolute zero*. A new temperature scale was then devised by Lord Kelvin, a great British physicist (1824 – 1907). The Kelvin scale is defined in such a way as to permit the laws of thermodynamics to be expressed in a simple form.

The International Standard temperature scale is the Kelvin scale with a new definition of the degree. The absolute zero is taken to be 0K and the triple point of water is taken to be 273.15K. (The triple point of water, the temperature at which pure liquid water, ice and water vapour are in equilibrium, will be discussed later.) With this definition of the degree, the boiling point of water at one-atmosphere pressure is 373.15K and the freezing point of water saturated with air at one-atmosphere pressure is 273.15K. Hence the SI Kelvin temperature is 273.15K greater than the centigrade temperature.

VIII. Answer the following questions about the text:

1. What is the absolute zero?
2. When was a new temperature scale defined?
3. What temperature is the triple point of water?
4. What is the triple point of water?
5. How can you convert the centigrade temperature to Kelvin?

IX. Fill in the blanks which information taken from the text:

1. A new temperature scale was then devised by _________, a great British physicist.
2. The concept was developed that this temperature -273°C is the minimum temperature, the _________.
3. Hence the SI Kelvin temperature is 273.15K _________ than the centigrade temperature.
4. The Kelvin scale is _________ in such a way as to permit the laws of thermodynamics
5. The absolute zero _________ to be 0K and the triple point of water is taken to be 273.15K.

X. Read the text, try to get it as a whole.

Text 14B

Temperature Dependence of Vapour Equilibrium

Experimental measurements show that the equilibrium vapour pressure of a liquid increases as the temperature increases. In the temperature range in which the vapour pressure is small, it is relatively insensitive to the temperature, but the vapour pressure grows at an increasing rate as the temperature is raised. The temperature at which the equilibrium vapour pressure becomes equal to 1 atm is called the normal boiling temperature, or *the boiling point*. In the boiling process, bubbles of vapour form throughout the bulk of the liquid. In other words, evaporation occurs *anywhere* in the liquid, not just at the upper surface. The reason that this occurs only when the vapour pressure equals the atmospheric pressure is easy to understand. In order for a bubble to form and grow the pressure of the vapour inside the bubble must be at least equal to the pressure exerted on it by the liquid. This, in turn, is equal to the pressure of the atmosphere plus the very small pressure due to the weight of the liquid above the bubble. Therefore, bubble formation and boiling occur only when the vapour pressure of the liquid is equal to the pressure of the atmosphere.

The initiation of a bubble in the bulk of a pure liquid is a very difficult process, since it requires that many molecules with kinetic energies greater than that required for vaporization must be close to one another. Hence, the fact that the liquid reaches the boiling temperature is no guarantee that boiling will occur. If it does not, continued addition of heat will cause the liquid to become superheated, that is, to reach a temperature greater than its boiling point. When finally occurring in a superheated liquid, the bubble formation proceeds with almost explosive violence, because the vapour pressure in any bubble formed greatly exceeds atmospheric pressure, the bubbles tending to expand rapidly. Such violent boiling can be avoided introducing agents which initiate bubbles in the liquid as soon as the boiling temperature is reached. Porous pieces of ceramic material which evolve small bubbles of air into which evaporation can occur serve very well in this application.

VIII. Answer the following questions about the text:

1. What does experimental measurement show about the equilibrium vapour pressure?
2. When does the vapour pressure grow?
3. How is the temperature at which the equilibrium vapour pressure becomes equal to 1 atm called?
4. What happens with the bubbles of vapour in the boiling process?

5. What is the reason for that?

6. When do bubble formation and boiling occur?

7. Why is the imitation of a bubble in a bulk of pure liquid very difficult?

8. What is it necessary to do in order to make liquid superheated?

9. What happens in a liquid when it begins boiling? Describe the procedure.

IX. Find sentences characterizing the following:

1. process of formation of the boiling point of water;
2. the reason of formation of bubbles and their growth;
3. the process of formation of bubbles within a liquid;
4. the tendency of bubbles to expand rapidly in a liquid;
5. the use of pieces of ceramic materials do contribute to evaporation.

Unit VIII
CHANGES OF MATTER

I. Remember the following words and words combinations from the text:

1. to require time for completion - требовать времени для завершения
2. change in oxidation state – изменение в степени окисления
3. neutralization of an acid by a base – нейтрализация кислоты щёлочью
4. presumably – предположительно
5. hydronium ion – ион двуокиси водорода
6. to collide – сталкиваться
7. collision – столкновение
8. delay in the reaction – задержка реакции
9. to formulation of a precipitate – формирование
10. silver chloride – хлорид серебра
11. crystalline grains – кристаллические гранулы
12. stannous ion – ион двухвалентного олова
13. to transfer – переносить, перемещать
14. appreciable reaction – заметная реакция
15. to be manifold – быть многообразным
16. intimacy of the mixture – тесная связь в смеси

II. Give the Russian equivalents for the following:

require time for oxidation state, to be extremely fast, to form the precipitate, oxidation-reduction reaction, an order for a reaction to take place, to transfer electrons, to observe a reaction, to affect the reaction, to collide with.

III. Give the English for the following:

нейтрализация кислоты основанием, смешивать растворы, при комнатной температуре, смесь водорода и кислорода, видимый свет, рентгеновские лучи, без изменения окислительного состояния, передача электронов, скорость реакции, быть многочисленным, концентрация реагентов.

IV. Translate the following sentences into Russian:

1. In order for a reaction to take place, the collision between the ions must result in the transfer of electrons from one ion to another.
2. The rate of the reaction depends on the temperature and pressure.
3. Ionic oxidation-reduction reactions are sometimes very slow.
4. In order that the reaction might occur, the reaction must be heated.
5. Every chemical reaction requires some time for its completion.

V. Translate the following sentences into English:

1. Все химические реакции происходят с разной скоростью.
2. Скорость реакции зависит от состава реагирующих веществ и условий реакции.
3. Существует множество факторов, которые оказывают влияние на реакцию.
4. Среди них прежде всего следует называть температуру, концентрацию, наличие катализаторов и другие.
5. Иногда скорость реакции в значительной степени зависит от присутствия катализаторов.

VI. Translate the following sentences, paying attention to the use of Modal Verbs:

1. The formulation of the precipitate such as that of silver chloride may require a few seconds.
2. In order for a reaction to take place, the collision must be of such a nature that electrons can be transferred from one iron to another.
3. A mixture of hydrogen and oxygen can be kept reaction taking place.
4. In order that the reaction might occur, the reactants must be heated.
5. The example of the fast reaction is that of neutralization of an acid by a base which proceeds as fast as the solutions can be mixed.

VII. Read the text below to find out information about the rate of chemical reactions.

Text 15A
Factors Influencing the Rate of Reactions

Every chemical reaction requires some time for its completion, but some reactions are very fast and some are very slow. Reactions between ions on solution without change in oxidation state are usually extremely fast. An example is the neutralization of an acid by a base, which proceeds as fast as the solutions can be mixed. Presumably nearly every time a hydronium ion collides with a hydroxide ion reaction occurs, and the number of collisions is very great, so that there is little delay in the reaction. The formulation of a precipitate, such as that of silver chloride when solution containing silver ion is mixed with a solution containing chloride ion, may require a few seconds, to permit the ions to diffuse together to form the crystalline grains of the precipitate:

$Ag^{+}(aq) + Cl^{-}(aq) \rightarrow AgCl(c)$.

On the other hand, ionic oxidation-reduction reactions are sometimes very slow. An example is the oxidation of a stannous ion by a ferric ion:

$2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} + Sn^{4+}$.

This reaction does not occur every time a stannous ion collides with one or two ferric ions. In order for a reaction to take place, the collision must be of such a nature that electrons can be transferred from one ion to another, and collisions that permit this electron transfer to occur may be rare. An example of a reaction that is extremely slow at room temperature is that between hydrogen and oxygen:

$2H_2 + O_2 \rightarrow 2H_2O$.

A mixture of hydrogen and oxygen can be kept for years but we can observe no appreciable reaction taking place.

That is why it is not unusual to hear chemists speaking about the factors that determine the rate of a reaction. These are manifold. The rate depends not only upon the composition of the reacting substances, but also upon their physical form, the intimacy of their mixture, the temperature and pressure, the concentrations of the reactants, special physical circumstances such as irradiation with visible light, ultraviolet light, X-rays, neutrons, or other waves or particles, and the presence of other substances that affect the reaction but are not changed by it.

VIII. Answer the following questions about the text:

1. What reactions proceed fast?
2. What reactions are usually slow?
3. In what way is silver chloride formed?
4. What example of oxidation-reduction reaction can you give?
5. What factors influence the reaction rate?

IX. Fill in the blanks which information taken from the text:

1. Among the factors that after ________ are temperature, concentration, etc.
2. On the other hand ________ are sometimes very slow.
3. An example of a reaction that is extremely slow at room temperature is between _________.
4. _________ of hydrogen and oxygen can be kept for years.
5. Reaction between ions in solution without change in _________ are usually extremely fast.

X. Read the text, try to get it as a whole.

Text 15B
Factors Affecting the Boiling Point

The temperature at which a liquid boils, is dependent not only upon the nature of the liquid itself, but also upon the pressure prevailing at the time the boiling point is determined. An increase in the atmospheric pressure causes a rise in the boiling point of a liquid; a decrease results in a lowering of the boiling point.

Each individual substance capable of existing in the liquid state has its own definite boiling point. Consequently, this property is used for identifying or characterizing a substance in the same way that density and other physical properties are employed.

Inasmuch as the boiling point of a substance is affected by changes in pressure, it has been found necessary to set up a *standard pressure* at which all boiling points can be compared. A pressure of 760 mm Hg has been selected as the standard. Thus, if the boiling point of water is given as 100° C, the measurement is understood to have been made at a pressure of 760 mm Hg. Nevertheless, it is quite true to say that the boiling temperature of water is 70°C at a pressure of 233.8 mm Hg; it is also correct to say that carbon tetrachloride boils at a temperature of 70°C, but in this case the pressure is 620 mm Hg. Boiling temperature should not therefore be used for distinguishing one substance from another unless the values used have been determined at the same pressure. Unless otherwise stated, a boiling point value is understood to be the temperature at which a substance boils under a pressure of 760 mm Hg.

One *atmosphere* (standard atmospheric pressure) is equal to 101.325 kNm^{-2}. It is not an approved SI (International System) unit of pressure, but it is especially important in chemistry because many properties of substances have been measured and recorded at 1-atm pressure. An approved SI unit of pressure is the pascal ($1\ Pa = 1\ H/m^2$).

Another unit of pressure that has been much used in the past is the torr, which is the height in millimetres of a column of mercury that balances the pressure. The symbol mmHg is sometimes used for torr. The name of the unit is taken from the name of the Italian physicist Evangelista Torricelli (1609 – 1647), known for having invented the mercury barometer. One atmosphere is equal to 760 torr.

XI. Find answers to the following questions in the text:

1. What factors is the boiling point of a liquid dependent on?
2. How does the atmospheric pressure affect the boiling point?
3. What was the need of setting up a standard pressure?
4. What pressure was selected as a standard?
5. In what way can the boiling point be used in comparing the substances?

6. What other units of pressure do you know?

7. What is one atmosphere equal to?

8. Why is SI (International System) unit of pressure very important in chemistry?

9. What is another unit of pressure that has been much used in the past?

XII. Find sentences characterizing the following:

1. role of an increase in the atmospheric pressure in boiling point of a liquid;

2. the characteristic of property of a liquid;

3. changes in pressure affect the boiling point of a liquid;

4. understanding the boiling point of a liquid;

5. the origin of the name torr.

Text 16A

A Catalyst

I. Remember the following words and words combinations from the text:

1. to alter the speed of a chemical reaction – изменить скорость химической реакции

2. to undergo chemical change – претерпевать химические изменения

3. to be specific inaction – быть специфическим в действии

4. to be useless – быть бесполезным

5. manufacture of sulphuric acid – производство серной кислоты

6. enzymes – ферменты

7. to aid the digestion of food – помогать в переваривании пищи

8. to proceed without catalysts – протекать без катализатора

9. foreign material – инородный материал

10. to augment the rate of a chemical reaction – увеличивать скорость химической реакции

11. elementary process – элементарный процесс

12. to be consumed – потребляться

13. to have smth regenerated – обладать чем-то регенерированным (восстановленным)

14. ammonia – аммиак

15. function as catalysts – действовать как катализатор

16. irradiation with visible light – облучение видимым светом

17. to affect the reaction – повлиять на реакцию

II. Give the Russian equivalents for the following:

biological system, to affect the reaction, to be specific in action, enzymes, digestion of food, to augment the rate of a chemical reaction, to provide the possibility, to alter the speed of a chemical reaction, foreign material, to consume a catalyst.

III. Give the English for the following:

увеличение атмосферного давления, уменьшение температуры, бесполезный катализатор, открывать химические реакции без катализаторов, специфические ферменты, подвергаться химическим изменениям, применение катализатора, небольшое количество инородного материала, регулироваться катализаторами, изменять скорость химической реакции.

IV. Translate the following sentences into Russian:

1. There is a tremendous number of factors affecting the reaction.
2. Catalysts are important only in chemical industry.
3. A particular property of a catalyst is that it is not consumed in the reaction.
4. Enzymes are catalysts for biological systems.
5. No reaction can proceed without a catalyst.

V. Translate the following sentences into English:

1. Катализатор влияет на реакцию и сам не изменяется.
2. В конце реакции катализатор должен восстанавливаться в первоначальном виде.
3. Катализаторы могут участвовать в биологических процессах.

4. Химики открыли множество реакций, которые происходят без катализаторов.

5. Когда соединение имеет какое-то количество инородного материала, его нельзя считать чистым.

VI. Translate the following sentences paying attention to Participle I or II.

1. There is a tremendous number of factors affecting the reaction.
2. A catalyst is a substance that alters the speed of a chemical reaction without itself undergoing any chemical change.
3. In biological systems substances called enzymes function as catalysts.
4. The phenomenon in which a relatively small amount of a foreign material, called a catalyst, augments the rate of a chemical reaction is called catalysis.
5. A catalyst provides the possibility of new elementary processes taking place, but it is not consumed during the reaction.

VII. Read the text below to find out information about the catalyst and the rate of reaction.

Text 16A
A Catalyst

A catalyst is a substance that alters the speed of a chemical reaction without itself undergoing any chemical change, usually only a small quantity of it is required.

Catalysts are usually specific in action; thus, a catalyst for one reaction is more often than not useless for any other reaction. They are extremely important substances not only in the laboratory but also in chemical industry and in biological systems. Thus, the manufacture of sulphuric acid, ammonia and margarine involves the application of catalysts, the most of the chemical reactions that occur in our bodies are regulated by these substances. In biological systems substances called enzymes function as catalysts, e. g., specific enzymes are used to aid the digestion of food in the stomach.

Chemists have discovered the great majority of reactions that proceed without catalysts. But there are almost innumerable other reactions that cannot be practically effected without a catalyst.

The phenomenon in which a relatively small amount of a foreign material, called a catalyst, augments the rate of a chemical reaction is called catalysis. A catalyst provides the possibility of new elementary processes taking place, but it is not consumed during the reaction. If we cannot have it regenerated, there is no catalysis.

VIII. Answer the following questions about the text:

1. What is the rate of reaction?
2. What chemical factors affect the course of a reaction?
3. What physical factors influence the speed of a reaction?
4. What is catalysis?
5. In what way does the presence of a catalyst affect the reaction rate?

IX. Fill in the blanks with the information from the text:

1. Special enzymes are used to aid _________ in the stomach.
2. A catalyst is a substance that _________ of a chemical reaction.
3. The manufacture of _________ involves the application of catalysts.
4. In biological systems substances called _________ function as catalysts.
5. Catalysts are usually specific _________.

X. Read the text, try to get it as a whole.

Text 16B

Nonideal Solutions

Consider a solid substance dissolving in a liquid solvent. The solid is such that when melted, it is converted to a liquid that, in turn, can form an ideal solution with the solvent. The dissolution of the solid can be pictured as occurring in two hypothetical stages:

solid solute → liquid solute → solute in solution.

The second of these steps does not involve any energy change, for the solution formed is ideal. In contrast, the first step does involve the absorption of energy in the amount ΔH_{fus} per mole of solute. Consequently, while the tendency toward maximum entropy favours the dissolution of the solid, the tendency toward minimum energy favours the solid remaining undissolved. Therefore, the solubility of the solid is limited, and a saturated solution which represents the best compromise between maximizing entropy and minimizing energy is formed. Since ΔH_{fus} is related to the strength of attractive forces between solute molecules, we can deduce that the magnitudes of these same forces determine the solubility of the solid in ideal solutions.

By using some care, we can extend our arguments to nonideal solutions. Two liquids which mix with the evolution of heat will be infinitely soluble in each other, for both energy and entropy effects favour their mixing. Two liquids which mix with the absorption of heat may have limited solubility in each other, for if the mixing process is energetically unfavourable, the tendency toward maximum molecular chaos may or may not be sufficient to allow the liquids to mix in all proportions. Likewise, the solubility of a solid is likely to be small if it enters the solution only with considerable absorption of heat. On the other hand, if the dissolution of the solid is accompanied by evolution of heat, the solubility of the solid may be quite high. Even with these generalizations it is difficult to predict or even rationalize qualitatively the solubilities of substances that form markedly nonideal solutions, for the energy and entropy changes that accompany the mixing of strongly irreacting molecules are subtle and difficult to anticipate.

XI. Find answers to the following questions in the text:

1. What hypothetical steps can be pictured when a melted solid is dissolved?

2. At what stage does the energy change take place?

3. Why is the solubility of the solid limited?

4. What two liquids will be infinitely soluble in each other?

5. When will the solubility of the solid be high?

6. Does the tendency toward maximum entropy favour the solid remaining undissolved?

7. What determines the solubility of solids in ideal solutions?

8. When is the mixing process of liquids unfavourable?

9. When will two liquids be soluble in each other?

XII. Find sentences characterizing the following:

1. the process of dissolving a solid in a liquid;
2. factors which solubility depends on;
3. prediction of solubility of a particular solute in a given solvent;
4. the difference between an ideal and nonideal solution;
5. difference between a process of dissolving a solid in a liquid from that of dissolving a liquid in a liquid.

Unit IX
METHODS OF ANALYSIS

I. Remember the following words and words combinations from the text:

1. works chemist – химик-аналитик
2. classical method of analysis – классический метод анализа
3. gravimetric analysis – гравиметрический анализ
4. volumetric analysis – объёмный анализ
5. to determine the weight of a product – определить вес продукта
6. to be based on volumes – основываться на объёмах
7. titration – титрование
8. determination of the strength of acid and basic solutions – определение концентрации растворов кислот и оснований
9. sole reason – единственная причина
10. the decline of the glamour and prestige of the analyst – упадок волшебства и престижа аналитика
11. to take natural substance apart – разбирать на части природные вещества
12. to synthesize in a test-tube – синтезировать в пробирке
13. evolution of research – эволюция исследований
14. to experience a renaissance – испытать оживление (возрождение)
15. ever-increasing competitive market – постоянно растущий конкурентный рынок
16. to come a demand – стать требованием
17. to introduce scientific concepts – знакомить с научными понятиями

II. Give the Russian equivalents for the following:

to depend on the classical methods, to be defined at, gravimetric analysis, respective constituents, to determine the volumes, the strength of acid and basic solutions, competitive market, a difficult situation, to introduce a concept, volumetric analysis.

III. Give the English for the following:

казаться странным, природные вещества, синтезировать в пробирке, химик-аналитик, потребность в новых методах анализа, огромное количество исследований, основываться на процессе титрования вещества, несуществующие в природе, быть направленным на, следующий шаг.

IV. Translate the following sentences into Russian:

1. The energy involved in any reaction is usually called the heat of reaction.
2. There are two methods of analysis: gravimetric and volumetric.
3. Gravimetric analysis is based on methods of determining the weights of the respective constituents of a product.
4. Quality became a very important factor in ever-increasing competitive market.
5. There came a demand for more rapid and more accurate methods of analysis.

V. Translate the following sentences into English:

1. Как ни странно, многие методы анализа используются и сейчас.
2. Классическими методами анализа являются гравиметрический анализ и объёмный анализ.
3. Химики сначала разделяли природные вещества, чтобы определить составляющие их элементы.
4. Потом они подошли к следующей ступени – синтезировать совершенно новое вещество.
5. Рост требований к веществу привёл к дальнейшему совершенствованию методов анализа.

VI. Translate the following sentences, paying attention to the use of Gerund:

1. Gravimetric analysis is based on methods of determining the weight of respective constituents of a product.

2. Chemists began gradually think about synthesizing constituents of nature substances in test-tube.

3. The next logical step, of course, was to begin think about producing things not found in the natural state.

4. Volumetric analysis is based on determining volumes by a process known as titration.

5. We had an evolution of research, principally in organic chemistry, directed toward synthesizing older new compounds.

VII. Read the text below to find out information about the classical methods of analysis.

Text 17A

Classical Methods of Analysis

Strange as it may seem now, the analyst and the "works chemist" of the 18th and 19th centuries depended almost entirely on what are frequently defined today as the classical methods of analysis, namely, gravimetric analysis and volumetric analysis. Gravimetric analysis is based on methods of determining the weights of the respective constituents of a product, whereas volumetric analysis is based on volumes rather than weights, the that is, volumes being determined by a process known as titration determination of the strength of acid and basic solutions.

Difficult as the situation of the so-called "works chemist" during the industrial revolution was, it was not the sole reason for the decline of the glamour and prestige of the analyst in the early days of the science of chemistry.

Following the logical sequence of events, it is not at all strange that chemist, having taken natural substances apart in order to determine their constituent elements, would then begin gradually to think about synthesizing in a test-tube, at least some of the useful things found in nature. The next logical step, of course, was to begin to think about producing things not found in the natural state. Thus, we had an evolution of research, principally in organic chemistry, directed towards synthesizing old or new compounds, chiefly the latter.

About halfway between World War I and World War II, the analytical chemist gradually began to experience a renaissance in his status with other members of the profession and with management. Quality became a very important factor in ever-increasing competitive markets. With this welcome change there came a demand for more rapid and more accurate methods of analysis. This demand led to a tremendous amount of research related to the broad field of analysis. New scientific concepts were introduced, many of them based on what might be called physical chemistry.

VIII. Answer the following questions about the text:

1. What methods of analytical chemistry are called classical methods of analysis?
2. What is gravimetric analysis?
3. What is volumetric analysis?
4. How did chemists come to the idea of synthesizing a substance?
5. What stimulated the evolution of methods of analysis?

IX. Fill in the blanks which information taken from the text:

1. Quality became a very important factor in ________.
2. This demand led to a ________ related to the blood field of analysis.
3. The next logical step, of course, was to begin to think about producing things _________state.
4. We had _________, principally in organic chemistry.
5. With this welcome change there _________ for more rapid and more accurate methods of analysis.

X. Read the text, try to get it as a whole.

Text 17B
Modern Methods of analysis

The so-called classical gravimetric and volumetric methods have by no means been superseded by physical chemistry and physical methods. Unlikely as such a statement may seem, instrumental analysis, as it is known today, supplements rather than supplants the so-called classical wet methods. Such terms as calorimetry, spectrophotometry, Raman effect, fluorimetry, spectrography, X-ray diffraction, radiometric methods, polarography, etc., are in common usage and every part of the analytical work now performed is through the use of instrumentation. Indeed, modifications of many of these instruments are now being moved out into actual manufacturing operations in order to provide continuous analysis.

One of the more modern developments in the field of analysis is that of microanalysis, employed where the size of the samples is considerably smaller than used in the type of analysis sometimes defined as macroanalysis. Today quite a number of analysts are directly concerned with what is frequently defined as trace analysis. The determination of very low concentrations is often of great importance in maintaining high quality of a product. A wide variety of new techniques have been developed to meet this need. Another field currently receiving greater attention is the matter of scientific sampling. Certainly, no method of analysis, accurate as it may be, will give a proper perspective if the sample employed is not reasonably representative of the whole.

Today the research analyst in the chemical process industries is an honoured member of the “team”. The use of this term has become widespread to describe the modern “team approach” to the discovery, development, and full-scale production of new products. Thus, the wheel of fortune for the analyst has made a complete circle.

XI. Find answers to the following questions in the text:

1. What is the position of instrumental analysis in analytical chemistry?
2. What is the purpose of modifying instruments?
3. What is the difference between macroanalysis, microanalysis and trace analysis?
4. What is every part of analytical work performed through?
5. Where is determination of very low concentrations very important?
6. What is another field receiving great attention now?
7. What requirements should the sample meet to allow the analyst to obtain proper results?
8. What is the position of the research analyst in industry of organization at present?
9. What does this term describe?

XII. Find sentences characterizing the following:

1. the role of analytical chemist in various periods of the history of chemistry;
2. the development of various analytical methods;
3. the field of applying microanalysis by chemists-analysts;
4. working in a team – advantages and disadvantages;
5. the role of the analyst in the chemical industries.

Text 18A

Statistical Methods in Analytical Chemistry

I. Remember the following words and words combinations from the text:

1. design and interpretation of chemical experimentation – планирование и интерпретация химических экспериментов
2. substitute – замена
3. scientific judgement – научное суждение
4. to constitute an objective aid – представлять собой объективную помощь

5. in view of the meticulousness – ввиду тщательности
6. to devote some thought – направить мысли
7. final interpretation of outcome – окончательная интерпретация результата
8. to act on intuition – действовать по интуиции
9. rudimentary study of data – повторение изученных данных
10. ranking studied effects – ранжирование изученных эффектов
11. observed disturbances – наблюдаемые нарушения
12. subject of an occasional intuition – предмет случайной интуиции
13. to result in more conspicuous plan – привести к более заметному плану
14. unavoidable experimental error – неизбежная ошибка эксперимента
15. to dismiss error as negligible – отклонить ошибку как незначительную
16. avoidance or correction of systematic error – отмена или исправление систематической ошибки
17. to offer some objective criteria – предложить некоторые объективные критерии
18. to estimate the quality of experimental work – оценить объём экспериментальной работы
19. important by-products – важные побочные продукты
20. to estimate objective – оценить задачу
21. statistical methodology – статистическая методология
22. effects of various variables – эффекты различных переменных
23. to require careful planning – требовать тщательного планирования
24. the questions under study – изученные вопросы

II. Give the Russian equivalents for the following:

the design of the experiment, to be a substitute for, to ignore experimental error, to require careful planning, important by-products, to estimate objective, scientific judgement, statistical methods, to estimate objective, unavoidable experimental error.

III. Give the English for the following:

объяснение результатов эксперимента, предложить объективные критерии, один из побочных продуктов, изучаемые переменные, рассматривать с точки зрения, в соответствии с наблюдаемыми факторами, избегать систематических ошибок, кажется приемлемым, повторное изучение данных, наблюдаемые нарушения.

IV. Translate the following sentences into Russian:

1. Two important aspects of experimentation are its design and interpretation of the results.
2. Very often the experimenter designs the experiment as it products acting on his intuition.
3. Before the experiment is started it is necessary to consider various possible results hypothetically.
4. Statistical methods are used in the design and interpretation of chemical experimentation.
5. One of the important by-products of statistical methods is an estimate of the quality of experimental work.

V. Translate the following sentences into English:

1. Очень важными в аналитической химии являются статистические методы.
2. Едва ли можно сказать, что планирование эксперимента – простое дело!
3. Объяснить конечный результат реакции бывает непросто и опытному химику.
4. Ученым удалось выработать некоторые методы, чтобы избежать ошибки при проведении экспериментов.
5. Объективными критериями правильности научной гипотезы можно считать только факты.

VI. Translate the following sentences and Define the Types of Subordinate Clauses.

1. Before the experiment is started it is necessary to consider various possible results hypothetically.
2. It is quite natural that many experiments could have resulted from thoroughly constructed plan.
3. Statisticians have succeeded to offer some criteria which are invaluable in many situations.
4. Hardly can it be denied that experiments require obtaining reliable results.
5. Very often the experimenter design the experiment as it proceeds acting on his own intuition.

VII. Read the text below to find out information about the statistical methods of analysis.

Text 18A

Statistical Methods in Analytical Chemistry

Statistical methods, as used in the design and interpretation of chemical experimentation, are not a substitute for common sense or for what scientists refer to as scientific judgement; they rather constitute an objective aid to judgement. In view of the meticulousness exhibited by scientific workers in the purely technical aspects of their experiments it seems appropriate to devote some thought to two further and no less important aspects of experimentation: its design and the final interpretation of its outcome. Very often the experimenter designs the experiment as it proceeds, acting on a moment's intuition. Similarly, the interpretation or a rudimentary study of data, the latter consisting in many cases in ranking studied effects in accordance with their observed disturbances caused by experimental and systematic errors. Naturally, even the most experienced worker is subject to an occasional intuition. Therefore natural, and actually borne out by the facts, is the assumption that many experiments could have resulted in more conspicuous and sharper constructed plan.

In taking cognizance of the unavoidable experimental errors, rather than in ignoring them or dismissing them as negligible, and in attempting a mathematical study of the avoidance or the correction of systematical errors, statisticians have succeeded, to a certain extent, in offering some objective criteria which are invaluable in these situations. One of the important by-products of these methods is an estimate of the quantity of experimental work that is necessary for obtaining sufficient factual proof for a scientific hypothesis, such an estimate being more objective than the guessing technique often used. But among the most important contributions of statistical methodology to scientific experimentation is the possibility of clearly separating the effects of various variables under study as well as the interactions of these variables with regard to the measured quantities, from the data resulting from a complex experiment. Hardly can it be denied that this requires careful planning. Even before the experiment is started, the various possible types of results must be hypothetically considered from the point of view of the questions under study.

VIII. Answer the following questions about the text:

1. In what fields of analytical chemistry can statistical methods be used?
2. What important aspects of experimentation should be taken into account?
3. What is the role of intuition in experimentation?
4. What must be the attitude to errors?
5. What is one of the most important by-products in statistical methods?

IX. Fill in the blanks with the information from the text:

1. _________ us used in the design and interpretation of chemical experimentation are not substitutes of scientific judgement.
2. They constitute _________ to judgement.
3. Sometimes the experimenter designs the experiment as it proceeds acting _________.

4. Statisticians have succeeded in offering _________which are invaluable in many situations.

5. Two important aspects of experimentation are its design and _________ of results.

X. Read the text, try to get it as a whole.

Text 18B

Who is Discoverer of Spectrum Analysis?

The more detailed is the scrutiny of the history of chemistry, the greater is the number of interesting facts that come to light.

Those accustomed to associate the name of Kirchhoff with the discovery of spectrum analysis will undoubtedly be surprised to learn that in the year 1854, five years prior to the work of Kirchhoff, an unassuming country doctor in a Pennsylvania village definitely demonstrated the possibility of determining various elements by means of their lines in the spectrum. In fact, this country doctor, David Alter, went further than this. He pointed out that the method could be used to determine the composition of celestial bodies, thus laying the foundation for the application of the spectroscope in astronomy, among the modern sciences. He even called attention to the possibility of detecting impurities in a metal by this method, thus speaking the language of the most up-to-date spectrographer.

The only possible claim to priority over Alter's discovery can be made in behalf of Sir John Herschel, who in 1824 demonstrated the possibility of detecting small quantities of an alkali by its flame spectrum. However, this work was described in an inaccessible journal, thus receiving practically no publicity. Unfortunately, it is not unfrequently that this happens. That is why scientists usually seek to publish their papers in prestigious journals: the better the reputation of the journal, the sooner the information it contains comes to the reader. Furthermore, confused by the continual presence of the strong orange lines, later found to be sodium lines. Herschel soon regarded his own discovery as incorrect. The same prevalent sodium lines kept other physicists of that time from realizing that each element has its characteristic line in the spectrum.

Alter, however, was not obstructed by this stumbling block. Neither did the lack of scientific instruments discourage him. He ground his own prism and constructed his own apparatus.

XI. Find answers to the following questions in the text:

1. What will surprise those who study the history of spectrum analysis?
2. What contribution did country doctor David Alter make to spectrum analysis?
3. What did he point out?
4. What did John Herschel's work demonstrate?
5. How did it happen that he's work remained unknown?
6. Where do scientists usually publish their articles?
7. What prevented Herschel from drawing the right conclusion?
8. What was the reason for it?
9. How did he correct the situation?

XII. Find sentences characterizing the following:

1. five years prior to the work of Kirchhoff;
2. Alter's discovery;
3. contribution to spectrum analysis made by Sir John Herschel;
4. the tendency of scientists to publish their articles;
5. attitude of Herschel to his own discovery.

SUPPLEMENTARY READING

Text 1
Conductance and Electrolysis

Generally speaking, the classification of a substance as a non-electrolyte or as an electrolyte is based on the conductance of its aqueous solution. Aqueous solutions of non-electrolytes do not conduct an electric current to any greater extent than pure water does, whereas aqueous solutions of electrolytes conduct an electric current and undergo electrolysis. Weak electrolytes give solutions which are relatively poor conductors because of a limited degree of ionization. On the other hand, aqueous solutions of strong electrolytes readily conduct an electric current.

If a strong electrolyte is formed as a result of a chemical reaction involving two weak electrolytes, the conductance of the resulting solution increases. If the ions of a strong electrolyte are removed from solution as an insoluble precipitate, or from a weak electrolyte with the ions of another reactant, the conductance of a mixture of the reactants is less than that of the strong electrolyte. After the reaction is complete, the conductance will increase upon further addition of the second reactant, provided the latter is a strong electrolyte.

Electrolysis always accompanies the passage of a direct current through an aqueous solution. Cations are reduced to a lower oxidation state, some of them to the free state, at the cathode; anions are oxidized to ions with a higher oxidation state, or to the free state, at the anode.

Text 2
Radiation Effects on Polymers

Radiation exerts two opposing effects on polymers. On the one hand, it breaks up the polymer molecules into smaller pieces. On the other, it causes liberation of a hydrogen atom from each of the two adjoining molecules with formation of a link between the two molecules (cross-linking). The existence of cross-links in a polymer makes the material tougher and higher melting and is very desirable for certain applications.

The cross-linking of polymers by radiation has been much studied. The irradiation of any organic compounds results in breaking of CH bonds, leaving free bonds on the carbon atoms while the hydrogen atoms go off together in pairs to form hydrogen gas. In a liquid the resulting free radicals can diffuse as a whole through the solution and eventually meet together and combine. In a solid polymer it is not clear how these centers get together. One proposed mechanism is that a hydrogen atom from a neighbouring carbon will pop into the vacated hydrogen space, producing a new free bond on the atom adjacent to the original free bond position. This process will continue, with the free bond flowing up and down the chain, until the free bond happens to find itself next to a free bond formed on the adjacent molecule which is likewise travelling up and down. Another mechanism, possible perhaps only with amorphous polymer, is that the long-chain molecules as a whole may move with respect to one another until the free bonds find themselves in proximity.

Whatever the mechanism of cross-linking may be, the result is of commercial value.

Text 3
The Role Theory in Chemistry

We start at the beginning and define *science* as a set of observations and theories about observations. We then define theory as a device for making predictions and correlations of observations. A theory is composed of *axioms*, which are not necessarily self-evident, procedure, and the output of the procedure. The axioms identify the system, select the procedure and its parameters, and interpret its output. Each theory is judged by the following *pragmatic criteria* listed in the order of decreasing importance.

How diverse is it?

How accurate is it?

How simple is it?

Like all science, theories evolve; they do so because the basis of our scientific knowledge is constantly changing. The best theory at a particular point in time is the theory that best satisfies the above criteria. It is not to be judged on a political or a religious basis.

A theory evolves. The axioms are conceived in the mind of the theorist who also may double as an experimentalist. The output of the theory are predictions and correlations that may suggest new experiments to the experimentalist. The predictions and correlations are then compared with observations. If the agreement between predictions-correlations and observation is "good" the theory is a "good" theory, which is a pragmatic value judgement. If the agreement is poor which occurs sometimes because new observations have been made a better theory must be found by some theorist generating new axioms and a new cycle. This axiomatic-cum-pragmatic (ACP) cycling is continued until the agreement between theory and experiment becomes "good". We call this process the ACP *epistemology of science* because (1) *epistemology* is the acquisition and validation of knowledge and (2) we wish to distinguish our simplistic view from the more erudite views of the professional philosophers.

The ACP epistemology can be applied to areas outside of science.

Text 4
Theories of Matter

There is a wide variety of chemical and physical theories from which we select as our example theories of matter (atoms, molecules, solids, nuclei, and elementary particles). We can illustrate the ACP epistemology with the familiar ball-and-stick theory of molecules. This theory employs sticks and coloured balls with holes drilled in them at prescribed angles. The procedure consists of assembling the balls and sticks into figures in all possible ways. The predictions of the theory include molecular geometry and the number of isomers expected for the molecule in question. We all feel comfortable with this ball-and-stick theory because it operates in the three-dimensional, classical world of our senses and seems "real" to us. While it is a very useful theory, it has a number of significant failures. For example, it fails to predict both the geometry and the number of isomers of benzene. More seriously, it fails to predict the electronic, vibrational, and rotational spectra of molecules. This failure to predict spectra is common to all classical theories and has made necessary the development of a new theory which includes predictive powers in this area. The nonclassical *quantum theory* is a theory that predicts more diversely, more quantitatively, but not more simply than the ball-and-stick theory.

Quantum theory has two essentially equivalent versions: one concerned with wave mechanics (derived from Schroedinger's work) and one concerned with matrix mechanics (due to Dirac-Heisenberg) which is our choice. The procedure of the *matrix mechanics theory of matter* (MMTM) is very interesting but is not relevant to the application of the procedure. It employs vector space and their bases, operators, matrices, secular equations, eigenvectors, eigenvalues, groups, group algebras, etc., concepts that are well known to mathematicians but essentially unknown to beginning physicists and chemists. In consequence MMTM may seem less "real" to these beginners than the classical ball-and-stick theory. The MMTM procedure can be applied uniformly to atoms, molecules, solids, nuclei, and elementary particles. It is clear that the concept of structure is much simpler and more intuitive in the ball-and-stick theory than in the MMTM theory. The MMTM structure concept is that of a set of building blocks (basis vector of a vector space) that are assembled under supervision of the Hamiltonian into a physically significant set of *structures* (eigenvectors to the Hamiltonian).

The numerical and algebraic calculations required in the MMTM procedure can become quite tedious but fortunately many of them have been or can be programmed for personal computers. The calculations of MMTM then become trivial and operational familiarity is quickly acquired. Consequently, the challenging part of MMTM becomes the selection of the vector space and the Hamiltonian and then the interpretation of the output.

Text 5
Molecular Theory

Matrix mechanics theory of matter (MMTM) is a better molecular theory than the ball-and-stick molecular theory. In the *ab initio* MMTM *molecular theory* the only parameters required by the procedure are Planck's constant, the charge and mass of the electron, and the number and kind of nuclei. This theory can for many molecules predict with high accuracy their equilibrium geometrics and their force constants. Unfortunately, it predicts other properties, e. g., dissociation energy, electronic spectra, etc., with a lower accuracy. The accuracy can be increased by the use of larger vector spaces, a technique that can be very difficult, very expensive, and/or impossible with the currently available scalar computers. The problem becomes easier with supercomputers that employ vector and/or parallel processors and larger memories, but there will always be some upper limit to the size of a molecule on which accurate *ab initio* calculations can be made. A theory which is less strongly computer-dependent is the *semiempirical molecular theory*. Its procedure employs a smaller vector space and its parameters are determined by comparison of predictions with a small number of observations.

An example of a semiempirical molecular theory is the *π-electron theory* of conjugated, unsaturated hydrocarbons. Here the size of the vector space is reduced by ignoring core and δ-bonded electrons and employing a single π-orbital for each carbon site. The size of the vector space can be further reduced by the use of either of two more approximate theories: the *π-Hückel molecular orbital theory*, which resembles the Bohr theory of the atom, and the *π-valence bond theory*, which resembles the ball-and-stick theory.

Text 6

The Manufacture of Sulphuric Acid

It is a matter of common knowledge among chemists that sulphuric acid is made by two processes, the *contact process* and the *lead-chamber process*, which are now about equally important.

In the contact process sulphur trioxide is made by the catalytic oxidation of sulphur dioxide (the name of the process refers to the fact that reaction occurs on contact of the gases with the solid catalyst). The catalyst formerly used was finely divided platinum; it has now been largely replaced by vanadium pentoxide, V_2O_5. The gas containing sulphur trioxide is then bubbled through sulphuric acid, which absorbs the sulphur trioxide. Water is added at the proper rate, and 98% acid is drawn off.

In the lead-chamber process oxygen, sulphur dioxide, nitric oxide, and a small amount of water vapour are introduced into a large lead-lined hamber. White crystals of nitrosulphuric acid, NOHSO4 (to put it in another way, sulphuric acid in which one hydrogen ion is replaced by the nitronium ion, $:N{\equiv}O^{+}:$), are formed. When steam is introduced the crystals react to form drops of sulphuric acid, liberating oxides of nitrogen. In effect, the oxides of nitrogen serve to catalyze the oxidation of sulphur dioxide by oxygen. The reactions that occur may be summarized as

$$2SO_2 + NO + NO_2 + O_2 + H_2O \rightarrow 2NOHSO_4;$$

$$2NOHSO_4 + H_2O \rightarrow 2H_2SO_4 + NO + NO_2.$$

The oxides of nitrogen, NO and NO_2, that take part in the first reaction, are released by the second reaction, and can serve over and over again.

It should be pointed out in conclusion that however widespread these processes may be, they are by no means the only ways of the manufacture of sulphuric acid.

Text 7

Benjamin Franklin and Electricity

January 17, 2006, will be the 300th anniversary of the birth of Franklin. Kant once remarked that Benjamin Franklin was a new Prometheus who had stolen fire from heaven. In his own day, Franklin was celebrated throughout all Europe as the world's foremost electrician and his book on the subject was in demand in many countries. Far-reaching in its influence, the book became an important Text in the electrical field and even today we still write of electricity in terms introduced in print by Franklin. Used in the electrical sense, probably for the first time, in the inventor's book were words such as armature, battery brush, charged, charging, condense, conductor, discharge, electrical fire, electrical shock, electrician, electrified, electrify, Leyden bottle, minus, negative, non-conducting, non-conductor, non-electric, plus, positive, and others.

Franklin saw his first electrical demonstration in Boston in 1746. He purchased all the apparatus used by the British experimenter, Dr. Spence, and proceeded in electrical experiments of his own with great interest. The work that he did was soon far ahead of the European discoveries. With great enthusiasm, he described new discoveries that were to him unique, for he had no way of telling what work his predecessors had done. Foremost among the observations was the discovery of the action of points in drawing off and throwing off the electrical fire. One of Franklin's scientific achievements was his experiment with the Leyden jar. He explained the startling discovery that the electrified jar became charged positively on the outside, negatively on the inside, and showed by means of experiment that the positive charge on the outer coating of the jar was exactly equal and opposite to the negative inner charge.

Besides the importance and usefulness of Franklin's discoveries, the world knows him well for his hypothesis concerning the electrical nature of lightning. Up to his discoveries the general impression was that lightning was caused by the explosion of poisonous gases in the air. In 1749, Franklin established that electrical fluid and lightning had similar properties of giving light, colour of the light, crooked direction, swift motion, being conducted by metals, crack or noise in exploding, subsisting in water or ice, rending bodies it passes through, destroying animals, melting metals, firing inflammable substances, sulphureous smell.

CONCLUSION

Основная цель пособия – обеспечение планомерного руководства аудиторной работой студентов, направленной на основательное изучение профессионально ориентированных текстов и их обсуждение с применением смыслового анализа.

Издание включает целевые задания к текстам, состоящие из вокабуляра, языковых и речевых упражнений для обсуждения в аудитории. Цель заданий – активизация словаря и восприятие смыслового содержания текста.

Тексты для дополнительного чтения тематически и лексически представляют собой продолжение модулей основной части пособия и предназначены для самостоятельной работы студентов.

Структура модулей и последовательность изложения учебного материала однотипны, что облегчает его усвоение и понимание.

Таким образом, чёткое структурированное пособие, в котором предложены новые пути отбора и организации учебного материала, последовательной системы упражнений, может помочь по-новому взглянуть на проблемы обучения чтению оригинальной литературы и извлечению необходимой когнитивной информации.

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