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ПОСОБИЕ ПО АНГЛИЙСКОМУ ЯЗЫКУ

для старших курсов энергетических вузов

АльянС

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Тексты пособия составлены на основе оригинальных английских и американских источников. Упражнения способствуют как лучшему усвоению и закреплению лексики и грамматики, так и дальнейшему развитию беспереводного понимания текстов на английском языке.

Цель пособия – подвести студентов к самостоятельному чтению и пониманию оригинальной научно-технической литературы по специальности на английском языке.

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ПРЕДИСЛОВИЕ

Настоящее пособие предназначается для студентов старших курсов энергетических вузов. Цель пособия — подвести студентов к самостоятельному чтению и пониманию оригинальной научно-технической литературы по специальности на английском языке.

Пособие состоит из следующих разделов: 1. Уроки, содержащие учебные тексты с упражнениями. 2. Лабораторные работы к учебным текстам. 3. Тексты для внеаудиторного чтения. 4. Приложение, содержащее идиомы, союзные и предлоговые группы.

Тексты пособия, составленные на основе английских, американских и советских источников, носят познавательный и научно-популярный характер. Некоторые тексты снабжены рисунками, которые служат основой для мотивированного высказывания.

Пособие содержит 22 урока, каждый из которых рассчитан на два аудиторных занятия и состоит из предтекстовых упражнений, основного текста, лексико-грамматических и речевых упражнений и дополнительных текстов, предназначенных для развития навыков поискового чтения. При составлении текстов и упражнений авторы уделяли большое внимание повторяемости лексических и грамматических явлений и придерживались принципа постепенного нарастания трудностей.

Грамматический материал включен в первые двадцать уроков, причем проработке каждой грамматической темы уделяется несколько уроков. Последние два урока включают весь пройденный грамматический материал.

Лабораторные работы предназначены для введения и закрепления слов, подлежащих активизации, и их производных, а также работы над произношением трудных слов. Лабораторные работы должны быть записаны на магнитную ленту. При отсутствии лабораторной устной речи и технических средств рекомендуется преподавателю самому прочитывать на занятиях упражнения из лабораторных работ вслух.

В третье издание (второе вышло в 1972 г.) внесены следующие изменения: основные тексты пособия частично переработаны. Введены предтекстовые упражнения, дополнительные тексты с упражнениями и новый раздел «Лабораторные работы». Часть текстов для внеаудиторного чтения переработана, их тематика расширена.

Авторы выражают глубокую благодарность доценту Московского энергетического института Крючкову И. П. за квалифицированные советы по вопросам науки и техники, а также особую признательность рецензентам к. ф. н. доц. Дубровской С. Г. и к. т. н. доц. Судовцеву В. А. за ценные замечания, которые способствовали улучшению пособия.

Авторы

SECTION I

UNIT ONE

Grammar: The Participle

	Participle I	Participle II	Perfect Participle
	simultaneousness (одновременность)		priority (предшествование)
Active	writing	—	having written
Passive	being written	written	having been written

Class Exercises

I. Translate the following sentences paying attention to the Participle.

1. The student is translating an article on refrigerators. 2. The student has translated an article. 3. The article is translated by the student. 4. The article is being translated by the student. 5. The student translating the article is comrade Novikov. 6. The article translated by the student is difficult. 7. The translated article is devoted to electrical furnaces. 8. Translating an article, the student used a dictionary. 9. Having translated the article, the student gave it to the teacher. 10. Having been asked to translate the article, the student translated it with great interest. 11. The article being translated is about the application of electricity.

II. Learn to recognize the following international words.

radio, student, civilization, lamp, result, machine, institute, lift, vacuum, energy, telephone, practical, fact, tram, refrigerator, technological

III. Do Laboratory Work 1.

TEXT I. ELECTRIC CURRENT SERVES US IN A THOUSAND WAYS

The electric current was born in the year 1800 when Volta constructed the first source of continuous current. Since that time numerous scientists and inventors, Russian and foreign, have greatly contributed to its development and practical application.

As a result, we cannot imagine modern civilization without the electric current. We can't imagine how people could do without electric lamps, without vacuum cleaners, refrigerators, washing machines and other electrically operated devices that are widely used today. In fact, telephones, lifts, electric trams and trains, radio and television have been made possible only owing to the electric current.

The student reading this article is certainly familiar with the important part which the electric current plays in everyday life. From the moment when he gets up in the morning until he goes to bed at night, he widely uses electric energy. Only when going to the institute either on foot or by bicycle, can he do without electricity. In fact, it is well known that electric current is necessary for the operation of trolley-buses, trams, buses and modern trains.

During the day the student will also use some electrical devices working in the laboratory, making use of the telephone, the lift, the tram and so on. As for the evening, if he studies or reads by an electric lamp, watches television, goes to the theatre or cinema, he certainly uses electricity.

Some people are more familiar with the various applications of the electric current in their everyday life than they are with its numerous industrial applications. However, electric energy finds its most important use in industry. Take, for example, the electric motor transforming electric energy into mechanical energy. It finds wide application at every mill and factory. As for the electric crane, it can easily lift objects weighing hundreds of tons.

A good example which is illustrating an important industrial use of the electric current is the electrically heated furnace. Great masses of metal melted in such furnaces flow like water. Speaking of the melted metals, we

might mention one more device using electricity, that is the electric pyrometer. The temperature of hot flowing metals can be easily measured owing to the electric pyrometer.

These are only some of the various industrial applications of the electric current serving us in a thousand ways.

Exercises

I. Translate the following sentences.

1. Speaking of the electrically operated devices, one can mention the refrigerator. 2. Having mentioned the name of Volta, the teacher spoke about his invention. 3. The first source of continuous current constructed by Volta appeared in 1800. 4. The temperature of hot flowing metals is often measured by the electric pyrometer. 5. The pyrometer used in industry is a device measuring temperature. 6. The pyrometer showing the temperature of metals melted in furnaces is also an electrical device. 7. Making this instrument, we could not do without a machine operated by electricity. 8. Going along the streets, one can see running trams, trolley-buses, buses and cars. 9. Being widely used in industry, electrical motors are also used in every home. 10. The problem solved helped to increase the speed of the train.

II. Translate the following sentences using the Participle.

1. Электрический мотор, преобразующий электрическую энергию в механическую, используется в повседневной жизни. 2. Говоря об электрическом токе, мы можем упомянуть имя Вольта. 3. Электрический пирометр измеряет температуру расплавленных металлов. 4. Поработав на фабрике, мой товарищ поступил в институт. 5. Электрические приборы, упомянутые в этой статье, были созданы русскими учеными. 6. Измеряя температуру горячих металлов, студент пользовался пирометром. 7. Измерив температуру металла, мы начали измерять температуру воды.

III. Give short answers to the following questions.

1. Does the motor find wide application in industry? 2. Is Volta a Russian scientist? 3. Does your friend go to the institute on foot? 4. Did you go to the theatre yesterday? 5. Is there an electric lamp on your table? 6. Has your

friend bought a new bicycle? 7. Are there many trolley-buses and trams in Moscow? 8. Do you watch television every day? 9. Do you use electrical devices? 10. Can you do without electricity? 11. Does the electric current play an important part in our life? 12. Does the electric motor transform electrical energy into mechanical energy? 13. Is the electric current necessary for the operation of trolley-buses and trams? 14. Is your house heated by an electric furnace?

IV. Form sentences using the words given below.

Model: lift, the, heavy, can, electric, objects, crane → The electric crane can lift heavy objects.

1. finds, industry, energy, in, application, electric, wide.
2. does, study, he, at, not, the, institute?
3. day, use, every, do, devices, you, electrical?
4. the, theatre, go, to, we, yesterday, not, did.

V. Put all possible questions to the following sentences.

1. The electric motor finds wide application in industry.
2. Russian scientists contributed greatly to the science of electricity.

VI. Form sentences using the following expressions.

to play a part in, to go on foot, to do without, to make use of, to be familiar with, to get up, to go to bed, to go by bicycle, to be born, to contribute to, to flow like water

VII. Translate the following groups of words.

в повседневной жизни; промышленное применение; печь, нагреваемая электричеством; важное применение; преобразующий механическую энергию; постоянный ток; при электрической лампе; в результате, благодаря электричеству; смотреть телевизор вечером

VIII. Find the wrong statements and correct them in several sentences.

1. It is impossible to measure the temperature of hot flowing metals. 2. The industrial application of the electric current contributes to the technological progress. 3. We use few electrical devices in our everyday life. 4. Modern civilization can do without the electric current. 5. The electric motor operates all electrical devices.

IX. Find the correct answer out of the three given below.

What device

1. measures the temperature of hot metals? a) refrigerator, b) pyrometer, c) motor

2. transforms electrical energy into mechanical energy? a) bicycle, b) telephone, c) motor

3. lifts objects weighing hundreds of tons? a) electric crane, b) electric furnace, c) vacuum cleaner

4. lights your room? a) tram, b) lift, c) lamp

X. Speak on:

1. The use of the electrical current in industry. 2. The use of the electrical current in everyday life.

XI. Retell the text.

UNIT TWO

Grammar: The Absolute Participle Construction

1. The source of the electric current having been discovered, many scientists began to experiment with it.— Когда источник электрического тока был открыт, многие ученые начали экспериментировать с ним.
2. The students were making experiments in the laboratory, the electrical devices being used.— Студенты проводили эксперименты в лаборатории, причем использовались электрические устройства.

Class Exercises

I. Translate the following sentences paying attention to the Absolute Participle Construction.

1. An object losing its potential energy, that energy is turned into kinetic energy. 2. Water falling from its raised position, energy is changed from potential to kinetic one. 3. My friend was reading an English article, his brother watching television. 4. Electrical devices find a wide application in every house, a refrigerator being one of them. 5. There being a hydroelectric station at the waterfall, the energy of the falling water is used to drive the turbines. 6. The energy sources of the world decreasing, the scientists must find new sources of energy. 7. There are different sources of energy, the sun being an unlimited source of all

forms of energy. 8. Industrial applications of energy increasing, more and more energy is needed every year.

II. Learn to recognize the following international words.

moment, electricity, operation, laboratory, metal, theatre, industrial, motor, crane, ton, pyrometer, temperature, mass, illustrate, industry

III. Do Laboratory Work 2.

TEXT 2. ENERGY

In the language of science energy is the ability to do work. There are various forms of energy, such as heat, mechanical, electrical, chemical, atomic and so on. One might also mention the two kinds of mechanical energy—potential and kinetic, potential energy being the energy of position while kinetic energy is the energy of motion.

It is well known that one form of energy can be changed into another. A waterfall may serve as an example. Water falling from its raised position, energy changes from potential to kinetic energy. The energy of falling water is generally used to turn the turbines of hydroelectric stations. The turbines in their turn drive the electric generators, the latter producing electric energy. Thus, the mechanical energy of falling water is turned into electric energy. The electric energy, in its turn, may be transformed into any other necessary form.

When an object loses its potential energy, that energy is turned into kinetic energy. Thus, in the above-mentioned example when water is falling from its raised position, it certainly loses its potential energy, that energy changing into kinetic energy.

We have already seen that energy of some kind must be employed to generate the electric current. Generally speaking, the sources of energy usually employed to produce current are either chemical, as in the battery, or mechanical, as in the electromagnetic generator. Chemical sources of current having a limited application, the great quantities of electric energy generated today come from various forms of mechanical energy.

The rising standards of modern civilization and growing industrial application of the electric current result in an increasing need of energy. Every year we need more and more energy. We need it to do a lot of useful things that

are done by electricity. However, the energy sources of the world are decreasing while the energy needs of the world are increasing. These needs will continue to grow as more motors and melted metals are used in industry and more electric current is employed in everyday life. As a result, it is necessary to find new sources of energy.

The sun is an unlimited source of energy. However, at present, only a little part of solar energy is being used directly. How can we employ solar energy directly to produce useful energy? This is a question which has interested scientists and inventors for a long time. Lavoisier and other great scientists of the past melted metals with the help of solar furnaces. Today, solar furnaces illustrate just one of the numerous ways to harness the sun. Using semiconductors, scientists, for example, have transformed solar energy into electric energy.

Exercises

I. Compare (a) and (b) paying attention to the Participle. Translate into Russian.

1. (a) Having brought the dictionaries from the library, the students began to translate the article. (b) The dictionaries having been brought from the library, the students began to translate the article.

2. (a) Having finished my translation, I gave it to the teacher. (b) The translation having been finished, I gave it to the teacher.

3. (a) Having finished the experiment, the students left the laboratory. (b) The experiment having been finished, the students left the laboratory.

4. (a) The professor delivering the lecture is a famous Soviet scientist. (b) The professor delivering] the lecture, the students were listening to him with great interest.

II. Find the sentences with the Absolute Participle Construction and translate them.

1. The girl is finishing her work. 2. The work is being finished by the girl. 3. The girl finishing her work is my sister. 4. Finishing her work, the girl was speaking to her friend. 5. The work having been finished, the students went home. 6. Having finished her work, the girl went for a

walk. 7. Having been finished in time, the work was given to the teacher. 8. My brother finished his work, his friend having helped him.

III. Translate the following sentences.

1. Падающая вода может приводить в действие турбину. 2. Говоря об энергии, мы могли бы упомянуть потенциальную и кинетическую энергию. 3. Работая в лаборатории, студент пользовался электрическими приборами. 4. Прочитав текст, мы начали переводить его. 5. Химические источники тока находят ограниченное применение в промышленности.

IV. Give short answers to the following questions.

1. Can one form of energy be changed into another form? 2. Does a generator produce mechanical energy? 3. Is the sun an unlimited source of energy? 4. Can we employ solar energy directly? 5. Have scientists transformed solar energy into electric energy? 6. Is potential energy the energy of motion? 7. Do we need more and more electric energy every year? 8. Are there various forms of energy? 9. Do you use electric energy every day? 10. Can the energy of falling water be used to drive turbines? 11. Is kinetic energy the energy of position?

V. Find the correct term out of the three given below.

1. The motor changes electrical energy into a) heat energy, b) chemical energy, c) mechanical energy.
2. The generator changes mechanical energy into a) chemical energy, b) electrical energy, c) light energy.
3. The battery changes chemical energy into a) solar energy, b) heat energy, c) electric energy.
4. The electric furnace changes electric energy into a) heat energy, b) chemical energy, c) mechanical energy.
5. The vacuum cleaner changes electrical energy into a) light energy, b) mechanical energy, c) solar energy.

VI. For the words given in (a) find the Russian equivalents in (b).

a) 1. to transform; 2. device; 3. application; 4. chemical; 5. potential; 6. source; 7. station; 8. to produce; 9. to drive; 10. to serve; 11. to do without; 12. to make use of; 13. as for; 14. to play a part; 15. semiconductor

b) 1. служить; 2. играть роль; 3. приспособление, прибор; 4. полупроводник; 5. использовать; 6. источник; 7. что касается; 8. потенциальный; 9. применение; 10. преобразовывать; 11. станция; 12. вырабатывать; 13. химический; 14. обходиться без чего-л.; 15. приводить в действие

VII. Retell Text 2.

VIII. Read Text 2A and find the English equivalents to the following Russian word combinations.

1. Электричество, вырабатываемое такой установкой, стоит дешевле, чем ... 2. ...были сконструированы для превращения солнечной энергии в электричество. 3. Количество солнечной энергии на один квадратный метр здесь равно энергии, вырабатываемой...

TEXT 2A. HARNESSING SOLAR ENERGY

The experiments on solar cells gave the possibility to collect enough data to predict the possible performance of solar stations. These experiments have led to the building of a solar furnace developing temperatures of 3,000°C in a sunray focal point. Electricity generated by such an installation costs less than that generated by a steam power-station.

The solar stations in the Kara-Kum desert will become producers of cheap electricity in the near future. The amount of solar energy per square meter here is equal to the energy generated by burning 200 kg of high quality coal.

Power cells of the size of a matchbox have been developed to convert solar energy into electricity. Such cells can accumulate sufficient energy in one bright day to power a large transistor radio for ten days.

IX. Point out which of the sentences contains the information from Text 2A.

1. It is quite possible that some day coal and other fuel may be replaced by atomic energy. 2. Solar stations will produce cheap electric energy in the near future. 3. The experiments on atmospheric electricity were made by many outstanding scientists.

UNIT THREE

Grammar: The Participle (Revision)

Class Exercises

I. Learn to recognize the following international words.

mechanical, form, potential, generator, kinetic, turbine, limit, battery, standard, hydroelectric, interest, engineer, type, reactor

II. Do Laboratory Work 3.

TEXT 3. ATOMIC ENERGY

A man trying to see a single atom is like a man trying to see a single drop of water in the sea while he is flying high above it. He will see the sea made up of a great many drops of water but he certainly will not be able to see a single drop. By the way, there are so many atoms in the drop of water that if one could count one atom a second, day and night, it would take one hundred milliard years. But that is certainly impossible.

Man has, however, learned the secret of the atom. He has learned to split atoms in order to get great quantities of energy. At present, coal is one of the most important fuel and our basic source of energy. It is quite possible that some day coal and other fuel may be replaced by atomic energy. Atomic energy replacing the present sources of energy, the latter will find various new applications.

The nuclear reactor is one of the most reliable "furnaces" producing atomic energy. Being used to produce energy, the reactor produces it in the form of heat. In other words, atoms splitting in the reactor, heat is developed. Gas, water, melted metals, and some other liquids circulating through the reactor carry that heat away. The heat may be carried to pipes of the steam generator containing water. The resulting steam drives a turbine, the turbine in its turn driving an electric generator. So we see that a nuclear power-station is like any other power-station but the familiar coal-burning furnace is replaced by a nuclear one, that is the reactor supplies energy to the turbines. By the way, a ton of uranium (nuclear fuel) can give us as much energy as 2.5 to 3 million tons of coal.

The first industrial nuclear power-station in the world was constructed in Obninsk not far from Moscow in 1954. It is of high capacity and has already been working for many years. One may mention here that the station in question was put into operation two years earlier than the British one and three and a half years earlier than the American nuclear power-stations.

A number of nuclear power-stations have been put into operation since 1954. The Beloyarskaya nuclear power-station named after academician Kurchatov may serve as an example of the peaceful use of atomic energy in the USSR.

Soviet scientists and engineers achieved a nuclear superheating of steam directly in the reactor itself before steam is carried into the turbine. It is certainly an important contribution to nuclear engineering achieved for the first time in the world.

We might mention here another important achievement, that is, the first nuclear installation where thermal energy generated in the reactor is transformed directly into electrical energy.

Speaking of the peaceful use of atomic energy it is also necessary to mention our nuclear ice-breakers. "Lenin" is the world's first ice-breaker with a nuclear installation. Its machine installation is of a steam turbine type, the steam being produced by three reactors and six steam generators. This ice-breaker was followed by many others.

The importance of atomic energy will grow still more when fast neutron reactors are used on a large scale. These reactors can produce much more secondary nuclear fuel than the fuel they consume.

Exercises

I. Translate the following sentences paying attention to the Participle.

1. Working at his new device, the inventor made numerous experiments. 2. We have been speaking about the peaceful use of atomic energy. 3. In future the nuclear reactor must be one of the most reliable "furnaces" producing atomic energy. 4. Atomic energy being developed in a reactor in the form of heat, we can get both heat and electrical energy. 5. The construction of power-stations operating on atomic fuel and generating electric current is quite necessary. 6. Being a source of heat and electri-

cal energy, atomic energy can also serve us in medicine. 7. The energy sources of the world decreasing, it is necessary to turn to atomic energy. 8. Water falling from its raised position changes potential energy into kinetic energy.

II. Form one sentence of each pair using the Absolute Participle Construction.

1. Atoms split in the reactor. Heat is developed. 2. There are many different sources of energy. Coal is the most important of them. 3. Atomic energy replaces the present sources of energy. We shall get more energy in the future. 4. The reactor produces energy in the form of heat. Heat is developed owing to the splitting of atoms in the reactor. 5. A nuclear power-station is like any other power-station. The coal burning furnace is replaced by a nuclear reactor.

III. Arrange the words given in (a) and (b) in pairs of antonyms.

a) 1. possible; 2. useful; 3. to construct; 4. present; 5. largest; 6. unlimited; 7. to increase; 8. to lose

b) 1. past; 2. impossible; 3. to find; 4. useless; 5. limited; 6. smallest; 7. to destroy; 8. to decrease

IV. Fill in the blanks with prepositions.

1. Electricity plays an important part ... everyday life. 2. It is difficult to imagine now how people could do ... electricity. 3. As my friend lives near the institute he usually goes there ... foot. 4. I often go ... bed late ... night. 5. One form ... energy can be changed ... another form. 6. Only a little part . .. solar energy is used directly ... present. 7. Soviet scientists made a great contribution ... nuclear engineering.

V. Put all possible questions to the following sentences.

1. Useful energy can be got from a nuclear reactor. 2. The first nuclear power-station was constructed in the USSR.

VI. Translate the following sentences paying attention to the words in bold type.

1. Modern civilization **needs** more and more electricity. 2. You **needn't** go to the laboratory today. 3. The energy **needs** in industry are increasing day by day. 4. There is no **need** to use kerosine lamps today. 5. What do we **need** electric energy for? 6. Cold **turns** water into ice. 7. The

sun, **in its turn, turns** ice into water. 8. The turbines **are turned** by steam, gas and water. 9. **In their turn,** turbines **turn** generators. 10. The teacher says, "It is your **turn** to read." 11. When you enter a dark room, **turn** the light **on,** and leaving it **turn** the light **off.** 12. It is possible to **turn** solar energy **into** electric energy owing to semiconductors.

VII. Define the following words according to the model given below.

Model: The motor is a device transforming electric energy into mechanical energy.

energy, battery, kinetic energy, nuclear reactor, potential energy

VIII. Ask your groupmate the following questions. Let him/her answer them.

1. if it is possible to see a single drop of water in the sea. 2. if the steam generator of a nuclear reactor contains water. 3. if man has learned to split atoms. 4. if atomic energy finds any new application in industry. 5. if the Soviet Union constructed the first nuclear power plant in the world.

IX. Answer the following questions.

1. What is the difference between potential energy and kinetic energy? 2. What sources of energy do you know? 3. What form of energy can be changed into another form? 4. What are the industrial uses of electricity? 5. Can you name the device which changes chemical energy into electrical energy? 6. What is the difference between a battery and a generator? 7. What may coal be replaced by in future? 8. When was the first industrial nuclear power-station put into operation? 9. What contribution to nuclear engineering did Soviet scientists make? 10. What electrical devices do you use at home? 11. What forms of energy do you know? 12. What is the world's first nuclear icebreaker?

X. Speak on:

1. The operation of a nuclear reactor. 2. The first industrial nuclear power-station. 3. The peaceful uses of atomic energy.

XI. Retell Text 3.

XII. Read Text 3A in 3 minutes and find the English equivalent to the following Russian sentence.

Элементы, которые были синтезированы, получили названия в честь ученых, чья работа имела важное значение в ядерной науке.

TEXT 3A. KURCHATOVIUM AND SOME OTHER NEW ELEMENTS

As early as in 1940, physicists learned to manufacture elements with atoms more complicated than those of uranium, with its atomic number 92. By 1960 ten of these elements, from 93 to 102 had been formed. One way of forming them was to bombard at atoms of elements already produced with small atomic nuclei.

Previous elements that had been synthesized had been named after scientists whose work had significance in nuclear science. Element 99 is einsteinium named after Einstein, who was the first to show that mass could be converted to energy; 101 is mendelevium named after Mendelyeev, who first developed the periodic table of elements.

In 1965 a group of Soviet scientists bombarded plutonium (94) with nuclei of neon (10) and obtained 104, which they named kurchatovium after Kurchatov, a well-known Soviet nuclear physicist.

Scientists in Dubna synthesized a new element which occupies position 106 in Mendelyeev's Table.

This element had a life of about a hundredth of a second, but that was much longer than had been expected.

The synthesis of the element increased our knowledge about the properties of the heaviest nuclei and pointed the way to new methods of obtaining them.

XIII. Point out the paragraph which expresses the main idea of Text 3A.

XIV. Rearrange the sentences to make a summary of the text.

1. The synthesis of the elements pointed out the way of obtaining new elements. 2. Physicists learned to manufacture elements with complicated atoms. 3. Soviet scientists in Dubna bombarded plutonium and obtained 104 which they named kurchatovium after Kurchatov, a well-known Soviet nuclear physicist. 4. Several synthesized elements had been named after outstanding scientists.

UNIT FOUR

Grammar: The Gerund

	Indefinite	Perfect
	simultaneousness	priority
Active	writing	having written
Passive	being written	having been written

Class Exercises

I. Translate the following sentences paying attention to the Gerund.

1. Learning English is not an easy thing. 2. His friend began learning the English language. 3. Studying natural phenomena without making observations is useless. 4. There are many methods of solving this problem. 5. On coming home my father began watching television. 6. Russian scientists played an important part in solving the problem of atmospheric electricity. 7. On splitting atoms in the reactor heat is developed. 8. Seeing is believing.

II. Learn to recognize the following international words.

atmospheric, Scandinavians, laboratory, electricity, experiment, kilometer, conductor, problem, professor, fact

III. Do Laboratory Work 4.

TEXT 4. LIGHTNING

The lightning flash is certainly the earliest manifestation of electricity known to man, although for a long time nobody knew that lightning and atmospheric electricity are one and the same thing. Indeed, for thousands of years people knew nothing about thunderstorms. However, they saw long sparks falling from the dark sky and heard thunder. They knew that these sparks could kill people or

strike their houses and destroy them. Trying to understand that dangerous phenomenon, they imagined things and invented numerous stories.

Take the early Scandinavians as an example! They thought that thunderstorms were produced by Thor, the god of thunder. Besides his throwing both thunder and lightning at some people, he was a hammer-thrower. According to the story, his powerful hammer had the property of always coming back to his hands after it had been thrown. The fifth day of the week, that is Thursday, was named after him. A story like that invented by those early Scandinavians could be also heard from other peoples.

However, time flies. Thunderstorms have long stopped being a problem that scientists tried to solve. Now everybody knows that lightning is a very great flash of light resulting from a discharge of atmospheric electricity either between a charged cloud and the earth or between charged clouds.

Even now some people do not like being out during a thunderstorm. Dark clouds cover the sky, turning day into night. There are lightning flashes followed by thunder which can be heard for kilometres around. Needless to say, there is always some danger in a thunderstorm for a very high building or a man standing in the open field.

Many years ago people learned to protect their houses from thunderstorms. Coming down from a charged cloud to the earth, lightning usually strikes the nearest conductor. Therefore, it is necessary to provide an easy path along which electrons are conducted to the earth. That Benjamin Franklin invented the lightning conductor is a well-known fact. The lightning conductor, familiar to everybody at present, is a metal device protecting buildings from strokes of lightning by conducting the electrical charges to the earth.

Franklin's achievements in the field of electricity were known to Lomonosov who, in his turn, made experiments of his own. Along with other scientific problems that Lomonosov studied was that of atmospheric electricity. Both Lomonosov and his friend Professor Rihman took great interest in it. Both of them tried to solve the problem in question. They made numerous experiments and observations without thinking of the possible danger. The first electrical measuring device in the world was constructed by Rihman. Making experiments of that kind was dangerous

and Professor Rihman was killed by a stroke of lightning while he was making one of his experiments.

As for Franklin's well-known kite experiment, you will read about it in the following lesson.

Exercises

I. Complete the following sentences using the Gerund according to the model given below.

M o d e l: When will you finish (to read) . . .? → When will you finish reading this English book?

1. Do you like (to go) . . .? 2. My friend never thought of (to become) . . . . 3. This is the device for (to turn) . . . . 4. Excuse me for (to be late) . . . . 5. Why are you translating a scientific article without (to read) . . .? 6. We went to the cinema instead of (to watch) . . . . 7. An electric lamp is used for (to light) . . . . 8. We began (to translate) the article after (to read) . . . .

II. Translate the following sentences using the Gerund.

1. Использование новых материалов способствует дальнейшему техническому прогрессу. 2. При объяснении физического явления преподаватель сделал несколько опытов. 3. Увеличение производства энергии необходимо. 4. Изобретатель был против изменения конструкции этого устройства. 5. Увидев прибор в действии, студенты решили, что он надежен. 6. Мы закончили обсуждать эту проблему к концу недели.

III. Put questions to the words in bold type.

1. For thousands of years **people** knew nothing about **thunderstorms.** 2. The fifth day of the week was **named after Thor.** 3. **Lightning** is a discharge of atmospheric electricity. 4. **The lightning conductor** provides an easy **path** for conducting electric charges to the earth. 5. **Rihman** constructed the first electrical measuring device. 6. **Experiments** on atmospheric electricity were made by **Lomonosov.** 7. Many years ago **people** learned to protect their houses from **thunderstorms.** 8. We use atomic energy for **peaceful** purposes.

IV. Translate the following sentences paying attention to the words in bold type.

a) 1. My friend's son looks **like** his father. 2. You may take any device you **like.** 3. Some liquids have **like** properties. 4. Steel **like** iron is widely used in industry. 5. A steam turbine is **like** any other turbine but it is turned by steam. 6. We did not **like** the film that we saw yesterday. 7. Did you **like** the story that you heard at the lesson yesterday?

b) 1. Lightning is an atmospheric phenomenon **that** greatly interested some scientists of the past. 2. **That** the Earth revolves about the Sun is known to everybody. 3. It is quite possible **that** in future coal may be replaced by nuclear fuel. 4. Atomic energy can serve people but we must never forget **that that** energy can also destroy the world. 5. When an object loses its potential energy **that** energy is turned into kinetic energy. 6. The operation of the motor is quite different from **that** of the generator. 7. Everybody knows **that** the Earth is round. 8. The climate in Moscow is better than **that** in London. 9. The film **that** we saw yesterday was very interesting.

V. Answer the following questions.

1. What is the earliest manifestation of electricity? 2. Are lightning and atmospheric electricity one and the same thing? 3. What did the early Scandinavians think about thunderstorms? 4. What is lightning? 5. Do you like to be out during a thunderstorm? 6. Is it dangerous to be in the open field during a thunderstorm? 7. Do people protect their houses from thunderstorms? 8. What does lightning usually strike? 9. Who invented the lightning conductor? 10. Who constructed the first electrical measuring device in the world?

VI. Put 5 questions to Text 4 beginning with the word **what.**

VII. Speak on the story told by the early Scandinavians.

VIII. Read Text 4A in 3 minutes and give a heading to each paragraph.

TEXT 4A. IS LIGHTNING GOOD OR BAD?

The intensity of lightning is tremendous. When we hear noises on our radio, we conclude that a storm is occurring somewhere in the country. It is not really the case. Similar disturbances have been heard on radio in New York, San Francisco, and elsewhere. It has been proved, moreover, that a powerful flash of lightning in the jungle of India

or over the South States suffices to produce disturbances on every radio throughout the world.

Lightning performs some very useful services for mankind. Every stroke of lightning produces some quantity of nitric acid from the nitrogen, hydrogen, and oxygen of the air. About 100,000 tons of nitric acid are produced in this way each year. It is more than man can produce nitrogen by the artificial process.

IX. Point out which of the sentences contains the information from Text 4A.

1. Coming down from a charged cloud to the earth, lightning usually strikes the nearest conductor. 2. Strokes of lightning can destroy buildings, that's why lightning conductors are used to protect them. 3. Strokes of lightning can produce disturbances on radio and at the same time they can do some useful things.

UNIT FIVE

Grammar: The Gerundial Construction

1. Lomonosov's having studied atmospheric electricity contributed to the development of science.— То, что Ломоносов изучал атмосферное электричество, способствовало развитию науки.
2. Everybody insisted on this experiment being made once more.— Все настаивали на том, чтобы этот эксперимент был проделан еще раз.

Class Exercises

I. Find the sentences with a) the Gerundial Construction; b) Gerund with different functions. Translate them into Russian.

1. The thunder is caused by heating the air by a spark. 2. A lightning conductor is a means of protecting buildings from strokes of lightning. 3. We know of this house being destroyed by a stroke of lightning. 4. After having studied the phenomenon of atmospheric electricity, Franklin invented the lightning conductor. 5. Franklin's having worked in the field of electricity is known the world over. 6. Before making experiments Franklin made numerous observations. 7. Protecting buildings from strokes of lightning

was impossible before Franklin's time. 8. A lightning conductor is capable of protecting buildings from strokes of lightning.

II. Learn to recognize the following international words.

milliard, secret, atom, to circulate, station, thermal, problem, electron, conductor, professor, experiment, atmospheric, method, academician, interval, condenser

III. Do Laboratory Work 5.

TEXT 5. ATMOSPHERIC ELECTRICITY

Electricity plays such an important part in modern life that in order to get it, men have been burning millions of tons of coal. Coal is burned instead of its being mainly used as a source of valuable chemical substances which it contains. Therefore, finding new sources of electric energy is a most important problem that scientists and engineers try to solve. In this connection one might ask: "Is it possible to develop methods of harnessing lightning?" In other words, could atmospheric electricity be transformed into useful energy?

Indeed, hundreds of millions of volts are required for a lightning spark about one and a half kilometre long. However, this does not represent very much energy because of the intervals between single thunderstorms. As for the power spent in producing lightning flashes all over the world, it is only about 1/10,000 of the power got by mankind from the sun, both in the form of light and that of heat. Thus, the source in question may interest only the scientists of the future.

It has already been mentioned that atmospheric electricity is the earliest manifestation of electricity known to man. However, nobody understood that phenomenon and its properties until Benjamin Franklin made his kite experiment. On studying the Leyden jar (for long years the only known condenser), Franklin began thinking that lightning was a strong spark of electricity. He began experimenting in order to draw electricity from the clouds to the earth. The story about his famous kite is known all over the world.

On a stormy day Franklin and his son went into the country taking with them some necessary things such as: a kite with a long string, a key and so on. The key was

connected to the lower end of the string. "If lightning is the same as electricity," Franklin thought, "then some of its sparks must come down the kite string to the key." Soon the kite was flying high among the clouds where lightning flashed. However, the kite having been raised, some time passed before there was any proof of its being electrified. Then the rain fell and wetted the string. The wet string conducted the electricity from the clouds down the string to the key. Franklin and his son both saw electric sparks which grew bigger and stronger. Thus, it was proved that lightning is a discharge of electricity like that got from the batteries of Leyden jars.

Trying to develop a method of protecting buildings during thunderstorms, Franklin continued studying that problem and invented the lightning conductor. He wrote necessary instructions for the installation of his invention, the principle of his lightning conductor being in use until now. Thus, protecting buildings from strokes of lightning was the first discovery in the field of electricity employed for the good of mankind.

Exercises

I. Translate the following sentences paying attention to the Gerundial Construction:

1. We didn't know about his being sent to the power-station. 2. I remember my having told her about the experiment. 3. His having asked such a question shows that he did not prepare the text. 4. We know of different experiments being made in this laboratory. 5. Your having been sent to Leningrad was known to everybody. 6. Everybody knows about your having worked at the nuclear power plant. 7. The professor knew about the students' going to the power-station. 8. The students read about the new achievements having been made in the field of nuclear physics. 9. Thanks to the lightning conductor having being invented, it is possible to protect buildings from strokes of lightning.

II. Complete the following sentences using the Gerund.

M o d e l: She cannot read English without... . → She cannot read English without consulting a dictionary.

1. My friend went home instead of... . 2. The students went on... . 3. When the teacher entered the classroom

the students stopped... . 4. Have you finished...? 5. I went to bed after... . 6. The friends spoke of... . 7. You must turn the light off before... .

III. Translate the following sentences using the Gerund.

1. Прежде чем делать опыты, необходимо проводить наблюдения. 2. Много лет назад люди научились защищать свои дома от ударов молнии. 3. Существуют различные способы получения электрического тока. 4. Ученые продолжали изучать новое явление. 5. Пирометр используется для измерения температуры горячих металлов. 6. Франклин изобрел громоотвод для защиты зданий от ударов молнии. 7. Ходить пешком очень полезно. 8. Атомный реактор используется для получения энергии.

IV. Find the Gerund in the text and define its function.

V. Fill in the blanks with suitable verbs, if necessary. Answer the following questions.

1. What ... the earliest manifestation of electricity? 2. What ... electricity? 3. What ... the early Scandinavians think about thunderstorms? 4. Who ... burning millions of tons of coal? 5. What property ... Thor's hammer possess? 6. Who ... invented the lightning conductor? 7. What experiments ... Lomonosov and Rihman make? 8. What device ... constructed by Rihman? 9. Who ... constructed the first measuring device?

VI. Put questions to the words in bold type.

1. Benjamin Franklin made **his kite experiment.** 2. **Nobody** understood that phenomenon. 3. **The story** of his kite is known all over the world. 4. **On a stormy day** Franklin and his son went **into the country.** 5. **The key** was connected to the lower end of the string. 6. Soon **the kite** was flying high **among the clouds.** 7. The electric sparks proved **that lightning is a discharge of electricity.** 8. The **wet** string conducted the electricity. 9. **Franklin** invented the lightning conductor.

VII. For the words given in (a) find the Russian equivalents in (b).

a) 1. to connect; 2. scientific; 3. because of; 4. charge; 5. power; 6. to destroy; 7. to protect; 8. phenomenon; 9. to name after; 10. to develop; 11. observation; 12. discovery; 13. property; 14. to electrify; 15. substance; 16. to solve a problem

b) 1. называть в честь; 2. вещество; 3. защищать; 4. свойство; 5. научный; 6. наблюдение; 7. решать проблему; 8. из-за; 9. открытие; 10. соединять; 11. сила, энергия; 12. заряд; 13. явление; 14. разрушать; 15. разрабатывать; 16. электризовать

VIII. Translate the following sentences paying attention to **both, both . . . and.**

1. The students made two experiments; they were **both** interesting **and** useful. 2. **Both** scientists studied atmospheric electricity. 3. **Both** of us will work in the institute laboratory tomorrow. 4. **Both** Lomonosov **and** Rihman were great scientists; **both** of them studied atmospheric electricity. 5. **Both** these devices were constructed in Moscow. 6. Electricity is used **both** in industry **and** in everyday life. 7. **Both** nuclear power **and** solar energy will be widely used in future. 8. The terms "lightning" and "atmospheric electricity" mean one and the same thing; **both** of them are used in literature. 9. Many scientists and inventors, **both** Russian **and** foreign, have greatly contributed to the development and practical application of the electric current. 10. **Both** chemical energy **and** mechanical energy can be transformed into electricity.

IX. Fill in the blanks with prepositions.

1. It is dangerous to go ... ... a stormy day. 2. Lightning is a very great flash ... light resulting ... a discharge ... atmospheric electricity. 3. Protecting buildings ... lightning was the first discovery ... the field ... electricity used ... the good ... mankind. 4. ... thousands ... years people knew nothing ... thunderstorms. 5. Lightning flashes are followed ... thunder which can be heard ... kilometres around. 6. There is always some danger ... a thunderstorm ... a very high building or a man standing ... the open field. 7. It is difficult to see a single drop ... water ... the sea. 8. Some scientists ... the past melted metals ... the help ... solar furnaces. 9. Modern civilization cannot do ... electrical appliances. 10. Electric current is necessary ... the operation ... trolley-buses, buses, and modern trains.

X. Translate into Russian.

a) the only son; the only example known; the only method of solving the problem; only you can do it for me;

coal is not only a source of heat, but also a source of valuable chemical substances; the letter was sent only yesterday

b) many students were present; at the present time; the present article; he is in Moscow at present; that is all for the present; good-bye for the present

XI. Form five sentences combining suitable parts of the sentences given in columns I and II.

I	II
1. The generator	1. measures the temperature of hot melted metals.
2. The lightning conductor	2. lifts objects weighing thousands of tons.
3. The motor	3. turns electrical energy into mechanical energy.
4. The electric crane	4. protects buildings from lightning strokes.
5. The pyrometer	5. converts mechanical energy into electrical energy

XII. Describe Franklin's kite experiment.

XIII. Give a short summary of the text.

UNIT SIX

Grammar: The Gerund. The Participle (Revision)

Class Exercises

I. Translate the following sentences and define the non-finite forms of the verb.

1. The students went on studying the properties of that new substance. 2. A long time ago people noticed the attracting ability of the magnet. 3. We heard of that experiment having been made last week. 4. The pole of the magnet pointing to the North is called the north pole of the magnet, the south pole pointing to the South. 5. There are different ways of producing electric current. 6. The magnet having the north pole and the south pole, we can use it in the compass. 7. Working at his new device, the inventor carried out an important research. 8. We know of his start-

ing some laboratory experiments. 9. An iron bar placed in the field of a magnet becomes magnetized.

II. Define what parts of speech these words are.

application, ability, continuous, use, important, numerous, civilization, electric, familiar, reader, widely, useful, powerful, property, certainly

III. Learn to recognize the following international words.

to transform, volt, kilometer, form, process, magnet, magnetism, to demonstrate, compass, astronomer, molecule, to neutralize, material

IV. Do Laboratory Work 6.

TEXT 6. MAGNETISM

In studying the electric current, we observe the following relation between magnetism and the electric current: on the one hand magnetism is produced by the current and on the other hand the current is produced from magnetism.

Magnetism is mentioned in the oldest writings of man. Romans, for example, knew that an object looking like a small dark stone had the property of attracting iron. However, nobody knew who discovered magnetism or where and when the discovery was made. Of course, people could not help repeating the stories that they had heard from their fathers who, in their turn, heard them from their own fathers and so on.

One story tells us of a man called Magnus whose iron staff was pulled to a stone and held there. He had great difficulty in pulling his staff away. Magnus carried the stone away with him in order to demonstrate its attracting ability among his friends. This unfamiliar substance was called Magnus after its discoverer, this name having come down to us as "Magnet".

According to another story, a great mountain by the sea possessed so much magnetism that all passing ships were destroyed because all their iron parts fell out. They were pulled out because of the magnetic force of that mountain.

The earliest practical application of magnetism was connected with the use of a simple compass consisting of one small magnet pointing north and south.

A great step forward in the scientific study of magnetism was made by Gilbert, the well-known English phys-

icist (1540-1603). He carried out various important experiments on electricity and magnetism and wrote a book where he put together all that was known about magnetism. He proved that the earth itself was a great magnet.

Reference must be made here to Galileo, the famous Italian astronomer, physicist and mathematician. He took great interest in Gilbert's achievements and also studied the properties of magnetic materials. He experimented with them trying to increase their attracting power. One of his magnets, for example, could lift objects weighing 25 times its own weight.

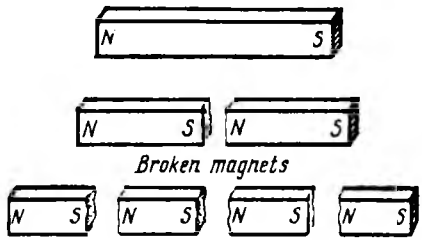

Fig. 1. How a magnet is affected by being divided

At present, even a schoolboy is quite familiar with the fact that in magnetic materials, such as iron and steel, the molecules themselves are minute magnets, each of them having a north pole and a south pole. When iron and steel are magnetized, the molecules arrange themselves in a new orderly way instead of the disarrangement in which they neutralize each other.

Dividing a bar magnet into two parts, one finds that each of the two parts is a magnet having both a north pole and a south pole. Thus, we obtain two magnets of a smaller size instead of having a single one of a larger size. Dividing one of these two smaller magnets into two will give us the same result. Thus, we could continue this process, always getting similar results (see Fig. 1).

On placing an unmagnetized iron bar near a strong magnet, we magnetize it. Rubbing the magnet is not required for that process. In other words, our iron bar has been magnetized by the strong magnet without rubbing it.

Exercises

I. Find the sentences with non-finite forms expressing a) simultaneousness of action; b) priority of action. Translate them into Russian.

1. Protecting buildings from strokes of lightning was a great achievement in the field of electricity. 2. Speaking of the magnet, the inventor made reference to its property

of attracting iron and steel. 3. Experiments showing the changes in substances are very important for industry. 4. The teacher objects to our translating such an easy text with a dictionary. 5. Soviet people constructed many hydroelectric stations, the one on the Angara being one of the largest. 6. In studying magnetism, we cannot help observing the relation between magnetism and the electric current. 7. Having invented the lightning conductor, Franklin continued working at the problem of atmospheric electricity. 8. The experiments having been made, we could discuss the results. 9. The atoms of different substances have different weights, their properties being also different. 10. Having experimented with electricity and magnetism, Gilbert wrote a book on magnetism. 11. Gilbert greatly contributed to the study of magnetism, Galileo taking great interest in Gilbert's achievements.

II. Translate the following sentences using either the Gerund or the Participle and define their functions.

1. Расщепляя атомы, человек может получить большое количество энергии. 2. Существуют различные виды электростанций, причем тепловые находят широкое применение в нашей стране. 3. Помещая железный предмет в поле магнита, мы намагничиваем его. 4. Работая в области электричества, ученые внесли большой вклад в науку. 5. Мы знаем о том, что Галилей создал первый в мире телескоп.

III. Form sentences with each of the following words.

similar, simple, single; some, the same

IV. Use the following expressions in sentences of your own.

all over the world, as well as, in this connection, in the form of, needless to say, to pay attention to, on the other hand

V. Translate the following questions and answer them.

1. Существует ли связь между электричеством и магнетизмом? 2. Знаете ли вы, кто открыл магнетизм? 3. Что вы знаете об атмосферном электричестве? 4. Кто доказал, что наша Земля является большим магнитом? 5. Что вы знаете о магнетизме? 6. Каковы свойства магнита? 7. Кто интересовался достижениями Гильберта? 8. Какие опыты проводил Франклин? 9. Какие магнитные

материалы вы знаете? 10. Какие свойства материалов изучал Галилей?

VI. Translate the following sentences paying attention to the words in bold type.

1. These electrical devices are very large. Who can **help** me **to carry** them to another laboratory? 2. After the experiment had been **carried out** the students **carried** the devices **away**. 3. What were the students **doing** when the teacher came into the classroom? They were **doing** exercises. 4. Why can't you **do without** the thermometer? The temperature of this metal is known. 5. He could not **go** to the cinema yesterday. 6. Do not **turn** the light **off**, I shall **go on** working. 7. I see nothing, **turn** the light **on**, please. 8. On heating ice **turns** into water. 9. Water, **in its turn, turns** into ice on freezing. 10. Let us **turn our attention** to the history of electricity. 11. Water **turns** the turbines at the hydropower station.

VII. Rearrange the sentences to make up a story of Franklin's kite experiment.

1. The key was connected to the lower end of the string. 2. The story about Franklin's famous kite is known all over the world. 3. They took some necessary things such as: a kite with a long string, a key, and so on. 4. It was proved that lightning is a discharge of electricity. 5. It was a stormy day. 6. The electricity was conducted from the clouds down the string to the key. 7. The kite was flying high among the clouds. 8. The rain wetted the string. 9. Atmospheric electricity greatly interested Franklin. 10. The rain fell.

VIII. Compare:

1. A generator and a motor. 2. Potential energy and kinetic energy. 3. Chemical energy and mechanical energy. 4. A nuclear power-station and a steam power-station.

IX. Speak on magnetism.

X. Read Text 6A in 2 minutes and answer the question "What changes take place in magnetized water?"

TEXT 6A. MAGNETIZED WATER

Soviet physicists have discovered that treatment of oversaturated water solutions with a magnetic field changes the process of crystal formation. It was also noted that upon

being withdrawn from the magnetic field, water retains its newly acquired qualities for a few days. The water "remembers" the magnetic field.

Under the influence of a magnetic field water changes its basic physical and chemical properties namely density, surface tension and electric conductivity. Salt solubility changes to an especially remarkable extent. These new properties were used for practical purposes. For instance, magnetized water forms almost no scales on boiler walls.

What is behind this interesting and unusual effect of magnetized water on living and non-living matter? Soviet scientists explain this by a change in the geometrical structure of molecules under the influence of magnetic fields. The magnetic field orientates and rearranges the molecules of water, thus causing changes in its physico-chemical properties.

XI. Point out which of these sentences contains the information from Text 6A.

1. In magnetic materials the molecules themselves are minute magnets. 2. Many physicists experimented with magnetism trying to find practical application of this interesting phenomenon. 3. The new properties of magnetized water were used for practical purposes.

UNIT SEVEN

Idioms. Set Expressions

Class Exercises

I. For the word combinations given in (a) find the English equivalents in (b).

a) 1. пока что; 2. несмотря на; 3. на самом деле; 4. благодаря; 5. то есть; 6. между прочим; 7. в результате; 8. по крайней мере; 9. вместо; 10. более или менее; 11. в свою очередь; 12. рассматриваемый

b) 1. at least; 2. as a matter of fact; 3. that is to say; 4. in one's turn; 5. in question; 6. so far; 7. instead of; 8. more or less; 9. in spite of; 10. thanks to; 11. as a result; 12. by the way

II. Learn to recognize the following international words.

strange, history, to start, effect, shock, period, philosopher, object, systematic

III. Do Laboratory Work 7.

TEXT 7. EARLY HISTORY OF ELECTRICITY

Let us now turn our attention to the early facts, that is to say, let us see how it all started.

History shows us that at least 2,500 years ago, or so, the Greeks were already familiar with the strange force (as it seemed to them) which is known today as electricity. Generally speaking, three phenomena made up all of man's knowledge of electrical effects. The first phenomenon under consideration was the familiar lightning flash —a dangerous power, as it seemed to him, which could both kill people and burn or destroy their houses. The second manifestation of electricity he was more or less familiar with was the following: he sometimes found in the earth a strange yellow stone which looked like glass. On being rubbed, that strange yellow stone, that is to say amber, obtained the ability of attracting light objects of a small size. The third phenomenon was connected with the so-called electric fish which possessed the property of giving more or less strong electric shocks which could be obtained by a person coming into contact with the electric fish.

Nobody knew that the above phenomena were due to electricity. People could neither understand their observations nor find any practical applications for them.

As a matter of fact, all of man's knowledge in the field of electricity has been obtained during the last 370 years, or so. Needless to say, it took a long time before scientists learned how to make use of electricity. In effect, most of the electrically operated devices, such as the electric lamp, the refrigerator, the tram, the lift, the radio, and so on, are less than one hundred years old. In spite of their having been employed for such a short period of time, they play a most important part in man's everyday life all over the world. In fact, we cannot do without them at present.

So far, we have not named the scientists who contributed to the scientific research on electricity as centuries passed. However, famous names are connected with its history and among them we find that of Phales, the Greek

philosopher. As early as about 600 B. C. (that is, before our era) he discovered that when amber was rubbed, it attracted and held minute light objects. However, he could not know that amber was charged with electricity owing to the process of rubbing. Then Gilbert, the English physicist, began the first systematic scientific research on electrical phenomena. He discovered that various other substances possessed the property similar to that of amber or, in other words, they generated electricity when they were rubbed. He gave the name "electricity" to the phenomenon he was studying. He got this word from the Greek "electrum" meaning "amber".

Many learned men of Europe began to use the new word "electricity" in their conversation as they were engaged in research of their own. Scientists of Russia, France and Italy made their contribution as well as the Englishmen and the Germans,

Exercises

I. Fill in the blanks with the following words and expressions.

in the form of, because, because of, to be interested in, to put into operation, as for, to be named after, in question, to turn one's attention to

1. The discovery ... was made by a well-known Soviet scientist. 2. Moscow University ... Lomonosov. 3. Franklin ... making experiments with atmospheric electricity. 4. ... the electric current, it is used both in industry and in our homes. 5. The first atomic power plant in the world ... in the USSR in June 1954. 6. Professor Rihman was killed by a stroke of lightning ... he did not think of possible danger. 7. Atom finds a wide application ... its ability of producing heat and energy. 8. The scientists of the Soviet Union ... the use of nuclear power for peaceful purposes.

II. 1) For the names of the countries given in (a) find the names of the nations given in (b).

a) 1. England; 2. France; 3. Russia; 4. Greece; 5. Italy; 6. Germany; 7. America

b) 1. The Italians; 2. The Greeks; 3. The Russians; 4. The Englishmen; 5. The Frenchmen; 6. The Germans; 7. The Americans

2) What do you call the people who live in: Germany, Russia, England, France, Italy, Greece, America?

III. Give short answers to the following questions.

1. Is magnetism and electricity one and the same thing? 2. Do magnets possess the property of attracting iron? 3. Do you know who discovered magnetism? 4. Was the phenomenon of electricity known to people in the past? 5. Did Gilbert work in the field of electricity? 6. Do you carry out experiments on lightning? 7. Is lightning a strong spark of electricity? 8. Can atomic energy be used for the good of mankind? 9. Do you know the history of electricity? 10. Was Phales a German philosopher? 11. Did you study the history of electricity? 12. Have you ever come into contact with an electric fish? 13. Can you do without electricity?

IV. Define the following terms.

lightning, lightning conductor, magnetism, refrigerator, generator, motor, turbine

V. Speak on:

1. Three electrical phenomena known to the people of the past. 2. Everyday use of electricity.

VI. Give a short summary of the text.

UNIT EIGHT

Grammar: The Participle. The Gerund
Set Expressions

Class Exercises

I. Translate the following sentences paying attention to the non-finite forms of the verb.

1. For heating a body, we place it in contact with another body at a higher temperature. 2. There are two diagrams in this figure, one of them showing the temperature difference. 3. Comparing the data obtained by our tests is the only means of solving the problem in question. 4. The instrument for measuring the temperature of hot flowing metals is similar to that widely used in our laboratory. 5. The engineers carried out the experiment, looking at the scale of the thermometer from time to time. 6. Thermome-

ters are employed for measuring temperature differences. 7. On the Centigrade scale the freezing point of water is marked 0°C, the boiling point being marked 100°C. 8. On being rubbed amber obtains the ability of attracting objects.

II. Give all the meanings of the following English words consulting a dictionary.

application, modern, general, familiar, standard, reason, to construct, natural

III. Do Laboratory Work 8.

TEXT 8. HISTORY OF THERMOMETERS

Placing a kettle full of cold water on the fire is quite an ordinary thing. This time we shall do it to carry out a simple experiment. Placing a finger into the kettle from time to time, we find that the water is gradually becoming hotter and hotter, until it boils at last. In scientific language we describe this phenomenon by saying that the temperature of the water is rising.

However, we need some more exact means of measuring the difference of temperature than our finger. In effect, the finger can give us neither exact information, nor numerical data.

As a matter of fact, the very first step in the development of heat engineering made it necessary to find a device for indicating temperature and for measuring its changes. As is well known, the thermometer is the very instrument that serves this purpose.

As early as 1602, Galileo invented an air thermometer. It consisted of a glass bulb containing air and connected to a glass tube, the latter being immersed into a coloured liquid. Galileo's air thermometer was sensitive not only to temperature changes but also to changes of atmospheric pressure.

The type of thermometer familiar to everyone at present was first put into general use as early as 1654. Making the first measuring instruments was not an easy thing at all. Needless to say, the most difficult problem of all was that of marking the degrees on the thermometer, in other words, of graduating the scale. It was decided, at last, to take two fixed points and to divide the interval between them into small equal parts or degrees. And then, in 1701, Isaak Newton, the famous English scientist, whose name is

known all over the world, constructed a scale in which the freezing point of water was taken as zero and the temperature of the human body as 12°.

Some time later the German physicist Fahrenheit proved that the temperature of boiling water was always the same at the same atmospheric pressure. It might therefore be used as a second fixed point instead of the temperature of the human body. As for the liquid used, it was mercury which has been mostly employed since that time.

On the Fahrenheit scale the boiling point of water is taken as 212° and the freezing point as 32°, the interval being divided into 180 equal parts. The scale under consideration is indicated by writing the letter F after the temperature, as for example, 212°F. This scale is mainly used in English-speaking countries.

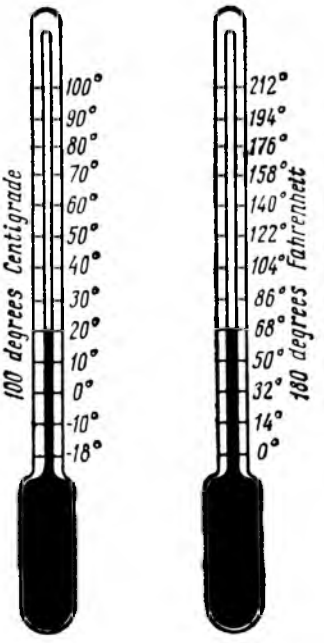

Fig. 2. Comparing the Fahrenheit and the Centigrade scales

So far we have not mentioned the Centigrade scale (see Fig. 2). On the Centigrade scale the freezing point of water is marked 0°C and the boiling point is marked 100°C, the letter C indicating this scale. This temperature scale is employed in the Soviet Union as well as in most other countries of the world.

Speaking of thermometers, one must make reference to the pyrometer. We know of its being used for measuring temperatures that are too high for mercury thermometers. We also know of its finding wide application in industry.

Exercises

I. Fill in the blanks with suitable words and word combinations given below.

1. A thermometer is employed for ... temperature

and for ... its changes. 2. The glass tube was immersed into a ... liquid. 3. As early as 1602 Galileo invented an ... . 4. The ... scale is employed in the Soviet Union. 5. ... looks like a yellow stone. 6. The Fahrenheit scale is mainly used in ... . 7. Galileo's air thermometer was sensitive to ... . 8. The scientists worked out the plan of their ... research.

coloured, Centigrade, amber, measuring, English-speaking countries, air thermometer, indicating, changes of atmospheric pressure, scientific

II. 1) For the verbs in (a) find suitable nouns in (b).

a) 1. to carry out; 2. to put into; 3. to contribute to; 4. to solve; 5. to deliver; 6. to take part in; 7. to go

b) 1. research; 2. a problem; 3. on foot; 4. an experiment; 5. operation; 6. science; 7. a lecture

2) For the nouns in (a) find suitable attributes in (b).

a) 1. famous; 2. boiling; 3. glass; 4. cold; 5. scientific; 6. electrical; 7. mercury

b) 1. water; 2. problem; 3. thermometer; 4. device; 5. bulb; 6. scientist; 7. point

III. 1) Translate the following word combinations.

temperature scale, lightning conductor, freezing point, human body, German-speaking countries, measuring instrument, temperature difference, boiling point, atmospheric pressure, numerical data, mercury thermometer, electrical device

2) Use these word combinations in sentences of your own.

IV. Give synonyms for the following words.

to use, big, learned man, owing to, instrument, various

V. Translate the following sentences paying special attention to the words in bold type.

1. You are **the only** engineer who speaks both English and German. 2. This is **the only** book by Turgenev that I haven't read. 3. All countries should use nuclear power for peaceful purposes **only**. 4. This phenomenon was studied first by Sokolov and **then** by Novikov. 5. Novikov's result was certainly better **than** that of his comrade. 6. Galileo constructed an air thermometer, some years **later** a

French scientist constructed another one, in which water was used instead of air. 7. Both Lomonosov and Rihman studied atmospheric electricity, **the latter** being Lomonosov's friend. 8. There are 26 **letters** in the English language. 9. The last **letter** of the English alphabet is "z". 10. **Some** students work and study at **the same** time. 11. This engineer carried on **some** experiments on the properties of semiconductors.

VI. Find the wrong statements and correct them.

1. We can do without the thermometer when we need exact data on the temperature of the body. 2. The thermometer is the very instrument for protecting buildings from thunderstorms. 3. As early as 1602 Galileo invented the Centigrade scale. 4. An air thermometer consisted of a metal bulb containing mercury and connected to a glass tube. 5. The glass tube in the air thermometer was immersed into water. 6. Water is the very liquid that is used in thermometers. 7. The Fahrenheit scale is widely employed all over the world. 8. Water temperature falls when a kettle is put on the fire. 9. Mercury is not used in thermometers at present.

VII. Answer the following questions.

1. What is this text about? 2. What do you do if you want to boil water? 3. What is the temperature of boiling water? 4. What instrument is used for measuring temperature? 5. What did Galileo invent? 6. What do you know about the air thermometer? 7. What is the difference between the Fahrenheit and the Centigrade scales? 8. What instrument measures the temperature of hot metals? 9. What is the difference between the mercury thermometer and the pyrometer? 10. When does water freeze?

VIII. Retell Text 8.

IX. Read Text 8A in 3 minutes and give a heading to it.

TEXT 8A

All hot bodies emit radiant heat. A radiation pyrometer determines the temperature of the hot body by measuring the radiant heat. The radiation is usually measured with a thermocouple, though it is sometimes better to use a photoelectric cell. A thermopile is an assembly of thermocoup-

les placed close together and connected in series. A thermocouple is simpler and usually cheaper than a radiant pyrometer. Most temperature measurements are therefore made with thermocouples. However certain measurements that are difficult or impossible to make with a thermocouple can be made by radiation methods. The following example shows the type of application for which radiation pyrometers are suitable.

Some measurements are made at temperatures which are too high for thermocouples, or conditions leading to rapid contamination of the element. For example, the roof of a steel melting furnace may reach a temperature of 1700°C in an atmosphere which will destroy any thermocouple in a day or two. Such a temperature is best measured with a radiation pyrometer.

X. Find in Text 8A the definition of the term "thermopile".

XI. Rearrange the sentences to make a summary of Text 8A.

1. A thermocouple is cheaper than a radiant pyrometer. 2. All hot bodies emit radiant heat. 3. A very high temperature is measured with radiant pyrometer. 4. The radiation is usually measured with a thermocouple. 5. Some measurements are made at temperatures which are too high for thermocouples. 6. A radiation pyrometer determines the temperature of the hot body by measuring the radiant heat.

UNIT NINE

Word-building

Class Exercises

I. Translate the following words paying attention to the suffixes and prefixes.

countless, distance, education, scholarship, impossible, to dissatisfy, observation, materialist, physical, unusual, extraordinary, conservation, invaluable, enlightener, possibility, to occupy, sunny, useful, discovery

II. Learn to recognize the following international words.

poet, academy, professor, academician, international, activity, cultural, university, literature, chemistry, materialist, gas

III. Do Laboratory Work 9.

TEXT 9. LOMONOSOV

The great Russian scientist, outstanding poet and enlightener, Lomonosov, was born in the village of Denisovka (now Lomonosovo), far off in the North, on November 19, 1711. He was very young when he easily mastered reading and writing. The boy longed for knowledge, he longed to master science. That longing was so great that at the age of 19 he left his father's home and started on foot for Moscow in spite of the long distance and the cold winter.

He experienced great want and countless hardships during his student years both in Moscow and later on in Germany where he had been sent to complete his education. Studying at the academy, he got only 3 copecks a day, that scholarship being his only means of living.

He mastered natural science as well as history, philosophy and engineering. In addition to the Russian language, he had a good knowledge of foreign languages, namely German, French, Greek and, last but not least, Latin which was the international language of science at that time. At the age of 35 Lomonosov was already an experienced professor and an academician.

It is quite impossible to name a scientific problem he did not turn his attention to. Nevertheless, theory alone left him dissatisfied. He knew by experience that it was useless and unreliable if it did not find practical application and could not, therefore, serve the good of his people and his country. He always tried to find practical application for the phenomena studied.

Lomonosov possessed an unusual capacity for work. His scientific activity lasted but 25 years, but in these 25 years he carried out an extraordinary amount of useful, educational work in various fields of scientific and cultural life. He carried on scientific research in natural science and made numerous reports on the results of his achievements. He lectured to students and translated the works of various foreign scientists into Russian for he wanted to educate "our own Newtons". For this very purpose he founded Moscow University and wrote his odes as well as numerous books on the Russian language and literature, on physics and so on.

For many years the great scientist carried on systematic laboratory-experimental work both in physics and chemist-

ry for, according to him, without observation and experiment there could be no progress in science. In this connection, one might ask: "Do you know that Lomonosov organized the first chemical laboratory in our country?" One more question: "Who built the first glass-making factory in Russia?" It was Lomonosov, of course!

As a materialist, Lomonosov studied physical properties of bodies on the basis of the molecular and atomic theory. He developed the kinetic theory of gases, the molecular kinetic theory of heat and first discovered the law of conservation of matter and momentum. He also found that light, heat and electricity are different forms of motion. As a result, many of his discoveries became invaluable contribution to world science.

From the very first and to the last days of his life he struggled alone for Russian science and the enlightenment of the Russian people.

Exercises

I. Form 10 sentences using the following words.

last—to last; very—the very; heat—to heat; only—the only; want—to want; water—to water; master—to master

II. For the words given in (a) find suitable prefixes in (b).

a) 1. natural; 2. to organize; 3. possible; 4. to satisfy; 5. ordinary; 6. valuable; 7. large; 8. to cover; 9. to write; 10. to charge; 11. usual

b) 1. re; 2. in; 3. im; 4. un; 5. dis; 6. extra; 7. super; 8. en

III. Translate the following sentences paying attention to the words in bold type.

1. I like to read **but** I have very little time for reading. 2. My friend speaks of nothing else **but** his examinations. 3. As for the power spent in producing lightning flashes it is **but** 1/10,000 of the power got by mankind from the sun. 4. The Fahrenheit scale is used in England, **but** it is not used in the Soviet Union. 5. We know that a thermometer is used **for** measuring temperature differences. 6. I was sent **for** the doctor. 7. These students studied English **for** 2 years. 8. Russian scientists and inventors work **for** this country. 9. Our professor left **for** Leningrad **for** he is going to work there **for** 3 weeks. 10. It is necessary **for**

me to be at home at 6 o'clock. 11. The scientist was observing a new phenomenon **for** a long time. 12. We need much electricity **for** it is used both in our homes and in industry.

IV. Translate into Russian.

last but not least; least of all; not in the least; he has not the least idea about it; this is the least he can do; read one page at least

V. Give as many nouns as possible with the following suffixes.

-or, -er, -ist, -ship, -tion, -ment, -ness

VI. For the adjectives given in (a) find suitable nouns in (b).

a) 1. natural; 2. famous; 3. electric; 4. useful; 5. long; 6. cold; 7. foreign; 8. scientific; 9. industrial; 10. molecular; 11. dark; 12. physical

b) 1. way; 2. language; 3. application; 4. property; 5. theory; 6. furnace; 7. sciences; 8. cloud; 9. work; 10. activity; 11. winter; 12. scientist

VII. Form sentences using the nouns qualified by adjectives given in Ex. VI.

M o d e l: Lomonosov studied natural sciences.

VIII. Form nouns from the following verbs.

to enlighten, to know, to educate, to transform, to master, to apply, to achieve, to observe, to generate, to protect, to require, to develop, to experience

IX. Form questions for the following answers.

1. In the village of Denisovka. 2. On November 19, 1711. 3. At the age of 19. 4. Yes, I do. 5. No, he did not. 6. At the age of 35. 7. On the basis of molecular and atomic theory. 8. He discovered the law of conservation of matter and momentum.

X. a) Fill in the blanks with prepositions, if necessary; b) retell the following extract.

Jack London

The great American writer Jack London was born ... the town ... San Francisco ... 1876. The young boy longed ... knowledge, but Jack's father could not send him ... school, as the family was very poor. London began working

when he was quite young. He sold different newspapers ... the streets. ... the age ... fourteen he began to work ... a factory. Then he worked as a fisherman. He had to work many hours ... a day. Nevertheless he experienced great want and countless hardships ... that time. In spite ... his hard work he was very fond ... reading and read very much. He studied ... school and later on ... the university. He took great interest both ... history and ... philosophy. ... 1896 London started ... Alaska ... the yellow metal. He did not live ... the North ... a long time. Soon he came back ... San Francisco and became famous as a writer. He greatly contributed ... the development ... progressive American literature. ... present his name is known all over the world.

XI. Answer the following questions.

1. Was Lomonosov born in Russia? 2. In what year was he born? 3. What did he long for? 4. Why did he leave his father's home? 5. Did he complete his education in America? 6. What subjects did he master? 7. What foreign languages did he know? 8. How long did his activity last? 9. Did Lomonosov deliver lectures to students? 10. For what purpose did he found Moscow University? 11. Who organized the first chemical laboratory in our country? 12. What theories did Lomonosov develop?

XII. Give a heading to each paragraph of Text 9.

XIII. Retell Text 9.

XIV. Read Text 9A in 3 minutes and choose the sentences which contain the information about Kapitsa's activities.

TEXT 9A. PYOTR KAPITSA

P. Kapitsa, an outstanding Soviet physicist, was born in Kronshtadt in the family of a general in 1894. He graduated from the Petrograd Polytechnic Institute in 1919. Kapitsa took great interest in physics while still at the institute.

In 1921 Kapitsa was sent to England on Lenin's instructions to renew scientific contacts. He worked in the famous Cavendish Laboratory headed by Rutherford. Kapitsa was elected a member of the Royal Society for his outstanding scientific work in the production of large magnetic fields.

In the middle of 1930s he organized the Institute of Physical Problems near Moscow. It was here that Kapitsa concentrated his attention on the research of superlow temperatures of liquid helium and superconductivity. He showed that helium conducted heat so well because it flowed with remarkable ease.

After the Great Patriotic War his scientific activity was directed to space research.

In 1950s Kapitsa also turned his attention to ball lightning — a phenomenon in which plasma exists for a much longer period than it was supposed.

Kapitsa was awarded a Nobel Prize for his great contribution to world science in 1978.

Today there are few names in the history of physics that can be placed next to his.

XV. Find in the text English equivalents to the following Russian word combinations.

1. ...сосредоточил свое внимание на исследовании сверхнизких температур; 2. ...возобновить научные контакты; 3. ...плазма существует гораздо более длительный период времени

UNIT TEN

Grammar: The Infinitive

	Indefinite	Continuous	Perfect	Perfect Continuous
	simultaneousness		priority	
Active	to write	to be writing	to have written	to have been writing
Passive	to be written	—	to have been written	—

Class Exercises

I. Choose the sentences with the infinitive expressing a) simultaneousness of action; b) priority of action. Translate them into Russian.

1. We shall translate this article. 2. Do you know this man? 3. They can translate this text without a dictionary. 4. To translate this article is not an easy thing to do. 5. We want to translate this article. 6. I remember to have seen this man last year. 7. To study much is to learn much. 8. To master a language one must work much. 9. The professor to deliver a lecture at our institute is an outstanding scientist. 10. The experiment to be carried on is described in this article. 11. Can this work have been done in such a short time? 12. He must be reading a newspaper in the reading-room. 13. He was glad to have been travelling in Europe.

II. Learn to recognize the following international words.

static, voltage, control, contact, salt, disc, zinc, biography, lecture, civilization, vacuum, practical, crane, pyrometer

III. Do Laboratory Work 10.

TEXT 10. FROM THE HISTORY OF ELECTRICITY

There are two types of electricity, namely, electricity at rest or in a static condition and electricity in motion, that is, the electric current. Both of them are made up of electric charges, static charges being at rest, while electric current flows and does work. Thus, they differ in their ability to serve mankind as well as in their behaviour.

Let us first turn our attention to static electricity. For a long time it was the only electrical phenomenon to be observed by man. As previously mentioned at least 2,500 years ago, or so, the Greeks knew how to get electricity by rubbing substances. However, the electricity to be obtained by rubbing objects cannot be used to light lamps, to boil water, to run electric trains, and so on. It is usually very high in voltage and difficult to control, besides it discharges in no time.

As early as 1753, Franklin made an important contribution to the science of electricity. He was the first to prove that unlike charges are produced due to rubbing dissimilar objects. To show that the charges are unlike and

opposite, he decided to call the charge on the rubber—negative and that on the glass—positive.

In this connection one might remember the Russian academician V. V. Petrov. He was the first to carry on experiments and observations on the electrification of metals by rubbing them one against another. As a result he was the first scientist in the world who solved that problem.

Who does not know that the first man to get the electric current was Volta after whom the unit of electric pressure, the volt, was named? His discovery developed out of Galvani's experiments with the frog. Galvani observed that the legs of a dead frog jumped as a result of an electric charge. He tried his experiment several times and every time he obtained the same result. He thought that electricity was generated within the leg itself.

Volta began to carry on similar experiments and soon found that the electric source was not within the frog's leg but was the result of the contact of both dissimilar metals used during his observations. However, to carry on such experiments was not an easy thing to do. He spent the next few years trying to invent a source of continuous current. To increase the effect obtained with one pair of metals, Volta increased the number of these pairs. Thus the voltaic pile consisted of a copper layer and a layer of zinc placed one above another with a layer of flannel moistened in salt water between them. A wire was connected to the first disc of copper and to the last disc of zinc.

The year 1800 is a date to be remembered: for the first time in the world's history a continuous current was generated.

Volta's Short Biography. Volta was born in Como, Italy, on February 18, 1745. For some years he was a teacher of physics in his home town. Later on he became professor of natural sciences at the University of Pavia. After his famous discovery he travelled in many countries, among them France, Germany and England. He was invited to Paris to deliver lectures on the newly discovered chemical source of continuous current. In 1819 he returned to Como where he spent the rest of his life. Volta died at the age of 82.

Exercises

I. Translate the following sentences paying attention to the Infinitive.

1. This is the device to be used in our experiment. 2. The thermometer is a device to measure the temperature.

3. Where are the articles to be translated by the students? 4. The letter to be answered was given to me. 5. The generator is a device to change mechanical energy into electric energy. 6. The Soviet Union was the first to use atomic energy for peaceful purposes. 7. V. V. Petrov was the first scientist to study the electrification of metals by rubbing them. 8. I was the last to answer the teacher's questions.

II. Form sentences according to the model using the verbs given below.

M o d e l: We can't help + Gerund... Мы не можем не... → We can't help speaking about the achievements of Soviet physicists. Мы не можем не говорить о достижениях советских физиков.

to answer, to repeat, to mention, to observe, to change, to think, to remember

III. For the words given in (a) find the Russian equivalents in (b).

a) 1. instrument; 2. liquid; 3. means; 4. mercury; 5. purpose; 6. difference; 7. law; 8. matter; 9. heat; 10. light; 11. opposite; 12. condition; 13. flow; 14. behaviour; 15. charge

b) 1. разница, разность; 2. вещество; 3. состояние, условие; 4. заряд; 5. поток; 6. жидкость; 7. ртуть; 8. противоположный; 9. закон; 10. средство; 11. тепло; 12. цель; 13. поведение; 14. прибор; 15. свет

IV. Translate the following sentences paying attention to the words in bold type.

1. The students carried out an experiment looking at the thermometer **from time to time.** 2. The cinema was invented before my **time.** 3. It is **high time** to begin work. 4. Four **times** three is twelve. 5. "Am I late?" — "No, you are just **in time.**" 6. "What is the **time**?" — "It's dinner **time.**" 7. The students went to the club and **had a good time** there. 8. **It took** a long **time** before people learned to split the atom. 9. I shall be back **in no time.** 10. **For a long time** people did not know that lightning and atmospheric electricity are one and the same thing. 11. Lomonosov lectured at the university and **at the same time** he worked in different fields of science. 12. I work in the laboratory two **times** a week.

V. Fill in the blanks with the words **one** or **for**.

1. Moscow is ... of the largest cities in the world. 2. ... must remember that it is necessary to study English at least an hour a day. 3. As ... rubber it was brought to Europe as early as the 15th century. 4. ... understands the importance of electricity when ... sees trams, trolley-buses and trains driven by it. 5. The energy of the atom is used ... peaceful purposes in our country. 6. ... must know the chemical properties of the atom. 7. We produce rubber ... it is quite necessary ... the development of our industry. 8. In 1819 Volta returned to Como ... he wanted to spend the rest of his life there. 9. This is a more important problem than that .... 10. I haven't got a dictionary, I must have ....

VI. Give antonyms for the following words.

north, pole, dark, on the one hand, small, arrangement, larger, magnetized, unfamiliar, like, positive, similar, to rest, in motion

VII. Explain the word-building of the following compound words.

newspaper, schoolboy, thunderstorm, ice-breaker, waterfall, fisherman

VIII. Answer the following questions.

1. What types of electricity do you know? 2. What is the difference between electricity at rest and electricity in motion? 3. What kind of experiments did Galvani carry on? 4. What did Franklin prove? 5. What are the two kinds of electrical charges? 6. Who was the first to produce a continuous current? 7. What was Volta? 8. What can you say about the behaviour of static charges? 9. What did Volta take interest in? 10. What did Volta's discovery result in? 11. What did Volta's device consist of? 12. Where did he spend the rest of his life?

IX. Retell Volta's biography.

UNIT ELEVEN

Grammar: The Subjective Infinitive Construction. The Objective Infinitive Construction

The Subjective Infinitive Construction	1. He is supposed to work at this plant.— Полагают, что он работает на этом заводе. 2. He seems to know English well.— Кажется, он знает английский хорошо.
The Objective Infinitive Construction	1. We suppose him to work at this plant.— Мы полагаем, что он работает на этом заводе. 2. I saw the water boil.— Я видел, что вода кипит.

Class Exercises

I. Choose the sentences with a) the Subjective Infinitive Construction; b) the Objective Infinitive Construction. Translate them into Russian.

1. Lightning proved to be a discharge of electricity. 2. The student is certain to know that alternating voltage can be increased and decreased. 3. Heat is known to be a form of energy. 4. We know the electrons to flow from the negative terminal of the battery to the positive one. 5. This scientist seems to have been working on the problem of splitting the atom. 6. The students saw the thermometer mercury fall to the fixed point. 7. Coal is considered to be a valuable fuel. 8. We expected many articles to have already been written on that subject. 9. The electrolytes appear to change greatly when the current passes through them. 10. The induced voltage causes the current to flow and the rotor to revolve.

II. Learn to recognize the following international words.

static, electrolyte, cycle, theory, result, thermometer, boiler, contact, fact

III. Give all the meanings of the following words.

current, table, iron, power, needle, pressure, wire, state, generation

IV. Do Laboratory Work 11.

TEXT 11. ELECTRIC CURRENT

Ever since Volta first produced a source of continuous current, men of science have been forming theories on this subject. For some time they could see no real difference between the newly-discovered phenomenon and the former understanding of static charges. Then the famous French scientist Ampere (after whom the unit of current was named) determined the difference between the current and the static charges. In addition to it, Ampere gave the current direction: he supposed the current to flow from the positive pole of the source round the circuit and back again to the negative pole.

We consider Ampere to be right in his first statement but he was certainly wrong in the second, as to the direction of the current. The student is certain to remember that the flow of current is in a direction opposite to what he thought.

Let us turn our attention now to the electric current itself. The current which flows along wires consists of moving electrons. What can we say about the electron? We know the electron to be a minute particle having an electric charge. We also know that that charge is negative. As these minute charges travel along a wire, that wire is said to carry an electric current.

In addition to travelling through solids, however, the electric current can flow through liquids as well and even through gases. In both cases it produces some most important effects to meet industrial requirements.

Some liquids, such as melted metals for example, conduct current without any change to themselves. Others, called electrolytes, are found to change greatly when the current passes through them.

When the electrons flow in one direction only, the current is known to be d. c., that is, direct current. The simplest source of power for the direct current is a battery, for a battery pushes the electrons in the same direction all the time (i.e., from the negatively charged terminal to the positively charged terminal).

The letters a.c. stand for alternating current. The current under consideration flows first in one direction and then in the opposite one. The a.c. used for power and lighting purposes is assumed to go through 50 cycles in one second. One of the great advantages of a.c. is the ease with

which power at low voltage can be changed into an almost similar amount of power at high voltage and vice versa. Hence, on the one hand alternating voltage is increased when it is necessary for long-distance transmission and, on the other hand, one can decrease it to meet industrial requirements as well as to operate various devices at home.

Although there are numerous cases when d.c. is required, at least 90 per cent of electrical energy to be generated at present is a.c. In fact, it finds wide application for lighting, heating, industrial, and some other purposes.

One cannot help mentioning here that Yablochkov, Russian scientist and inventor, was the first to apply a.c. in practice.

Exercises

I. According to the models given below form sentences combining suitable parts of the sentence given in columns I, II, III, IV.

Model a): The current is known to consist of moving electrons.

I	II	III	IV
1. Professor Rihman	1. was observed	1. to have started	1. by man 25 centuries ago.
2. Amber	2. is said	2. to have been observed	2. for Moscow on foot.
3. Lomonosov	3. is known	3. to have been killed	3. minute light objects after rubbing.
4. Electrical effects	4. are certain	4. to attract and to hold	4. in English-speaking countries.
5. The Fahrenheit scale		5. to be used	5. by a stroke of lightning.

Model b): We know lightning to be a discharge of electricity.

I	II	III	IV
	1. Galileo	1. to be	1. positive and negative.
	2. the charges	2. to have invented	2. important effects.
	3. the electric current	3. to flow	3. an air thermometer.
1. We know	4. the alternating current	4. to produce	4. first in one direction and then in another.
	5. the Soviet scientists	5. to have been	5. to the science of electricity.
	6. static electricity	6. to have greatly contributed	6. the only electrical phenomenon observed by man of the past.

II. Translate the following sentences using the Infinitive.

1. Чтобы получить постоянный ток, необходимо иметь его источник. 2. Пирометр используется для измерения температуры горячих металлов. 3. Человек научился расщеплять атомы для того, чтобы получать большое количество энергии. 4. Ученые пытаются решить проблему, связанную с новыми явлениями электричества. 5. Громоотвод — металлическое приспособление для защиты зданий от молнии. 6. Проводить опыты с атмосферным электричеством было очень опасно в то время. 7. Намагнитить предмет — это значит поместить его в поле магнита.

III. Form six sentences combining suitable parts of the sentences given in columns I and II.

I	II
1. The electric current is	1. the energy of position.
2. Kinetic energy is	2. electricity at rest.
3. Static electricity is	3. the flow of moving electrons.

4. Potential energy is	4. the energy of motion.
5. The direct current is	5. a discharge of electricity.
6. Lightning is	6. the flow of electrons in one direction.

IV. Answer the following questions.

1. Who first produced a source of continuous current? 2. After whom was the unit of current named? 3. Who determined the difference between the current and the static charges? 4. What did Ampere suppose? 5. What can you say about an electron? 6. What charges do you know? 7. When does a wire carry an electric current? 8. Do liquids conduct current? 9. What can you say about the electrolytes? 10. What do you call d.c.? 11. What is the advantage of a.c.? 12. Where is a.c. used? 13. Who first applied a.c.?

V. Ask your groupmates the following questions. Let him/her answer them.

1. if electricity is a form of energy. 2. if there are two types of electricity. 3. if alternating voltage can be increased and decreased. 4. if Franklin made an important contribution to the science of electricity. 5. if Ampere determined the difference between the current and the static charges. 6. if the electric current can flow through liquids and through gases. 7. if the electrolytes change greatly when the current passes through them. 8. if a negatively charged electron will move to the positive end of the wire.

VI. Put two questions to each paragraph of the text. Ask your groupmates to answer them.

VII. Find the wrong statements and correct them.

1. Electrons flow from the positively charged terminal of the battery to the negatively charged terminal. 2. Ampere supposed the current to flow from the negative pole to the positive one. 3. Static electricity is used for practical purposes. 4. Static electricity is not very high in voltage and it is easy to control it. 5. To show that the charges are unlike and opposite Franklin decided to call the charge on the rubber positive and that on the glass negative. 6. Galvani thought that electricity was generated because of the contact of the two dissimilar metals used. 7. Volta took great interest in atmospheric electricity and began to carry on experiments. 8. The direct current is known to

flow first in one direction and then in the opposite one. 9. The direct current used for power and lightning purposes is assumed to go through 50 cycles a second.

VIII. Explain why:

1. static electricity cannot be used to light lamps, to boil water, to run electric trains and so on. 2. voltage is increased and decreased. 3. the unit of electric pressure is called the volt. 4. students must learn English. 5. Ampere was wrong as to the current direction. 6. the current is said to flow from the positive end of the wire to its negative end.

IX. Define the following terms.

battery, alternating current, direct current, static electricity, electric current, wire, laboratory, terminal, electron

X. Give a heading to each paragraph of Text 11. Explain why you have given such a heading.

XI. Give a short summary of Text 11.

UNIT TWELVE

Grammar: The Infinitive (Revision)

Class Exercises

I. Choose the sentences with the Infinitive Constructions and translate them.

1. I want to explain theory to him. 2. I want you to explain theory to him. 3. We heard our scientist speak over the radio. 4. We heard the latest news over the radio. 5. The students observed the liquid change. 6. The students observed the liquid changes. 7. The teacher made me speak English. 8. The teacher made a report in English.

II. Make up four sentences using the Infinitive Constructions according to the models given below.

M o d e l: 1. The factory is supposed to increase its production.
2. We expected the delegation to arrive soon.

III. Do Laboratory Work 12.

TEXT 12. WHAT IS HEAT?

What makes one thing hot and another cold? What do the terms "hot" and "cold" really mean?

Scientists are known to have worked for a long time to find an answer to the last question. They decided at last that the manifestation of heat was caused by a weightless substance or fluid called "caloric" which flowed from a hot body to a cold one. However, experience showed that certain heat effects could not be explained by the above theory, namely: the development of heat owing to friction as well as the temperature changes during the compression or expansion of a gas.

M. V. Lomonosov was the first to state that heat phenomena were due to molecular motion. His statement proved to be correct years after his death.

At present, we know heat to be a form of energy. Besides, we are quite familiar with the fact that all substances are made up of little particles called molecules. These are so minute that a single drop of water, for example, contains millions of them. Although a drop of water left on the table may seem to be at rest, everyone of its molecules is really moving about, colliding with other molecules, pushing them, and changing direction. Of course, while one molecule is travelling, all the other millions of molecules in the drop of water are doing the same thing.

What process takes place when we place a kettle full of cold water on the fire, in other words, when we want to heat water? The molecules begin to move much faster then, so that every time there is a collision, they jump away from each other much farther than they did before. As a result, the drop of water becomes larger, that is to say, it expands. In scientific language this property is called expansion.

The faster molecular movement makes the water first warm and then hot. On taking the kettle from the fire, we expect the molecules to slow down, and indeed the water begins to get cold. When the tea is said to be "hot" it really means that its molecules are travelling very fast. On the contrary, they are moving more slowly, when the tea is cold.

Heat and temperature are closely connected. To show that similar quantities of heat may produce different effects in different substances is not difficult at all. Placing a

needle on the fire at the same time as a kettle of cold water, we find that the needle is red-hot before there is any marked difference in the water temperature.

One must say here that a red-hot needle receives far less heat than a kettle full of boiling water but its temperature is nevertheless much higher. But if we place it in the boiling water, although the latter is certain to possess far more heat than the former, the needle gives up heat to the water and not vice versa. When two bodies at different temperatures are brought into contact, we expect the warmer body to get cold while the colder one will be warmed. In this case, heat is said to flow from one body to the other by conduction.

As for expansion caused by heating, it is useless and even dangerous in some cases while in others one cannot do without it. For example, to measure temperature we employ a thermometer, that is the instrument based on the expansion of bodies when heated.

Exercises

I. Translate the following sentences using the Infinitive Constructions.

1. Мы знаем, что тепловая энергия — это энергия молекулярного движения. 2. Известно, что молекулы движутся в различных направлениях. 3. В течение долгого времени считали, что тепло — это невесомое вещество. 4. Говорят, что молекулы воды движутся быстрее, когда ее нагревают. 5. Считают, что молекулы холодного вещества движутся медленнее. 6. Известно, что при нагревании тела расширяются. 7. Студенты, наверное, понимают разницу между постоянным и переменным током.

II. Translate the following sentences and define the function of the word **one**.

1. Observations show that a hot object radiates more heat than a cold one. 2. One can say that heat is one form of energy. 3. This problem is more complicated than the one you have told me about. 4. The direct current is the flow of electrons in one direction. 5. Heat is known to pass from a hotter body to a colder one. 6. There are many hydropower stations in the USSR, the one on the Angara being one of the largest. 7. One of the most important uses of electricity is the production of heat. 8. The alternating current flows

first in one direction and then in the opposite one. 9. To measure the temperature one uses a thermometer.

III. Arrange the following words in pairs of antonyms.

at rest, positive, solid, right, fast, the last, useful, charge, hot, dark, negative, the first, increase, wrong, valuable, decrease, liquid, in motion, invaluable, slow, useless, discharge, cold, light

IV. Arrange the following words in pairs of synonyms.

to employ, to make, to travel, motion, similar, various, different, like, to receive, liquid, movement, to help, fluid, to assist, to do, to get, to use, to move

V. a) Form verbs from the following nouns.

increase, weight, statement, movement, difference, compression, collision, flow, application, requirement, knowledge, education, expansion, heat, water, paper

b) Use the verbs formed in sentences of your own.

VI. Translate the following sentences paying attention to the words in bold type.

1. Static **charges** are known to be at rest. 2. Alternating current **changes** its direction many times a second. 3. We know the electric **charges** to be positive and negative. 4. Some liquids are known to conduct current without any **changes** to themselves. 5. On the contrary the electrolytes are known to **change** greatly when the current flows through them. 6. One can **charge** dissimilar objects by rubbing them. 7. When water boils there is a gradual **change** of water into gas.

VII. Translate the following questions and answer them.

1. Что такое тепло? 2. Почему предполагали, что тепло — это невесомое вещество? 3. Могли ли люди наблюдать некоторые тепловые эффекты? 4. Что происходит благодаря трению и сжатию? 5. Какие тепловые явления (phenomena) установил Ломоносов? 6. Из чего состоит вещество? 7. Как называются мельчайшие частицы вещества? 8. Что происходит, когда тело нагревается? 9. Существует ли заметная разница температур между холодным и горячим телами? 10. Какой прибор используется для измерения температуры?

VIII. Speak on the work of the following scientists using the words given below.

Franklin: to prove, unlike, charge, to rub, dissimilar, object, rubber, negative, glass, positive

Volta: continuous current, to produce, the first, unit, electric, pressure, volt, voltaic pile

Lomonosov: to state, heat, phenomena, molecular, motion, atomic, theory, law, conservation, matter

IX. Give your examples of the effects of heat and cold on the body.

UNIT THIRTEEN

Grammar: The Infinitive (Revision)

Class Exercises

I. Choose the sentences with a) the Subjective Infinitive Construction; b) the Objective Infinitive Construction. Translate them into Russian.

1. The current is known to flow when the circuit is closed. 2. To stop the current flow is to break the circuit in some point. 3. To stop the current flow you must open the circuit. 4. A fuse is expected to melt and break the circuit. 5. Much more heat is required for the water to boil in the kettle than for the needle to become white-hot. 6. Various switches are used to open or to close a circuit. 7. A switch is a device to break or to close the circuit. 8. We know the circuit to be a path of an electric current. 9. We may expect a short circuit to result from wire fault. 10. The overloading of the line is likely to produce a short circuit. 11. Electromotive force is necessary for the current to flow along the circuit. 12. Ampere supposed the current to flow from the positive pole of the source to the negative pole.

II. Read and translate the following words which had been used in the previous texts.

amount, numerous, opposite, charge, dissimilar, minute, terminal, requirement, substance, statement, quantity, conduction, importance

III. Do Laboratory Work 13.

TEXT 13. ELECTRIC CIRCUIT

The electric circuit is the subject to be dealt with in the present article. But what does the above term really mean? We know the circuit to be a complete path which carries the current from the source of supply to the load and then carries it again from the load back to the source.

The purpose of the electrical source is to produce the necessary electromotive force required for the flow of current through the circuit.

The path along which the electrons travel must be complete otherwise no electric power can be supplied from the source to the load. Thus we close the circuit when we switch on our electric lamp.

If the circuit is broken or, as we generally say "opened" anywhere, the current is known to stop everywhere. Hence, we break the circuit when we switch off our electrical devices. Generally speaking, the current may pass through solid conductors, liquids, gases, vacuum, or any combination of these. It may flow in turn over transmission lines from the power-stations through transformers, cables and switches, through lamps, heaters, motors and so on.

There are various kinds of electric circuits such as: open circuits, closed circuits, series circuits, parallel circuits and short circuits.

To understand the difference between the following circuit connections is not difficult at all. When electrical devices are connected so that the current flows from one device to another, they are said to be connected in series. Under such conditions the current flow is the same in all parts of the circuit, as there is only a single path along which it may flow. The electrical bell circuit is considered to be a typical example of a series circuit. The parallel circuit provides two or more paths for the passage of current. The circuit is divided in such a way that part of the current flows through one path, and part through another. The lamps in your room and your house are generally connected in parallel.

Now we shall turn our attention to the short circuit sometimes called "the short". The short circuit is produced when the current is allowed to return to the source of supply without control and without doing the work that we want it to do. The short circuit often results from cable fault or wire fault. Under certain conditions, the short may cause

fire because the current flows where it was not supposed to flow. If the current flow is too great a fuse is to be used as a safety device to stop the current flow.

The fuse must be placed in every circuit where there is a danger of overloading the line. Then all the current to be sent will pass through the fuse.

When a short circuit or an overload causes more current to flow than the carrying capacity of the wire, the wire becomes hot and sets fire to the insulation. If the flow of

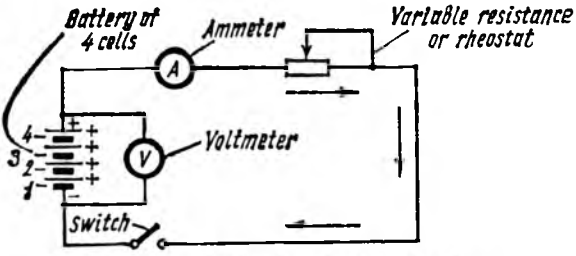

Fig. 3. A simple electric circuit

current is greater than the carrying capacity of the fuse, the fuse melts and opens the circuit.

A simple electric circuit is illustrated in Fig. 3. In this figure a 4-cell battery has been used, the switch being in an open position. If the switch is in a closed position, the current will flow around the circuit in the direction shown by the arrows.

Exercises

I. a) Give suitable prepositions where necessary. b) Form sentences with the following Infinitives.

to answer, to apply, to be interested, to contribute, to consist, to depend, to enter, to connect, to play a part, to pay attention, to go, to be followed, to carry

II. Fill in the blanks with the words and expressions given below.

as, as well, as well as

1. It is necessary to remember the term "circuit" ..., it is impossible to work with electricity without circuits. 2. A short circuit may cause wire fault ... cable fault. 3. Travelling through solids, the electric current can flow through liquids and gases ... . 4. The magnitude of the

current ... the voltage and resistance may vary from a small amount to a very large quantity. 5. ... a cold object and a hot one are brought into contact, the former gets warmer and the latter gets colder. 6. Fuses are used ... safety devices. 7. ... a cold conductor becomes warmer it is unable to pass charges ... it did before.

III. Translate the following questions and answer them.

1. Do you want to translate this article? 2. Do you want me to translate this article? 3. Do you know this scientist? 4. Do you know this scientist to have worked in the field of physics? 5. Did you hear my report? 6. Did you hear my friend make a report? 7. Did you see our teacher? 8. Did you see our teacher enter the room?

IV. Ask your groupmate the following questions. Let him/her answer them.

1. if a circuit is a complete path. 2. if there are different kinds of circuits. 3. if the current can pass through liquids. 4. if we open the circuit when we switch on the light. 5. if the lamps in the room are connected in series. 6. if the fuse is a safety device. 7. if the fuse must be placed in every circuit. 8. if the current flows when the circuit is closed

V. Answer the following questions.

1. What is discussed in the present article? 2. What do we call an electric circuit? 3. What kinds of circuits do you know? 4. When is a "short" produced? 5. What does a short circuit often result from? 6. What safety device is used in the circuit when the current is too great? 7. What do we mean by the term "short circuit"? 8. What does the term "closed circuit" mean? 9. Why does the current flow when the circuit is closed? 10. What do you call a fuse? 11. Does the current flow when the switch is in the open position?

VI. Speak on the difference between:

1. Closed circuits and open circuits. 2. Series circuits and parallel circuits. 3. Fuses and switches.

VII. Describe Fig. 3.

VIII. Retell Text 13.

IX. Read Text 13A in 3 minutes and point out the main idea of each paragraph.

TEXT 13A. ELECTRICITY MAY BE DANGEROUS

Many people have had strong shocks from the electric wires in a house. The wires seldom carry current at a higher voltage than 220, and a person who touches a bare wire or terminal may suffer no harm if the skin is dry. But if the hand is wet, he may be killed. Water is known to be a good conductor of electricity and provides an easy path for the current from the wire to the body. One of the main wires carrying the current is connected to earth, and if a person touches the other one with a wet hand, a heavy current will flow through his body to earth and so to the other wire. The body forms part of an electric circuit.

When we are dealing with wires and fuses carrying an electric current, it is best to wear rubber gloves. Rubber is a good insulator and will not let the current pass to the skin. If no rubber gloves can be found in the house, dry cloth gloves are better than nothing. Never touch a bare wire with the wet hand, and never, in any situation, touch a water pipe and an electric wire at the same time.

We all use electricity in our homes every day but sometimes forget that it is a form of power and may be dangerous. At the other end of the wire there are great generators driven by turbines turning at high speed. One should remember that the power they generate is enormous. It can burn and kill, but it will serve us well if we use it wisely.

X. Find the wrong statement and correct it in several sentences.

1. The wires carrying the current are connected to earth. 2. Water provides a path for the current to flow. 3. The electric power can serve us well if it is used wisely.

XI. Point out which of the sentences contains the information from Text 13A.

1. The path along which the electrons travel must be complete. 2. The short circuit often results from cable fault or wire fault. 3. We must always remember that electricity can be dangerous and one should use it carefully.

XII. Give your examples of careless use of the electric energy. What should be done in such cases?

UNIT FOURTEEN

Grammar: The Attribute. Attributive Clauses.

Class Exercises

I. a) Apply suitable attributes to the following nouns.

M o d e l: electric charge

wire, engineering, conductor, difference, opposition, material, line, insulator, light, cord

b) Form sentences using the above nouns qualified by adjectives.

II. Translate the following sentences paying attention to the attribute and attributive clauses.

1. The methods of solving the problem were discussed at the lesson. 2. The problem solved opened up new possibilities of nuclear energy application. 3. The devices the Soviet Union produces are known all over the world. 4. The data obtained helped the students in their research work. 5. The measuring instruments we use in the laboratory were produced in the USSR. 6. The power generated was supplied to a number of factories. 7. The teacher spoke about the device to be tested and the motor to be started. 8. The material the conductors are made of must withstand high temperatures. 9. The data obtained are of great importance.

III. Do Laboratory Work 14.

TEXT 14. CONDUCTORS AND INSULATORS

All substances have some ability of conducting the electric current, however, they differ greatly in the ease with which the current can pass through them. Metals, for example, conduct electricity with ease while rubber does not allow it to flow freely. Thus, we have conductors and insulators.

What do the terms "conductors" and "insulators" mean? Substances through which electricity is easily transmitted are called conductors. Any material that strongly resists the electric current flow is known as an insulator.

Let us first turn our attention to conductance, that is the conductor's ability of passing electric charges. The four factors conductance depends on are: the size of the

wire used, its length and temperature as well as the kind of material to be employed.

It is not difficult to understand that a large water pipe can pass more water than a small one. In the same manner, a large conductor will carry the current more readily than a thinner one. Fig. 4 illustrates this fact better than words alone.

It is quite understandable, too, that to flow through a short conductor is certainly easier for the current than through a long one in spite of their being made of similar material. Hence, the longer the wire, the greater is its opposition, that is resistance, to the passage of current.

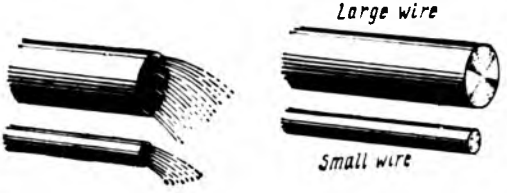

Fig 4. Comparing water flow and current flow

As mentioned above, there is a great difference in the conducting ability of various substances. For example, almost all metals are good electric current conductors. Nevertheless, copper carries the current more freely than iron; and silver, in its turn, is a better conductor than copper.

Generally speaking, copper is the most widely used conductor. That is why the electrically operated devices in your home are connected to the wall socket by copper wires. Indeed, if you are reading this book by an electric lamp light and somebody pulls the metal wire out of the socket, the light will go out at once. The electricity has not been turned off but it has no path to travel from the socket to your electric lamp. The flowing electrons cannot travel through space and get into an electrically operated device when the circuit is broken. If we use a piece of string instead of a metal wire, we shall also find that the current stops flowing.

A material like string which resists the flow of the electric current is called an insulator.

There are many kinds of insulation used to cover the wires. The kind used depends upon the purposes the wire or

cord is meant for. The insulating materials we generally use to cover the wires are rubber, asbestos, glass, plastics and others.

Rubber covered with cotton, or rubber alone is the insulating material usually used to cover desk lamp cords and radio cords.

Glass is the insulator to be often seen on the poles that carry the telephone wires in city streets. Glass insulator strings are usually suspended from the towers of high voltage transmission lines. One of the most important insulators of all, however, is air. That is why power transmission line wires are bare wires depending on air to keep the current from leaking off.

Conducting materials are by no means the only materials to play an important part in electrical engineering. There must certainly be a conductor, that is a path, along which electricity is to travel and there must be insulators keeping it from leaking off the conductor.

Exercises

I. Complete sentences according to the model given below.

Model: The method used ... . → The method used is described in the present article. Используемый метод описан в данной статье.

1. The device tested... . 2. The results obtained... . 3. The temperature measured... . 4. The phenomenon studied... . 5. The conductors used... . 6. The substance mentioned... . 7. The method proposed... .

II. Translate the following groups of words.

research work—research work plan; water pipe—water pipe material—water pipe material quality; power supply—power supply increase—power supply increase problem; transmission line—transmission line wire—transmission line wire insulation; space investigation—space investigation program—space investigation program discussion

III. For the words given in (a) find the Russian equivalents in (b).

a) 1. wire; 2. statement; 3. to cause; 4. collision; 5. to control; 6. feature; 7. similar; 8. direction; 9. opposition; 10. positive; 11. path; 12. to consider; 13. as well; 14. to expect; 15. to place

b) 1. положительный; 2. также, тоже; 3. считать, рассматривать; 4. направление; 5. ожидать, рассчитывать; 6. помещать; 7. путь, контур; 8. противодействие; 9. особенность; 10. подобный; 11. столкновение; 12. управлять; 13. утверждение; 14. вызывать, заставлять; 15. проволока

IV. Answer the following questions.

1. What is discussed in the present article? 2. Do all substances conduct the electric current easily? 3. What is a conductor? 4. What does conductance depend upon? 5. What materials are the best conductors of electricity? 6. Does temperature influence the conductor's resistance? 7. What feature of the conductor is illustrated in Fig. 4? 8. What is the difference between a conductor and an insulator? 9. What insulators do you know? 10. Why are power transmission line wires bare? 11. What insulation is used on the cords of your electrical devices? 12. Can we do without insulators?

V. Explain why:

1. we need conductors and insulators. 2. we compare water flow and current flow. 3. we mostly use copper conductors. 4. the current flows when you turn on the light. 5. lightning strikes the nearest conductor. 6. there must be a difference of potential in the circuit.

VI. Give a heading to each paragraph of Text 14. Explain why you have given such a heading.

VII. Describe Fig. 4.

VIII. Retell Text 14.

IX. Read Text 14A consulting a dictionary.

TEXT 14A. INSULATOR SURFACE TREATMENT

When the insulator is covered with a thin film of conducting electrolyte, a leakage current flows to ground over the insulator surface and this gives rise to heating. The heat so generated causes the moisture to evaporate until a dry non-conducting band is formed around the insulator across which the line to ground voltage is impressed. A visible discharge occurs across this dry band, the roots of which generate considerable heat and evaporate more moisture causing the dry band to widen. However the cur-

rent in the discharge is limited by the resistance on either side. In the majority of cases, therefore the band widens to such an extent that the voltage across it is insufficient to maintain a discharge and extinction occurs.

X. Find in Text 14A English equivalents to the following Russian word combinations.

1. ток утечки уходит в землю; 2. вырабатывают значительное тепло и испаряют еще больше влаги; 3. слой расширяется до такой степени, что напряжение на нем недостаточно для поддержания разряда; 4. тепло ... заставляет влагу испаряться

XI. Point out which of the sentences contains the information from the text.

1. There is a great difference in the conducting ability of various substances. 2. The heat generated on the insulator surface evaporates the moisture until a dry non-conducting band is formed around the insulator. 3. The conductance depends on four factors. 4. Insulators play an important role in electrical engineering.

UNIT FIFTEEN

Grammar: Conditional Sentences. Emphatic Constructions.

I. If atomic energy replaces the present sources of energy, we shall get more energy than we produce at present.— Если атомная энергия заменит существующие источники энергии, мы получим больше энергии, чем производим в настоящее время.

II. If atomic energy replaced the present sources of energy, we should get more energy.— Если бы атомная энергия заменила существующие источники энергии, мы получили бы больше энергии.

III. If professor Rihman had thought of the possible danger, lightning would not have killed him.— Если бы профессор Рихман подумал о возможной опасности, молния не убила бы его.

Class Exercises

I. Choose the sentences which can be translated with **бы.**

1. Were the resistance lower, the current would be larger. 2. In case the material offers a high resistance we consider it to be a good insulator. 3. There will be no electron flow between the two charged bodies provided they are connected by a glass rod. 4. Unless they apply new devices, they will not be able to obtain good results. 5. Had the laboratory test been successful, the electric machine would be put into operation. 6. If we change the e.m.f., the electric current changes as well.

II. Translate the following words paying attention to prefixes.

disorder, interaction, impossible, unequal, misunderstanding, reread, unbalanced, immaterial, dissimilar, interplanetary, mispronounce, rearrange, reconstruct

III. Do Laboratory Work 15.

TEXT 15. ELECTROMOTIVE FORCE AND RESISTANCE

As was previously stated, there is always a disorderly movement of free electrons within all substances, especially metals.

Let us assume that there is a movement of electrons through the wire, say, from point A to point B. What does it mean? It means that there is an excess of electrons at point A. Unless there were a flow of electric current between A and B in any direction, it would mean that both the former and the latter were at the same potential. Of course, the greater the potential difference, the greater is the electron flow.

The electromotive force (e.m.f.) is the very force that moves the electrons from one point in an electric circuit towards another. In case this e.m.f. is direct, the current is direct. On the other hand, were the electromotive force alternating, the current would be alternating, too. The e.m.f. is measurable and it is the volt that is the unit used for measuring it.

One need not explain to the reader that a current is unable to flow in a circuit consisting of metallic wires alone. A source of an e.m.f. should be provided as well. The source under consideration may be a cell or a battery, a generator, a thermocouple or a photocell, etc.

In addition to the electromotive force and the potential difference reference should be made here to another important factor that greatly influences electrical flow, namely, resistance. So, to resistance shall we turn our attention now. The student probably remembers that all substances offer a certain amount of opposition, that is to say resistance, to the passage of current. This resistance may be high or low depending on the type of circuit and the material employed. Take glass and rubber as an example. They offer a very high resistance and, hence, they are considered as good insulators. Nevertheless, one must not forget that all substances do allow the passage of some current provided the potential difference is high enough.

Imagine two oppositely charged balls suspended far apart in the air. In spite of our having a difference of potential, no current flows. How can we explain this strange behaviour? The simple reason is that the air between the balls offers too great a resistance to current flow. However, the electrons could certainly flow from the negatively charged ball towards the positively charged one provided we connected them by a metal wire. As a matter of fact, it is not necessary at all to connect both balls in the manner described in order to obtain a similar result. All that we have to do is to increase the charges. If the potential difference becomes great enough, the electrons will jump through the air forming an electric spark.

One should mention in this connection that certain factors can greatly influence the resistance of an electric circuit. Among them we find the size of the wire, its length, and type. In short, the thinner or longer the wire, the greater is the resistance offered. Besides, could we use a silver wire, it would offer less resistance than an iron one.

Exercises

I. Translate the following sentences.

a) 1. If an e.m.f. is applied to a path, the electrons will move toward the point of higher potential. 2. If people of the past had known that lightning was atmospheric electricity, they would not have invented numerous stories about it. 3. If a wire were held against an electrified body, electricity would flow along the wire to its other end. 4. If coal were not used as fuel, we should get more valuable products.

b) 1. Were that liquid heated, it would greatly expand. 2. Were there no flow of current between A and B in any direction, then A and B would be at the same potential. 3. Were the electromotive force alternating, the current would be alternating as well. 4. Should you break the circuit, no current would flow. 5. Had they used a larger water pipe for their last experiment, more water would have passed through that pipe. 6. The current will flow around the circuit unless we break the circuit in some point.

II. Translate the following sentences and define the function of the word **provided**.

1. These electrical devices are provided with rubber insulators. 2. These electrical devices provided with rubber insulators were produced at a large factory. 3. These electrical devices can work for a long time provided they are made of high-quality material. 4. The electric current flows provided there is a complete circuit. 5. Lightning did not strike the house as it was provided with a lightning conductor. 6. Ohm's law provided the possibility of determining resistance provided the voltage and current were known. 7. The electrons will jump through the air forming an electric spark provided the potential difference becomes great enough. 8. The students will be able to translate difficult articles provided they have dictionaries.

III. Complete the following sentences.

a) 1. If my friend comes to Moscow, we... . 2. If I had time tomorrow, I... . 3. If my friend had not entered the institute last year, he... . 4. If I were you I... . 5. If the teacher had given me the dictionary at the last lesson, I... . 6. If my brother goes to England, he... .

b) 1. He would have done it unless... . 2. We should have gone to the country yesterday provided... . 3. I should finish my work in time tomorrow unless... . 4. She will answer all the teacher's questions provided... .

IV. Translate the following sentences.

1. It was in 1800 that Volta first produced a continuous current. 2. It is the thermometer that measures the temperature of a substance. 3. It was Lomonosov who stated that heat phenomena were due to molecular motion. 4. It is the ampere that is the unit of current. 5. It is in the Soviet Union that atomic energy was first used for

peaceful purposes. 6. It was Popov who was the inventor of the radio. 7. It is the difference of potential that causes the free electrons to flow from one point of the conductor to another.

V. a) Fill in the blanks with prepositions; b) retell the following extract.

The great French physicist Ampere was an absent-minded man. One day he was waiting .... his friend. The appointed hour arrived, passed and his friend did not come. As Ampere had to go ... he took a piece ... chalk and wrote ... his door: "I have gone ... . I shall return ... two hours." And he went ... .

He returned two hours later. While he was going upstairs he worked out a very difficult problem.

"If my friend had come ... the appointed hour," he said ... himself, "I should have told him ... this problem. I shall speak ... him ... it now. Perhaps he will be able to solve it." So when Ampere came ... his own door and saw the words written ... it, he decided that he was ... his friend's door. "Oh," said he, "he has gone ... I am very sorry! Were he ... home, we should discuss my problem." And he wrote the following words: "Very sorry that I have not found you ... home." Then he went downstairs again.

VI. For the words and expressions given in (a) find the Russian equivalents given in (b).

a) 1. in the same manner; 2. generally speaking; 3. to turn one's attention; 4. on the basis of; 5. electrical engineering; 6. for this reason; 7. to meet requirements; 8. by means of; 9. nevertheless; 10. on the contrary; 11. to offer resistance; 12. under such conditions; 13. as well as; 14. as a result; 15. in spite of; 16. under consideration

b) 1. в результате; 2. рассматриваемый; 3. при помощи; 4. в таких условиях; 5. оказывать сопротивление; 6. вообще говоря; 7. тем не менее; 8. таким же образом; 9. обращать внимание; 10. электротехника; 11. удовлетворять требованиям; 12. несмотря на; 13. на основе чего-л.; 14. наоборот; 15. также, тоже; 16. по этой причине

VII. Put all possible questions to the following sentences.

1. The excess electrons will flow towards the point of deficiency. 2. The parallel circuit provides two or more paths for current flow.

VIII. Apply suitable adjectives to the following nouns.

difference, spark, force, wire, factor, resistance, conductor, ball

IX. Form new words of the same root, define what parts of speech they are.

active, differ, ease, conductance, resist, generator, turn

X. Answer the following questions.

1. What force moves the electrons from one point to another? 2. What is an electromotive force? 3. Is the electromotive force measurable? 4. What unit is used for measuring an e.m.f.? 5. What devices may be used as a source of an e.m.f.? 6. What factors greatly influence the current flow in the circuit? 7. What does resistance depend on? 8. What materials are good insulators? 9. What is shown in Fig. 4? 10. What factors can influence the resistance of an electrical circuit? 11. Does silver wire offer less resistance than an iron wire?

XI. Speak on:

1. Electromotive force. 2. Resistance.

UNIT SIXTEEN

Grammar: Conditional Sentences. Emphatic Constructions.

Class Exercises

I. Translate the following sentences and change them according to the model given below.

M o d e l: **The sun** is an unlimited source of almost all kinds of energy. → It is the sun that is an unlimited source of almost all kinds of energy.

1. Electric energy is changed into heat **in the electrical appliances.** 2. **An increase in temperature** increases the molecular motion. 3. **Ampere** showed the difference between the current and the charges. 4. Electricity is produced **at steam power plants.** 5. **The heating effect of the current** is the subject of this article. 6. Overheating **in transmis-**

sion lines is most undesirable. 7. **Work** produces heat directly or indirectly. 8. **The heat engine** turns heat into work.

II. Translate the following word combinations.

a) at least, thanks to, because of, as to, in case, at times, in short, by means of, in spite of, instead of, all over the world

b) из-за выделяемого тепла, при помощи электрического нагреваемого прибора, благодаря химической реакции, в случае уменьшения кпд, что касается тепловой потери, по крайней мере внутри лампочки, иногда это желательно, короче говоря, во всем мире, что касается нити накала, вместо механической энергии, несмотря на разность потенциалов

III. Define the meaning of the prefixes in the following words, translate them.

irreplaceable, supernatural, overloaded, reaction, invaluable, discharge, indirectly, outstanding, semiconductor, impossible

IV. Do Laboratory Work 16.

TEXT 16. HEATING EFFECT OF AN ELECTRIC CURRENT

The production of heat is perhaps the most familiar among the principal effects of an electric current, either because of its development in the filaments of the electric lamps or, may be, because of the possible danger from overloaded wires.

As you know, of course, a metal wire carrying a current will almost always be at a higher temperature than the temperature of that very wire unless it carries any current. It means that an electric current passing along a wire will heat that wire and may even cause it to become red-hot. Thus, the current can be detected by the heat developed provided it flows along the wire.

The reader is certain to remember that the heat produced per second depends both upon the resistance of the conductor and upon the amount of current carried through it. As a matter of fact, if some current flowed along a thin wire and then the same amount of current were sent through a thicker one, a different amount of heat would be developed in both wires. When the current is sent through

the wire which is too thin to carry it freely, then more electric energy will be converted into heat than in the case of a thick wire conducting a small current.

Let us suppose now that a small current is flowing along a thick metal conductor. Under such conditions the only way to discover whether heat has been developed is to make use of a sensitive thermometer because the heating is too negligible to be detected by other means. If, however, our conductor were very thin while the current were large the amount of generated heat would be much greater than that produced in the thick wire. In fact, one could easily feel it. Thus, we see that the thinner the wire, the greater the developed heat. On the contrary, the larger the wire, the more negligible is the heat produced.

Needless to say, such heat is greatly desirable at times but at other times we must remove or, at least, decrease it as it represents a waste of useful energy. In case heat is developed in a transmission line, a generator or a motor, it is but a waste of electric energy and overheating is most undesirable and even dangerous. It is this waste that is generally called "heat loss" for it serves no useful purposes and does decrease efficiency. Nevertheless, one should not forget that the heat developed in the electric circuit is of great practical importance for heating, lighting and other purposes. Owing to it we are provided with a large number of appliances, such as: electric lamps that light our homes, streets and factories, electrical heaters that are widely used to meet industrial requirements, and a hundred and one other necessary and irreplaceable things which have been serving mankind for so many years.

In short, many of the invaluable electrical appliances without which life would seem strange and impossible at present can be utilized only because they transform electric energy into heat.

The production of heat by an electric current is called heating effect. One might also name its light effect provided the heat in the conductor be great enough to make it white-hot, so that it gives off light as well as heat. Take the filament of an electric lamp as an example. We know it to glow because of heat. By the way, were we able to look inside a hot electric iron, we should see that its wires were glowing too. A similar statement could be applied as well to almost any electric heating device. All of them give off a little light and a lot of heat.

Exercises

I. Complete the following sentences.

a) 1. If I asked the teacher to explain grammar to me, she... . 2. If he had been to England last year, he ... . 3. If I asked my sister to bring me the dictionary, she... . 4. If she asked her friend to help her, he... . 5. If they had been asked to carry the experiment out, they... .

b) 1. ...provided the weather were fine. 2. ...unless it rains. 3. ...if we are free on Sunday. 4. ...provided we had had time yesterday. 5. ...if you brought me the textbook.

II. Translate the following sentences paying attention to the words in bold type.

1. **The faster** the molecules of a substance move, **the higher** is the temperature of the substance. 2. **The larger** the water pipe, **the more** water passes through it. 3. **The more** you read, **the more** you learn. 4. **The shorter** the wire, **the less** is its resistance to current flow. 5. **The greater** the number of free electrons in a substance, **the better** that substance conducts electricity. 6. **The higher** the temperature of a metal, **the higher** is its resistance.

III. Use the conjunctions **either . . . or, neither . . . nor, both . . . and** in sentences given below.

M o d e l: He will read or write. → He will either read or write. → He will neither read nor write. He will both read and write.

1. She speaks English or German. 2. He or she can translate this article. 3. We shall go by bus or by tram.

IV. Answer the following questions.

1. How can electricity be detected? 2. What are the principal effects of an electric current? 3. Why does the current-carrying wire become red-hot? 4. What does the heat produced per second depend upon? 5. Why is heat developed in a transmission line undesirable? 6. What device turns heat into work? 7. What do we call the heating effect of an electric current? 8. When does the conductor become white-hot? 9. What takes place inside any electric heating device?

V. Ask your groupmate the following questions. Let him/her answer them.

a) 1. if it is possible to convert electric energy into heat. 2. if we can obtain heat from the sun by employing radiant energy. 3. if he is able to look inside a hot electric iron. 4. if it is desirable at times to remove heat. 5. if heat decreases efficiency.

b) 1. what the three principal effects of an electric current are. 2. how the current passing along the wire can be detected. 3. where different electrical appliances are used. 4. when overheating is most undesirable and even dangerous.

VI. Speak on the heating effect of an electric current.

VII. Read Text 16A in 2 minutes without a dictionary.

TEXT 16A. IF THERE WERE NO ELECTRICITY

At present it is difficult even to imagine the time when there was no electricity, when people had to do without it.

What would our everyday life be like if there were no electricity?

Can you imagine a situation when all devices producing electricity would stop operating?

If this happened in the evening while you were in the cinema, you would be sitting in the dark without light. Then you would walk along dark streets. You would try to take a trolley-bus or a tram, it would be impossible. As there would be no light at home, you should use either a smoking kerosene lamp or a candle.

You would like to use the telephone or to watch TV but they would not work because they both depend upon electric current. This example shows the importance of electricity in everyday life.

VIII. Find the English equivalents to the following Russian word combinations.

1. если бы не было электрического освещения; 2. вы захотели бы посмотреть телевизор; 3. все устройства перестали бы работать

IX. Enlarge upon the subject.

What would happen if there were no electricity?

UNIT SEVENTEEN

Grammar: The Complex Sentence

Class Exercises

I. Translate the following sentences paying attention to the subordinate clauses.

1. A current-carrying coil of wire which is long in comparison with its diameter is called a solenoid. 2. The experiments Oersted carried on attracted Ampere's attention. 3. The electric circuit can be closed, if necessary. 4. It was Ampere who showed the difference between the current and the static charges. 5. That the unit of current is named after the famous French physicist Ampere is probably known to you. 6. When placing an iron core within a solenoid, we obtain an electromagnet. 7. The phenomenon Oersted pointed at interested Ampere greatly. 8. We know that the direction of the magnetic effect of the current can be found thanks to Ampere's rule. 9. If suspended so that it can rotate freely, the solenoid points north and south when the current flows.

II. Learn to recognize the following international words.

magnetic, compass, parallel, effect, magnet, magnetism, solenoid, electromagnet, process, electricity

III. Do Laboratory Work 17.

TEXT 17. MAGNETIC EFFECT OF AN ELECTRIC CURRENT

The invention of the voltaic cell in 1800 gave electrical experimenters a source of a constant flow of current. Seven years later the Danish scientist and experimenter, Oersted, decided to establish the relation between a flow of current and a magnetic needle. It took him at least 13 years more to find out that a compass needle is deflected when brought near a wire through which the electric current flows. At last, during a lecture he adjusted, by chance, the wire parallel to the needle. Then, both he and his class saw that when the current was turned on, the needle deflected almost at right angles towards the conductor. As soon as the direction of the current was reversed, the direction the needle pointed in was reversed too.

As seen in Fig. 5 the north end of the needle moves away from us when the current flows from left to right. Oersted also pointed out that provided the wire were adjusted below the needle, the deflection was reversed.

The above-mentioned phenomenon highly interested Ampere who repeated the experiment and added a number of valuable observations and statements. He began his research under the influence of Oersted's discovery and carried it on throughout the rest of his life.

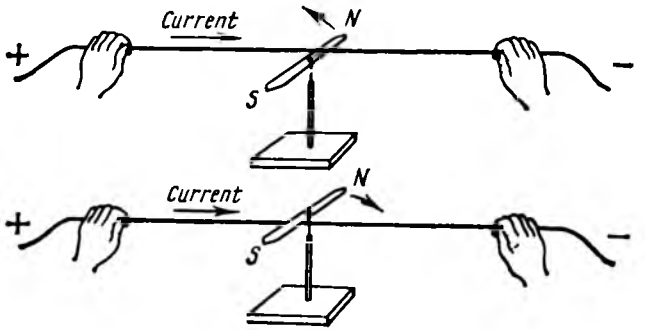

Fig. 5. Influence of an electric current on a compass needle

Everyone knows the rule thanks to which we can always find the direction of the magnetic effect of the current. It is known as Ampere's rule. Ampere established and proved that magnetic effects could be produced without any magnets by means of electricity alone. He turned his attention to the behaviour of the electric current in a single straight conductor and in a conductor that is formed into a coil, i.e. a solenoid.

When a wire conducting a current is formed into a coil of several turns, the amount of magnetism is greatly increased.

It is not difficult to understand that the greater the number of turns of wire, the greater is the m.m.f. (that is the magnetomotive force) produced within the coil by any constant amount of current flowing through it. In addition, when doubling the current, we double the magnetism generated in the coil (see Fig. 6).

A solenoid has two poles which attract and repel the poles of other magnets. While suspended, it takes-up a north and a south direction exactly like the compass needle.

A core of iron becomes strongly magnetized if placed within the solenoid while the current is flowing.

When winding a coil of wire on an iron core, we obtain an electromagnet. That the electromagnet is a controllable and reliable magnet is perhaps known to everyone. It is, so to say, a temporary magnet provided by electricity. Its

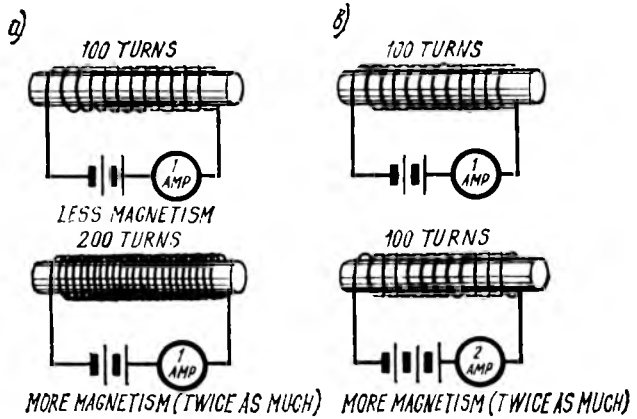

Fig. 6. The dependence of the amount of magnetism on the number of turns of wire and the strength of the current:

a) The number of turns of wire in the coil affects the magnetic strength; b) The strength of the current through the coil influences the magnetic strength of the coil

behaviour is very simple. The device is lifeless unless an electric current flows through the coil. However, the device comes to life provided the current flows. The iron core will act as a magnet as long as the current continues to pass along the winding.

Exercises

I. Fill in the blanks with suitable words given below.

where, which, when, who, that

1. We know ... Oersted established the relation between the flow of electric current and a magnetic needle. 2. The great scientists Volta, Ampere and Yablochkov may be named among those ... have greatly contributed to electrical engineering. 3. The end ... the lines of force leave the coil after passing through its core will act like a north

magnetic pole. 4. ... there is a certain connection between electricity and magnetism was proved by experiments. 5. ... he placed the wire parallel to the needle he saw ... the needle deflected. 6. A wire ... is wound in the form of a solenoid acts like a magnet as long as it is carrying a current.

II. Translate the following sentences and define the functions of the word **that.**

1. It is clear that the greater the number of free electrons in a substance, the better that substance conducts the electric current. 2. An electric current passing through a wire heats that wire. 3. It is the unit of current that is named after Ampere. 4. That a solenoid has two poles that attract and repel the poles of other magnets is a well-known fact. 5. The physics of bodies at rest is much simpler than that of the bodies that are in motion. 6. There was a time when lightning was a problem that scientists tried to solve but at present everybody knows that it is an electric spark like that produced by the electric machines. 7. Experiments show that all gases expand when heated.

III. Translate the following sentences paying attention to the words in bold type.

a) 1. Ampere's contribution to electrodynamics **as** he called the new science began in 1820. 2. **As** it is impossible to detect electricity by our physical senses, we generally detect it by its effects. 3. An electromagnet loses its magnetic properties **as soon as** the current is turned off. 4. In certain branches of industry, chemical energy is **not so** widely used **as** mechanical energy. 5. The average speed of all molecules remains the same **as long as** the temperature is constant. 6. In order to produce electricity more economically the generators must be **as** large **as** possible. 7. **As** a gas is cooled, it loses heat **as well as** energy. 8. The magnetic effect of an electric current is the subject of the present article, **as for** the heating effect it was dealt with before.

b) 1. Rubber is a **very poor** conductor of electricity. 2. This is **the very** appliance which I need for my experiment. 3. Lomonosov was born in the family of a **poor** peasant. 4. All metals are **poor** insulators of electric current. 5. The Soviet Union is a great **country.** 6. Next summer I shall have a **rest** in the **country.** 7. **The rest** of the story should be translated at home. 8. Electricity at **rest** or in

a static condition does no work. 9. Heat **causes** many chemical reactions. 10. What **causes** the electrons to flow along the wire? 11. A short circuit may be the **cause** of fire.

IV. Give suitable prepositions to the following verbs and form sentences with the Infinitives obtained.

to equip, to depend, to compare, to consist, to contribute, to be interested, to be familiar, to point, to look, to start, to speak

V. Answer the following questions.

1. When was the voltaic cell invented? 2. What did Oersted decide to establish? 3. What did he find out? 4. When did the needle deflect? 5. Who repeated Oersted's experiments? 6. Do you know Ampere's rule? 7. What did Ampere establish and prove? 8. When is magnetism greatly increased? 9. Is the magnetic effect produced when the charges are at rest? 10. What is an electromagnet? 11. When does the iron core act as a magnet?

VI. Compare:

1. Potential energy and kinetic energy. 2. A series circuit and a parallel circuit. 3. A conductor and an insulator. 4. The magnetic effect of an electric current and the heating effect of an electric current.

VII. Give a short summary of Text 17.

VIII. Look at Fig. 5 and describe Oersted's discovery.

IX. Describe Fig. 6.

UNIT EIGHTEEN

Grammar: The Complex Sentence (Revision)

Class Exercises

I. Translate the following sentences paying attention to the subordinate clauses.

1. The plants which supply electricity over long distances are equipped with large alternators. 2. When asked about the dynamo the student mentioned its inventor. 3. The experiments Oersted made attracted Ampere's attention. 4. The armature and the electromagnet are the prin-

cipal parts the generator consists of. 5. That the electromagnets are controllable is a very important thing, since they can attract and repel magnetic materials. 6. The alternator is a machine that generates a.c. 7. A bar of iron becomes strongly magnetized if inserted into the solenoid while the current is flowing.

II. Read the following abbreviations and give their full forms.

i.e., a.c., d.c., r.p.m., e.m.f., m.m.f., 317°F, 45°C, etc.

III. Learn to recognize the following international words.

solenoid, shunt, electrification, dynamo, primitive, rotor, kilowatt, electromagnet, apparatus, industry, plan, elementary

IV. Do Laboratory Work 18.

TEXT 18. GENERATORS

The dynamo invented by Faraday in 1831 is certainly a primitive apparatus compared with the powerful, highly efficient generators and alternators that are in use today. Nevertheless, these machines operate on the same principle as the one invented by the great English scientist. When asked what use his new invention had, Faraday asked in his turn: "What is the use of a new-born child?" As a matter of fact, "the new-born child" soon became an irreplaceable device we cannot do without.

Although used to operate certain devices requiring small currents for their operation, batteries and cells are unlikely to supply light, heat and power on a large scale. Indeed, we need electricity to light up millions of lamps, to run trains, to lift things, and to drive the machines. Batteries could not supply electricity enough to do all this work.

That dynamo-electric machines are used for this purpose is a well-known fact. These are the machines by means of which mechanical energy is turned directly into electrical energy with a loss of only a few per cent. It is calculated that they produce more than 99.99 per cent of all the world's electric power.

There are two types of dynamos, namely, the generator and the alternator. The former supplies d.c. which is simi-

lar to the current from a battery and the latter, as its name implies provides a.c.

To generate electricity both of them must be continuously provided with energy from some outside source of mechanical energy such as steam engines, steam turbines or water turbines, for example.

Both generators and alternators consist of the following principal parts: an armature and an electromagnet. The electromagnet of a d.c. generator is usually called a stator for it is in a static condition while the armature (the rotor) is rotating. Fig. 7 shows the principles the construction of an elementary d.c. generator is based upon. We see the armature, the electromagnet, the shunt winding, the commutator and the load. Alternators may be divided into two types: 1. alternators that have a stationary armature and a rotating electromagnet; 2. alternators whose armature serves as a rotor but this is seldom done. In order to get a strong e.m.f., the rotors in large machines rotate at a speed of thousands of revolutions per minute (r.p.m.). The faster they rotate, the greater the output voltage the machine will produce.

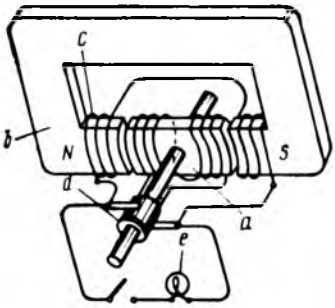

Fig. 7. A simple type of elementary direct current generator (dynamo)

In order to produce electricity under the most economical conditions, the generators must be as large as possible. In addition to it, they should be kept as fully loaded as possible all the time. It is interesting to note here that the biggest generators ever installed at any hydroelectric station in the world are those installed in the USSR. As you are likely to remember the Bratskaya hydroelectric station is equipped with 225,000 kilowatt (kW) generators. Soviet scientists constructed more powerful generators which are installed at the Krasnoyarskaya station. The Konakovskaya, the Zaporozhskaya and the Uglegorskaya steam power-stations have large rated capacity. Our industry produces even greater power installations of 1,200 MW for the steam power plants which play such an important part in the electrification plan of the USSR.

Exercises

I. Translate the following sentences.

1. There is a great number of engineering problems the Soviet scientists work at. 2. It is quite impossible to name a scientific problem Lomonosov did not turn his attention to. 3. There are many electric appliances we cannot do without. 4. The experiment I told you about will take much time. 5. The direction the needle points in changed several times. 6. The speed a given molecule travels with is greatly increased when a gas is heated.

II. Form adjectives using the suffixes **-able, -ful, -less, -ous.**

control, continue, danger, value, replace, need, power, peace, use, life, change, desire, vary

III. Form adverbs using the suffix **-ly** and translate them.

exact, electrical, general, gradual, negative, natural, opposite, previous, usual, easy, hard, late

IV. Translate the following sentences paying attention to the construction **the former . . . the latter.**

1. There are two kinds of current: a.c. and d.c. **The former** changes its direction, **the latter** does not. 2. I have two friends, Nick and Pete. **The former** studies at the university, **the latter** works at the factory. 3. He has a book on electrical engineering and a book on nuclear physics. **The former** is in Russian and **the latter** is in English. 4. I spoke to professors G. and W. **The former** delivers lectures on chemistry, **the latter** on semiconductors.

V. Form five sentences combining suitable parts of the sentences given in columns I and II.

I	II
1. The electric circuit	1. is a temporary magnet provided by electricity.
2. The e.m.f.	2. is an electrical appliance used in daily life.
3. The heat engine	3. is a path to be followed by the current from the source and back to the source.

4. The iron	4. is the force that makes electrons move along a conductor.
5. The electromagnet	5. is a device by means of which heat is turned into work.

VI. Answer the following questions.

1. When did Faraday invent the dynamo? 2. Was Faraday an American scientist? 3. Can batteries supply power on a large scale? 4. What do we need electricity for? 5. What are dynamo electric machines used for? 6. What types of dynamos do you know? 7. What are the principal parts of a generator? 8. In what condition is the stator of an electromagnet? 9. What generators is the Bratsk hydroelectric station equipped with? 10. How many generators are installed at the Konakovskaya steam power plant? 11. What is their rated capacity? 12. What are the largest steam power plants in Europe? 13. What does Fig. 7 show?

VII. Ask your groupmate the following questions. Let him/her answer them.

1. if batteries can supply light, heat and power on a large scale. 2. if the electromagnet is a temporary magnet provided by electricity. 3. if the electromagnet is lifeless unless the electric current flows through the coil. 4. if the iron core will act as a magnet as long as the current continues to pass along the winding. 5. if the alternator provides a.c. 6. if the generator must be turned by some outside source of mechanical energy.

VIII. Define the following terms.

electromotive force, electric circuit, heating effect of an electric current, magnetic effect of an electric current, electromagnet, generator

IX. Look at Fig. 7, name a, b, c, d, e and describe the figure.

UNIT NINETEEN

Grammar: Impersonal Constructions

Class Exercises

I. Translate the following sentences paying attention to the Impersonal Constructions.

a) 1. It is easy to understand Ampere's rule. 2. It was desirable to compare the results obtained. 3. It is necessary

to find new sources of energy. 4. It was difficult for Oersted to find out why the compass needle was deflected.

b) 1. One can say that there are unlimited sources of energy. 2. One could not obtain good results without repeating the test. 3. There are so many atoms in a water drop that if one could count one atom a second, day and night, it would take one hundred milliard years. 3. One may mention here that the first industrial nuclear power plant in the world was constructed in this country.

c) 1. They employ different methods to obtain better results. 2. They produce modern machines at our plant. 3. They say that lasers will be widely used in the near future.

d) 1. It is supposed that people learnt to protect their houses from thunderstorms years ago. 2. It is said that these substances have similar properties. 3. It is well known that one form of energy can be converted into another form.

II. Give all the meanings of the following words consulting a dictionary.

scale, generation, armature, revolution, commutator, amplitude, iron, needle, second

III. Do Laboratory Work 19.

TEXT 19. POWER TRANSMISSION

They say that about a hundred years ago, power was never carried far away from its source. Later on, the range of transmission was expanded to a few miles. And now, in a comparatively short period of time, electrical engineering has achieved so much that it is quite possible, at will, to convert mechanical energy into electrical energy and transmit the latter over hundreds of kilometres and more in any direction required. Then in a suitable locality the electric energy can be reconverted into mechanical energy whenever it is desirable. It is not difficult to understand that the above process has been made possible owing to generators, transformers and motors as well as to other necessary electrical equipment. In this connection one cannot but mention the growth of electric power generation in this country. The longest transmission line in pre-revolutionary Russia was that connecting the Klasson power-station with Moscow. It is said to have been but 70 km long, while the pre-

sent Volgograd—Moscow high-tension transmission line is over 1000 kilometres long. (The reader is asked to note that the English terms "high-tension" and "high-voltage" are interchangeable.) Generally speaking, the length of high-tension transmission lines in the Soviet Union is so great that they could circle the globe six times, if not more.

It goes without saying that as soon as the electric energy is produced at the power-station, it is to be transmitted over wires to the substation and then to the consumer. However, the longer the wire, the greater is its resistance to current flow. On the other hand, the higher the offered resistance, the greater are the heating losses in electric wires. One can reduce these undesirable losses in two ways, namely, one can reduce either the resistance or the current. It is easy for us to see how we can reduce resistance: it is necessary to make use of a better conducting material and as thick wires as possible. However, such wires are calculated to require too much material and, hence, they will be too expensive. Can the current be reduced? Yes, it is quite possible to reduce the current in the transmission system by employing transformers. In effect, the waste of useful energy has been greatly decreased due to high-voltage lines. It is well known that high voltage means low current, low current in its turn results in reduced heating losses in electrical wires. It is dangerous, however, to use power at very high voltages for anything but transmission and distribution. For that reason, the voltage is always reduced again before the power is made use of.

Lasers. Soviet scientists are successfully developing quantum generators, called lasers, for emitting light amplitude radio waves. Theoretical calculations have shown that lasers are very likely to transform the energy of light radio waves into electrical energy with an efficiency amounting to about 100 per cent. It means that electrical power might be transmitted over considerable distances with negligible losses and what is very important without the use of transmission lines.

Exercises

I. Translate the following sentences into English using the Impersonal Constructions.

1. Говорят, что это изобретение увеличит к. п. д. машины. 2. Теперь можно считать наше исследование

завершенным. 3. Полагают, что результаты опять подтвердили теоретические расчеты. 4. Следует упомянуть, что советские ученые давно работают над проблемой передачи энергии с помощью лазера. 5. Очень важно, что новое оборудование не дорогое. 6. Рабочему было трудно понять причину повреждения установки. 7. Желательно использовать все виды энергии для получения электричества.

II. Complete the following sentences.

1. Owing to the transformer it became possible... . 2. It was Ampere who... . 3. The dynamo-electric machines are used for... . 4. In order to reduce resistance in a wire, it is necessary... . 5. The waste of useful energy can be decreased ... . 6. Coal is burned in order to... . 7. Lasers are used for ... .

III. Translate the following sentences.

1. Чем сильнее магнитное поле, тем больше ток. 2. Чем больше ток, текущий по проводнику, тем выше температура проводника. 3. Чем меньше труба, тем меньше воды проходит через нее. 4. Чем больше скорость движения между магнитным полем и проводниками, тем больше ток. 5. Чем короче проводник, тем меньше сопротивление проходящему току.

IV. For the terms given in (a) find the Russian equivalents in (b).

a) 1. power plant; 2. power supply; 3. power generation; 4. power source; 5. power transmission; 6. power unit; 7. power installation; 8. power substation; 9. power transformer; 10. power factor; 11. power engineering; 12. power capacity; 13. power distribution; 14. power loss

b) 1. выработка электроэнергии; 2. потеря энергии; 3. электроподстанция; 4. силовой трансформатор; 5. коэффициент мощности; 6. производительность; 7. источник энергии; 8. распределение энергии; 9. электростанция; 10. передача электроэнергии; 11. силовая установка; 12. источник питания; 13. энергетика; 14. энергоблок

V. a) Choose the right term; b) explain the statements.

1. The coil of wire that rotates in a dynamo or a motor is known as: a) a turbine, b) a stator, c) an armature, d) a generator. 2. Running water is an illustration of: a) potential energy, b) kinetic energy, c) electric energy, d)

heat energy. 3. Steam generators produce electrical energy from: a) potential energy, b) chemical energy, c) light energy, d) mechanical energy.

VI. Answer the following questions.

1. What made it possible to transmit electric energy over hundreds of kilometres? 2. Can electric energy be reconverted into mechanical energy? 3. What are transformers used for? 4. What do you know about the longest transmission line in pre-revolutionary Russia? 5. How long is the Volgograd—Moscow high-tension transmission line? 6. In what way can the heating losses be reduced in transmission lines? 7. How can resistance be reduced in electric wires? 8. Why are high-voltage lines used for power transmission? 9. Is it possible to use quantum generators for power transmission? 10. What have theoretical calculations shown?

VII. Define the following terms.

power-station, nuclear reactor, transmission line, solenoid, electromagnet, heat losses, rotor

VIII. Retell Text 19.

IX. Read Text 19A in 1 minute and find the definition of "secondary cells".

TEXT 19A. STORAGE BATTERIES

Storage batteries are made up of a number of rechargeable cells, often called secondary cells to distinguish them from primary cells. Secondary cells are made of several different materials but all work on the principle of reversible chemical action between two dissimilar electrodes (plates) immersed in an active solution (electrolyte). Particular battery designs are, of course, much more complicated and have several plates in parallel, closely packed with insulating separators.

X. Find English equivalents to the following Russian word combinations.

чтобы отличить их от первичных элементов, на основе обратимого химического действия, изоляционные прокладки

UNIT TWENTY

Grammar: The Passive Voice

Class Exercises

I. Translate the following sentences.

1. The students were asked to carry on the experiment. 2. You will be given two new magazines. 3. I was told to translate the instructions. 4. The questions were answered at once. 5. The theory was followed by a number of experiments. 6. The data obtained are often referred to. 7. The new discovery was much spoken about. 8. This machine is often made use of. 9. This apparatus is often made use of. 10. The lecture will be followed by a new film.

II. Form as many words as possible using suffixes and prefixes. Define what parts of speech the new words are and translate them.

engine, apply, differ, electric, value, oppose, transform, magnet, conduct, neglect

III. Learn to recognize the following international words.

globe, laser, quantum, theoretical, induction, electronic, plastics, asbestos, volt

IV. Do Laboratory Work 20.

TEXT 20. TRANSFORMERS

The transformer is a device for changing the electric current from one voltage to another. As a matter of fact, it is used for increasing or decreasing voltage. A simple transformer is a kind of induction coil. It is well known that in its usual form it has no moving parts. On the whole, it requires very little maintenance provided it is not misused and is not damaged by lightning.

We may say that the principal parts of a transformer are two windings, that is coils, and an iron core. They call the coil which is supplied with current the "primary winding", or just "primary", for short. The winding from which they take the current is referred to as the "secondary winding" or "secondary", for short. It is not new to you that the former is connected to the source of supply, the latter being connected to the load.

When the number of turns of wire on the secondary is the same as the number on the primary, the secondary voltage is the same as the primary, and we get what is called a "one-to-one" transformer. In case, however, the number of turns on the secondary winding is greater than those on the primary, the output voltage is larger than the input voltage and the transformer is called a step-up transformer. On

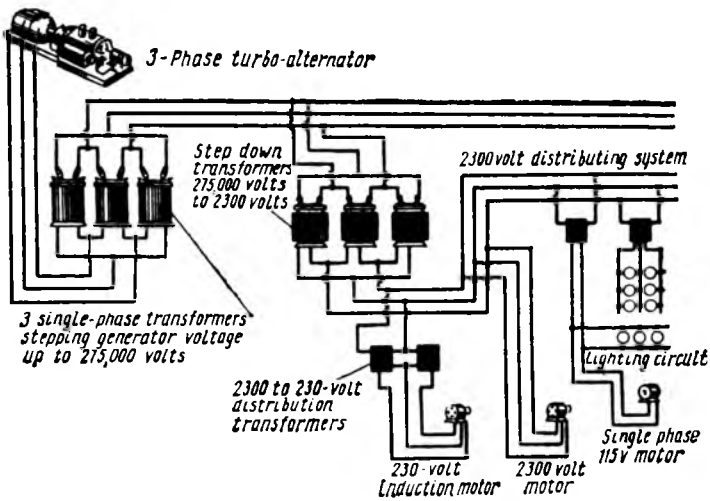

Fig. 8. The use of transformers for many purposes in transmission and distribution systems

the other hand, the secondary turns being fewer in number than the primary, the transformer is known as a step-down transformer.

The transformer operates equally well to increase the voltage and to reduce it. By the way, the above process needs a negligible quantity of power. It is important to point out that the device under consideration will not work on d.c. but it is rather often employed in direct-current circuits.

Fig. 8 shows how transformers are used in stepping up the voltages for distribution or transmission over long distances and then in stepping these voltages down. In this figure, one may see three large step-up transformers which are used to increase the potential to 275,000 volts for transmission over long-distance transmission lines.

At the consumer's end of the line, in some distant locality, three step-down transformers are made use of to reduce that value (i.e., 275,000 volts) to 2,300 volts. Local transformers, in their turn, are expected to decrease the 2,300 volts to lower voltages, suitable for use with small motors and lamps. One could have some other transformers in the system that reduce the voltage even further. All radio sets and all television sets are known to use two or more kinds of transformers. These are familiar examples showing that electronic equipment cannot do without transformers.

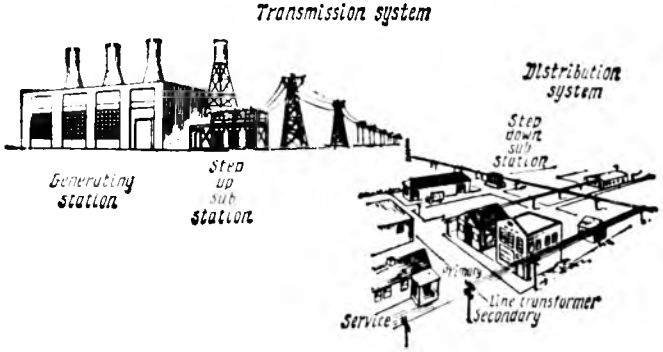

Fig. 9. Transmission and distribution systems

The facts you have been given above illustrate the wide use of transformers and their great importance.

Another alternating-current system of transmission and distribution is shown in Fig. 9. You are asked to follow the whole process, that is, to describe it from beginning to end.

Exercises

I. Translate the following sentences paying attention to the Subjective Infinitive Constructions and the Passive Voice.

1. This substance was supposed to have some important properties. 2. This device is expected to be the best for converting heat into work. 3. The new power plant is known to have been put into operation. 4. This invention was considered to be of great practical importance. 5. A magnetic flux is assumed to consist of magnetic lines of force taken as a whole.

II. Translate the following sentences.

1. Говорят, что этот прибор описан в предыдущей статье. 2. Считали, что ток течет от положительного потенциала к отрицательному. 3. Говорят, что мой друг — хороший математик. 4. Известно, что Ломоносов основал Московский университет. 5. Кажется, что это вещество имеет некоторые другие свойства. 6. Известно, что переменный ток меняет свое направление.

III. Form nouns from the following words using suitable suffixes.

construct, develop, consider, distribute, deflect, equip, connect, require, produce, state, suit

IV. For the word combinations given in (a) find the Russian equivalents in (b).

a) 1. a number of; 2. as a matter of fact; 3. on the basis of; 4. for this reason; 5. it goes without saying; 6. at last; 7. on the whole; 8. to step up; 9. to increase current; 10. to offer resistance; 11. electrical engineering; 12. to step down

b) 1. наконец; 2. повышать (напряжение); 3. оказывать сопротивление; 4. понижать (напряжение); 5. ряд; 6. увеличить ток; 7. на основе чего-л.; 8. по этой причине; 9. в целом; 10. электротехника; 11. на самом деле; 12. само собой разумеется

V. Translate the following sentences and define the functions of the word **but**.

1. The Fahrenheit scale is mainly used in English-speaking countries but it is not used in the Soviet Union. 2. His scientific activity lasted but twenty years, but in these twenty years he did very much. 3. Motors are widely employed not only in industry but also in everyday life. 4. There is but one measuring scale in the instrument. 5. Everyone took an examination in physics but Comrade Novikov. 6. A simple transformer is but a kind of induction coil.

VI. Arrange the following words in the pairs of synonyms.

a) 1. amount; 2. big; 3. matter; 4. application; 5. at present; 6. tube; 7. research; 8. to step down; 9. appliance; 10. minute; 11. arrow

b) 1. investigation; 2. device; 3. needle; 4. quantity; 5. substance; 6. to lower; 7. small; 8. large; 9. new; 10. use; 11. pipe

VII. Arrange the following words in the pairs of antonyms.

a) 1. left; 2. increase; 3. beginning; 4. d.c.; 5. above; 6. step-up; 7. at rest; 8. high; 9. short; 10. more

b) 1. end; 2. low; 3. long; 4. step-down; 5. in motion; 6. less; 7. decrease; 8. below; 9. a.c.; 10. right

VIII. Answer the following questions.

1. What is a transformer? 2. What is a transformer used for? 3. Are there any moving parts in a transformer? 4. Can a transformer be damaged by lightning? 5. What are the principal parts of a transformer? 6. How many windings are there in a transformer? 7. What winding is connected to a load? 8. What is the purpose of a step-up transformer? 9. What is known as a step-down transformer? 10. Does a transformer work on d.c.? 11. In what circuits is the transformer used? 12. For what purpose are step-down transformers used? 13. Is your radio set equipped with a transformer? 14. Can we do without transformers? 15. Are transformers used both in industry and in our homes?

IX. Compare:

1. A solenoid and an electromagnet. 2. A direct current and an alternating current. 3. A step-up transformer and a step-down transformer. 4. A stator and a rotor. 5. A primary winding and a secondary winding.

X. Retell Text 20.

XI. Read Text 20A in 2 minutes and give a heading to each paragraph of the text.

TEXT 20A

The primary alternating current produces an alternating magnetic flux in the iron core, and this alternating magnetic flux passes through the turns of the secondary winding. According to well-known electromagnetic laws, this flux produces an alternating e.m.f., or voltage, in the secondary winding. In spite of the fact that there is no electric connection between the two circuits—the primary and the secondary—the application of a voltage to one is known to produce a voltage at the terminals of the other.

Inefficiency in a transformer is caused mainly by heat losses due not only to current flowing in the coils but also to unwanted currents induced in the core of the transform-

er. Currents induced in the core are generally called "eddy currents". The flow of eddy currents is stopped in its progress and the efficiency of the transformer is increased by constructing the transformer core of flat sheets of soft iron.

XII. Define the main idea of each paragraph of Text 20A.

XIII. Find the English equivalents to the following Russian word combinations.

нежелательные токи, наводимые в сердечнике трансформатора; создает переменный магнитный поток; изготовление сердечника трансформатора

UNIT TWENTY-ONE

Class Exercises

I. a) Form sentences using the following word combinations.

the very device to be employed, the problem to be solved, the temperature to be measured, the story to be told, the research work to be finished, the apparatus to be designed

b) Complete the following sentences, using the Infinitive Construction.

M o d e l: ... is expected to ... . → The scientist is expected to deliver an interesting lecture.

1. ... know him to .... 2. ... wanted us to .... 3. ... expected you to .... 4. ... is supposed to .... 5. ... was considered to .... 6. ... is known to ... .

II. a) Form verbs using the suffix **-ize**.

civil, revolution, equal, neutral, modern

b) Form verbs using the prefix **over-**.

load, throw, grow, come, estimate, power, take, heat

c) Form nouns using suffixes **-or, -er**.

work, translate, act, speak, steam, boil, conduct, engine, fact, heat

III. Do Laboratory Work 21.

TEXT 21. ELECTRIC MOTOR

The electric motor is a device employed for transforming electrical energy into mechanical energy. We know it to turn machinery and various appliances.

We have already seen the generator convert mechanical energy into electric energy. Now, the process is reversed. It is electricity that is supplied to the machine and it is motion that we obtain. From all that has been said in the previous articles about our getting magnetism from electricity and about the generation of electric current by using magnetism, it is obvious that generators and motors are similar in certain respects. There is certainly some difference in detail but in both of them we find an armature with windings, a commutator and brushes combined with an electromagnet for producing the magnetic field. However,

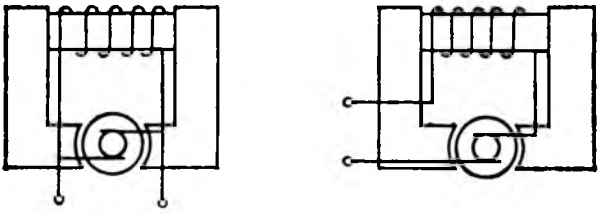

Fig. 10. Shunt and series windings of armature and field coils

in an electric motor one shunt winding is not sufficient and a second one called a series winding should be added. "Why is it necessary?" one might ask. The fact is that the motor should have a powerful effect at the very moment when the current is switched on, as for instance, in an electric tram or a train. A very strong magnetic field is needed to obtain a so-called powerful starting torque. This is achieved by adding a series winding to the magnetic coils (Fig. 10). It is connected not in shunt with the armature but in series with it. Thus, all the heavy starting current, passing through the armature winding, now passes through the series field coil and provides a strong field necessary for starting, the shunt field winding providing the running conditions.

No appliance ever created by man has probably such a wide range of size and such a variety of application as a motor. In fact, on the one hand, there are all kinds of mighty giants in the motor world. These giants are known to perform innumerable operations wherever required. On the other hand, there exist all kinds of small-sized and even

minute motors which are able to power various complex machines and operate equally well under any conditions.

So far nothing was said of what a motor does in our homes. In a modern home there are many different electric motors in machines and devices utilized to meet our daily requirements: to tell the time, to wash clothes, to cool the refrigerator, to clean or brush various things, to shave, to circulate air in a warm room on a hot summer day, and so on. In effect, vacuum cleaners, washing machines, and modern refrigerators do work thanks to electric motors. It follows that in the electric motor we have a valuable and powerful appliance capable of fulfilling the required operations exactly and with just the desirable power and rate of motion. It is readily switched on, at will, and it continues running until we switch it off. There are often cases when it is simply impossible to replace it by any other means. In short, the motor finds application in industry and engineering, in agriculture and transport, in medicine and our homes.

Exercises

I. Translate the following sentences.

1. The flow of current being reduced, the speed of the motor is decreased. 2. It is on the above basis that all our power plants are constructed at present. 3. We know of this substance having been used owing to its high quality. 4. Copper being a good conductor, we were asked to use it when carrying on our research work. 5. By changing the value of the resistance we can increase the current. 6. Having been used for a long time, the instrument lost its former quality. 7. Were that solid substance heated, it would greatly expand. 8. To observe is the primary rule of any experiment. 9. The professor wants us to turn our attention to the problem of semiconductors. 10. The new invention proved to be of great practical importance.

II. Translate the following sentences using the Passive Voice.

1. Приборы будут получены завтра. 2. Студентам дали новые инструкции. 3. Об этих достижениях много говорят. 4. Меня просили провести испытание. 5. Пример последовал за правилом. 6. Нам показали новые материалы. 7. Их учат иностранным языкам. 8. На эти

письма ответили вчера. 9. На этот вопрос нелегко ответить. 10. На ваши статьи часто ссылаются.

III. Define the function of the words in bold type.

1. The methods **applied improved** the quality of production. 2. The machine **used showed** good results. 3. The experiment **described attracted** everybody's attention. 4. The appliance **received required** some improvement. 5. The substances **utilized neutralized** each other. 6. The amount of electricity **generated depended** on the quality of the coal. 7. The scientists **mentioned contributed** greatly to the development of science.

IV. Translate the sentences and define the function of the word **one**.

1. One hundred years ago there were neither electric lamps nor electric motors. 2. One might mention many more well-known facts and names. 3. The motor in question is more powerful than the one you spoke about yesterday. 4. There was only one problem to be solved. 5. The first student gave more correct answers that the last one. 6. One can reduce heat losses in a transmission line. 7. One of you will compare the results obtained.

V. Fill in the blanks with the following expressions.

to find application in, to make use of, to play an important part in, to take interest in, to pay attention to

1. Many Russian scientists of the past ... the development of Russian science. 2. Lomonosov ... not only ... physics but also in chemistry. 3. We ... minute motors as well as mighty giants. 4. Insulators as well as conductors ... electrical engineering. 5. The Soviet scientists ... great ... the peaceful use of atomic energy.

VI. Define the following terms.

a transformer is a device which... , a dynamo is a machine which..., a battery is a device which... , a switch is a device which... , an engine is a machine which... , a thermometer is a device which... , a motor is a device which ... , a generator is a machine which...

VII. Answer the following questions.

1. What device is discussed in the present article? 2. What is a motor employed for? 3. What kind of motors do you know? 4. Does the generator convert electrical

energy into mechanical energy? 5. What parts of a motor do you know? 6. What is a very strong magnetic field needed for? 7. What does the shunt field winding provide? 8. What does a motor do in our homes? 9. Do motors serve you every day? 10. Where does a motor find its wide application?

VIII. Describe Fig. 10.

IX. Speak on:

1. The use of electric motors in industry. 2. The use of electric motors in everyday life.

X. Read Text 21A in 1 minute and find the description of the underground power-station.

TEXT 21A. UNDERGROUND HYDROELECTRIC POWER-STATION

In about 1889 what may have been the world's first underground hydroelectric power-station was installed in one of the mines in America. This plant comprised six 40 in. impulse wheels operating under a vertical head of 1,680 ft, each runner being connected to a generator supplying power to the mill a short distance away. Designs and techniques have gradually improved during the past years and there are now 300 underground hydroelectric power-stations either in service or under construction.

XI. Point out which of the sentences contains the information from the text.

1. A very strong magnetic field is achieved by adding a series winding to the magnetic coil. 2. The power-station of this kind supplied power to the mill a short distance away. 3. The device under consideration will not work on direct current but it is employed in direct current circuits.

UNIT TWENTY-TWO

Class Exercises

I. Translate the following sentences.

1. After studying the properties of solids we shall deal with the properties of liquids. 2. The problem to be dealt with will require much time. 3. Thermodynamics is the subject the scientist will deal with in the next article. 4. Before dealing with this new device one should study all its

parts. 5. The next problem the professor dealt with was connected with the application of semiconductor lasers. 6. The work the students deal with is difficult but interesting. 7. Under ordinary conditions the only current one could deal with is a.c.

II. Give all the meanings of the following words consulting a dictionary.

number, figure, matter, reverse, injection, location, principle

III. Do Laboratory Work 22.

TEXT 22. MAGNETOHYDRODYNAMIC GENERATOR

Magnetohydrodynamics (MHD) is a field of fluid mechanics. The latter deals with the flow of the fluid or gas conducting electricity in the magnetic field. As gases can flow too they are considered as liquids.

More than a hundred years ago in 1831, Faraday discovered electromagnetic induction. Today every schoolchild knows the experiment from the school physics laboratory. If a conductor connected to an electric circuit crosses the space between the poles of a magnet an electric current is induced in it. But the metal conductor can be replaced by any other conductor. For example, it may be a flow of electroconducting liquid or gas.

If gases are heated to some thousands of degrees the atoms that make them up are broken down into electrically charged particles, the latter interacting with the magnetic field.

A high temperature gas in an MHD generator gives the same result as a copper armature in a conventional d.c. generator. By means of suitable electrodes part of the energy of the ionized gas passing through the magnetic field is converted directly into electricity. It is this conversion that we are mostly interested in.

An MHD generator combines the functions of both a steam turbine and an electrical generator. As the energy of the gas is converted directly into electrical energy, an MHD generator is in principle a much simpler device than a turbogenerator.

As shown in Fig. 11 it consists of a nozzle, a channel with electrodes and insulators, located in the magnetic

field. The generator under consideration has no moving parts that cause energy losses. Thus it can withstand much higher temperatures than those of the turbines.

As a result of high temperature operation a power plant with an MHD generator is more efficient than a turbine power plant. Studies show that an MHD power plant can reach 50% efficiency, and 55-60% in the future, the highest obtainable efficiency of a thermal power plant being 40%.

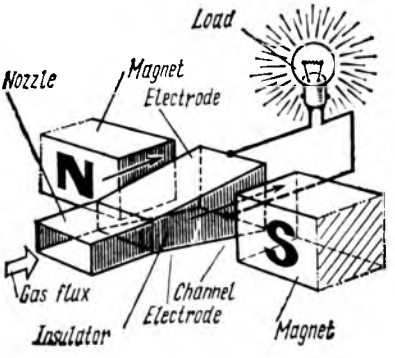

Fig. 11. MHD generator

MHD energy conversion becomes possible only with the right combination of gas velocity, electrical conductivity and magnetic field induction.

It is the study of the above-mentioned combination that has led to the development of three approaches to the MHD power generation. The first one is the open cycle generator where the ionized gas flux is injected into the nozzle of the channel. The second approach is the closed cycle generator in which plasma circulates inside the MHD generator itself. In the third, a liquid metal is used instead of a plasma in the channel. All three approaches are investigated at present. So far, the open cycle generator seems to be the most feasible of them.

The first experimental industrial MHD installation "U-25" was constructed in Moscow. The above installation is known to have been put into operation in 1971. Its capacity is 20,000 kW. The U-25 operates on natural gas and has a magnet about 10 metres long.

By the end of the present century the consumption of electricity is expected to be ten times as great as it is today. To increase power production rapidly we shall not only have to build giant thermal power plants but also to develop principally new power generation methods. There is every reason to believe that large MHD stations will be operating in our country in the near future.

Exercises

I. Translate the following sentences paying attention to the words in bold type.

a) 1. The fourth state of matter is known **as** plasma. 2. **As** the devices were out of date it was decided not to install them. 3. The gas cools **as** it flows through the generator. 4. **As** a charged particle is called an ion, we may consider the free electrons **as** negative ions. 5. The term "hydrodynamics" is used **as** a synonym for fluid dynamics. 6. **As** heat is absorbed by a body, the temperature of the latter rises.

b) 1. The physical properties of plasma have been a problem **since** the discovery of that state of matter. 2. **Since** the steam gives up its heat energy to drive the turbine its temperature and pressure fall. 3. I worked at the power plant last year and I have not been there **since**. 4. Automatic control in the simplest form has been known **since** the beginning of the steam age. 5. Silver is the best conductor known **since** it offers the least resistance to the current flow.

II. Fill in the blanks with the words and expressions given below. Translate the sentences.

1. with the result; 2. as a result; 3. results; 4. resulted in; 5. the results; 6. resulted from

1. We have discussed ... obtained. 2. When the electric current flows along the conductor, heat .... 3. Faraday's experiments ... a great discovery. 4. Almost all bodies expand ... of heating. 5. Faraday carried on different experiments with coils, wire and magnetic needles with varying .... 6. In a cell the potential difference is maintained by the chemical action; copper is at a higher potential than zinc ... that a current of positive electricity flows from the copper to the zinc. 7. The possibility of designing first MHD power plants... the investigation of MHD energy conversion.

III. Arrange the following words in the pairs of synonyms.

a) 1. feasible; 2. flux; 3. to transform; 4. liquid; 5. to investigate; 6. speed; 7. to build; 8. wire; 9. change; 10. conventional

b) 1. velocity; 2. to construct; 3. possible; 4. to research; 5. conductor; 6. transformation; 7. usual; 8. to convert; 9. fluid; 10. flow

IV. Form seven sentences combining suitable parts of the sentences given in columns I and II.

I	II
1. Magnetohydrodynamics is	1. the functions of a steam turbine and an electrical generator.
2. Faraday discovered	2. a liquid metal is used instead of a plasma in the channel.
3. An MHD generator combines	3. the consumption of electricity will be ten times as great as it is today.
4. An MHD generator consists	4. the right combination of electrical conductivity, velocity and the magnetic field.
5. The first problem was	5. electromagnetic induction.
6. In the third approach	6. of a nozzle, a channel with electrodes and insulators.
7. By the end of the present century	7. a field of fluid mechanics.

V. Answer the following questions.

1. What does fluid mechanics deal with? 2. Why are gases considered as liquids? 3. Who discovered electromagnetic induction? 4. What experiment does every schoolchild know? 5. When do the atoms of gases break down into electrically charged particles? 6. What particles interact with the magnetic field? 7. What functions does an MHD generator combine? 8. Why is an MHD generator a much simpler device than the turbogenerator? 9. What does an MHD generator consist of? 10. Why is a power plant with an MHD generator more efficient than a turbine power plant? 11. What is the first approach to MHD power generation? 12. What can you say about the first Soviet MHD installation? 13. What is its capacity?

VI. Describe Fig. 11.

VII. Retell Text 22.

VIII. Read Text 22A in 1 minute and give a heading to it.

Faraday performed the first experiment in MHD in the early nineteenth century. He put two electrodes in the Thames River trying to develop an electrical signal from the flow of the river through the earth's magnetic field. There were two problems in this simple experiment.

The first one was the lack of combination of electrical conductivity, velocity and the magnetic field. The second problem was connected with the difficulties in the extraction of the electric current at the electrodes. The latter still remains a critical problem for the scientists to solve.

IX. Point out which of the sentences contains the information from the text.

1. MHD energy conversion becomes possible only with the right combination of gas velocity, electrical conductivity and magnetic field induction. 2. A power plant with MHD generator is more efficient than a turbine power plant. 3. The problem of the extraction of the electric current at electrodes is important for MHD.

SECTION II

LABORATORY WORKS

LABORATORY WORK 1

I. Practise the pronunciation of the following words. Repeat them after the speaker.

electricity, motor, temperature, either, thousand, continuous, numerous, foreign, contribute, development, result, vacuum, machine, familiar, night, bicycle, mechanical, object, pyrometer, imagine, civilization, refrigerator, weigh, telephone, theatre

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **application** — применение. The motors find different applications.
2. **as for** — что касается. My friend speaks English well. As for me I can't do it.

3. **current** — ток. Where is the current used?
4. **device** — прибор, приспособление. We use different devices at home.
5. **to do without** — обходиться без чего-либо. We can't do without the telephone.
6. **electric(al)** — электрический. A vacuum cleaner is an electrical device.
7. **furnace** — печь, горн. Is there an electric furnace in your room?
8. **inventor** — изобретатель. Popov is the inventor of the radio.
9. **laboratory** — лаборатория. There are electrical furnaces in our laboratory.
10. **to make use of** — использовать. The students make use of electrical devices in the laboratory.
11. **to measure** — измерять. Can you measure the electric current?
12. **to play a part** — играть роль. Electrical devices play an important part in our life.
13. **scientist** — ученый. What scientists work at your institute?
14. **to serve** — служить, обслуживать. Atoms serve the people.
15. **to transform** — преобразовывать. Is it possible to transform the electric current?
16. **to watch television** — смотреть телевизор. I watch television in the evening.
17. **to weigh** — весить. How much does this machine weigh?

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

application—to apply—appliance—applicable; electrical—electricity—electrically—electrician; inventor—invention—to invent—inventiveness; to measure—measure—measurement—measurable; scientist—science—scientific—scientifically; to serve—service; to transform—transformer—transformation; to weigh—weight—weightless—weightlessness

IV. Translate the following groups of words.

to play an important part, to make use of furnaces, to do without devices, to transform current, as for Soviet scientists

что касается нашей лаборатории, электрическая печь, обходится без электрического тока, важное применение, известный изобретатель, пользоваться приборами, служить народу

V. Listen to Text 1 and repeat it after the speaker.

VI. Answer the questions (see Ex. III).

LABORATORY WORK 2

I. Practise the pronunciation of the following words. Repeat them after the speaker.

language, science, ability, mechanical, potential, energy, chemical, turbine, hydroelectric, employ, either, generate, civilization, industrial, industry, electricity, directly, numerous, kinetic

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **battery** — батарея. Volta made the first battery.
2. **to change** — изменять, преобразовывать. Electrical energy can be changed into mechanical energy.
3. **chemical** — химический. Chemical energy can be transformed into work or into electrical energy.
4. **to drive** — приводить в движение. Electrical current drives various machines at factories and mills.
5. **to employ** — использовать, применять. Electrical cranes are employed in industry.
6. **generally** — обычно. The pyrometer is generally used to measure high temperatures.
7. **to harness** — использовать энергию (воды, ветра, солнца). The scientists try to harness the wind.
8. **generator** — генератор. Generators generate electrical energy.
9. **in one's turn** — в свою очередь. The motor transforms electrical energy into mechanical energy, mechanical energy in its turn drives the machines.
10. **kind** — вид, род. There are all kinds of machines in our laboratory.
11. **to produce** — производить, создавать, выпускать. Where are these vacuum cleaners produced?
12. **source** — источник. There are different sources of energy.

13. **solar** — солнечный. Solar energy can find various applications.
14. **semiconductor** — полупроводник. Semiconductors are widely used in industry.
15. **to turn** — превращать. The motor turns electrical energy into mechanical energy.
16. **waterfall** — водопад. The energy of a waterfall can be used to produce electricity.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

chemical—chemistry—chemist—chemically; to drive—drive—driver; to employ—employment—employer; generator—generation—to generate; to produce—produce—production—producer—to reproduce—reproduction

IV. Translate the following groups of words.

to make use of the lift, chemical sources of current, industrial application, semiconductor devices, potential energy, solar furnace

источник постоянного тока, преобразовывать электроэнергию, электрический прибор, механическая работа, в свою очередь, в повседневной жизни, различные ученые и изобретатели

V. Listen to Text 2 and repeat it after the speaker.

VI. Answer the questions (see Ex. IV).

LABORATORY WORK 3

I. Practise the pronunciation of the following words. Repeat them after the speaker.

single, high, night, quantity, source, therefore, furnace, liquid, through, turbine, nuclear, uranium, other, supply, achieve, directly, question, thermal, energy

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **achievement** — достижение. The invention of the generator was a great achievement.
2. **capacity** — мощность; способность; емкость. The capacity of Krasnoyarskaya hydroelectric station is six million kW.

3. **coal** — уголь. Coal is a source of energy.
4. **to construct** — строить, создавать. Many new houses are constructed in Moscow.
5. **to contain** — содержать. This magazine contains many useful articles.
6. **contribution** — вклад. Soviet scientists make a great contribution to world science.
7. **engineering** — техника. The students study electrical engineering at our institute.
8. **in question** — обсуждаемый, о котором идет речь. The generators in question were constructed in Leningrad.
9. **installation** — установка. There are various electrical installations in our laboratory.
10. **nuclear** — ядерный, атомный. Nuclear fuel is used in the reactor.
11. **peaceful** — мирный. Peaceful use of nuclear energy began soon after the World War II.
12. **in the form** — в виде. We use solar energy in the form of heat.
13. **power-station (plant)** — электростанция. The nuclear power-station can produce not only electric energy but also heat.
14. **to put into operation** — вводить в действие. Several large power-stations were put into operation last year.
15. **reliable** — надежный. Soviet refrigerators are reliable in operation.
16. **steam** — пар. Steam is used to produce electricity.
17. **to supply** — снабжать, доставлять, поставлять. Coal is supplied to the power plants.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

achievement—to achieve; to construct— construction—constructor — constructive—to reconstruct; to contain — container; contribution — to contribute; installation — to install; form—to form—to reform — reformation — formation; nuclear—nucleus—nuclei; peaceful—peace; reliable—to rely—reliability

IV. Translate the following groups of words.

to construct power-stations, reliable installations, to put into operation, to supply energy, an important achievement, nuclear power-stations

содержать воду, большой вклад, в виде энергии, строить электростанции, мирный атом, обсуждаемые проблемы

V. Listen to Text 3 and repeat it after the speaker.

VI. Answer the questions (see Ex. IX).

LABORATORY WORK 4

I. Practise the pronunciation of the following words. Repeat them after the speaker.

lightning, people, electron, experiment, although, atmospheric, thunderstorm, however, sky, destroy, dangerous, phenomenon, imagine, numerous, discharge, needless, danger, earth, measure, nothing

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **to charge** — заряжать. What kinds of batteries can be charged?
2. **to conduct** — проводить. All metals conduct the electric current.
3. **dangerous** — опасный. Electricity may be dangerous.
4. **to destroy** — разрушать. Atoms can serve the people and they can also destroy the world.
5. **to discharge** — разряжать. When the battery operates it discharges.
6. **to invent** — изобретать. Radio was invented by the Russian scientist Popov.
7. **lightning** — молния. Lightning is a discharge of electricity.
8. **like** — подобный, похожий, как. A nuclear power-station is like any other power-station. The melted metals blow like water.
9. **to name after** — называть в честь. Moscow University is named after Lomonosov.
10. **observation** — наблюдение. Observation is very important for any experiment.
11. **path** — путь; контур электрической цепи. Can you see the path travelled by the electrons?
12. **phenomenon** — явление. The scientists observed the unknown phenomenon.

13. **property** — свойство. What are the properties of semiconductors?
14. **to provide** — снабжать, обеспечивать. The nuclear power-stations are provided with nuclear fuel.
15. **scientific** — научный. Our students take part in scientific work.
16. **to solve a problem** — решать задачу, проблему. It is difficult to solve this problem without the teacher's help.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

charge—to charge—chargeable—to discharge—to recharge; to conduct—conductor—conductivity—conductance; dangerous—danger—dangerously; inventor—to invent—inventive—inventiveness; like—unlike—likely; observation—to observe—observer—observable; scientific—science—scientist—scientifically

IV. Translate the following groups of words.

electrical charges, invented devices, known phenomenon, useful property, scientific study, to solve a difficult problem, to destroy houses, to conduct current, to name after the inventor

проводить наблюдения, заряжать батарею, научная статья, подобные свойства, снабжать топливом, разрушать дома

V. Listen to Text 4 and repeat it after the speaker.

VI. Answer the questions (see Ex. V).

LABORATORY WORK 5

I. Practise the pronunciation of the following words. Repeat them after the speaker.

burn, therefore, require, ton, however, thunderstorm, mankind, light, thus, atmospheric, earth, key, thought, among, electrify, jar, use, famous

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **all over the world** — во всем мире. Yuri Gagarin is known all over the world.

2. **because of** — из-за, вследствие. Uranium is dangerous because of its radioactivity.
3. **to burn** — сжигать. We burn coal to get energy.
4. **to connect** — соединять, связывать. All the batteries are connected. My work is connected with semiconductors.
5. **to develop** — развивать, разрабатывать. Franklin developed a new theory of electricity.
6. **discovery** — открытие. Faraday made his famous discovery in 1831.
7. **to electrify** — электрифицировать; электризовать. Our country is electrified. These objects are electrified.
8. **engineer** — инженер. We shall become engineers.
9. **field** — поле; область *(науки, техники)*. In autumn our students worked in the fields. In what field of science did Volta work?
10. **instead of** — вместо. What fuel can be used instead of coal?
11. **to mention** — упоминать. Speaking about continuous current we can mention the name of Volta.
12. **power** — энергия; держава. The reactor supplies power to the turbine. The Soviet Union is a great power.
13. **to protect** — защищать. Workers of the nuclear power-station are protected from radiation.
14. **substance** — вещество; материя. Many chemical substances can be produced from coal.
15. **valuable** — ценный. Coal is the source of valuable substances.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

to connect—connection—to disconnect; to develop—development; discovery—to discover—discoverer—to rediscover; to electrify—electrification; engineer—engine—engineering; power—powerful—to power; to protect—protection—protector—protective; valuable—value—to value

IV. Translate the following groups of words.

to burn coal, because of water power, to electrify metal, useful substance, in the field of radio, to develop new devices, instead of chemical sources, to power the motor

новое открытие, во всем мире, электрифицированная страна, советские инженеры, защищать дома, наэлектризованный предмет

V. Listen to Text 5 and repeat it after the speaker.

VI. Answer the questions (see Ex. V).

LABORATORY WORK 6

I. Practise the pronunciation of the following words. Repeat them after the speaker.

magnetism, other, however, writings, ability, among, substance, unfamiliar, iron, mountain, compass, north, south, forward, astronomer, physicist, mathematician, experimented, increase, weight, molecule, minute, arrange, neutralize, size, single, thus, process, unmagnetize

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **ability** — способность. Energy is the ability to do work.
2. **to attract** — притягивать. What substances attract each other?
3. **to carry out** — проводить. When will you carry out your experiment?
4. **to consist of** — состоять из. All substances consist of atoms.
5. **force** — сила. Atmospheric electricity is a dangerous force that can kill people.
6. **iron** — железо. Iron conducts electricity.
7. **magnetism** — магнетизм. Who discovered magnetism?
8. **to make reference to** — ссылаться на, упоминать. In his article the scientist makes reference to the properties of iron.
9. **to obtain** — получать. The students obtained valuable results of their experiment.
10. **on the one hand** — с одной стороны; **on the other hand** — с другой стороны. On the one hand atoms can serve people and on the other hand they can destroy the world.
11. **to possess** — обладать. Uranium possesses radioactivity.

12. **to prove** — доказывать. Franklin proved that lightning is an electrical phenomenon.
13. **physicist** — физик. Physicists study the properties of semiconductors.
14. **relation** — связь; отношение. Who observed the relation between magnetism and the electric current?
15. **single** — один. In 1954 there was a single nuclear power-station in the world.
16. **steel** — сталь. Steel and iron melt at high temperatures.
17. **weight** — вес. What is the atomic weight of uranium?

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

ability—disability—to be able—able; to attract—attraction—attractive; force—to force; iron—to iron; magnetism—magnet—to magnetize—to demagnetize—magnetic; physicist—physical—physics—physician; weight—to weigh—weightless—weightlessness

IV. Translate the following groups of words.

the ability to attract, to carry out an experiment, to possess the property, a single device, a famous physicist, to make reference to the problem

показать отношение, плавить сталь в печи, с одной стороны, с другой стороны, большая сила, состоять из веществ

V. Listen to Text 6 and repeat it after the speaker.

LABORATORY WORK 7

I. Practise the pronunciation of the following words. Repeat them after the speaker.

phenomena, knowledge, effect, earth, object, learned ['lə:nɪd] man, contribute, scientific, research, century, Phales, philosopher, minute, light, physicist, Europe, engage, Russia, France, Italy, the Germans

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **as a matter of fact** — действительно, на самом деле. As a matter of fact there is a relation between electricity and magnetism.

2. **at least** — по крайней мере. Electrical devices were invented at least 100 years ago.
3. **to come into contact** — соприкасаться. It is dangerous to come into contact with high voltage.
4. **due to** — благодаря, вследствие, из-за. We can watch TV due to electricity.
5. **famous** — известный. Famous scientists work at our institute.
6. **to generate** — производить, вырабатывать, генерировать. The first nuclear power plant generated current in 1954.
7. **in spite of** — несмотря на. We burn coal in spite of its being a source of chemical products.
8. **knowledge** — знания. Students get knowledge at the institute.
9. **to mean** — значить, означать. The words 'atmospheric electricity' and 'lightning' mean one and the same thing.
10. **more or less** — более или менее. All metals have more or less similar properties.
11. **needless to say** — нечего и говорить. Needless to say, we need more and more electrical energy.
12. **research** — исследование. Soviet scientists contribute greatly to scientific research.
13. **to take time** — занимать время. Learning English words takes much time.
14. **that is to say** — то есть, иными словами. Nuclear fuel, that is to say, uranium is used in reactors.
15. **to turn one's attention to** — обращать внимание. Galileo turned his attention to the properties of magnetic materials.
16. **various** — различный. Gilbert made various experiments on electricity and magnetism.
17. **under consideration** — рассматриваемый, обсуждаемый. The instructions under consideration were written for the new installation.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

to generate—generation—regeneration—generator; to mean—meaning—meaningless; research—to research—researcher—to search; various—variety—to vary—variable; knowledge—to know

IV. Translate the following groups of words.

famous mathematician, to generate electric energy, due to various applications, in spite of difficulties, the example under consideration

несмотря на большие достижения, известные наблюдения, благодаря громоотводу, различные установки, на самом деле, по крайней мере в лаборатории

V. Listen to Text 7 and repeat it after the speaker.

VI. Answer the questions (see Ex. III).

LABORATORY WORK 8

I. Practise the pronunciation of the following words. Repeat them after the speaker.

thermocouple, quite, gradually, language, phenomenon, rise, however, measure, effect, neither, data, numerical, development, purpose, air, pressure, instrument, famous, German, physicist, Fahrenheit, therefore, liquid, mercury

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **body** — тело. It is very important to know the quantity of energy present in a body.
2. **to boil** — кипеть. We boil water to produce steam.
3. **boiling point** — точка кипения. The boiling point of water depends on atmospheric pressure.
4. **degree** — градус; степень. Steel melts at 1300 degrees.
5. **data** — данные. These data were used in research work.
6. **difference** — разность, разница. What is the difference between potential and kinetic energy?
7. **freezing point** — точка замерзания. What is the freezing point of water?
8. **to indicate** — показывать, указывать. The capacity of the generator is indicated in the instruction.
9. **the latter** — последний из упомянутых. Coal and uranium are fuels, the latter is used in nuclear reactors.
10. **liquid** — жидкость. At what temperature does this liquid boil?
11. **means** — средство. A lightning conductor is a means of protecting houses from lightning.
12. **mercury** — ртуть. Mercury is a metal.

13. **pressure** — давление. What is the atmospheric pressure today?
14. **purpose** — цель, намерение. What is the purpose of this laboratory work?
15. **to put into use** — вводить в действие, запускать. A new reactor was put into use.
16. **to rise** — подниматься, возрастать. When the body is heated its temperature rises.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

to boil—boiler; difference—to differ—differential; to invent—inventor—invention—inventive; liquid—to liquefy—liquefaction; pressure—to press—press; to indicate—indication—indicator—indicative

IV. Translate the following groups of words.

high pressure, temperature difference, freezing point of water, scientific data, to indicate degrees, useful means

указывать давление, точка кипения, последний из упомянутых, ввести станцию в действие, кипятить воду, жидкое топливо

V. Listen to Text 8 and repeat it after the speaker.

VI. Answer the questions (see Ex. VII).

LABORATORY WORK 9

I. Practise the pronunciation of the following words. Repeat them after the speaker.

enlightener, enlightenment, worth, experience, Germany, complete, academy, scholarship, philosophy, language, foreign, academician, nevertheless, theory, unreliable, therefore, phenomena, activity, extraordinary, amount, numerous, purpose, literature, physics, chemistry, law

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **amount** — количество. A large amount of work was done by the students in summer.
2. **at a result** — в результате. The discovery was made as a result of a long research work.
3. **chemistry** — химия. Chemistry is my favourite subject.

4. **to experience** — испытывать; претерпевать. Lomonosov experienced great difficulties when he was a student.
5. **heat** — тепло, теплота. Heat is a form of energy.
6. **in addition to** — вдобавок, в дополнение. Electricity is used in every home in addition to its industrial applications.
7. **to last** — длиться, продолжаться. How long will the lecture last?
8. **law** — закон, право. What laws did Newton discover?
9. **light** — свет; светлый. This lamp gives little light.
10. **matter** — вещество, материя. What kind of matter is used in your experiment?
11. **motion** — движение. Kinetic energy is the energy of motion.
12. **natural** — естественный. Natural sciences are studied at the university.
13. **nevertheless** — тем не менее. Lightning conductor is an old invention, nevertheless it is used at present.
14. **numerous** — многочисленный. Gilbert made numerous experiments on magnetic materials.
15. **on the basis of** — на основе. Galileo studied magnetic materials on the basis of Gilbert's achievements.
16. **physics** — физика. Do you study physics?
17. **theory** — теория. Franklin developed a new theory of electricity.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

amount—to amount to; chemistry—chemist—chemical; to experience—experience—experienced—unexperienced; heat—to heat—to overheat—overheating; light—to light—to enlighten—enlightener—enlightenment; natural—nature—unnatural; physics—physical—physically—physicist—physician; theory—theoretical—theoretically—theoretician

IV. Translate the following groups of words.

in addition to theory, as a result of discovery, natural mistake, physics law; electric light, on the basis of motion

большое количество, длиться два дня, тем не менее, изучать теплоту, многочисленные достижения, новая теория

V. Listen to Text 9 and repeat it after the speaker.

VI. Answer the questions (see Ex. XI).

LABORATORY WORK 10

I. Practise the pronunciation of the following words. Repeat them after the speaker.

thus, ability, behaviour, phenomenon, previously, least, object, control, opposite, academician, another, result, unit, develop, dead, jump, thought, pair, thus, layer, wire, continuous, biography, chemical, died, age

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **as well as** — так же как. Steel as well as iron are magnetic materials.
2. **at rest** — в покое. A body at rest possesses potential energy.
3. **behaviour** — поведение; режим *(работы)*. We observed the behaviour of gas molecules.
4. **charge** — заряд. What kinds of charges do you know?
5. **condition** — условие; состояние. Some substances change greatly under certain conditions. An object is in static condition when it does not move.
6. **to control** — управлять, контролировать. Students learn to control various machines.
7. **copper** — медь. Copper is a valuable metal.
8. **to flow** — течь. The electrons flow along a conductor.
9. **in motion** — в движении. The molecules are always in motion.
10. **negative** — отрицательный. He gave a negative answer.
11. **opposite** — противоположный. These two objects move in the opposite direction.
12. **positive** — положительный. A battery has a positive and a negative pole.
13. **previously** — заранее, предварительно. The temperature of the liquid was previously measured.
14. **to remember** — помнить, вспоминать. You must remember the new words.
15. **the rest of** — остаток; остальной. Some students of our group stayed in Moscow, the rest of them went to the country.
16. **to travel** — путешествовать. It is interesting to travel in summer.

17. **to try** — пытаться; испытывать. I shall try to solve this problem. It is necessary to try this instrument several times.
18. **unlike** — разноименный. A battery has unlike poles.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

charge—to charge—chargeable—to discharge—to recharge—rechargeable; to control—control—controllable; condition—conditional—tocondition; negative—negation—negatively; opposite—to oppose—opposition; positive—positively; to travel—travel—traveller

IV. Translate the following groups of words.

negative pole, to control industrial processes, the rest of the book, hard conditions, unlike charges

в покое, управлять электрическим током, так же как, положительные заряды, противоположные полюса

V. Listen to Text 10 and repeat it after the speaker.

VI. Answer the questions (see Ex. VIII).

LABORATORY WORK 11

I. Practise the pronunciation of the following words. Repeat them after the speaker.

since, continuous, theory, subject, vice versa, charge, famous, Ampere, unit, determine, circuit, negative, right, certainly, wrong, opposite, thought, wire, minute, particle, however, liquid, through, requirement, example, without, themselves, others, electrolyte, alternating, purpose, cycle, advantage, voltage, high, although, practice

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **alternating current** — переменный ток. The alternating current is used in our homes and factories.
2. **as well**— также. Lomonosov knew German, French, Greek, and Latin as well.
3. **to be certain** — обязательно, несомненно. The lecture is certain to begin in time.
4. **to consider** — рассматривать; считать. We must consider this question as soon as possible. We consider your answer to be wrong.

5. **to decrease** — уменьшить, понижать. Atmospheric pressure decreases before thunderstorm.
6. **to determine** — определять. The students will determine the steam pressure in the turbine.
7. **direction** — направление. We must determine the direction of the wind.
8. **direct current** — постоянный ток. A battery is a source of a direct current.
9. **to increase** — возрастать; увеличивать. The energy needs of the world are increasing.
10. **to meet requirements** — удовлетворять требованиям. Soviet instruments meet modern requirements.
11. **particle** — частица. What particles does the atom consist of?
12. **to require** — требовать. This test requires much time.
13. **statement** — утверждение; формулировка. Lomonosov's statements are quite correct.
14. **subject** — предмет; тема. We study different subjects. What is the subject of your report?
15. **terminal** — зажим, вывод, клемма. There are two terminals in the battery.
16. **voltage** — напряжение. High voltage is dangerous.
17. **wire** — проволока, провод. Wires are made of different metals.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

to be certain — certain — certainly; to consider — considerable—consideration—considerably; to determine—determinate—determination; direction—to direct—direct—indirect—misdirection—directly; to increase—increase; statement—to state—state; subject—to subject—subjective; wire—to wire—wireless

IV. Translate the following groups of words.

to increase voltage, negative terminal, opposite direction, electrical wires, charged particles, to meet industrial requirements, important statement

интересный предмет, важное заявление, уменьшить тепло, зажим батареи, стальная проволока

V. Listen to Text 11 and repeat it after the speaker.

VI. Answer the questions (see Ex. IV).

LABORATORY WORK 12

I. Practise the pronunciation of the following words. Repeat them after the speaker.

another, term, cause, weightless, certain, effect, development, compression, expansion, molecular, death, besides, quite, molecule, single, assume, although, process, fire, collision, jump, farther, tea, really, quantity, needle, nevertheless, higher, while, other, thermometer

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **to cause** — вызывать, заставлять; причинять. Harnessing solar energy to produce electricity causes great difficulties.
2. **certain** — некоторый; определенный. Certain substances do not conduct the electrical current.
3. **collision** — столкновение. It is possible to observe the collision of molecules.
4. **compression** — сжатие. The gas temperature increases under compression.
5. **conduction** — проводимость. Copper possesses greater conduction than iron.
6. **development** — развитие. Great attention is paid to the development of nuclear physics.
7. **effect** — действие, влияние; результат. What effects of the electrical current are useful?
8. **expansion** — расширение, увеличение. Great expansion of research work is planned in the field of nuclear physics.
9. **to expect** — ожидать; рассчитывать. We expect the discovery to produce great changes.
10. **to explain** — объяснять. The teacher explained the problem to the students.
11. **friction** — трение. Friction is not always useful.
12. **fire** — огонь; пожар. Fire is a cause of heat. Sometimes lightning causes fire.
13. **to place** — помещать, класть. If you place a steel object into a magnetic field it is magnetized.
14. **quantity** — количество. Nuclear fuel contains great quantities of energy.
15. **to take place** — происходить, иметь место. What takes place inside a nuclear reactor?

16. **term** — термин. What new terms are used in your article?

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

to cause—cause—causeless; certain—uncertain—certainly; effect—to effect—effective; expansion—to expand—expansive; to place—place—to displace—to replace; quantity—quantitative—quantitatively; collision—to collide

IV. Translate the following groups of words.

certain effects, expansion of gas, the development of theory, collision of particles, physical terms, to explain the laws

вызывать некоторые действия, важные термины, большое количество тепла, столкновение атомов, сжатие газов

V. Listen to Text 12 and repeat it after the speaker.

VI. Answer the questions (see Ex. VII).

LABORATORY WORK 13

I. Practise the pronunciation of the following words. Repeat them after the speaker.

circuit, really, complete, purpose, electromotive, required, through, thus, break, liquid, vacuum, series, another, single, typical, passage, fault, fuse

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **cable** — кабель. We tested the new cables in the high voltage laboratory.
2. **to carry** — нести; пропускать *(ток)*. Who of you will carry the thermometer? The ability to carry electrical charges is known as conduction.
3. **closed circuit** — замкнутая цепь. The current flows when there is a closed circuit.
4. **complete** — замкнутый; полный. This circuit consists of some complete paths. His answer is not complete.
5. **conductor** — проводник. Copper is the best conductor of electricity.

6. **to deal with** — иметь дело; рассматривать. Lesson 10 deals with the history of electricity.
7. **fault** — повреждение, авария. The fault of the electrical system was caused by lightning.
8. **fuse** — предохранитель. A fuse placed in an electrical circuit serves as a means of protection.
9. **generally speaking**— вообще говоря. Generally speaking the classification of nuclear power-stations depends on the number of circuits.
10. **load** — нагрузка. The load of the power-stations often varies.
11. **open circuit** — разомкнутая цепь. The current does not flow if there is an open circuit.
12. **to pass** — проходить; пропускать. When large currents pass through a wire it heats up.
13. **safety device** — предохранительное устройство. A fuse is a safety device.
14. **short circuit** — короткое замыкание. A short circuit is dangerous as it sometimes causes fire.
15. **to supply** — снабжать; подводить *(ток)*. Our laboratory is supplied with electrical materials. This power-station supplies power to our city.
16. **switch** — выключатель. A switch is used to break the circuit.
17. **transmission line** — линия электропередачи. A new high-voltage transmission line was put into operation in Siberia.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

to carry—carrier; complete—to complete—completely—incomplete; conductor—to conduct—conduction—conductivity—conductive; fault—faulty—faultless; load—to load—to overload—overload—to unload; to pass—pass—passage; to supply—supply—supplement—supplementary; switch—to switch on—to switch off

IV. Translate the following groups of words.

to carry current, to deal with conductors, heat load, switches and fuses, open and complete circuits, transmission line

вообще говоря, короткое замыкание, предохранительное устройство, пропускать ток, замкнутая цепь

V. Listen to Text 13 and repeat it after the speaker.

VI. Answer the questions (see Ex. V).

LABORATORY WORK 14

I. Practise the pronunciation of the following words. Repeat them after the speaker.

insulator, ease, length, through, passage, nevertheless, iron, socket, once, telephone, air, bare, wire, path, purpose, why

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **air** — воздух. Air is a poor conductor of electricity.
2. **bare wire** — оголенный провод. A bare wire is a wire not covered with insulating material.
3. **cord** — шнур. A cord is a small insulated cable.
4. **to cover** — покрывать. The train covers a great distance from Moscow to Vladivostok.
5. **electrical engineering** — электротехника. We study electrical engineering.
6. **glass** — стекло; стакан. Glass is a good insulator. We need glasses for a chemical experiment.
7. **insulation** — изоляция. If a wire is covered with insulation it is called an insulated wire.
8. **to leak off** — утекать. If there is no insulation the current can leak off the conductor.
9. **opposition** — противодействие, сопротивление. When the temperature rises opposition to the passing current increases.
10. **pole** — полюс; столб, опора. Any magnet has two poles. What are the poles of a transmission line made of?
11. **to resist** — сопротивляться, противодействовать. We shall consider the ability of insulators to resist the current flow.
12. **rubber** — резина. Rubber is a perfect insulator.
13. **similar** — одинаковый, похожий, однородный. Some liquids have similar properties.
14. **socket** — розетка, патрон *(электролампы)*. Copper wires connect electrical devices to the socket.
15. **to turn off** — выключать. If the switch is turned off the current does not flow.
16. **to transmit** — передавать *(электроэнергию)*; посылать. Electricity is transmitted by wires.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

air—to air; to cover—cover—to discover—to uncover; insulation—insulator—to insulate; opposition—to oppose—opposite; to resist—resistance—resistor; rubber—to rub; similar—similarity—dissimilar; to transmit—transmitter—transmission

IV. Translate the following groups of words.

air insulator, similar conditions, to cover, the wires, electrical engineering, wall socket, North pole

выключать свет, стеклянные изоляторы, оголенный провод, передавать электрический ток, покрытый резиной, высокий столб

V. Listen to Text 14 and repeat it after the speaker.

VI. Answer the questions (see Ex. IV).

LABORATORY WORK 15

I. Practise the pronunciation of the following words. Repeat them after the speaker.

previously, electromotive, within, especially, excess, unless, both, measurable, cell, thermocouple, photocell, etc., type, nevertheless, passage, strange, behaviour, enough, jump, through, size, length

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **cell** — элемент. A battery is an electrical cell.
2. **electromotive force** — электродвижущая сила. Electromotive force is the subject of the present article.
3. **excess** — избыток, излишек. How can we use the excess of generated electrical energy?
4. **far apart** — на расстоянии. We shall place these lamps far apart.
5. **free** — свободный. Free electrons move within all metals.
6. **in case** — в случае. The current flows in case the circuit is closed.
7. **to influence** — влиять. The temperature influences the conductance of metals.
8. **movement** — движение. The movement of free electrons constitutes the electrical current.
9. **to offer resistance** — оказывать сопротивление. All substances offer some resistance to the passing current.

10. **potential difference** — разность потенциалов. The electrical current flows if there is a potential difference.
11. **provided** — при условии. The resistance in electrolytes decreases provided their temperature increases.
12. **reason** — причина, основание. What is the reason for current leakage off the conductors?
13. **size** — размер. What is the size of a nuclear reactor?
14. **to suspend** — подвешивать. Insulator strings are suspended from the towers of transmission lines.
15. **unit** — единица; установка, агрегат. The ampere is the unit of current. A generator is a unit which generates electricity.
16. **unless** — если не. The current will not flow unless there is a potential difference in the circuit.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

excess—to exceed—excessive; free—to free—freedom; to influence—influence—influential; movement—to move—movable—moveless; reason—to reason—reasonable; to suspend—suspension

IV. Translate the following groups of words.

solar cell, to offer great resistance, large size, electrical units, free time, provided the distance is small

в некоторых случаях, электродвижущая сила, простой элемент, подвешивать лампы, избыток электронов, разность потенциалов, свободное движение

V. Listen to Text 15 and repeat it after the speaker.

VI. Answer the questions (see Ex. X).

LABORATORY WORK 16

I. Practise the pronunciation of the following words. Repeat them after the speaker.

effect, perhaps, either, cause, thus, both, amount, through, thicker, thin, then, suppose, whether, sensitive, thermometer, negligible, while, undesirable, efficiency, nevertheless, requirement, utilize, enough

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **a number of** — ряд. Last week we carried out a number of tests.

2. **appliance** — прибор. What appliances are used in our homes?
3. **to convert** — превращать, преобразовывать. Water can be converted into steam.
4. **to detect** — обнаруживать, открывать. The fault was detected by the measuring instruments.
5. **to develop heat** — выделять тепло. When the current flows along the wire heat is developed.
6. **desirable** — желательный. We must heat this wire to the desirable temperature.
7. **efficiency** — эффективность; коэффициент полезного действия. The efficiency is an important feature of any machine. The efficiency of an old turbine is low.
8. **loss** — потеря. It is necessary to decrease power losses in transmission lines.
9. **negligible** — незначительный, пренебрежимо малый. Most of the nonmetals transmit a negligible amount of current.
10. **to overheat** — перегревать. Overheated wires can cause fire.
11. **principal** — основной, главный. The atom is the principal particle of all matter.
12. **to remove** — удалять, устранять. Nuclear fuel is removed from the reactor for replacement.
13. **to represent** — представлять. The heat losses are represented in the diagram.
14. **waste** — потеря, пустая трата. Heat produced in a transmission line is a waste of energy.
15. **white-hot** — раскаленный добела. The current can heat a substance white-hot.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

appliance—to apply—application, to convert—conversion—converter; to detect—detector—detection—detective; desirable—to desire—desire—undesirable; efficiency—efficient—inefficient—efficiently; to overheat—to heat—heat—to reheat—heater; to remove—removal—removable; to represent—representation—representative

IV. Translate the following groups of words.

a number of appliances, waste of time, negligible losses, desirable effects, to convert heat into work, overheated furnace

потеря тепла, желательное применение, основной вопрос, увеличивать к. п. д., удалять топливо, перегревать провода

V. Listen to Text 16 and repeat it after the speaker.

VI. Answer the questions (see Ex. IV).

LABORATORY WORK 17

I. Practise the pronunciation of the following words. Repeat them after the speaker.

cell, effect, source, voltaic, establish, deflect, brought, adjust, chance, right, angle, towards, reverse, highly, throughout, straight, amount, magnetomotive, double, other, winding, electromagnet, controllable

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **to add** — прибавлять, складывать. When we add heat temperature rises.
2. **at right angles** — под прямым углом. The magnetic and the electrical fields act at right angles to each other.
3. **to adjust** — регулировать; устанавливать. We must adjust the voltage before our experiment. The student adjusted a thermometer above a heated body.
4. **as soon as** — как только. The current will flow as soon as you close the circuit.
5. **coil** — катушка. Let us pass the current through the coil.
6. **constant** — постоянный. The temperature of boiling water does not change at constant pressure.
7. **core** — сердечник. The core of the electromagnet is usually made of iron.
8. **to establish** — устанавливать, основывать. Who established the relation between current and resistance?
9. **to find out** — выяснять; понимать. Who found out the relation between electricity and magnetism?
10. **needle** — стрелка. The compass needle always points to the North.
11. **to reverse** — изменять на обратное, реверсировать. If the resistance is reversed the current in the circuit is reversed too.

12. **to repel** — отталкивать. Like poles of the magnet repel each other.
13. **rule** — правило. Why did you not learn grammar rules?
14. **straight** — прямой. This article deals with a straight conductor carrying a current.
15. **turn** — виток. The coil may contain several turns of wire.
16. **to turn on** — включать. In the evening I turn the TV on.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

to add—addition; to adjust—adjustment—adjustable; constant—constancy—constantly; to establish—establishment—to reestablish; to reverse—reversal—reversible; rule—to rule—ruler

IV. Translate the following groups of words.

to adjust the instrument, constant temperature, coil of wire, iron core, to reverse the direction, principal rule

стальная стрелка, прямой проводник, как только, под прямым углом, изменять направление, установить разницу

V. Listen to Text 17 and repeat it after the speaker.

VI. Answer the questions (see Ex. V).

LABORATORY WORK 18

I. Practise the pronunciation of the following words. Repeat them after the speaker.

dynamo, certainly, primitive, apparatus, highly, efficient, principle, irreplaceable, without, although, unlikely, supply, enough, purpose, type, imply, continuously, machine, stator, stationary, economical, install, equip, armature, winding

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **armature** — якорь. The armature is a part of a generator.
2. **to calculate** — рассчитывать, вычислять. If you know Ohm's law you can calculate the circuit.

3. **compared with** — по сравнению с. A ton of uranium can give much more energy compared with a ton of coal.
4. **to equip** — оборудовать. Our laboratory is equipped with reliable instruments.
5. **to install** — устанавливать, монтировать. A new powerful generator was installed at the power plant.
6. **to operate** — работать, действовать. A transformer operates on the principle of electromagnetic induction.
7. **rated capacity** — номинальная мощность. The Uglegorskaya power plant has reached its rated capacity.
8. **revolutions per minute** — оборотов в минуту. How many revolutions per minute does this steam turbine make?
9. **to rotate** — вращать(ся). Water rotates the turbines at the hydropower stations.
10. **scale** — масштаб; шкала. Measuring instruments are produced on a large scale in the USSR. The Centigrade scale is not used in Great Britain.
11. **speed** — скорость. Gas turbines rotate with great speed.
12. **stationary** — неподвижный, стационарный. No current is generated while the magnet is stationary.
13. **the former** — первый из упомянутых; **the latter** — последний из упомянутых. There are two kinds of current: a. c. and d. c. The former changes its direction, the latter does not.
14. **steam power plant**— тепловая электростанция. Steam power plants operate on gas and coal.
15. **winding** — обмотка. Faraday's coal consisted of eight windings of copper wire.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

to calculate—calculation—calculator—to miscalculate; construction—to construct—constructor—constructive; to equip—equipment—to reequip; to install—installation; to operate—operation—operative—operator; revolution—to revolve—revolutionary; to rotate—rotation—rotary—rotor; winding—to wind—wind

IV. Translate the following groups of words.

compared with the results, to install the turbine, to equip with reliable installations, stationary equipment, rotor windings, 5000 revolutions per minute

увеличивать скорость, номинальная мощность мотора, тепловая электростанция, первый из упомянутых, последний из упомянутых, в большом масштабе

V. Listen to Text 18 and repeat it after the speaker.

VI. Answer the questions (see Ex. VI).

LABORATORY WORK 19

I. Practise the pronunciation of the following words. Repeat them after the speaker.

transmission, ago, away, comparatively, achieve, quite, kilometre, then, suitable, locality, whenever, undesirable, process, equipment, growth, while, interchangeable, circle, consumer, expensive, distribution, successfully, laser, negligible

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **to amount to** — доходить до. The electric power generation in the USSR amounted to a great figure.
2. **at will** — по желанию. The temperature in this room can be regulated at will.
3. **considerable** — значительный. We pay considerable attention to the construction of steam power-stations.
4. **distribution** — распределение. Power distribution is indicated by a straight line in this figure.
5. **to emit** — излучать, выделять, испускать. A hot body emits heat.
6. **equipment** — оборудование. Soviet equipment is reliable in operation.
7. **expensive** — дорогой. Nuclear fuel is more expensive than mineral fuel.
8. **growth** — рост, увеличение. The growth of cities requires the increase of power generation.
9. **range** — диапазон. This measuring instrument has a wide temperature range.
10. **to reduce** — понижать, уменьшать. High voltage is usually reduced at distribution substations.
11. **to result in** — приводить к; заканчиваться. The scientist's work resulted in a great discovery.
12. **successfully** — успешно. Our industry successfully develops powerful reactors.

13. **transmission** — передача. Underground cables are used for power transmission in large cities.
14. **tension** — напряжение. High-tension transmission lines cross our country from East to West.
15. **wave** — волна. Popov experimented with electromagnetic waves.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

considerable—to consider—consideration; distribution—to distribute—distributor; to emit—emissive—emission—emitter; equipment—to equip—to reequip; to reduce—reduction—reducer; successfully—successful—unsuccessful—to succeed—success; transmission—to transmit—transmitter

IV. Translate the following groups of words.

considerable success, to emit electrons, load distribution, to reduce power losses, to result in great achievements, growth of population, straight line

дорогое оборудование, передача электроэнергии, значительное расстояние, излучать тепло, распределение учебников

V. Listen to Text 19 and repeat it after the speaker.

VI. Answer the questions (see Ex. VI).

LABORATORY WORK 20

I. Practise the pronunciation of the following words. Repeat them after the speaker.

transformer, another, decrease, whole, require, maintenance, damage, winding, core, primary, just, refer, supply, equally, reduce, process, negligible, rather, figure, consumer, suitable, further, equipment, illustrate, importance

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **consumer** — потребитель. Power transmission system connects the power-station to the consumer.
2. **to damage** — разрушать, повреждать. The Dnieper power-station was damaged during the Great Patriotic War.

3. **induction coil** — индукционная катушка. The induction coil is connected to the circuit in order to increase its inductance.
4. **input** — вход; подводимая мощность; входной. The input power of this substation is limited.
5. **local** — местный. The voltage is reduced at local substations.
6. **maintenance** — техническое обслуживание, уход. The maintenance of this new equipment is expensive.
7. **number** — число; номер. The number of nuclear power plants has increased in this country. What is the number of your telephone?
8. **output** — выходная мощность; выходной. The scientists try to increase the output power of the generators.
9. **to point out** — указывать. The achievements of the Soviet Union in power engineering were pointed out in my report.
10. **primary** — первичный; первичная обмотка трансформатора; **secondary** — вторичный, вторичная обмотка трансформатора. A simple transformer has a primary and a secondary winding.
11. **source of supply** — источник питания. A battery is a source of supply.
12. **to step down** — понижать. What device is used to step down the voltage?
13. **to step up** — повышать. A transformer is used to step up and down the voltage.
14. **value** — величина. Let us compare these two given values.
15. **whole** — целый, весь. The students have translated the whole article.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

consumer—to consume—consumption; to damage—damage—damageable; local—to locate—location—locality; maintenance—to maintain; number—to number—numerous; primary—prime—primarily; value—to value—valuable—invaluable—to overvalue

IV. Translate the following groups of words.

to damage by lightning, secondary distribution line, the number of windings, to step up the current, source of supply, the whole world

индукционная катушка, число потребителей, понижать напряжение, вся страна, местные фабрики, первичная обмотка

V. Listen to Text 20 and repeat it after the speaker.

VI. Answer the questions (see Ex. VIII).

LABORATORY WORK 21

I. Practise the pronunciation of the following words. Repeat them after the speaker.

machinery, reverse, supply, machine, previous, obvious, respect, armature, commutator, brush, shunt, sufficient, series, effect, torque, variety, mighty, giant, perform, innumerable, clothes, circulate, vacuum, medicine

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **brush** — щетка. There are usually two brushes in the motor.
2. **commutator** — коллектор. There is a commutator in d. c. motor.
3. **to exist** — существовать. Water can exist in three states.
4. **field winding** — обмотка возбуждения. The field windings can be connected with the armature windings.
5. **to follow** — следить; следовать. The scientists followed the movement of elementary particles. The rule was followed by an example.
6. **to fulfil** — выполнять. We fulfilled our plan in time.
7. **in certain respects** — в некотором отношении. You are right in certain respects.
8. **mighty** — мощный, могущественный. The Soviet Union is a mighty state.
9. **machinery** — машины, механизмы. Our laboratory is equipped with modern machinery.
10. **operation** — работа; действие, операция. The operation of trams depends on electricity.
11. **to perform** — выполнять, совершать. Computers perform many operations per second.
12. **rate** — скорость. At high temperature the reaction rate increases.
13. **to replace** — заменять. The old machines were replaced by the new ones.

14. **shunt** — шунт; шунтовой. This article deals with shunt generators.
15. **sufficient** — достаточный. My knowledge of physics is not sufficient.
16. **torque** — момент, пусковой момент. Torque produces rotation.
17. **variety** — разнообразие. A great variety of machines are produced at Moscow plants.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

to exist—existence; to follow—follower; to fulfil—to overfulfil—fulfilment—overfulfilment; machinery—machine—to machine; operation—to operate—operative—operator; to perform—performance—performer; to replace—replacement—replaceable—irreplaceable; sufficient—sufficiency—insufficient—sufficiently

IV. Translate the following groups of words.

mechanical operation, variety of methods, to follow an example, sufficient experience, shunt winding, to perform work, commutator

обмотка возбуждения, в некотором отношении, щетки мотора, скорость движения, пусковой момент, заменить мотор

V. Listen to Text 21 and repeat it after the speaker.

VI. Answer the questions (see Ex. VII).

LABORATORY WORK 22

I. Practise the pronunciation of the following words. Repeat them after the speaker.

magnetohydrodynamics, mechanics, liquid, electromagnetic, physics, induce, result, armature, ionize, through, convert, directly, nozzle, channel, high, electrode, conductivity, approach, cycle, flux, inject, investigate, feasible, consumption, giant

II. Listen and repeat the following words, groups of words and sentences. Translate the sentences.

1. **approach** — подход. The scientists discussed a new approach to the problem.
2. **at present** — в настоящее время. At present 80 per cent of electricity is generated at thermal power-plants.

3. **consumption** — потребление, расход. The consumption of electricity increases all over the world.
4. **conventional** — обычный, общепринятый. Thermal power plants burn conventional fuel.
5. **channel** — канал. The students measured the flow of water in the channel.
6. **flux** — поток. We often speak of magnetic lines of force or of magnetic flux.
7. **to inject** — вводить, впрыскивать. A liquid fuel is injected into the furnace.
8. **to interact** — взаимодействовать. A moving conductor interacts with the magnetic field.
9. **to investigate** — исследовать. Soviet scientists investigate the properties of a plasma.
10. **to ionize** — ионизировать. A plasma is a highly ionized gas.
11. **to make up** — состоять. All substances are made up of molecules.
12. **nozzle** — сопло. Passing through the nozzle the steam loses its pressure.
13. **to reach** — достигать. The water begins to boil when its temperature reaches 100°C.
14. **velocity** — скорость. The words 'speed' and 'velocity' are synonyms.
15. **to withstand** — выдерживать. Steel can withstand high temperature.

III. Listen to the words, their derivatives and repeat them after the speaker. Translate them into Russian.

consumption—to consume—consumer; to inject—injection—injector; to interact—interaction; to investigate—investigation—investigator; to ionize—ionization—ion; to remain—remainder

IV. Translate the following groups of words.

fuel consumption, scientific approach, steam nozzle, to withstand cold, to inject air, to reach the city

стальное сопло, исследовать свойства, магнитный поток, ионизировать воздух, длинный канал, в настоящее время, большая скорость

V. Listen to Text 22 and repeat it after the speaker.

VI. Answer the questions (see Ex. V).

SECTION III

SUPPLEMENTARY READING

CYCLOTRON

One of the ways to investigate the atom is to send high energy charged particles into the atom and see what comes out of it. One of several machines that can give high energies to charged particles is a cyclotron. A cyclotron does not give all the energy to a charged particle at one time. It gives the energy to the particle in steps. An electrostatic field is used to give the energy to the particle. To turn the particle before each energy step a constant magnetic field is used.

A cyclotron consists of two hollow metal plates which are called the dees. They are made of copper or other conducting material that will not shield a magnetic field and a large magnet to supply a constant magnetic field.

A charged particle such as a proton enters the cyclotron in the middle between the dees. A high voltage between the dees accelerates the charge while the charge travels the space between the dees. When the charge is inside one hollow metal dee, there is no electrostatic force on the charge because the metal effectively shields the electrostatic force. However, the magnetic field goes through copper as well as through air, so the charge will always have a magnetic centripetal force on it.

During the time when the charge travels along the semicircular path in one of the dees the voltage across the dees is reversed. In this way, the charge is accelerated each time when it travels between the dees. Since the charge is accelerated each time it enters the space between the dees the charge will travel in ever widening circles, making a special path. The energy given to the particle is limited only by the radius of the circle until the speed of the particle approaches the speed of light. When the particle approaches the speed of light, the mass of the particle begins to increase. The time which the charge spends turning around inside the dees gets out of step with the charge of the voltage across the dees. When this happens, the voltage between the dees is likely to subtract energy from the particle but not to add energy to it.

Physicists have developed many atomic accelerators, such as the synchrocyclotron and the synchrotron. They lessen the economic problems of building large magnets and compensate for the increasing mass of the charged particles as they approach the speed of light.

A group of physicists at the Joint Institute for Nuclear Research in Dubna is developing the theory of fundamental particles and nuclear physics. Their work is known all over the world. Experiments on the synchrocyclotron and the proton synchrotron gave a lot of new information on the interaction of particles. Cyclotrons enabled scientists to synthesize isotopes of heavy elements with the atomic weight 102 to 106. The study of the nuclear properties using neutron beams from a pulse reactor has given interesting and valuable results. Using a computer and automatic data processing is of great help for the physicists.

The first large Soviet accelerator constructed in Dubna was followed by dozens of powerful engineering physics installations, most as big as large factories. Hundreds of unique experiments were carried out on Serpukhov's accelerator to find out the ways the particles making up the atomic nucleus interact.

Physicists spent a long time looking for hypothetical heavy particles called quarks. These could theoretically explain all the inner ties in the microcosmos and thus bring us nearer to a single theory of the interaction of forces in nature. The quarks, that is subelementary particles, may exist but they cannot be examined in a free state. The only way to determine their existence or prove that they are beyond our reach is to increase the capacity of the accelerators.

REACTOR OF THE FUTURE

Man receives nine-tenths of the energy he needs by burning valuable materials like oil, coal and gas in furnaces and engines. However, the resources of these materials are not unlimited. It is estimated that they will be exhausted in 150-200 years or so. What will happen then? Shall we leave the future generations without energy? These are the questions the scientists are mostly interested in.

Soviet scientists are intensively working at the prob-

lem of creating controlled thermonuclear reactors. Positive results of research in this field would give man a practically inexhaustible source of energy.

The tests on the Tokomak-7, the world's first large thermonuclear installation with superconducting magnetic windings have proved the possibility of creating superconducting magnetic systems for retaining plasma at one million degrees Centrigrade.

The huge building in which the experiments are made looks like a big factory. The equipment and installations simulate and recreate the processes going on inside the Sun and in the remote stars. Scientists try to tame matter in a plasma state. Theoretical calculations and numerous experiments show that a controlled thermonuclear reaction would take place if we could heat a compound of 10^{14} nuclei of heavy isotopes of hydrogen deuterium and tritium to a temperature of one hundred million degrees and make the tiny ball shine for, at least, one second.

An inexhaustible terrestrial sun would light up, its light dispelling the forecasts about the inevitable energy crisis.

This is the reactor of the future. The nearest to it, that we have at present, are the Tokomaks constructed by the Soviet scientists. The Institute of Atomic Energy named after Kurchatov where the Tokomaks were born made the next big steps forward on this difficult road. The Tokomak-7 proved in practice for the first time that the magnetic windings cooled to cosmic cold could become a superconductor even within 35 cm from the plasma heated to a million degrees.

The Tokomak-7 is about the same size as the preceding the Tokomak-10. But unlike the latter it has superconducting coils to create the magnetic field preventing the plasma from coming into contact with the chamber walls.

What are the advantages of the new coils? It is possible to raise the plasma temperature to 13 million degrees in the Tokomak-10. But to reproduce a thermonuclear reaction lasting half a second, the installation requires the energy produced by a 200 thousand kW power plant. The superconducting coils require thousands of times less energy than the copper ones in the Tokomak-10.

Let us consider another advantage of the Tokomak-7. The experiment on the Tokomak-10 lasts less than a second. Then it has to be turned off so that the coils would

not overheat, whereas the Tokomak-7 having superconducting coils can operate as long as required.

Using superconductivity in thermonuclear installations, it is possible to make experiments without thinking about the coils overheating and at much less energy consumption. This paves the way to intense research on the Tokomak-15. The latter is an intermediate step to the thermonuclear power plant. It is twice the size of the Tokomak-7. A smaller Tokomak-11 is used for experiments on methods to heat plasma to much higher temperatures by ejecting a beam of fast neutron atoms of hydrogen and deuterium into the burning area.

As for fuel the thermonuclear power plant would use sea water or a variety of hydrogen it contains in enormous amounts.

In short, our scientists do their best to carry out a controllable thermonuclear reaction so as to light up the man-made sun on earth.

SEMICONDUCTORS

The periodic law of elements discovered by Mendelyeev had a number of important scientific and industrial results, one of them being the discovery of germanium. Germanium is the semiconductor used in most transistors available at present.

But what are semiconductors? They include almost all minerals, many chemical elements, a great variety of chemical compounds, alloys of metals, and a number of organic compounds. Like metals, they conduct electricity but they do it less effectively. In metals all electrons are free and in insulators they are fixed. In semiconductors electrons are fixed, too, but the connection is so weak that the heat motion of the atoms of a body easily pulls them away and sets them free.

It is not difficult to understand that the term "semiconductor" has been used because the material in question really occupies a place between the conductors of the electric current and the non-conductors, that is insulators. The term shows that they conduct electricity less readily than conductors but much better than insulators.

Minerals and crystals appear to possess some unexpected properties. For instance, it is well known that their conductivity increases with heating and falls with cooling.

As a semiconductor is heated, free electrons in it increase in number, hence, its conductivity increases as well. However, heat is by no means the only phenomenon influencing semiconductors. They are sensitive to light, too. Take germanium as an example. Its electrical properties may greatly change when it is exposed to light. With the help of a ray light directed at a semiconductor, we can start or stop various machines, effect remote control, and perform lots of other useful things. Just as they are influenced by falling light, semiconductors are also influenced by all radiation. Generally speaking, they are so sensitive that a heated object can be detected by its radiation.

As previously mentioned, such dependence of conductivity on heat and light has opened up great possibilities for various uses of semiconductors. The semiconductor devices are applied for transmission of signals, for automatic control of a variety of processes, for switching on engines, for the reproduction of sound, protection of high-voltage transmission lines, speeding up of some chemical reactions, and so on. On the one hand they may be used to transform light and heat energy directly into electric energy without any complex mechanism with moving parts, and on the other hand, they are capable of generating heat or cold from electricity.

Soviet engineers and scientists turned their attention to semiconductors more than thirty years ago. They saw in them a means of solving an old engineering problem, namely, that of direct conversion of heat into electricity without boilers or machines. Semiconductor thermocouples created in the USSR convert heat directly into electricity just as a complex system consisting of a steam boiler, a steam engine and a generator does it.

PROGRAMMING

A computer is a machine for solving mathematical problems.

Since computers are sometimes called thinking machines or robots that can think, these names lead to misunderstanding. It is true that no machine can really think in the usual sense, but the computers do many important and wonderful things. Besides their solving complex mathematical problems, computers can predict the paths of satellites, guide ballistic missiles in flight and so on.

Before the computer can do any work, someone must give it a program in the language which it is able to understand.

It is the programmer who translates the calculation into a number of instructions based on the kinds of switching.

This work requires attention, and the solving of difficult problems takes time usually much longer than the calculation itself.

The programmer must be a language expert. The languages he uses are not all spoken languages like Russian, English or French. Some of them are universal languages understood by scientists and engineers all over the world. These are mathematics and the language of reasoning, that is logic. May be you don't consider mathematics to be a language but such is really the case. It is the means used by scientists for communicating with each other.

In other words, the programmer's work consists in translating the details of a problem into a language the machine can understand and work with. In addition to it, the programmer must be able to study, to analyse, and to plan problems.

Understanding of programming fundamentals is important for understanding the computation process. After finding out what a computer should do, the engineer can start to design the machine.

A modern automatic electronic computer is often called a data processing system. We know of its carrying out a long series of arithmetic and logical operations on the basis of instructions given to it at the start of the problem. Logical operations include such work as sorting, selecting, comparing and matching various kinds of information.

A computer can work as a translator. Each year, millions of reports on scientific research are published, a great number of them being in foreign languages. In this mass of Russian, English and French data there are clues to interplanetary flights, nuclear power, more powerful batteries. Computers have been put to work for translating these scientific publications. For doing translations, every word in a Russian dictionary is listed on tape under a code number or address. The English, French or German equivalents for each word are given in the same number or address. Then, for translating from English into Russian, for exam-

ple, a tape with the English code numbers is fed into the machine, which matches the numbers and prints out the Russian translation.

The computer is capable of making over a thousand translations a day.

LASERS

In 1950s a new principle of electromagnetic wave generation was discovered almost at one and the same time by Soviet and American scientists. This principle is used in a laser which can produce a very concentrated beam of light.

The letters LASER stand for Light Amplification by Stimulated Emission of Radiation. The light produced by a laser is much more intense than ordinary light. With ordinary light, all the light waves are of different lengths. Whereas with lasers all the light waves are of the same length and this increases their intensity.

As is known atoms are made up of neutrons, electrons and protons. The electrons circle round the protons and neutrons. In a laser the electrons are excited to a higher energy level. As the electrons return from their excited state to their normal state, they emit energy. This energy is emitted as light which can be seen.

The light emitted from a laser is unique in several ways. Since it is produced by one or more atomic transitions it consists of a single frequency or a series of frequencies. Furthermore, unlike most light sources in which the light is emitted in all directions, laser light comes out in a straight narrow beam.

It is the high concentration of light energy over a very small area that makes the laser so useful. A laser is not a source of energy. The energy from the source of supply is only converted by a laser into an intense narrow beam of light energy.

There are many types of lasers, which utilize both solid, liquid and gaseous materials, but they all operate almost in the same way. The most common laser is the helium-neon laser. There is 10 per cent helium and 90 per cent neon gas in a glass tube. There are mirrors at the ends of the tube. The electrons get energy from a power supply and they are excited to high energy states. The energy emitted by the electrons in the form of light is

reflected by the mirror at one end of the tube. The light can only escape through the partially transparent mirror at the other end of the tube.

One might also mention semiconductor lasers which can transform electrical energy into light energy with an efficiency up to 100 per cent. The lasers mentioned are used in sputniks for outer space research.

Lasers have found many practical applications. They are now used for many scientific, industrial and medical purposes. Lasers are used in communication, location of distant objects, for welding and machining metals because their narrow beam can heat a tiny area to a very high temperature. The beam can also be used for drilling holes in steel and even in diamonds. As the beam is so small, it is very important in medicine and is used in eye operations.

As laser beams diverge so little, they can be directed to other planets and the reflected beam will still be strong when it arrives back to the Earth. The distance from the Earth to the Moon has been very accurately measured by means of lasers.

The Soviet scientists have developed a new type of laser beam operating on pairs of complex organic molecules. The new lasers will widen the field of their application in science and technology. The researchers believe that laser technology will enable them to obtain high temperature plasma and solve several problems of controlled thermonuclear reaction.

One of the most interesting uses of the laser is to produce three-dimensional pictures known as holograms. When a laser hologram is made on a film, the laser light is split into two parts by a mirror. One part goes directly to the film. The other part is directed to the object to be photographed where it is reflected back to the film. The interference of these two beams, when they reach the film allows the film to record the intensity and the relative phase of the light at each point. It is the additional information contained in the phase that allows a three-dimensional picture to be projected when the laser light is shown on or through the film.

The hologram can be projected into the middle of the room and one can walk around it, looking at it from all sides, it changes as if it were real. But there is nothing material there.

The principles of holography are now applied to movies and soon we shall have three-dimensional movies and television.

Though the 20th century is rightly called the age of the atom or the space age, it would be also correct to call it the age of the laser, since the latter can be used almost everywhere.

OUTER SPACE RESEARCH

The first man to think of space flight by means of rockets on scientific principles was Konstantin Eduardovich Tsiolkovsky. This great Russian scientist was born on September 17, 1857.

In 1903 he began publishing a series of articles in an aviation magazine in which he wrote about the theory of rocketry. He also wrote articles on man-made satellites.

On October 4, 1957 the world's first artificial Earth's satellite was launched in the Soviet Union. It opened the era of space research in the history of civilization. *Sputnik 1* circled the globe every 90 minutes at a distance from 156 to 560 miles above its surface and sent its signals to the Earth by radio. In the same year the Soviet Union launched *Sputnik 2* with a dog on board. That was the first living organism placed in the orbit around the Earth. The first American satellite *Explorer 1* was placed in the orbit in 1958.

On January 2, 1959 the USSR launched *Luna 1*, the first satellite which surpassed Earth's escape velocity and left the Earth for ever. It passed by the Moon at a distance of 3,700 miles from its surface. *Luna 2* reached the Moon. That was the first man-made object to be left on another planet. A little later in the same year *Luna 3* passed around the Moon and sent back the first photographs of the far side of the Moon. These moon "firsts" were followed by launching *Sputnik 5* with two dogs and returning them safely after 18 orbits. The first living organisms returned safely from the orbital flight.

A remarkable event took place on April 12, 1961. Yuri Gagarin became the first man to orbit the Earth. He made a single orbit in 108 minutes, and returned safely back to the Earth. It was manned space flight that captured man's imagination the world over.

Four years later the Soviet Union placed *Voskhod 2* into orbit with two cosmonauts on board. One of them Alexei Leonov left the spaceship and spent ten minutes in open space. It was the first space walk in the world.

Luna 9 made the first soft landing on the Moon. It took photographs of the Moon from its surface and sent them back to the Earth.

Under the Intercosmos program the socialist countries have joined efforts to develop space research. The satellites carry equipment designed and produced in the countries of socialist community. In 1978, an international crew with representatives of the Soviet Union and Czechoslovakia made a flight on board a spaceship, docked with an orbital research complex and transferred to the orbital station. This was for the first time in the history of space research. The citizens of Czechoslovakia, the GDR, Poland, Bulgaria, Hungary, Cuba, Vietnam, Mongolia and Rumania also took part in flights on board Soviet spaceships and orbital stations.

From the time the first man-made satellite lifted into orbit up to the present, thousands of earth satellites have been carrying out an extensive research program. The satellites of the *Kosmos* series transmit valuable data on various scientific problems. The satellites of the *Meteor* and *Molniya* series serve to maintain long-range and TV communication and collect information for weather forecasting.

Five Soviet satellites were put into orbit around Mars and Venus. Six modules made soft landing on these planets. Photographs of some regions of Mars, two panoramas of Venus and information on physical characteristics in the near planet's atmosphere were obtained.

Very important is the role of orbital stations which are, in effect, extraterrestrial laboratories conducting observations beyond the possibility of ground-based means. Soviet cosmonauts brought to orbital stations by spaceships do research work there and carry out experiments.

Soviet science and engineering achieved further outstanding success in space research. This was the longest manned space flight having continued for 185 days.

Astronomy can now celebrate one of its greatest victories. It is on March 1 and 5, 1982 that the descent capsules of the Soviet automatic interplanetary stations *Venera 13* and *Venera 14* made a soft landing on Venus' surface. The

instruments transmitted very interesting information about the mysterious planet for 57 minutes, operating in temperatures of 465°C and under a pressure of 94 atmospheres. The Soviet scientists received a great number of interesting results from different districts of Venus.

Outer space is an endless road and nothing can stop man in his longing for knowledge and progress. Outer space is becoming part of our life, of our way of thinking, of our research programs.

RADAR

Radio Detection and Ranging or "radar", for short, is one of the outstanding electronic developments of the twentieth century.

Assume that a flying airplane is high above the earth on a dark night. A searchlight station on the ground sends out a narrow light beam. When this beam strikes the airplane, light is reflected from the surface of the plane to the observer's eyes and the plane is detected.

With radar, an invisible narrow radio beam, striking the plane, is reflected to a radio receiver located near the transmitter and, thus, the plane is detected. However, it is not enough to find the target we are interested in. We must know how far the detected plane is, how high up as well as its compass position in relation to the observer.

With the radar equipment assistance, we are able to measure the time it takes the radio wave to travel from the transmitter to the planet and back again to the receiver. Knowing the speed at which the radio wave travels, it is relatively easy to calculate the distance between the plane and the radar station observer.

Because of the great speed of the radio wave, the time intervals are in the order of microseconds. The cathode-ray tube is the very device to be used for determining these small intervals of time.

Assume that at the instant when the transmitter sends its radio beam at the target, the electron stream in the cathode-ray tube is set moving horizontally at the rate which will make the trace across the face of the tube one inch (2.54cm) per one hundred microseconds. Further assume that the plane is at such a distance from the transmit-

ter that the radio wave requires 1000 microseconds to reach it. Since the reflected wave will require the same time to reach the receiver the whole travel will consume 2000 microseconds.

During the interval, the trace on the face of the cathode-ray tube will have travelled 2 inches. If we had some method of marking the trace so that it would record the instant at which it was received, we should be able to tell the time required for the round trip. The only thing to be done consists in measuring the distance between the two marks.

The radio wave is sent out as a short pulse of energy usually lasting only about one microsecond. Part of this pulse is sent to the vertical deflecting plates of the cathode-ray tube. Its effect is to produce a short pip on the trace. When the reflected pulse is received it, too, goes to the vertical deflecting plates of the tube. Thus, a second pip appears on the trace.

By means of a scale printed on the cathode-ray tube face we can translate the distance existing between the two pips of the trace into the distance between the target and the radar station. Since each pulse duration is short and the time between pulses is relatively long the average power consumed is small.

Is there a possibility of employing the radar equipment for peaceful purposes? Yes, there certainly is. Radar developed for war purposes was quickly adapted to peacetime needs especially in the field of navigation to detect obstacles which normally would not be seen for some reason or other.

BALL LIGHTNING

It is quite probable that there are several different physical forms of ball lightning, each having its own characteristic set of properties. These phenomena are rare and this rarity leads to the wide variety of descriptions of ball lightning.

Lightning balls seem to appear near the end of severe electrical storms. This happens after the air has been highly ionized and is filled with electromagnetic disturbances generated by the conventional lightning.

The diameters of observed lightning balls range from a few inches to rare instances of many feet. The average

diameter of a ball is about 10 inches. The balls usually move by rolling or sliding along conductors such as telephone wires, fences, and other metallic objects.

The lifetime of a ball of lightning may range from a few seconds to minutes. One large ball was observed to hang near the base of a cloud for 15 minutes. The calculated surface temperature of a lightning ball can be as high as 5,000°C. When the ball decays, a great amount of energy is released.

The Soviet physicist Pyotr Kapitsa was the first to present a reasonable explanation for the majority of the questions in a hypothesis for ball lightning. His ideas on the energy balance, on the importance of resonance phenomena, and on the fixed dimensions of ball lightning are well known. The theory put forward by him in 1955 starts with the description of a powerful flash of lightning at the end of a thunderstorm. It paves the way for the appearance of ball lightning at sufficient ionization of the air and the presence of vapours necessary for ionization of the rising current of air. The ionized clouds of plasma are composed of the atomic nuclei of gas stripped of their electrons. These nuclei possess their own periods of electromagnetic oscillations and are able to absorb the incoming external electromagnetic energy of the same period. This is known as the resonance effect.

Details of Kapitsa's hypothesis include the reasoning that during the luminescence period, some energy is supplied continuously into the ball lightning and the energy source is outside the ball. This reasoning is based on the conservation of energy principle and on the realization that the ball lightning is suspended in the air with no visible link with the energy source. Thus the only source of energy is the absorption of intense outside radio waves. The resonance characteristic of the absorption process is determined by the form of the ball lightning alone and by its dimensions. For effective absorption of radio waves by the lightning ball, the natural frequence of the electromagnetic oscillations within the ball, must coincide with the natural period of the absorbed radiation.

As to academician Kapitsa, his field of interests was not limited by high temperatures alone. In 1978 he was given a Noble prize for his fundamental discoveries and inventions in the field of low temperatures and superconductivity.

THERMAL POWER-STATION

A modern thermal power-station is known to consist of four principal components, namely, coal handling and storage, boiler house, turbine house, switchgear.

If you have not seen a power-station boiler it will be difficult for you to imagine its enormous size.

Besides the principal components mentioned above there are many additional parts of the plant. The most important of them is the turbogenerator in which the current is actually generated.

A steam turbine requires boilers to provide steam. Boilers need a coal-handling plant on the one hand and an ash-disposal plant on the other. Large fans are quite necessary to provide air for the furnaces. Water for the boilers requires feed pumps. Steam must be condensed after it has passed through the turbines, and this requires large quantities of cooling water. The flue gases carry dust which must be removed by cleaning the gases before they go into the open air.

A modern thermal power-station is equipped with one or more turbine generator units which convert heat energy into electric energy. The steam to drive the turbine which, in its turn, turns the rotor or revolving part of the generator is generated in boilers heated by furnaces in which one of three fuels may be used—coal, oil and natural gas. Coal continues to be the most important and the most economical of these fuels.

Large installations with mighty turbogenerators are operating at a number of thermal power-stations in the USSR. It is necessary to point out that the power machine building industry has started to manufacture even greater capacity installations for thermal power-stations.

At present great attention is paid to combined generation of heat and electricity at heat-and-power plants and to centralized heat supply. One of the world's largest heat-and-power installations is operating at the Moskowskaya thermal power-station-25.

Thermal power-stations are considered to be the basis of the Soviet power industry. More than 80% of the country's total power output comes from the above stations.

It is necessary to say that separate power-stations in our country are integrated into power systems. Integration of power systems is a higher stage in scientific and tech-

nical development of power engineering. The Integrated Power System in the central part of the USSR is one of the largest in the world. It covers the territory from the Volga river to the Western boundaries of our country and is connected with power systems of the European socialist countries.

HYDROELECTRIC POWER-STATION

Water power was used to drive machinery long before Polzunov and James Watt harnessed steam to meet man's needs for useful power.

Modern hydroelectric power-stations use water power to turn the machines which generate electricity. The water power may be obtained from small dams in rivers or from enormous sources of water power like those to be found in the USSR. However, most of our electricity, that is about 86 per cent, still comes from steam power-stations.

In some other countries, such as Norway, Sweden, and Switzerland, more electric energy is produced from water power than from steam. They have been developing large hydroelectric power-stations for the past forty years, or so, because they lack a sufficient fuel supply. The tendency, nowadays, even for countries that have large coal resources is to utilize their water power in order to conserve their resources of coal. As a matter of fact, almost one half of the total electric supply of the world comes from water power.

The locality of a hydroelectric power plant depends on natural conditions. The hydroelectric power plant may be located either at the dam or at a considerable distance below. That depends on the desirability of using the head supply at the dam itself or the desirability of getting a greater head. In the latter case, water is conducted through pipes or open channels to a point farther downstream where the natural conditions make a greater head possible.

The design of machines for using water power greatly depends on the nature of the available water supply. In some cases great quantities of water can be taken from a large river with only a few feet head. In other cases, instead of a few feet, we may have a head of several thousands of feet: In general, power may be developed from water by action of its pressure, of its velocity, or by a combination of both.

A hydraulic turbine and a generator are the main equipment in a hydroelectric power-station. Hydraulic turbines are the key machines converting the energy of flowing water into mechanical energy. Such turbines have the following principal parts: a runner composed of radial blades mounted on a rotating shaft and a steel casing which houses the runner. There are two types of water turbines, namely, the reaction turbine and the impulse turbine. The reaction turbine is the one for low heads and a small flow. Modified forms of the above turbine are used for medium heads up to 500-600 ft, the shaft being horizontal for the larger heads. High heads, above 500 ft, employ the impulse type turbine. It is the reaction turbine that is most used in the USSR.

Speaking of hydraulic turbines, it is interesting to point out that in recent years there has been a great increase in size, capacity, and output of Soviet turbines.

Hydropower engineering is developing mainly by constructing high capacity stations integrated into river systems known as cascades. Such cascades are already in operation on the Dnieper, the Volga and the Angara.

NUCLEAR POWER PLANT

The heart of the nuclear power plant is the reactor which contains the nuclear fuel. The fuel usually consists of hundreds of uranium pellets placed in long thin cartridges of stainless steel. The whole fuel cell consists of hundreds of these cartridges. The fuel is situated in a reactor vessel filled with a fluid. The fuel heats the fluid and the superhot fluid goes to a heat exchanger, i. e. steam generator, where the hot fluid converts water to steam in the heat exchanger. The fluid is highly radioactive, but it should never come into contact with the water that is converted into steam. Then this steam operates steam turbines in exactly the same way as in the coal or oil fired power-plant.

A nuclear reactor has several advantages over power-plants that use coal or natural gas. The latter produce considerable air pollution, releasing combusted gases into atmosphere, whereas a nuclear power plant gives off almost no air pollutants. As to nuclear fuel, it is far cleaner than any other fuel for operating a heat engine. Furthermore, our reserves of coal, oil and gas are decreasing so nuclear fuel is to replace them. It means that coal and oil

can be used for some other purposes. The amount of nuclear fuel which the nuclear power-plant consumes is negligible while the world's uranium and thorium resources will last for hundreds of years.

The construction of the world's first nuclear power-plant in Obninsk near Moscow is a great historical event and the beginning of atomic energetics. Since then our country has achieved a great progress in this field. It should be noted that while the unit capacity of the Obninsk nuclear power-plant was five thousand kW, that of the first unit of the Leningradskaya nuclear power-plant was one million kW.

Our industry produces two main types of reactors namely vessel-type reactors and channel-type reactors. The former are installed at the Novovoronezhskaya and the Armenian nuclear power-plants, the latter operating at the Leningradskaya and Kurskaya power-plants.

It is necessary to mention here that channel-type reactors have been operating since 1954 at the world's first nuclear power-plant and in the far North-East of our country where they produce both electricity and heat.

The nuclear power-stations are mostly designed for generation of electricity. If a station generates only electric energy, it is equipped with condensing turbines and the station is known as a condensing one. At present the nuclear power-stations mainly operate as condensing plants. The nuclear power-stations designed to produce not only electrical energy but also heat are called nuclear heat-and-power plants.

A fast-neutron reactor which supplies both electricity and heat for desalting sea water was put into operation in Shevchenko on the Caspain Sea. Its capacity is partly used for generating electricity, the rest going as heat to obtain desalted water. It should be also mentioned that that area has no natural fresh water and was a lifeless desert before the nuclear power plant began operating there.

According to the program of nuclear power development, the nuclear power plants are mainly built in the European part of the USSR. This increases the power supply reliability in the most industrially developed areas of our country. Besides it reduces the transportation of fuel from the East and saves millions tons of coal and oil.

In 1979, there were 226 nuclear power-plants all over the world. It is not a very great figure compared with the

thermal and hydropower stations. However, by the end of the present century half of all the world's electricity will come from nuclear power plants.

Of all the methods of energy production nuclear power engineering presents the least danger to nature. But so far it is incapable of providing the necessary amount of energy—the road it has passed is too short. Therefore, along with the accelerated construction of nuclear power-stations, much attention will be paid in the USSR to the development of coal-based thermal power-stations reliably provided with fuel resources.

In keeping with the economic and social development plan of the USSR for 1981-1985 and for the period up to 1990 electricity production will reach a great figure.

APPENDIX

IDIOMS, CONJUNCTIONAL AND PREPOSITIONAL PHRASES

according to согласно
along with вместе с, наряду
all over the world во всем мире
a number of ряд, несколько
apart from кроме, помимо
as a matter of fact на самом деле, фактически
as a result в результате
as close as possible как можно ближе
as early as еще *(о времени)*
as far as ... is concerned что касается ...
as far back as еще (в), уже (в)
as follows как следует ниже, следующим образом
as for что касается
as in the case как в случае с
as long as пока, до тех пор пока
as soon as как только
as to что касается
as well также
as well as так же, как и
at any rate по крайней мере, во всяком случае
at last наконец
at least по крайней мере
at once тут же, сразу же
at present в настоящее время
at the same time в то же самое время, одновременно
at times иногда, временами
at will по желанию

because of из-за, вследствие
both ... and и ... и, как ... так и
but for если бы не
by all means непременно
by chance случайно
by means of при помощи, посредством
by no means никоим образом, ни в коем случае
by some means or other тем или иным образом
by the way между прочим
by turns по очереди

consideration should be given to следует обратить внимание на
can't but нельзя не, не могу (может и т. д.) не
can't help + (Gerund) нельзя не, невозможно не

deal with иметь дело с, рассматривать
do a world of good делать много хорошего
do without обойтись без
due to благодаря; обусловленный

either ... or или ... или
ever since с того времени, с тех пор

first впервые, сначала
for ever навсегда, вечно
for example, for instance например
for short короче, для краткости
for the present на этот раз, пока
for the sake of ради
for this reason по этой причине
for want of из-за недостатка (нехватки) чего-л.
from time to time время от времени

give rise to вызывать, способствовать
give way to уступать
go into operation вступать в действие

have nothing to do with не иметь никакого отношения к, не иметь ничего общего с

in addition to кроме того, к тому же
in case в случае, если

in certain respects в некотором отношении
in comparison with по сравнению с
in effect в действительности, в сущности
in fact фактически, на самом деле, в действительности
in its turn в свою очередь
in no time очень быстро, моментально
in order to для того, чтобы
in other words иными словами
in particular в особенности
in question о котором идет речь
in short короче говоря
in spite of несмотря на
instead of вместо того, чтобы
in terms of с точки зрения
in this connection в связи с этим
in view of ввиду
it goes without saying ясно, само собой разумеется
it is high time давно пора
it is not the case дело обстоит не так
It stands to reason ясно, очевидно
it was not until лишь только в, еще в *(о времени)*

keep in mind иметь в виду, помнить
kind of своего рода

last but not least последний по порядку, но не последний по значению
last but one предпоследний

make use of использовать
meet the needs (requirements) удовлетворять нуждам (требованиям)
more or less более или менее
needless to say нечего и говорить
neither . . . nor ни . . . ни
no longer больше не
no matter неважно, независимо от
no sooner . . . than едва, как только
not at all вовсе нет, нисколько
not to speak of не говоря уж о
no wonder не удивительно
of course конечно
on account of из-за, вследствие
one and the same thing одно и то же
on the basis of на основе, на основании
on the contrary наоборот
on the one hand с одной стороны
on the other hand с другой стороны
on the part of со стороны
on the whole в целом, в общем
or so или около этого, приблизительно
owing to вследствие, благодаря

pay attention to обращать внимание на
play a part in играть роль
put into operation ввести в действие, в эксплуатацию
put into use ввести в действие

rather than скорее чем, а не
result from получать в результате, происходить из-за
result in иметь результатом, приводить к

say скажем
so far до сих пор, пока что
so to say так сказать

take advantage of воспользоваться
take into account принимать во внимание, в расчет
take into consideration принимать во внимание
take part in принимать участие в
take place происходить
thanks to благодаря
that is то есть
that is to say то есть, иными словами
the former первый (из упомянутых)
the latter последний (из упомянутых)
the rest of остальной
the . . . the чем . . ., тем

under consideration рассматриваемый
up to до

with respect to по отношению к, относительно

CONTENTS

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Тексты пособия составлены на основе оригинальных английских и американских источников. Упражнения способствуют как лучшему усвоению и закреплению лексики и грамматики, так и дальнейшему развитию бесперевodного понимания текстов на английском языке.

Цель пособия – подвести студентов к самостоятельному чтению и пониманию оригинальной научно-технической литературы по специальности на английском языке.

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