Міністерство освіти та науки України
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АНГЛІЙСЬКА МОВА В ЕЛЕКТРОТЕХНІЦІ ТА ЕЛЕТРОМЕХАНІЦІ

Методичні вказівки
до практичних занять для студентів I-II курсів
денної форми навчання за напрямом підготовки
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Англійська мова в електротехніці та електромеханіці. Методичні вказівки до практичних занять для студентів І-ІІ курсів денної форми навчання за напрямом підготовки 6.050701 − «Електротехніка та електротехнології» / Укладачі: Кот О.В., Єршов Р.Д. – Чернігів: ЧНТУ, 2015. – 56 с. (рос. мовою).

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СОДЕЖАНИЕ

Электротехника должна быть самостоятельной наукой,
объединяющей всю практику (собственно электротехнику)
и теорию электричества – электрику. Электротехника,
хотя и кровное дитя физики, должна оторваться
от своей матери и жить отдельно, самостоятельно.
Андрей ПЛАТОНОВ.

ПРЕДИСЛОВИЕ

Методические указания составлены в соответствии с требованиями действующей программы по английскому языку для технических специальностей в высших учебных заведениях и предназначены для студентов I-II курсов дневной формы обучения по направлению подготовки 6.050701 − «Электротехника и электротехнологии», которые продолжают изучение английского языка на основе знаний, полученных в средней школе.

Указания представляют собой комплекс учебных материалов, организованный в соответствии с конкретными заданиями и условиями обучения, имеющими целью формирование навыков и умений у учащихся в различных видах речевой деятельности. Указания способствуют обучению чтению и пониманию специального неадаптированного текста на английском языке без словаря (или с ограниченным его использованием) для получения необходимой информации и ведения связанной беседы по специальности.

Текстовый материал и система разработанных к нему заданий расположена по степени нарастания языковой сложности и содержат начальные сведения по электродинамике и теоретическим основам электротехники в порядке естественного изучения тем в ходе этих курсов.

PREFACE. ELECTRICAL ENGINEERING

I. Read the text to yourself and grasp the main idea of it

Electrical engineering is the science dealing with the techniques of utilizing electrical and magnetic phenomena for practical purposes. One of the main branches of electrical engineering is electrical power engineering concerned with the production of electrical energy from other forms of energy, power transmission over long distances, distribution among consumers, and reconversion of power for ultimate utilization into mechanical, thermal, chemical, and other forms of energy.

Electrical engineering has made the noteworthy contribution[1] to the technological advances in many professional branches. It enables engineering to promote the integrated mechanization and automation of production processes, put into operation more and more automatic transfer lines, shops and plants. Electrical engineering forms the basis for electrothermic and electrolytic methods of metal production and treatment. Electrical energy is easily convertible and therefore finds wide use[2] in electric welding, high-frequency steel hardening, and in many other applications. Mechanical, chemical, civil, and structural engineers use the products of electrical engineering for remote metering, process control, heating, refrigeration, power distribution within buildings, etc.

Modern electronics offers the possibility[3] of fabrication of miniature devices for computers and various automatic apparatus designed for control over production processes.

Automation of production processes relies on[4] a wide range of vacuum, gas-filled, and semiconductor devices. Rapid development in computer engineering makes it possible to elaborate automatic control systems and to solve important economic problems. Electrical devices intended to collect, process, transmit, and display information are the vital means of automated control systems.

Wide introduction and application of electrical and electron devices call for well-trained workers, who must be familiar with basic laws of electrical engineering and know the principle of operation of DC and AC machines, transformers, meters, and also vacuum and semiconductor devices.

Notes:

1) has made the noteworthy contribution – сделал(а) значительный вклад;
2) finds wide use – находит широкое применение;
3) offers the possibility – предоставляет возможность;
4) relies on – опираться на.

II. Answer the following questions:

1) What does the electrical engineering deal with ?
2) What is electrical power engineering concerned with ?
3) Where does electrical engineering find its use ?
4) What kind of possibility does modern electronics offer ?
5) What must well-trained workers be familiar with ?

1 BASIC CONCEPTS OF ELECTRICITY AND MAGNETISM

I. Make sure that you know these words. Say what Russian words help you to guess their meanings

Ma´terial; **ph**e´nomenon [f], *(pl)* phenomena; manife´sta**tion** [ʃn]; ´magnetism [æ]; in´d**u**ction [ʌ]; pr**a**ctical [æ]; period [´piəriəd]; telegra**ph** [f]; tele**ph**one [f]; Coulomb [´ku:lɔm]; ma´ch**i**ne [i:]; as´so**c**iate [ʃ]; **ch**emical [k]; ´con**c**entrate [s]; oxide [´ɔksaid]; sulphate [sʌlfeit]; pro´portion; arc [a:k]; ´ener**g**y [ʤ], na**ture** [tʃə],´tr**a**nsport [æ].

II. Memorize the following words and word-combinations. b) Check if you know their meanings

1. certain [sə:tn] – *определенный*; **a**mber [æ] *янтарь*; gl**a**ss [a:] – стекло; fur – мех; cap**a**city [æ] – способность; cork – пробка; ability – способность; lodestone – магнитный железняк; etc. [it´setrə] – и так далее; qu**a**ntitative l**a**ws [ɔ] [ɔ:] – количественные законы; induction – индукция; prior to [´praiə] – до; increa**s**e [s] *v.* – увеличивать; current revolution – современная революция; notably [nɔutəbli] – особенно; rub *v.* – тереть; silk – шелк;

2. acquire [ə´kwaiə] – приобретать; a bit of paper – кусочек бумаги; similarly подобным образом; iron **ores** [ɔ:z] – железная руда; an**c**ient times [ʃ] – древние времена; get w**ea**ker [i:] – слабеть; investigate *v.* – исследовать; the only – единственный; the lightning rod – молниеотвод; expend *v.* – увеличиваться (в объеме); ever-increasing control – все возрастающее управление.

III. Give English equivalents to the Russian words and word-combinations in brackets and translate the sentences into Russian

1. When we rub (определенные) substances, notably (янтарь) and (стекло) with (шелк) or (мех), they (приобретать) the (способность) to attract small (кусочки бумаги) and (пробка). 2. This (явление) is the manifestation of electricity. 3. (Подобным образом), the ability of certain (железная руда) such as (магнитный железняк) to attract small bits of iron is a manifestation of magnetism. 4. All these things were known from (древние времена). 5. Most of the basic (количественные законы) of electricity and magnetism were discovered between 1784 and 1831. 6. Michael Faraday discovered magnetic (индукция). 7. (До этого) the only practical electrical (изобретение) was the (молниеотвод). 8. The practical utilization of electricity (увеличивать) rapidly with the development of the telegraph, the telephone, incandescent lighting and electric motors. 9. Uses of electricity (расширять) to this day with the (современная революция) in microelectronics. 10. Microelectronics gives us (все более возрастающее управление) over the machines.

TEXT A. CHARGING A BODY

I. Read the text to yourself and grasp the main idea of it

The only way to charge a body negatively is to add electrons to it, and the only way to charge it positively is to take electrons away from it, leaving an excess of positive electricity.

When the rubber rod was charged negatively by rubbing with cat’s fur, some electrons passed from the cat's fur to the rubber rod, leaving the cat’s fur charged positively and the rubber charged negatively. On the other hand, when the glass rod was charged positively by rubbing with silk, some electrons passed from the glass to the silk, leaving the glass rod charged positively and the silk charged negatively.

TEXT B. ELECTRICITY AND MAGNETISM

I. a) Read the text. b) Find the part of it dealing with the descriptions of the electricity and magnetism

When certain substances, notably amber and glass are rubbed with a material such as silk or fur they acquire the capacity to attract small bits of paper and cork. This phenomenon is a manifestation of electricity, one of the fundamental forces of nature. Similarly, the ability of certain iron ore, such as lodestone, to attract small bits of iron is a manifestation of magnetism, another fundamental force.

Although these simple electric and magnetic phenomena have been known since ancient times, most of the basic quantitative laws of electricity and magnetism were discovered between 1784, when Charles Coulomb investigated the forces between charged objects and 1831, when Michael Faraday discovered magnetic induction.

Prior to this 50 year period of discovery, the only practical electric invention was the lightning rod of Benjamin Franklin (1752). After this period, the practical utilization of electricity increased rapidly with the development of the telegraph (1844), the telephone (1877), incandescent lighting (1880) and electric motors (1887). Uses of electricity have continued to expand to this day, with the current revolution in microelectronics giving us ever increasing control over the machines.

ASSIGNMENTS

I. a) Find out the key sentences in the Text A. b) Say what physical phenomenon the text is concerned with

II. a) Skim through the Text B and find the part of it dealing with the fundamental forces of nature. b) Discuss formation with your fellow-students

III. a) Find the paragraph in the Text B containing information about the discovering of the basic quantitative laws of electricity and magnetism. b) Discuss it

IV. Answer the following questions embracing the contents of the Text A and the Text B

1. What is the way to charge a body negatively or positively ? 2. What capacity did amber and glass acquire when rubbed with silk or fur ? 3. What is magnetism? 4. When were the basic quantitative laws of electricity and magnetism discovered? 5. When did C. Coulomb investigate the forces between charged objects? 6. When did M. Faraday discover magnetic induction? 7. What was invented by B. Franklin?

V. Be ready to discuss the information obtained from the Text B

VI. Make a short summary of the Text B

VII. Speak on the Text A and the Text B according to the following plan:

1) The manifestation of electricity;
2) The most important development in electricity.

TEXT C. BASIC ELECTRIC CONCEPTS

I. Be sure that you know these words

associate *v.* − связывать; mention − упоминать; application − приспо собление, применение; act along − действовать самостоятельно; own − собственный; thin − тонкий; solid − твердый; event − событие; numerous − многочисленный; however − однако; presence − присутствие; yet − все же, еще; retain *v.* − удерживать, сохранять; permanent − постоянный; liberate *v.* − освобождать; e.g. (for example) − например; obvious − очевидный; exert *v.* − оказывать действие; heat *v.* − нагревать; surface − поверхность.

II. Memorize these words and word-combinations used in their specialized meanings

device − прибор; sound − звук; loud speaker − громкоговоритель; lead − свинец; purify *v.* − очищать; resistive − резистивный, имеющий сопротивление; deposit − осаждать; silver − серебро; electric fire − электрическая печь; electric current − электрический ток; copper − медь; wire − провод; plate *v.* − покрывать; solution – раствор, решение.

III. Find these word-combinations and terms in the Text C and translate the sentences containing them

lead-acid battery − кислотно-свинцовая батарея; fork lightning – разряд молнии; sufficient to melt − достаточно, чтобы расплавить; arc welding − дуговая сварка; to glow red hot − раскаливать докрасна; candlestick − подсвечник; gimlet − буравчик.

IV. Give English equivalents to the Russian words in brackets. Translate these sentences

1. An electric (печь) is the most (очевидный) example of the heating effect of a current. 2. This wire (раскалён докрасна) as the current passes through it. 3. If the wire is very (тонкий) it is heated (добела). 4. A great proportion of light to heat is released as in the tungsten (вольфрамовая лампа накаливания). 5. Electrolysis is used (очищать) metals such as (медь). 6. The element of the fire is just highly (резистивный) wire. 7. During (дуговая сварка) and (молния) large (количество)

of electrical energy are concentrated and give temperature (достаточно, чтобы расплавить) metals.

I. a) Read the text. b) Find the part of it describing three basic effects of an electric current and examples of electromagnetism and chemical effect of current

We associate all kinds of events and devices with electric current: electric light, electric transport, electric sound, etc. They are too numerous to mention. However, there are only three basic effects of an electric current and all the other applications follow from them: (a) magnetic effect, (b) chemical effect, (c) heating effect.

The magnetic effect of current is the basis for most electromechanical devices. Near a current there is a magnetic field and this exerts a force on other currents or magnetic materials.

The presence of magnetic materials such as iron, can make the forces thousands of times greater than the currents acting alone, and yet it is the current which control the magnet.

Loudspeakers and electric motors are other applications of electromagnetism.

The materials themselves may retain the magnetism and become permanent magnets which exerts their own influence. Permanent magnets are the basis for some of the simpler devices. The compass needle responds to the magnetic field of the Earth which is itself a permanent magnet.

When a lead acid battery is charged the acid becomes more concentrated and hydrogen and oxygen are liberated. As the battery discharges the acid gets weaker and lead oxide on the positive plate is charged to lead sulphate. These processes are examples of the chemical effect of a current, i.e. electrolysis. Electrolysis is used to purify metals such as copper and aluminum and to deposit metals onto surface, e.g., silver plating.

An electric fire is the most obvious example of the heating effect of a current. The element of the fire is just highly resistive wire which glows red hot as the current passes through it.

If the wire is very thin it is heated white hot and a greater pro portion of light to heat is released as in the tungsten filament lamp. Hotter still and more dramatic are the effects of arc welding and fork lightning when large amounts of electrical energy are concentrated to give temperature sufficient to melt metals.

ASSIGNMENTS

I. Read the Text C attentively and answer the following questions.

1. What do we associate electric current with ? 2. How many effects of an electric current are there ? 3. What is the magnetic effect of current ? 4. What can make the forces thousands of times greater than the currents acting along ? 5. What applications of electromagnetism do you know ? 6. What may become permanent magnets? 7. When does the acid become more concentrated ? 8. What is the result of the battery discharge? 9. What is electrolysis ? 10. What is the most obvious result of the heating effect of a current ?

II. Read the text and find the part of it describing three basic effects of electric current and examples of electromagnetism and chemical effect of current

III. Pick out and translate the sentences with the Infinitive and Gerund

TEXT D. MAGNETISM

I. Match the following English words and word-combinations with the Russian ones

to be familiar with	прямой угол
temporary magnet	Буравчик
permanent magnet	средний палец
observe	правая рука
Thumb	менять направление
forefinger	указательный палец
right hand	Наблюдать
Reverse	большой палец
Gimlet	быть знакомым с
Middle finger	постоянный магнит
right angle	магнит с временным магнетизмом (электромагнит)

II. a) Read the Text D and say what it is about. b) Review the text

Anyone working in the field of electricity must be familiar with the principles of magnetism because generators, transformers and motor depend on magnets and magnetism for their operation.

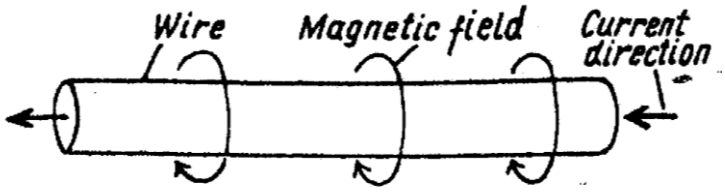

Figure 1.1 − The relation between electricity and magnetism.

A magnet is either permanent or temporary. If a piece of iron or steel is magnetized and retains its magnetism, it is a permanent magnet. A com pass is one form of permanent magnet. Others with which you are probably familiar are horse-shoe-shaped magnets and bar magnets. Each one of these magnets has a north magnetic pole and south magnetic pole; in fact, all magnets have a north and south poles.

When current flows through a coil, a magnetic field with a north and a south pole is set up just like that of a permanent magnet. However, when the current stops, the magnetic field also disappears. This type of temporary magnetism is called electromagnetism. Permanent magnets are used for the magnetic field necessary in the operation of small, inexpensive electrical motors.

When electricity flows through a wire or conductor, magnetic lines of force (magnetic flux) are created around that wire (Figure 1.1). When a piece of wire is passed through a magnetic field (magnetic lines of force), electricity is created in that wire. We then can readily see the relation between electricity and magnetism. In fact, the very existence of the electrical industry is dependent upon magnetism and magnetic circuits.

TEXT E. RULES FOR DIRECTION OF CURRENT AND MOTION

I. Read the text and find the part of it describing the methods of determining direction of the lines of force

To determine the polarity of an electromagnetic solenoid: In looking at the end of a solenoid, if an electric current flows in it clockwise, the end to the observer is a south pole and the other end is a north pole; if the current flows counter-clockwise, the position of the pole is reversed.

To determine the direction of the lines of force set up around a conductor: If the current in a conductor is flowing away from the observer, then the direction of the lines of force will be clockwise around the conductor (the rule of gimlet).

To determine the direction of an induced current in a conductor that is moving in a magnetic field: Place thumb, forefinger, and middle finger of the right hand each at right angles to the other two; if the fore finger shows the direction of the lines of force and the thumb shows the direction of the motion of the conductor, then the middle finger will show the direction of the induced current.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text D

1. Why must anyone working in the field of electricity be familiar with the principles of magnetism ? 2. What kind of magnets do you know ? 3. What do all magnets have ? 4. What is set up in a coil when current flows through it ? 5. Where are permanent magnets used ? 6. Where is electromagnetism used ? 7. How can we determine the polarity of an electromagnetic solenoid ? 8. How can we determine the direction of the lines of force set up around a conductor ? 9. How can we determine the direction of an induced current in a conductor that is moving in a magnetic field ?

II. a) Examine Fig. 1.1 and describe it. b) Answer the questions

1. What does Figure 1.1 show ? 2. What does electricity flow through ? 3. When are magnetic lines of force created around the wire ? 4. When is electricity created in the wire ?

EXERCISES

I. Analyze the structure of the following words and give their initial forms

Magnetic, magnetism, to magnetize; movement, movable, remove; direction, directional, director.

II. Give the degrees of comparison of the following words

High, large, long, wide, big, little, good, small, great, many, much, few, well, bad, far, easy, difficult, different.

III. Change the sentences adding some words and using comparative and superlative degrees of adjectives and adverbs

Model. This is **an interesting** book. This book is **more interesting** than that one. (This is the **most interesting** book I have ever read.) I like to swim **much**. He likes to swim **more** than I. (He likes to swim **most** of all).

1. The Kiev Metro is beautiful. 2. I like to read much. 3. He knows English badly. 4. Professor explains the material well. 5. The students were answering loudly. 6. A big house was erected nearby. 7. This problem is simple.

IV. a) Translate the following sentences. b) Pay attention to the words and word-combinations in bold type

1. The education system in France rather differs **from that** in USA. 2. The aeronautics is one of the many branches of mechanical engineering, **the one that is the most interesting** to me. 3. The more I read about this event **the less** I understand it. 4. This problem is not so difficult as **the one that** we solved last time. 5. He studied this subject **as much as possible.**

V. Find Infinitives and Gerunds in the following sentences. State their functions and translate them into Russian

a) 1. To develop a new device we had to study structures of many other similar devices. 2. To obtain the desired properties of the device the scientist had to continue this experiment. 3. To determine the direction of the lines of force set up around a conductor we must know the rule of gimlet. 4. The above mentioned method is used to determine the polarity of an electromagnetic solenoid. 5. To make an electric current flow continuously along a wire, a continuous supply of electrons must be available at one end and a continuous supply of positive charges at the other. 6. To avoid possible breakdown of the insulation, the practice is to put extra insulation on the end turns.

b) 1. Before switching on current for a test the circuit should be thoroughly checked. 2. On joining the upper ends of the metals with a metal wire we caused the current to flow through the wire. 3. In this case the reading will fall slowly after reaching full load. 4. In making permanent steel magnets we must prepare steel of high quality.

2 ELECTRON THEORY AND CURRENT

I. Make sure that you know these words. Say what Russian words help you to guess their meanings

Me´chanics, me´chanical [k]; ´stationary, con´di**tion**, re´ac**tion**, ´attrac**tion**, mi´gra**tion** [ʃn]; e´lectron, ´orbit; ´planet; ´miniature [tjə]; d**y**´namics [ai]; ´s**u**bstance, con´d**u**ctor [ʌ].

II. Memorize the following words and word-combinations

to be divided – делиться; in a stationary condition − в неподвижном состоянии; the subject of considerable study − предмет внимательного изучения; evidence − подтверждение; to take part − принимать участие; c**o**re [ɔ:] − сердцевина; nucleus [ˊnju:lkiəs] − ядро, центр; t**i**ny bodies [ai] − крошечные тела; confined to orbit − привязанный к орбите; under certain circumstances − при определенных обстоятельствах.

III. Give English equivalent to the Russian words and word-combinations in brackets and translate the sentences into Russian

1. Electricity like mechanics may (разделить) into two main branches, namely static electricity and current (dynamic) electricity. 2. Static electricity the electricity at rest or (в неподвижном состоянии), while current electricity treats electricity in motion. 3. Nothing was really known about the nature of electricity, although its effects had been (предметом внимательного изучения). 4. It was accepted that the electricity was some kind of fluid, but there was no experimental (подтверждения) to support the theory. 5. Atom was defined as the smallest part of a chemical element that can (принимать участие) in a chemical reaction without transformation of itself structure. 6. It was shown that the atom, far from being solid, is more like a miniature solar system, with small bodies rotating around a central (сердцевина) or (ядра). 7. These (крошечные тела) behave much as planets in the solar system. 8. Some substances contain not only planetary electrons, i.e. electrons which are (привязаны к орбите) of an atom, but also free electrons. 9. In such substances (при определенных обстоятельствах, условиях) we can get a flow or migration of electrons through the substance, and we then speak of *an electronic current*.

IV. Read the Text A and find the part of it describing the behavior of electrons

TEXT A. ELECTRIC CURRENTS

Electricity, like mechanics, may be divided into two main branches, namely, static electricity and current electricity, corresponding to the mechanical ideas of statics and dynamics, respectively. Static electricity is the electricity at rest, or in a stationary condition, while current electricity treats electricity in motion.

Until recently[1], nothing was really known about the nature of electricity, although its effects had been the subject of considerable study. It was accepted that electricity was some kind of fluid, but there was no experimental evidence to support the theory. In fact[2], it was known that matter was built up from atoms, and an atom was defined as the smallest part of a chemical element that can take part in a chemical reaction. Originally, it was believed that the atom was a tiny but solid mass, but, some years ago, it was shown that the atom, far from being solid[3], is more like a miniature solar system, with small bodies rotating around a central core or nucleus. These tiny bodies behave much as the planets in the solar system, for they travel in definite orbits, and the whole system is held together[4] by forces of attraction to the

central nucleus. It was also found that these miniature planets are extremely small charges of negative electricity, and they were therefore named electrons.

Some substances contain not only planetary electrons, i.e. electrons which are confined to the orbit of an atom, but also free electrons. These electrons can move freely between the atoms or from atom to atom. Such substances are called electric conductors. In such substances under certain circumstances we can get a flow or migration of electrons through the substance, and we then speak of an electric current.

Notes:

1) until recently − совсем еще недавно, до недавнего времени;
2) in fact − на самом деле;
3) far from being solid − будучи далеко не сплошной массой;
4) is held together − удерживаться (около ядра).

TEXT B. ELECTRIC FIELDS AND ELECTRONS

I. Memorize the following words and word-combinations

Field – поле; to conduct electricity – проводить электричество; escape – освободиться, вырваться; to cause to move – заставить двигаться, перемещаться; to cease – прекращаться, переставать; to connect the positive terminal – подсоединяться к клемме со знаком полюс; to exert a force on – оказывать влияние на …, применять силу к…; a fundamental law – основополагающий закон; near the surface – у поверхности; to leave an excess – оставлять избыток; to rearrange – перестраиваться, изменять порядок следования.

II. Translate the text into Russian paying attention to the laws concerning electric fields

The electronic engineer produces the electric fields which he desires by applying a voltage[1] between electrodes, that is, pieces of metal which conduct electricity. A conductor is full of electrons[2] which are free to move within the conductor[3], but cannot escape through its surface. It also contains fixed positive charges[4] equal in total charge[5] to the charge of the free electrons.

Suppose we tried to produce an electric field in a conductor. If we succeeded in producing such a field, the field would cause the electrons in the conductor to move. They would move into such a pattern as to reduce the electric field. They would move into some regions, causing an excess of electrons and a negative charge in those regions, and they would move away from other regions, leaving a positive charge in those regions. These charges would tend to reduce the field, and when the field finally became zero, the electrons would cease to move. Hence, there is never any electrical field inside a conductor.

If we connect one electrode to the positive terminal of a battery and another electrode to the negative terminal of a battery, there will be an electric field between the two electrodes, and this field will exert a force on any electron in it. The general direction of the force will be away from the negative electrode and toward the positive electrode. The field extends right up to the surface[6] of the electrodes. A

fundamental law of the electric fields is that very near the surface of an electrode − that is, a conductor, any piece of metal − the direction of the electric field must be normal to the surface of the conductor.

The electric field exerts a force on the electrons near the surface of the conductor. If the electric field is normal to the surface, this force is straight inward or outward. An outward force[7] draws an excess of electrons to the surface. An inward force[8] pushes the electrons in from the surface and leaves an excess of positive charges. If, however, there were a component of the electric field parallel to the surface, it would cause the electrons to slide along parallel to the surface just inside the conductor, and this would so rearrange the electrons as to change the electric field so as to make it normal to the conductor at all points.

Thus, we have two important laws concerning electric fields: (1) there is no electric field within a conductor; (2) the electric field just outside of a conductor is always normal to the surface of the conductor.

Notes:

1) by applying a voltage − подавая напряжение;
2) a conductor is full of electrons − в проводнике имеется большое количество электронов;
3) within the conductor − внутри проводника;
4) fixed positive charges − постоянные положительные заряды;
5) total charge − суммарный заряд (общее число зарядов);
6) right up to … − прямо к …, вплоть до …;
7) outward force − сила, направленная к поверхности проводника изнутри;
8) inward force − сила, направленная внутрь проводника.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the text A and B

1. What is the electricity divided into? 2. What is the difference between static electricity and current or dynamic one ? 3. How was electricity considered until recently ? 4. What does an atom look like ? 5. What substances are called electric conductors ? 6. What does the electric engineer apply to obtain the electric fields ? 7. What will the field produced cause ? 8. When there is never any electrical field inside a conductor ? 9. What is to be done to produce the electric field ?

II. Put the verbs in brackets in the Passive Voice. Translate the sentences into Russian

1. Electricity, like mechanics, may (to divide) into two main branches. 2. Until recently, nothing (to know) really about the nature of electricity. 3. It (to accept) that electricity was some kind of fluid. 4. The atom (to define) as the smallest part of a chemical element. 5. Originally, it (to believe) that the atom was a tiny but solid mass. 6. It (to show) that the atom is like a miniature solar system. 7. Such substances (to call) electric conductors.

III. Pick out the key sentences from the Text A and B. Translate the sentences. IV. Make a short summary of the Text A and B

3 ELECTRICAL UNITS AND CIRCUITS

I. Make sure that you know these words. Say what Russian words help you to guess their meanings. b) Repeat these words after the speaker

Ampere [ˊæmpɛə], ammeter [ˊæmitə], b**a**ttery [æ], poten**t**ial [ʃ], experimental [eksˌperiˊment], maximum [ˊmæksiməm], volt [voult], voltmeter [ˊvoltˌmi:tə], voltage [ˊvoultidʒ], **g**ene´rator [dʒ], pro´portional, graph [græf], re´s**u**lt [ʌ], con´d**u**ctor [ʌ], value [ˊvælju:], re´**s**istor [z], watt [wɔt], effect [ˊifekt].

II. a) Memorize the following words and word-combinations. b) Check it you know their meanings

I. Stream − поток; particle − частица; arrangement − *зд.* соединение; burn (burnt) v. − гореть; calculate v. − рассчитывать; circuit − цепь; conductor − проводник; connection − соединение; current − ток; deduce v. – устанавливать; determine v. − определять; define v. − определять; mains − электрическая **сеть**; measure v. − измерять; match v. − сопоставлять, согласовывать; obey v. − подчиняться (выполняться); particular − отдельный; produce v. − производить; quantity − количество, величина; ratio − отношение; raise v. − поднимать; rearrange – изменять взаимное размещение *преобразовывать*; resistance − сопротивление; equation − уравнение; experimental − опытный; flow (flew, flown) v. − течь; law − закон; low value − малая величина; to go dim (bright) − затухать (разгораться); just below − чуть ниже; electromotive force (e.m.f.) − электродвижущая сила (ЭДС); light bulb − электролампа; stream n. − поток; suggest v. − предлагать; verification − проверка; potential difference (p.d.) − разность потенциалов; in series − (соединять) последовательно; to be true − быть действительным; become significant − становиться значительным.

II. set up v. − устанавливать; drop v. − падать; just as − также, как; pressure − давление; mean (meant) v. − значить; really − действительно; force v. − заставлять; energy per unit charge − энергия на единицу заряда; supply − снабжать; liquid − жидкость; pipe − труба; the same thing − то же самое; available − в наличии; from one point to another − от одной точки к другой; source − источник; connect in line − соединять последовательно.

III. Give English equivalents to the Russian words and word-combinations in brackets and translate the sentences into Russian

1. An electric (ток) is a (поток) of charged particles, which flow in (проводник). 2. We have just (определить) the unit of current. 3. A voltage (приложенное) to a conductor in a circuit (создавать) a current. 4. The (отношение) of U to I for a (отдельный) conductor is called the (сопротивление) of the conductor R. 5. Ohm's (закон) can be (выражен) in the experimental results. 6. In the graph we have seen the (проверка) of Ohm's law. 7. (Преобразуя уравнение) we have *U=IR*.

8. A high resistance (ограничивать) the current to a (малая величина). 9. Values of current (измеряться). 10. A resistor carries a current of 0.2A when a (разница потенциалов) of 4.0 V is applied across it. 11. Electrons move under the influence of (электродвижущая сила − ЭДС). 12. This equation (справедливо) for resistors (включенные последовательно). 13. These (величины) are (сопоставлять) with the current units. 14. In a parallel (устройство) of resistors the following equation is true.

TEXT A. CURRENT AND RESISTANCE

I. Read the text to yourself and grasp the main idea of it

An electric current (*I*) is a stream of charged particles. In a conductor the particles that move are electrons which are so small that they can flow past the atoms without resistance, Current *I* is measured in terms of the quantity of charge *Q* flowing per unit tune − $I=Q/t$.

The charge on a single electron is very small as a unit of charge. Quantity of charge is measured in coulombs (symbol − *C*) where *1 coulomb* = $6{,}24\cdot10^{8}$ electron charges. We can determine the unit of current the ampere (symbol A).

A voltage applied to a conductor in a circuit produces a current. One have found that for some conductors the current *I* directly proportional to the voltage *U*, i.e. $I \sim U$. This is Ohm's law and it can be expressed in the experimental results shown in the graph of Figure 3.1, a.

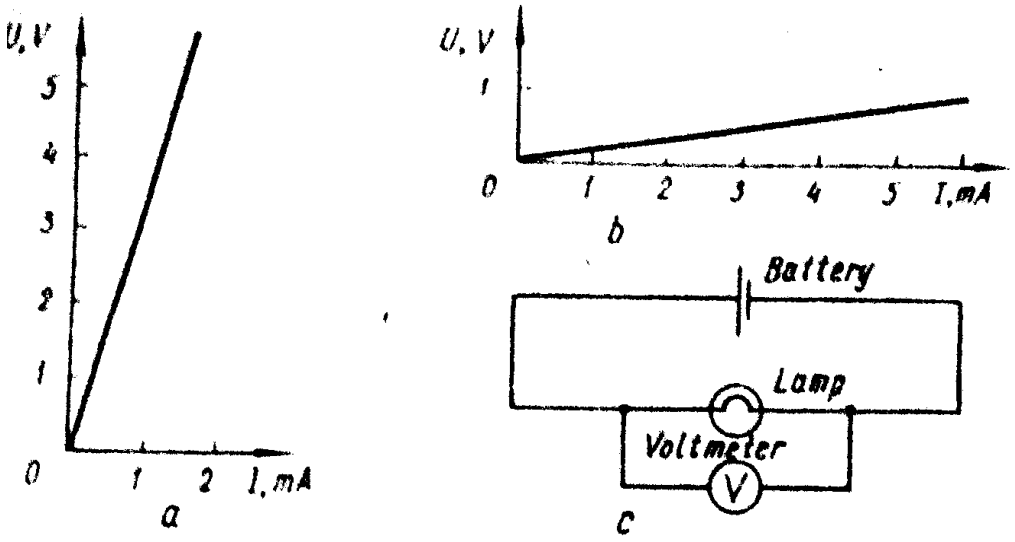

Figure 3.1 − Volt-ampere characteristics (a) for high-resistance; (b) low-resistance; (c) using the voltmeter to measure p.d. across the contacts of a lamp.

The ratio of *U* to *I* for a particular conductor is called the resistance of the conductor *R*: $R=U/I$. The unit of the resistance is the ohm, symbol Ω. The resistance determines how much current flows for a given voltage. Rearranging the equation we must have $U=I\cdot R$ or $I=U/R$.

A high resistance restricts the current to a low value When the resistance is small the current is large (Figure 3.1, b).

TEXT B. VOLTAGE

I. Read the text and find the part of it dealing with the source of energy

The voltage is the force that drives the current around the circuit The source of energy, e.g., a battery exerts the force of the charge by setting up a positive or high potential at one contact, and a negative or low potential, at the other. The current flows from the positive to the negative contact or expressed another way, from higher to lower potential.

The potential drops around the circuit from positive to negative just as the liquid pressure drops around the pipes from the higher pressure.

The difference in potential between two points is measured in volts. In fact we use the term "voltage" or "voltage drop" or "potential difference" (p.d.) to mean the same thing.

Voltage is really a measure of how much energy is available to force each coulomb of charge move from one point to another. Voltage = energy per unit charge, i.e. *volts=joules/coulombs*.

When we are considering the maximum energy per coulomb that a force of voltage can supply, we refer to it as the electromotive force or e.m.f. for short. The e.m.f. of a source is measured in volts. E. m. f. is only used to describe a source potential such as a battery or generator whereas the terms voltage or potential difference (p.d.) may refer to any part of a circuit.

Voltmeters are used to measure potential differences. They are not connected in line with the circuit but parallel to it between the points that are being considered (Figure 3.1, c).

ASSIGNMENTS

I. a) Skim through the Text A and find the part of it dealing with the measuring of current and the resistance of the conductor R. b) Discuss the information with your fellow-student

II. a) Find the part of the Text B containing information about the potential drop. b) Discuss it

III. Answer the following questions embracing the contents of the Text A and Text B

1. What is an electric current ? 2. What is the size of particles in a conductor ? 3. In what terms is current measured ? 4. What produces current in a circuit? 5. What is the relation between current and voltage ? 6. What is resistance ? 7. What la the unit of the resistance ? 8. What is voltage? 9. What does the battery exert ? 10. How does the current flow ? 11. How does the potential drop around the circuit ? 12. What units is p.d. between two points measured in ? 13. What other terms can we use instead of voltage? 14. What is e.m.f. ? 15. What is used to measure the p.d. ?

IV. Pick out the key sentences from the Text B. Translate the sentences

TEXT C. MORE DETAILS ON RESISTANCE AND OHM' LAW

I. Read the text paying attention to the main Ohm's discovery

Georg Ohm, a German physicist, was the first to notice that, when using a cell with a constant voltage, the amount of current would change when different loads were connected across it.

For instance, Ohm noticed that more current would flow through a copper wire than would flow through an iron wire of the same size and that more current would flow through a thick wire than through a thin wire of the same material. Georg Ohm concluded that some types of materials tend to resist the flow of current more than others. Iron has greater resistance than copper.

A thin wire has greater resistance than a thick wire. To resist means to hold back. Resistance tends to reduce the amount of current that is flowing through a circuit.

If Ohm used a larger cell but kept the voltage and the resistance in the load the same, would more current flow? No. The size of the cell does not affect the amount of current delivered. Only voltage and resistance control this.

Ohm then connected a cell with a higher e.m.f.[1] (voltage) to the same load, and he discovered that more current flowed into the circuit. The unit used to measure resistance was later named after its discoverer. The basic unit of resistance is the ohm. An ohm is defined as the amount of resistance that will allow 1 ampere of current to flow at an electromotive force of 1 volt.

Georg Ohm discovered that different types, shapes, and quantities of materials subject to the same e.m.f.[2] tend to resist the flow of current to varying degrees. Assuming that voltage is constant, if the current in a circuit increases, it is because the resistance in the circuit decreases.

A good way to see the type of relation that exists between current, voltage and resistance is in division:

$$\frac{(numerator)}{(denominator)} = \frac{15}{3} = 5(quotient).$$

As we increase the numerator, the quotient will become larger. As we increase the denominator, the quotient (current) will become smaller. Georg Ohm saw this same relationship between arithmetic and electricity and stated it in a law (now called Ohm's law). Since current increases as voltage increases and decreases as voltage decreases, current equals voltage divided by resistance.

"I" is the letter symbol for current, "E" is the letter symbol for electromotive force, and "R" stands for external resistance, "r" is the internal resistance of e.m.f. source. Ohm's law is expressed by equation:

$$I = \frac{E}{R + r}.$$

In many practical applications another form of Ohm's law called «Differential form of Ohm's law» also uses. It is expressed by equation:

$$I = ne\overline{V}S,$$

where "n" is the **charge density** (number of electrons carriers per unit volume in conductor); "e" is the charge of a single electron ($e \approx 1{,}6022 \cdot 10^{-19}$C); "$\overline{V}$" is the **average drift velocity** of electrons through the conductor, "S" is the **cross-sectional area** of the conductor. Product of $ne\overline{V}$ called **current density, − *J***. Hence current *I* is the flux of the current density *J* through the surface *S*.

Notes:

1) e.m.f. = electromotive force − электродвижущая сила (э.д.с.);
2) subject to the same e.m.f. − *зд.* под действием одной и той же э. д. с.

TEXT D. FUNDAMENTAL ELECTRICAL UNITS

I. Read the text and make your correct choice

The three basic electrical units in any electrical circuit are the ampere, ohm, and volt. The ampere is an electrical unit to measure the flow of currents a circuit; the resistance, or opposition to the flow of current is measured in ohms; while the external force applied to a circuit to overcome the opposition to the flow of current is measured in volts.

The ampere: The rate at which electricity flows through a conductor is represented by the unit called the ampere and may be compare to the rate of flow of water through a pipe in gallons per second. The unit strength of an ampere is represented when an electrical current passing through a specified solution of nitrate of silver in water deposits silver at the rate of .001118 gram per second.

The ohm: All substances offer resistance to the flow of electricity through them. This opposition or resistance is measured with a unit called the ohm. The resistance of all metals increases with the increase in temperature while the resistance of carbon, insulating materials, and electrolytic solution decrease with an increase in their temperatures.

The volt: In order to overcome the resistance of conductors and cause current to flow, an external force is necessary. This force is commonly called voltage since the unit of measurement is volt. This force is also referred to as electromotive force or electric pressure. The electromotive force that will cause a current of 1 ampere to flow through a resistance of 1 ohm equals 1 volt. A kilovolt (kV) = 1,000 volt; a millivolt (mV) = .001 volt; and a microvolt (μV) = .000001 volt.

Another important unit of electrical measurement is the watt − the unit of power. Power is defined as the rate at which work is done or the rate at which energy is expanded.

II. Multiple Choice

1. The coulomb is a unit of what quantity?
(a) a current, (b) charge, (c) resistance, (d) voltage.
2. Which of the following equations does not correctly describe Ohm's law ?
(a) $U = I \cdot R$, (b) $I = U/R$, (c) $R = UI$, (d) $R = U/I$.
3. Which of the following quantities does an ammeter measure directly ?
(a) voltage, (b) current, (c) resistance, (d) charge.

4. Which of the following quantities are measured in volts?
(a) voltage, (b) p.d., (c) energy, (d) e.m.f.
5. Which of the following quantities is true for resistors in series?
(a) $U = U_1 + U_2$, (b) $I = I_1 + I_2$, (c) $R = R_1 + R_2$, (d) $R = 1/R_1 + 1/R_2$.
6. Which of the following quantities are matched with the correct units ?
(a) voltage: joule, (b) current: ampere, (c) resistance: ohm, (d) power: watt.
7. In a parallel arrangement of resistors R_1 and R_2, which of the following is true ?
(a) $R = 1/R_1 + 1/R_2$, (b) $I = I_1 + I_2$, (c) $U = U_1 + U_2$, (d) $R = R_1 + R_2$.
8. Which of the following are units of electrical energy ?
(a) watt, (b) kilowatt*hour, (c) joule, (d) ampere.
9. In a parallel connection of light bulbs to the mains when one bulb burns out, what is the effect on the other bulbs ?
(a) other bulbs go out, (b) little or no effect,
(c) other bulbs go dim, (d) other bulbs go bright.
10. If in question 9 the lamps were in series: what would the effect be ? Multiple choice answer:
1 (b), 2 (c), 4 (abd), 5 (ac), 6 (acd), 7 (ab), 8 (bc), 9 (b), 106 (a).

ASSIGNMENTS

I. Match the following English words and word-combinations with the Russian ones

electric pressure	резистивная цепь
the unit strength of an ampere	электрические устройства
electromotive force (e.m.f.)	электрическое напряжение
power factor	электродвижущая сила
resistive circuit	коэффициент мощности
electrical construction works	единица силы тока в один ампер

II. Form nouns using the following suffixes.

-ence: to depend, to exist, to differ; **-ance:** to resist; **-ment:** to develop, to move, to measure; **-(t)ion:** to calculate, to oppose, to conduct.

III. Find nouns with suffixes -ence, -ance, -ing, -ment, -tion in the Text D

IV. Put questions to the words and word-combinations in bold type. Translate the sentences

1 The external force applied to a circuit to overcome the opposition to the flow of current is measured in volts. 2. The voltage is equal to the current multiplied by the resistance. 3. The electrical current passing through a specified solution of nitrate of silver in water deposits silver. 4. This formula is read as the voltage squared divided by the resistance. 5. The current equals voltage divided by the resistance. 6. Having measured voltage and resistance we can find the value of me current. 7. Being

learned Ohm's Law gives the possibility to measure the current in a circuit. 8. Having been set down the equation can be used for defining missing quantity. 9. When studied well the problem can be solved successfully. 10. While making experiments the scientist discovered the law of measuring three basic electrical units.

V. read the text closely and pick out the key sentences. Translate the sentences

VI. Look through the text and find the part of it dealing with the electromotive force

VII. Read the text and pick out all technical terms. Translate them

VIII. Translate the text to be sure you understand it well

4 BATTERIES FOR ELECTRONICS

I. Make sure that you know these words. Say what Russian words help you to guess their meanings

group [gru:p], battery [ˈbætəri], series [siəri:s], parallel [ˈpærəlɛl], specific [spəˈsifik], voltage [ˈvəultədʒ], rating [ˈreitiŋ], carbon-zinc [ˈka:bən ziŋk], material [məˈtiəriəl], limit, reduce [riˈdju:s].

II. Memorize the following words and word-combinations. Check if you know their meanings

connected together – соединенные (вместе), to consist of … – состоять из …, named after … − названный по …, the amount of current – сила тока, a resistance of the circuit – сопротивление в цепи, to be damaged – быть поврежденным, выйти из строя, in order to … − для того, чтобы …

III. Read the text and answer the following questions

1. What is called a battery ? 2. What does a battery consist of ? 3. What are cells often named after ? 4. When will a cell be damaged ? 5. What do you do to increase the voltage of a battery ? 6. How can you reduce the amount of current ?

TEXT A. BATTERIES

A group of cells connected together is called a battery. A battery consists of two or more cells connected together, in either series or parallel[1]. It is also possible to have a battery that consists of some cells in series along with others connected in parallel. Each cell has a specific voltage rating[2]. A carbon-zinc cell (cells are often named after the material out of which they are made) has a voltage rating of 1.5v. The amount of current that a cell delivers is determined by a resistance in the circuit. But if too much current is drawn from the cell too quickly, the cell will be damaged. Thus, we frequently want to limit the amount of current drawn from the cell. In order to reduce the amount of current drawn from each cell, we can connect cells in parallel. In order to increase the voltage of a battery, you would connect its cells in series.

Notes:

1) in either series or parallel − последовательно или параллельно;
2) voltage rating − номинальное значение напряжения.

I. Memorize the following words and word-combinations

Sources of electricity – источники электричества; to be familiar with … – быть значимым с …; practical applications – практические применения (прикладные задачи); fundamentals – основы; device – прибор, устройство; to furnish energy – поставлять энергию; interchangeably – один вместо другого, одно заменяя другим; strictly speaking – строго говоря; unavailable – не имеющийся в наличии; light – зд. легкий; to be considered – учитываться; dilute [dai′lju:t] – разведённый, разбавленный; to exist – существовать; to be unlike – быть непохожим, разным; depend upon … [ə′pɔn] – зависеть от …

II. Give English equivalents to the Russian words and word-combinations in brackets and translate the sentences into Russian

1. So far we have been using cell and batteries as (источники энергии). 2. The electronic technician should быть (знаком с) some factors concerning their theory of operation and their (практического применения). 3. This section will help you learn some of the (основных сведений, знаний) of cells and batteries. 4. The battery (поставляет) electrical energy to the circuit. 5. The word "battery" and "cell" are often used (одно вместо другого). 6. (Строго говоря), they are not the same. 7. They are used as (источники) of power for portable equipment or where power lines (не имеются в наличии). 8. Some batteries must be made very small and (лёгкими). 9. He placed a strip of zinc and strip of copper in a jar containing (разведенную) acetic acid (vinegar). 10. He then founded that a difference in electrical pressure (существовала) between the zinc and the copper. 11. The two electrodes had to be (разными) substances for a voltage to exist. 12. The voltage between electrodes (зависит от) the type of substances used for the electrons.

TEXT B. CELLS AND BATTERIES

I. Read the text to yourself and grasp the main idea of it

So far[1] we have been using cells or batteries as sources of electricity. Although cells and batteries are a subject for the chemical engineer, the electronic technician should be familiar with some of the facts concerning their theory of operation and their practical applications. This section will help you learn some of the fundamentals of cells and batteries.

A battery is a device that contains energy stored in a chemical form. When an external circuit is hooked up to a battery[2], the battery furnishes electrical energy to the circuit. The battery was the first source of electrical energy developed by man, and it is still widely used. The words "battery" and "cell" are often used interchangeably, but strictly speaking they are not the same. A battery is a combination of cells.

Batteries have many applications in electronics. They are used as sources of power for portable equipment or where power lines are unavailable. You will find them in miniaturized apparatus such as hearing aids[3], and in missiles, in satellites, and many types of equipment used in modern space electronics. Batteries must be selected with current rating in mind[4]. If you select a battery two factors must be considered: current rating and voltage output[5]. Batteries come in a great many types[6], depending upon the voltages they are required to furnish and the current drain[7] they must withstand. Another factor is the physical construction of the battery; some must be made very small and light — for example, those used in hearing aids. Still another factor is the service life[8] of the battery, how long it will be required to be useful. And the cost of the battery must also be considered.

The battery got its start[9] from an experiment performed by Volta, an Italian scientist, in 1798. He placed a strip of zinc and a strip of copper in a jar containing dilute acetic acid (vinegar). He then found that a difference in electrical pressure existed between the zinc and the copper. You know that a difference in electrical pressure is more commonly known as voltage. When Volta measured the voltage, he found it was about 1.1 volts, with the copper positive and the zinc negative. So the copper was called the positive electrode and the zinc the negative electrode. The acid is known as the electrolyte.

One very important fact discovered by Volta was that the two electrodes had to be unlike substances for a voltage to exist[10]. Another important fact later discovered is that the voltage between the electrodes depends only upon the type of substances used for the electrons. This means that if we increase the size of the electrodes, the voltage will stay the same.

Notes:

1) so far − до сих пор;
2) is hooked up to a battery − присоединен к батарее;
3) hearing aids − слуховой аппарат;
4) in mind − с учетом;
5) current rating and voltage output − номинальное значение тока и выходное напряжение;
6) batteries come in a great many types − используется большое количество батарей разного типа;
7) current drain − утечка тока;
8) service life − срок службы;
9) got its start − взяла своё начало;
10) for a voltage to exist − для того, чтобы возникло напряжение.

TEXT C. PRIMARY AND SECONDARY CELLS

II. Read the text, find the part of which dealing with the description of reusable cells

All cells may be classified into two main types: primary and secondary. A primary cell is a cell that keeps "wearing out"[1] when it is being used; after a certain time, the chemicals in it become "used up"[2] and it must be discarded[3]. The common

flashlight cell is an example of a primary cell; after prolonged use it goes "dead" and must be replaced with a new one. We say that the chemical action in a primary cell is not reversible; this means that eventually the primary cell becomes "used up".

The other type of cell isreuseable[4] and is called the secondary cell. In secondary cells, the chemical action is reversible. This means that whatever happened to make the cell wear out can be reversed to "rejuvenate" the cell. This cannot be done in a primary cell. When a cell is being used, that is, when it is supplying current to a load, we say it is discharging. The cell that is being used to light an electric lamp is discharging. On the other hand[5], when the chemical action is made to reverse in a secondary cell by sending current through it in the opposite direction, we say the cell is recharging. All cells can be discharged, but only secondary cells can be recharged. A battery made up of secondary cells is sometimes called a storage battery.

Notes:

1) keeps "wearing out" − изнашивается;
2) become "used up" − расходуются;
3) must be discarded − должна быть списана за ненадобностью;
4) is reusable − способен к восстановлению;
5) on the other hand − с другой стороны.

ASSIGNMENT

I. Skim through the Text A and divide it into logical parts. Choose the key sentences and translate them

II. Find the part of the Text A describing applications of batteries

III. Ask your friend about the history of a battery

IV. Translate the Text B to be sure you understand it well

EXERCISES

I. Find the words in the Text A and the text B with the suffixes -tion, -al, -able, -ic, -ing, -ing, -ment, -ance(-ence); define their initial forms and the translate them into Russian

II. Give the main forms of these verbs

Know, speak, get, find, use, become, charge, prolong, consider, depend.

III. Find the following words and word-combinations in the Texts and translate the sentences with them

The electronic technician, and external circuit, to be widely used, portable equipment, miniaturized apparatus, to require, electrical pressure, flashlight, to wear out, to supply current to a load, made up of.

IV. In the following sentences find the Infinitive, Gerund, Participle II, state their functions and translate the sentences

1. A battery is a device that contains energy stored in a chemical form. 2. Lighting layout for building construction should be designed to provide the highest visual comfort and performance that is consistent with type of area to be lighted and the budget provided. 3. When the chemical action is made to reverse in a secondary cell by sending current through it in the opposite direction , we say the cell is recharging.

V. Translate the sentences using the Gerund formed with verbs in brackets

1. Учёный продолжал работу (work) над исследованиями. 2. Демонстрация (demonstrate) его опытов оказалась не такой уже легкой задачей. 3. Повторяя (repeat) эксперименты, получаем более достоверные данные. 4. Будучи выведенным (set) на нужную орбиту, спутник Земли может продолжать движение (move).

5 ELECTROMOTIVE FORCE AND ELECTRIC RESISTANCE

I. Practice the pronunciation of the following words. Memorize their Russian equivalents

Conductor [kən′dʌktə] – проводник; amount [ə′maunt] – величина, количество; resistance [ri′zistəns] – сопротивление; affect [ə′fekt]– влиять, затрачивать, оказывать воздействие; cause [′kɔ:z] – стать причиной, вызывать, повлечь за собой; drop [′drɔup] – падение, спад; draw [′drɔ:] – получать из …, извлекать; circuit [′sə:kit] – цепь, контур, схема; measure [′meʒə] – мера, измерять; interrupt [ˌintə′rʌpt] – прерывать; deflec**tion** [ʃn]– отклонение; potential [pə′tenʃəl] – потенциал, напряжение относительно нуля.

II. Read the text to yourself and find the part of it dealing with: a) internal resistance to the flow of current; b) total resistance in the circuit; c) voltage drop; d) terminal voltage; e) electromotive force

TEXT A. TERMINAL VOLTAGE AND ELECTROMOTIVE FORCE

The materials that make up a cell[1] are not perfect conductors. This means the cell has a certain amount of internal resistance to the flow of current. When a cell is shown schematically, its internal resistance is represented as a resistance in series with the cell. Let us see how the internal resistance affects the operation of the cell. Suppose the cell is a 2-volt cell, and the load resistance is 4 ohms. According to Ohm's law, a potential of 2 volts across 4 ohms should cause a current flow of 3.5 amperes. However, the total resistance in the circuit is the load resistance (4 Ohms) plus the internal resistance (l ohm) of the cell. So the total resistance is 5 ohms. Calculate the total current, using the total voltage and the total resistance. Total current = 5 amperes. Now, using the formula *E=IR*, compute the voltage across the load resistor. The voltage across the load resistor is 1.6 volts. Here is something to think about![2] The voltage of the cell was 2 volts, yet when the load resistor is connected to the cell, there is only 1.6 volts across the load resistor. Somewhere we

lost 0.4 volts! Across which resistance does this 0.4 volts appear? Internal resistance of cell.

You know when current is drawn from the cell, there is a voltage drop across the internal resistance of the cell. The voltage drop across the internal resistance of the cell must be subtracted from the voltage of the cell in order to determine the voltage across the load.

The voltage of the cell when no current is being drawn is called the open-circuit e.m.f. of the cell. The open-circuit e.m.f. of a cell is also referred to as[3] the no-load voltage. The voltage between the terminals of a cell when it is connected across a load is called the terminal voltage. In order to find the terminal voltage, subtract the voltage drop across the internal resistance of the cell from the open-circuit e.m.f. So, the terminal voltage is always less than the open-circuit e.m.f.

Electromotive force (e.m.f.) of a source is the force that tends to cause free electrons to move in a closed external circuit. The e.m.f. appears in a source of energy even of no current flows through the external circuit, i.e. when circuit is open, in which case the e.m.f. is equal to the potential difference across the terminals of the source if we disregard the *IR* drop in the source itself. The practical unit is volt (V).

The e.m.f. continuously maintains the potential difference across the terminals of the source, regardless of whether the external circuit is closed or not. For the current to flow uninterruptedly through a closed circuit, electric charges should move within the source of energy in the direction opposite to that of the action of electric field forces. Such a motion of charges is due to the action of forces applied from the outside.

A much-used cell can have a full-rated e.m.f. but a higher-than-normal internal resistance[4]. Measuring the e.m.f. of such a cell would not give a true indication of its merit, because when current is drawn from such a cell the terminal voltage would be very low because of the internal resistance. Therefore, a practical, dependable way of checking the quality of a cell is to connect a load resistor in series with it and then measure the terminal voltage. This is usually done by using a load resistor that draws one-half the maximum current capacity of the cell. The internal resistance can then be determined by measuring the terminal voltage. You already know that continued use of a cell makes its internal resistance increase. This is due to the partial polarization.

Sometimes, if the cell is given a resting period[5] the depolarizer gets a chance to work, and the cell may "snap back" for a while[6]. Another thing that increases the internal resistance of a cell is a decrease in temperature. This means if the temperature goes down, the internal resistance increases.

To make sure whether the e.m.f. is present in the source of energy, we can connect a voltmeter with the source terminals to take the reading. If the e.m.f. is present, the needle of the meter will move across the scale through a certain angle; the higher the e.m.f., the greater the deflection of the needle[7]. But, as will be shown later in the text, the meter will read not the e.m.f., but the potential difference across the source terminals, i.e. the voltage between the two points. Voltages above 1000 are usually expressed in kilovolts (kV). Very small potential differences are expressed in millivolts (mV) or microvolts (μV or uV). The symbols commonly used to designate e.m.f., potential difference, and voltage are E, e, V, and v.

Notes:

1) The materials that make up a cell − материалы, из которых изготавливается элемент;
2) Here is something to think about ! − Здесь есть над чем задуматься!;
3) is also referred to as − называется также;
4) higher-than-normal resistance − сопротивление большее, чем внутреннее, нормальное;
5) is given a resting period − временно не используется;
6) "snap back" for awhile − немного «отдохнуть»;
7) deflection of the needle − отклонение стрелки прибора.

ASIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about

II. Answer the following questions embracing the content of the text

1. How does the internal resistance affect the operation of the cell ? 2. What does the total resistance in the circuit represent ? 3. How do you calculate the voltage across the load ? 4. What is the no-load voltage ? 5. What do we call the open-circuit e.m.f. of the cell ? 6. What kind of force causes free electrons to move ? 7. What does the e.m.f. continuously maintain ? 8. How do you proceed to check the quality of a cell ? 9. What can increase the internal resistance of a cell ? 10. What causes the needle of the meter to deflect ?

III. Make up a plan of the text

IV. Retell the text according to your plan

V. Speak on: 1. The voltage of a cell. 2. The electromotive force

TEXT B. RESISTANCE

I. Read the following words and memorize the Russian equivalents

Impede [in′pi:d] – мешать, препятствовать; denote – осознавать; overcome – преодолевать; value [′vælju:] – величина, значение; maintain [men′tein] – поддерживать; cross-section – поперечное сечение, поперечный разрез; area [′ɛəria] – площадь, пространство; equal – одинаковый; inversely – обратно; resistivity specific resistance – удельное сопротивление; express – выражать; square – квадратный; relation – уравнение; equation – формула; to hold for – *зд.* соответствовать; adjust – регулировать, настраивать, устанавливать; lever [′li:və] − рычажок, рукоятка; stepwise – постепенно, рывками; conductance – электропроводимость; reciprocal – равный, соответственный.

II. Memorize the following terms

The directed movement of charges – направленной движение зарядов; the flow of current –зд. движение электрического тока; a closed circuit – замкнутая цепь; the cross-sectional area of conductors – площадь поперечного сечения

проводников; inversely proportional – обратно пропорциональный; expressed in many terms – выраженный в разных величинах; the property of a material to conduct electric current – способность материала проводить электрический ток;

III. a) Read the text. b) Find the parts of it dealing with typical characteristics of resistance

Whatever the conductor, its molecules and atoms resist the directed movement of charges through it. In other words, both an external circuit and a source of energy oppose the flow of current. The property of a substance or a circuit element, or a device that impedes the current is called the *electric resistance* or *resistance*, for short, denoted by R as shown in

Figure 5.1.

A source of energy connected to a closed circuit expends a part of its energy on overcoming the opposition of the internal and the external circuit.

The unit of electric resistance is the ohm (Ω). One ohm is the value of resistance of a line conductor through which a constant potential difference of one volt will maintain a current of one ampere, i.e. $1\Omega = {}^{1\text{V}}\!/_{1\text{A}}$. Submultiples and multiples of the ohm are used to measure very small and very large resistances. The microhm ($\mu\Omega$) is one-millionth of the ohm, the kilohm ($\text{k}\Omega$, or k) is a thousand ohms, and the megohm ($\text{M}\Omega$) is a million ohms.

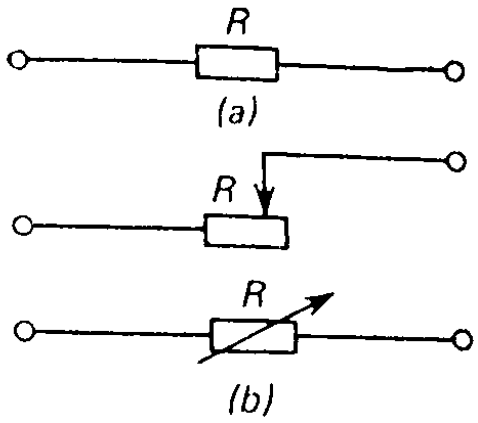

Figure 5.1 − Symbols of a resistor (a) and variable resistor (b).

The resistance of conductors to electric current depends on conductor materials, the length and cross-sectional area of conductors. If we compare two conductors from the same material, the longer conductor will offer a higher resistance than the shorter one equal in cross section; if they are equal in length but differ in cross section, the conductor of a larger cross-sectional area will have a lower resistance.

Thus, the resistance of a conductor is proportional to its length and inversely proportional to its cross-sectional area. The constant of proportionality relating the length I and cross-sectional area A of a conductor to its resistance R is called the resistivity, or specific resistance, $\rho = {}^{RA}\!/_{l}$. If we express R in ohms, A in mm^2, and l in m, the unit of resistivity is then $\Omega\ \text{mm}^2/\text{m}$. The resistivity can be expressed in many terms, for example, in ohms times square centimeters per centimeter ($\Omega\,\text{cm}$), or in ohms times square meters per meter ($\Omega\ \text{m}$).

The resistance of a conductor of resistivity ρ, length l, and area A, is:

$$R = \rho \cdot {}^{l}\!/_{A}.$$

The resistance of conductors depends on temperature. For pure metals, it commonly varies directly with temperature. Each metal is defined by its temperature coefficient of resistance − α, which relates the change of resistance to the original value of 1 ohm for a change of temperature by 1°C.

Thus, if the value of α corresponds to T_1 for which the resistance R_1 is known, the resistance R_2 of the conductor at any temperature T_2 is given by:

$$R_2 = R_1 \cdot \left[1 + \alpha\left(T_2 - T_1\right)\right].$$

It should be kept in mind that the above relation holds for the temperature range below 100°C.

A variable resistor used to limit, control, or adjust the amount of current in a circuit is called a *rheostat* or simply a *resistor*. Rheostats are made from wire of high resistivity, for example, from nickel chromium (**nichrome**), and provided with levers or knobs to vary the resistance in the circuit uniformly or stepwise.

The property of a material to conduct electric current is called the conductance (g or G). Resistance and conductance are reciprocal terms. The unit of g in the older system is the reciprocal ohm or mho (Ω^{-1}). In the newer SI system of units, g is in Siemens (S). Thus, the relation between resistance and conductance is $g = {}^{1}\!/_{R} = {}^{A}\!/_{\rho l} = {}^{\gamma A}\!/_{l}$ or $R = {}^{1}\!/_{g}$.

The quantity γ in the above relation is conductivity which is the reciprocal of resistivity, so the relation between y and p is $\gamma = {}^{1}\!/_{\rho}$ or $\rho = {}^{1}\!/_{\gamma}$.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text; b) Say what the text is about

II. Skim through the Text B and find the part of it dealing with the electric resistance

III. Find the part in the Text B containing information about the resistance of conductors

IV. Answer the following questions embracing the contents of the Text A and Text B

1. What does the e.m.f. continuously maintain ? 2. In what direction should electric charges move for the current to flow uninterruptedly through a closed circuit ? 3. What are small potential differences expressed in ? 4. What resist the directed movement of charges through the conductor ? 5. What happens to a source of energy when it is connected to a closed circuit ? 6. What does the resistance of conductors depend on ? 7. What kind of device is called a rheostat ?

V. Make up the plan of the text

VI. Retell the text according to your plan

EXERCISES

I. a) Find in the Text A and Text B the sentences, containing the following verbs; b) Define their tense-forms and translate the sentences into Russian

To appear, to close, to show, to impede, to offer, to depend, to vary.

II. Give three forms of the following verbs:

To draw, to show, to use, to concentrate, to conduct, to represent, to flow, to use, to know, to think, to understand.

III. a) Define the forms of the following Participles; b) State the verbs they are formed of; c) Translate them

Writing; sitting; reading; having read; written; having written; having been written; having asked; having been asked; being asked; asking; taking; having been taken; taken; being taken; given; giving; having been given; having given; done; used; doing; lying; tying; referring; connecting; connected; preferred; worked.

IV. a) State the Infinitives of the following Participles II of irregular verbs; b) Translate them

Overcome, found, taken, written, done, read, spoken, known, said, been, given, set out, brought, arisen.

V. Transform the following sentences into the Past and Future

1. We can solve this problem with the help of Ohm's law. 2. You must calculate these data. 3. May I measure this quantity in volts? 4. They cannot describe Ohm's law correctly.

VI. a) Translate the following sentences; b) Pay attention to the subordinate clauses beginning with "whether" and "if"

1. We do not know whether they have asked this question correctly. 2. They ask if we could describe Ohm's law. 3. He does not know whether electromotive force is measured in volts or in some other units. 4. Professor asked if the resistors were connected in series. 5. My friend asks if I am able to make a parallel arrangement of resistors.

VII. Substitute the subordinate clauses for Participial Constructions

1. The external force which is applied to a circuit to overcome the opposition to the flow of current is measured in volts. 2. The voltage is equal to the current which is multiplied by the resistance. 3. The electrical current that is passing through a specified solution of nitrate or silver in water deposits silver. 4. The resistance is equal to the wattage that is divided by the current squared. 5. The current that is Posing through the conductor equals 2 amperes.

VIII. Change Continuous Tenses into Perfect Tenses

1. I am switching on the radio. 2. Torn is showing all figures to us. 3. The student is writing down a new rule. 4. We are considering the voltage as an energy per unit charge. 5. They are determining the resistance.

IX. a) Translate the following sentences; b) Pay attention to the words and word-combinations in bold type

1. **In order to define the power** in watts we must know Ohm's law, that is the watt is the voltage times the current. 2. The solution of the formula is: the watt is equal to the current **squared times** the resistance. 3. **For defining** the power in watts according to the formula the voltage squared must be divided by the resistance. 4. **In order to overcome** the resistance of conductors and cause current to flow, **an external force** is necessary. This force is also referred to **as electric pressure**. 5. This unit strength of an ampere is represented when an electrical current **passing through a special solution of nitrate of silver in water** deposits silver at the rate of.001118 gram per second.

X. Translate the sentences and explain the use of Perfect Tenses

1. We have calculated the resistance in each case. 2. Yesterday we had calculated the resistance in each case before we began solving the problem. 3. We shall have calculated the resistance in each case before we begin to solve the problem.

XI. Memorize the reading of the following mathematical actions

=	is equal to (equals, is makes)	Равно
+	plus	Плюс
-	minus	Минус
×	multiplied by, … times	умноженное на
÷, :	divided by (into)	деленное на
$\mathbf{2^2}$	two squared, two to the second power	два в квадрате, два во второй степени
$\mathbf{2^3}$	two to the third power	два в кубе, дв,а в третьей степни
$\mathbf{10^{-7}}$	ten to the minus seventh power	десять в минус седьмой степени
0.3	ou point three, zero point three, point three	три десятых, ноль целых и три десятых
0.0004	ou point three ouz four, point three ouz four	четыре десятитысячных
34.321	thirty four point three two one	Тридцать четыре целых и триста двадцать одна тысячная

Examples:

2 + 3 = 5 (Two plus three is equal to five.) is (equals);
3 + 6 = 9 (Three plus six is (equals) nine);
3 × 3 = 9 (Three multiplied by 3 equals nine);
10 ÷ 2 = 5 (Ten divided by two equals five).

6 DIRECT CURRENT (DC) AND DC CIRCUITS

I. Make sure that you know these words. Say that Russians words help you to guess their meanings

Source [sɔ:s], short, e´lectrical, zero [ziərəu], pro´portional, ef´fects, re´sulting, line [lain], ´positive, ´negative, ´energy, ´generator, lamps, motors, con´vention, section, action, e´quivalent.

II. Memorize the following words and word-combinations

In addition to – в дополнение к …; load – нагрузка, потребитель электрической энергии; to convert into – превращать, преобразовывать в …; an arrangement – расположение; excess current – превышение силы тока (избыточный ток); a constant motion of charges – постоянное движение зарядов; a steady flow of electrons – постоянный по(ток) электронов; to cause a mechanical force – вызывать механическую силу (силу механической природы); to cross section of a conductor – поперечное сечение проводника.

III. Give English equivalents to the Russian words and word-combinations in brackets and translate the sentences into Russian

1. (В дополнение к) a source and a switch, a simple circuit usually includes a load. 2. (Потребитель преобразует) electricc energy (в) nonelectric forms of energy. 3. The source is damaged by (избыточным током) that is drawn from it, and connecting wires may overheat and cause damage of fire. 4. A source of energy connected to a load through line conductors sustains (постоянное движение зарядов).

5. The current flowing in two conductors spaced a certain distance apart (вызывает механическую силу) acting on the conductors. 6. Electric current determines the quality of electricity − Q, passing through the (поперечное сечение проводника).

IV. Read the Text A and find the parts of it describing: a) a simple circuit; b) conversion of energy; c) particularities of the direct current; d) and external circuit

TEXT A. DC CIRCUITS AND SOURCES OF ENERGY

A simple circuit consists of a source, switch, and load. A short circuit is a no-load path, that is, an electrical path with virtually no resistance. In addition to a source and a switch, a simple circuit usually includes a load. When a short circuit occurs, no electricity flows through the load. Because the resistance in the short

circuit is nearly zero, the current that flows through the short circuit will be very large; current is inversely proportional to resistance. There are many undesirable effects resulting from a short circuit. There is no current where you want it. The source is damaged by the excess current that is drawn from it, and connecting wires may overheat and cause damage of fire.

The simplest DC circuit, as shown in Figure 6.1, consists of a source of electric energy *E*, an electric load *L*, and a pair of line wires or conductors W_1 and W_2 connected to the positive (plus) and the negative (minus) terminal of the source to supply the load.

The source of electric energy, or of electromotive force (e.m.f.), converts the mechanical, chemical, thermal, and other forms of energy into electric energy. The load converts electric energy to nonelectric forms of energy. Electric energy sources are electric generators, primary (galvanic) cells, and secondary (storage) cells. The symbols of generators and primary and secondary cells appear in Figure 6.2. Electric loads are lighting lamps, electric motors, electric heaters, and other types of using equipment.

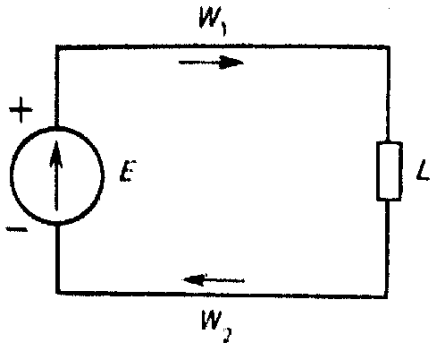

Figure 6.1 − Simplest electric circuit.

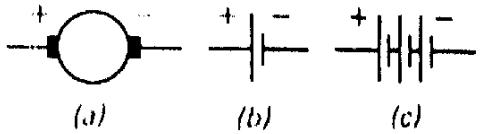

Figure 6.2 − Symbols of a DC geneator (a); primary or secondary cell (b), and primary or secondary battery (c).

An arrangement of primary cell or secondary cell interconnected in a proper way forms a primary-cell battery or a secondary-cell battery, respectively. A source of energy connected to a load through line conductors sustains a constant motion of charges, called electric current, in a closed circuit.

Direct current is necessarily unidirectional, but may be either steady or varying in magnitude. Direct current in metal conductors is a steady directed flow of free electrons in a closed circuit. By convention the direct current is assumed to flow in the direction of motion of positive charges, opposite to the actual flow of electrons. But this conventional positive direction of current or voltage, as designated by arrows in Figure 6.1, causes little inconvenience.

The current flowing in two conductors spaced a certain distance apart causes a mechanical force acting on the conductors. The practical unit is the ampere (*A*). In the International System of Units, abbreviated **SI**, the ampere is an electric current of such magnitude that when maintained in two straight parallel conductors of infinite length and negligible cross section, at a distance of one meter from each other in vacuum, would produce between the conductors a force of 2×10^{-7} Newton (*N*) per

meter of length. The Newton is the *SI* unit of force that will give a mass of 1 kilogram an acceleration of one meter per second per second.

Electric current determines the quantity of electricity, Q, passing through the cross section of a conductor in a unit time. The practical unit is the coulomb (C), which is the amount of electricity passed through the conductor by an electric current of one ampere in one second.

Line wires together with a load form an external circuit where an electric current arises by the action of a potential difference that exists between the terminals of a source. The current flows in the direction from the point of higher potential (positive terminal) toward the point of lower potential (negative terminal). The unit of electric potential, or the difference of potential between the two points, is the volt (V), which is equivalent to the force required to produce a current of one ampere through a resistance of one ohm.

TEXT B. SERIES AND PARALLEL CIRCUITS

I. Memorize the following words and word-combinations

To be connected end to end − быть соединённым последовательно друг к другу; to apply a voltage – приложить напряжение; divided equally – разделённый равномерно; filament circuit – цепь накаливания; to exceed – превышать; voltage drop – падение напряжения; to determine – определять.

II. Translate the text into Russian paying attention ti the difference between series and parallel circuits

A circuit in which all components are connected end to end is called a series circuit. The current flowing through each resistance in a series circuit is the same. In a series circuit, the sum of the voltage drops is always equal to the applied voltage. To find the total resistance of a series circuit you add the resistance of each part of the circuit. If a voltage is applied to a series circuit with several equal resistances, the applied voltage will be divided equally among the resistances.

One of the most frequent uses of a series circuit is the series filament circuit in electronic equipment. The purpose of the filament is to heat the cathode so that the cathode will give off electrons. A tube manual[1] will give you the rated filament voltage[2] of a tube. Generally, this voltage should not be exceeded. In order not to exceed the rated voltages in series filament circuits, the filaments of the electron tubes are selected so that the sum of the voltage drops across each filament will equal the voltage applied. When this sum does not equal the applied voltage, a line resistance is connected in series with the filaments.

In radios and television receivers that have series filament circuits, 110V is generally used as the source voltage.

To draw a line[3], we could say that: 1) the current through any one resistor in a series circuit is the same as the current through any other resistor and this is the same as the total current; 2) in a series circuit the applied voltage is equal to the sum of the voltage dropped across each individual resistor; 3) the total resistance is the sum of the individual resistors in a series circuit.

In a parallel circuit total current is the sum of the currents in each branch of the circuit. Each branch in a parallel circuit adds its current to the currents of the other branches. The voltage drop across each resistor of a parallel circuit is the same. The total resistances in parallel are less than anyone resistor. To determine the total resistance of a parallel circuit we use the following basic formula:

$$R_t = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} . \qquad (1)$$

(1) R sub *t* equals *dash*, *one* divided by *the ratio of one* divided by *R* sub *one*, plus *one* divided by *R* sub *two*, plus *one* divided by *R* sub *three*.

Notes:

1) a tube manual − справочник по электронным лампам;
2) the rated filament voltage − номинальное значение напряжения на катоде;
3) to draw a line − подводя итоги.

ASSIGNMENTS

I. Answer the following questions embracing the contents of the texts A and B

1. What is the necessary for an electrical circuit to be completed ? 2. When is the current flowing through the circuit is very large ? 3. What is the short circuit ? 4. What does Figure 6.1 show ? 5. What is the Newton ? 6. What do we call a series circuit ?

II. Discuss the problems of a simple circuit

III. Make up a plan of the text B

IV. Retell the text according to your plan

EXERCISES

I. Find in the texts the derivates of the following words. Translate them as their primary forms

Load, desirable, heat, duct, ply, range, direct, convenience, nation, breviate, valency, pose, vision.

II. a) Find in the Text A and the Text B the sentences containing the following verbs. b) Define their tense-forms and translate the sentences into Russian

To occur, to result, to damage, to draw, to appear, to sustain, to assume, to apply, to exceed.

III. Give three forms of the following verbs

Include, flow, designate, give, arise, add, equal, have, use, be.

IV. a) Define the tense-forms of the verb in the following sentences. b) Translate these sentences into Russian

1. Because the resistance in the short circuit is nearly zero, the current that flows through the short circuit will be very large. 2. If a voltage is applied to a series circuit with several equal resistances the applied voltage will be divided equally among the resistances. 3. Generally, this voltage should not be exceeded.

V. a) Define the forms and functions of the Participles. b) State the verbs they are formed of. c) Translate them into Russian

1. resulting, damaged, shown, connected, called, assumed, designated, passing, used, dropped;

2. undesirable effects resulting from a short circuit; damaged by the excess current; as shown in Figure 6.1; a source of energy connected to a load; called electric current; the direct current is assumed to flow; as designated by arrows; the quality of electricity passing through to cross section; in radios 110V is generally used; the sum of the voltage dropped.

7 KIRCHHHOFF'S LAWS

I. Make sure that you know these words. Say what Russian words help you to guess their meanings

Relation, practice, direction, series, respectively, negative, sum, principle, conservation, mass.

II. Memorize the following words and word combinations. Check if you know their meanings

Connected in series – *соединённые последовательно;* any part of the circuit – *любой участок цепи;* a common point – общая точка; junction points – *точки соединения;* nodes – *узловые точки;* closed circuit – *замкнутая цепь;* as depicted in … – *как изображено на …;* the left side – *левая сторона;* the principle of the conservation of mass – *принцип сохранения массы;* in other words – *другими словами;* gain – *выигрыш;* loss – *потеря.*

III. Read and translate the text paying attention to the circuit having a few points called nodes or junctions

TEXT A. KIRCHHOFF'S FIRST LAW

For a circuit consisting of a source of energy and a load connected in series, the relation between the current, e.m.f., and the resistance of the entire circuit or between the current, voltage, and resistance of any part of the circuit obeys Ohm's law.

In practice, however, use is mostly made of the circuits in which the currents flow to or from a common point in several directions through the connections made to this point. A circuit may have a few such points called nodes, nodal points, junctions, or junction points. The connection made between the two neigh boring nodes is known as the branch of the circuit. In a closed circuit electric charges cannot store at any nodal point, for, otherwise, this would cause a change in the potentials at

the points of the circuit. So, the amount of electricity flowing into any point must flow away from it again. In other words, the charges arriving at any point are equal to the charges leaving this point, per unit time.

Assume that in the circuit, as depicted in Figure 7.1, the currents flow from a nodal point a through four branches which converge at *a* point *b*. Denote the current in the series part of the circuit by *I* and the currents in the branches by I_1 I_2, I_3, and I_4 respectively. The relation between the currents in such a circuit is as follows:

$$I = I_1 + I_2 + I_3 + I_4 .$$

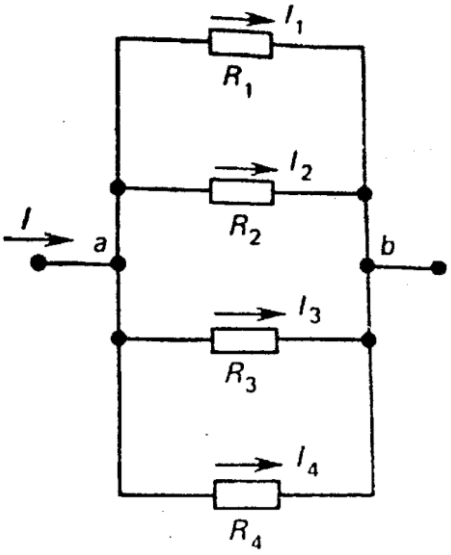

Figure 7.1− Resistors in parallel.

If in a few connections made to a nodal point the directions of currents are different, the currents directed toward the point are considered positive and those directed away from it negative. The left side of the equality above represents the sum of currents flowing into the point and the right side of the equality represents the sum or currents flowing out of the point. This statement is Kirchhoff s first law, or the current law, which defines the principle of conservation of mass, for it states that the sum of all the currents flowing to any point in a circuit is equal to the sum of the currents flowing from this point, or the algebraic to of all the currents directed toward any point in the circuit is zero. In other words, there is no gain or loss of current anywhere in the circuit.

I. Make sure that you know these words. Say what Russian words help you to guess their meanings

Algebraic, oppose, effect, zero, traverse, tracing, illustrated, complex, external, identical.

II. Memorize the following words and word combinations. Check if you know their meanings

The principle of conservation of energy − принцип (закон) сохранения энергии; the algebraic sum − алгебраическая сумма; the potential drops − падение напряжения (снижение потенциала); to traverse the circuit − проходить по контуру (цепи); coincide in direction − совпадать по направлению; to oppose each other − противопоставлять друг другу, отличаться друг от друга; to differ in direction − не совпадать по направлению; to trace around − очертить; positive (negative) sign − знак «плюс» («минус»); equality − равенство; expression − выражение.

TEXT B. KIRCHHOFF'S SECOND LAW

Kirchhojf s second law is a statement of the principle of conservation of energy. This is the voltage law which states that in any closed circuit the algebraic sum of all the e.m.f.s is equal to the algebraic sum of the potential drops in the resistances connected in series:

$$E_1 + E_2 + E_3 + \ldots + E_n = I_1R_1 + I_2R_2 + I_3R_3 + \ldots + I_kR_k, \quad \sum_{i=1}^{n} E_i = \sum_{j=1}^{k} I_jR_j . \qquad (1)$$

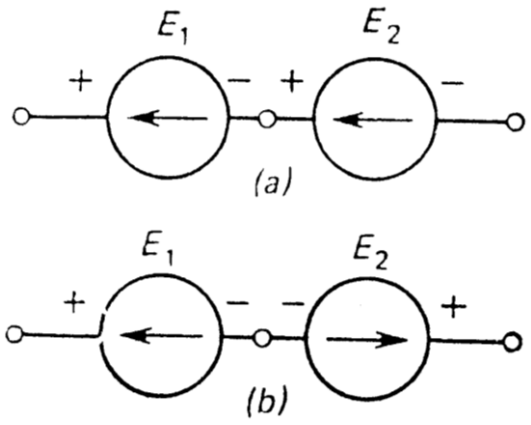

Figure 7.2 − Connection of the sources of e.m.f in series aiding (a) and in series op position (b).

Kirchhoff s voltage law states in effect that the algebraic sum of all the e.m.f.s and potential differences in any closed circuit is zero, $\sum E = 0$. In writing the above equations, one may traverse the circuit in either direction and arbitrarily specify the signs of current directions. If a circuit consists of two sources of energy connected in series, as in Figure 7.2 (a), and the two e.m.f.s coincide in direction, the total e.m.f. is equal to the sum of these two e.m.f.s, $E=E_1+E_2$. If the two e.m.f.s oppose each other, as in Figure 7.2 (b), the total emf is equal to the difference between the two e.m.f.s, $E=E_1-E_2$.

In a circuit having a few sources in series, the e.m.f.s of which differ in direction, the total e.m.f. is the algebraic sum of the e.m.f.s of all the sources. In tracing around the closed loop to sum up the e.m.f.s, the e.m.f.s of one direction are written with a positive sign and those of the opposite direction with a negative sign.

The closed loop designated by points *a, b, c, d,* as illustrated in Figure 7.3, is commonly a part of the complex network. Since the branches are connected to the points *a*, *b*, *c*, and *d*, the currents I_1, I_2, I_3 and I_4 that differ in magnitude flow in different directions.

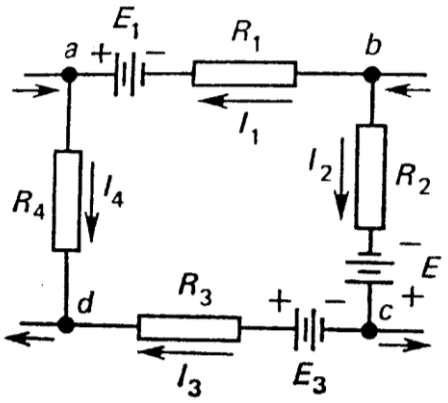

Figure 7.3 − Closed loop.

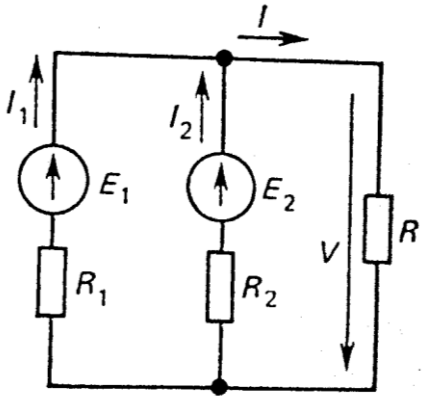

Figure 7.4− Parallel connection of the sources of e.m.f.

Applying Kirchhoff s second law, we can write for such a loop:

$$E_1 - E_2 - E_3 = I_1\left(R_{01} + R_1\right) + I_2\left(R_{02} + R_2\right) + I_3\left(R_{03} + R_3\right) + I_4 R_4, \qquad (2)$$

where R_{01}, R_{02}, and R_{03} are internal resistances of the sources of e.m.f., and R_1, R_2, R_3 and R_4 are load resistances.

For a particular case where branches are absent and the loop has all the paths connected in series, the total resistance is the sum of all the resistances. If the external circuit of a source of e.m.f. with an internal resistance R_0 comprises a series group of resistances R_1, R_2, and R_3, by Kirchhoff s voltage law we can write the following equality: $E = I \cdot \left(R_0 + R_1 + R_2 + R_3\right)$. K the loop had several sources of e.m.f., the left side of this equality would represent the algebraic sum of all the e.m.f.s.

With two or more sources of e.m.f. connected in parallel, the currents through the sources are generally not identical.

Referring to Figure 7.4, where two parallel-connected sources of e.m.f.s E_1 and E_2 with internal resistances R_1 and R_2 operate into a load of external resistance *R*, we can define the current *I* in the external circuit and the currents I_1 and I_2 in the sources by the following expressions: $I = I_1 + I_2$ or $I = U/R$; $I_1 = \left(E_1 - U\right)/R_1$ or $I_1 = \left(E_1 - IR\right)/R_1$; $I_2 = \left(E_2 - U\right)/R_2$ or $I_2 = \left(E_2 - IR\right)/R_2$. Hence, the external current is:

$$I = \frac{E_1 R_2 + E_2 R_1}{R_1 R_2 + R R_1 + R R_2}. \qquad (3)$$

ASSIGNMENTS

I. Answer the following questions embracing the contents of the Text A and Text B

1. Whom law does the relation between the current, e.m.f. and the resistance of the entire circuit obey to ? 2. What kind of points may each circuit have ? 3. How do we name the connection made between the two neighbouring nodes ? 4. What are the charges arriving at any point equal to ? 5. What currents do you consider positive or negative ? 6. What does the current law define ? 7. Do you have some loss of current anywhere in the circuit ? 8. What does Kirchhoff's second law state ? 9. When is the total e.m.f. the algebraic sum of the e.m.f.s of all the sources ? 10. When do the currents flow in different directions ? 11. In what case the total resistance is the sum of all the resistances ? 12. When are the currents through the sources not identical ? 13. What can we define when two parallel-connected sources operate into a load of external resistance ?

II. Read and translate the Text B paying attention to the behaviour of currents in the closed loop and when the sources are parallel-connected ?

8 VOLTAGE DIVIDERS AND POTENTIOMETERS

I. Give the initial forms of the following words. Translate them

Division, resistor, successive, across, proportional, potentiometer, amplifier, television, discharge, improve, output.

II. Match the following English words and word-combinations with the Russian ones

require	содержать
power supply	преобразовать ток
series	конденсаторы
voltage drop	вольтметр
variable resistor	проигрыватель
device for measuring voltages	улучшать устойчивость
record player	реостат
improve stability	источник энергии
convert the current	выходное напряжение, (выход по напряжению), выход со стабилизируемым напряжением
voltage output	падение напряжения
Contain	требовать
Capacitors	последовательное соединение

TEXT A. VOLTAGE DIVIDERS

I. a) Read the Text A. b) Comment on the difference of voltage and necessity of its dividing

Many electronic devices often require different voltages at various parts of the circuit. These different voltages can be obtained by having a different battery for each necessary voltage, or a separate power supply for each voltage required. Generally, however, it is more economical to have one power supply and use series resistors to divide the source voltage into the quantities desired. A set of series resistors used to divide voltages is called a voltage divider.

Voltage division results from successive voltage drops across series resistances. The largest amount of voltage is dropped over the smallest resistor. When each resistor in a voltage divider has the same resistance, equal voltages are dropped across each one. The voltage drops in a series circuit are proportional to resistance. Since, in a voltage divider, the voltage dropped by a resistance is proportional to the resistance; if the resistance is increased, the voltage dropped across the resistor will increase.

TEXT B. PRACTICAL VOLTAGE DIVIDERS

I. a) Read the Text B. b) Find the part of it dealing with the characteristic of a potentiometer and the notion a bleeder resistor. c) Translate the Text into Russian

A potentiometer consists basically of a variable resistor[1]. The resistor may be either wirewound or carbon. The potentiometer received this name because it was originally the principal element in an early device for measuring voltages. The variable resistance is connected to vary the amount of voltage supplied to a load. Practically all volume controls on radios, record players, amplifiers, and television sets are potentiometers.

The resistor in a loaded voltage divider through which the least amount of current flows is called the bleeder resistor[2]. Bleeder current is the current that passes through the bleeder resistor.

Many factors determine the proper amount of bleeder current. Generally, voltage dividers are used with power amplifiers that convert AC (alternating current) to DC (direct current). These power supplies contain capacitors. Large capacitors should have a path to discharge through[3], and this is provided by the bleeder resistor. High bleeder current also improves the stability of the power supply. Generally, bleeder resistors in a power supply draw about 10 per cent of the total current, but there are many exceptions to this rule.

Quite frequently, voltage dividers are designed with relatively low resistance, permitting high current to flow. This is done so that changing loads have a minimum effect on the voltage output. Low-resistance voltage dividers are used so variations in loads will have a minimum effect on the voltage output.

Notes:

1) variable resistor − регулируемое сопротивление, реостат;
2) bleeder resistor − делитель напряжения;
3) a path to discharge through − возможность разрядки.

TEXT C. VOLTAGE AND POWER AMPLIFIERS

I. Practice the pronunciation of the following many-syllable words. b) Make sure that you know these words

1. amplify, approximate, indicate, operate, memorize, microphone, capacitance, maximum, remedy, decibel, magnitude, possible, absolute, parallel, acoustical, principal;

2. medium, subsequent, period, material, genius, radio, miscellaneous, previous, appreciable; variety, society;

3. deliver, determine, develop, continue, exhibit, consider.

II. a) Memorize the following keyword-combinations to the text. b) Check if you know their meanings

Principal classes, voltage amplifier, minute currents, appreciable power, total amplification, early stages, feedback circuits, two classes of amplification, minute currents from microphones, a large part of the output, some of the remedies employed, the bias of the first stage, an absolute unit of power level, several stages of amplification, which occur in the first stage.

III. Memorize the following words of the same stem

To amplify, amplifier, amplification; to pick up, pickup; to suit, suitable; to drive, drive, driver; special, specially, especially; to design, design, designer; possibility, possible, impossible; to load, load; to determine, determination; to consider, consideration, considerable; to care, care, careful, careless, carefully; to choose, choice; to express, expression; to lose, loss; frequency, frequent, frequently; to measure, measure, measurement; to accept, acceptable; to distort, distortion; to couple, coupling.

IV. Read the text to yourself, grasp the main idea of it paying attention to the notes

There are two principal classes of amplification used in audio. The first is the **voltage** amplifier, which builds up minute currents from microphones, low-level pickups, etc., and increases the minute ***output*** voltages of these devices to a value suitable for driving following vacuum tubes.

The **power** amplifier is designed to deliver appreciable audio power to loudspeakers, recording cutters, etc.

Multi-stage amplifiers generally consist of several stages of voltage amplification followed by one or more stages of power amplification, the voltage from the previous stage output being applied to the grid of the next stage. The total amplification is limited by miscellaneous noises produced as a result of thermal agitation and shot effect which occur in the first stage and are amplified along with the signal. When the amplification becomes so great that these noises become a large part of the output, the amplifier becomes useless. Therefore, it is necessary to keep the noise down, especially in the first stage. Operating the units at lower voltages and using special tubes and feedback circuits are some of the remedies employed.

In multistage design it is important to proportion the stages so that none of the early stages can become overloaded before maximum output is obtained in later stages. Such a condition may occur if the volume control is placed in the second stage and the input device delivers more voltage than the bias of the first stage. Placing the volume control in a later stage will make the condition even worse unless the amplifier is to be used for only one input device having a very low output. In general, it is best to put the volume control in the earliest possible stage and to place the tubes having low bias and high gain early in the circuit.

A tube used as a voltage amplifier delivers maximum amplification (equal to mu) if the load is infinite and the actual plate voltage remains at the rated value. The gain drops with the plate load and with the plate voltage, so that the best compromise of plate load and plate voltage must be determined. Other problems such as parallel capacitance must be taken into consideration as well as careful choice of tubes as recommended in the tube handbooks.

Maximum undistorted power output is obtained from triodes when the load equals $2R_p$, and for pentodes when the load is approximately one-fifth R_p.

In addition, note that the power amplifier operates under conditions of plate current cut-off, with the stage efficiency depending on the cut-off angle.

The gain of amplifiers is often given in decibels. The decibel is a logarithmic unit, expressing the ratio between two magnitudes of power. Mathematically: db equals 10 $\log(P_i/P_2)$, where Pi and P_2 are the output and input power (in watts) respectively of the amplifier. When the impedance at input and output are equal, the decibel may also be expressed in terms of voltage or currents: db equals 20 $\log (I_1/I_2)$.

The decibel is used, in addition, as a unit of loss and gain in networks. Although the decibel is not an absolute unit of power level, it can be used to indicate the power level in decibels above or below an arbitrary "Zero Level". One of the most frequently employed zero levels is 6 milliwatts. In acoustical measurements a zero level of 10 to the 16th watts per square cm. has been accepted.

Audio-Frequency (a_f), as well as Radio-Frequency (r_f), amplifiers may be further divided according to their type of coupling into resistance-coupled, transformer-coupled, impedance-coupled, and direct-coupled amplifiers.

Notes:

1) in audio − в низкочастотной (звуковой) технике;
2) builds up − усиливает;
3) to deliver power − подводить мощность;
4) along with the signal − вместе с сигналом;
5) to keep the noise down − снижать шумы;
6) in general – вообще;
7) are some of the remedies employed − представляют собой некоторые из используемых способов
8) to proportion − подобрать, рассчитать;
9) early stages − предыдущие каскады;
10) later stages − последующие каскады;
11) remains at the rated value − остается номинальной;
12) must be taken into consideration − нужно принимать во внимание;
13) as well as − а также;
14) in addition to – кроме;
15) expressed in terms to voltage − выражено через напряжение.

ASSIGNMENTS

I. Choose the key sentences from the text and compare them with its title. b) Say what the text is about

II. Find the part in the in the text containing information about the main feature of multi-stage amplifiers

III. Answer the following questions embracing the content of the text

1. How many principal classes of amplification are there ? 2. What is the purpose of voltage (power) amplifier ? 3. What do multi-stage amplifiers generally consist of ? 4. When does the amplifier become useless ? 5. Why is it necessary to keep the noise down ? 6. Why is it best to put the volume control in the earliest possible stage ? 7. What problems must be taken into consideration when using

amplifiers ? 8. Under what conditions is maximum undistorted power obtained ? 9. In what units is the gain of amplifiers often given ? 10 What is a decibel ?

EXERCISES

I. Arrange the following words in pairs of synonyms:

use, minute, etc., generally, keep, obtain, instrument, tiny, usually, magnitude, device, maintain, get, take into consideration, in addition, and so on, employ, take into account, besides, indicate, frequently, show, value, often, principal, main.

II. Arrange the following in pairs of antonyms:

above, early, low, useless, important, suitable, high, below, unimportant, useful, distorted, late, careful, often, unsuitable, seldom, careless, undistorted.

III. What is the English for:

а) усилитель мощности, усилитель напряжения, электронная лампа, многокаскадный, регулятор громкости, цепь обратной связи, коэффициент усиления, номинальная величина, неискаженный, анодная нагрузка, усилитель звуковой частоты, усилитель высокой частоты, усилитель с непосредственной связью;

б) и т. д., в результате, особенно, вообще, справочник, потеря, а также, соответственно, посредством, кроме того, согласно.

IV. Translate into English using the words of the text:

Существует два вида усилителей: усилители напряжения и усилители мощности. Первые усиливают очень малые токи от микрофонов, датчиков, низкой чувствительности и т. д., и увеличивают выходное напряжение этих устройств до необходимого уровня. Усилители мощности предназначены для увеличения звуковой частоты в громкоговорителях, рекордерах и т. д.

Многокаскадные усилители обычно состоят из нескольких каскадов усиления напряжения и одного или более каскадов усиления мощности. Общее усиление ограничивается шумами. Необходимо, поэтому, снижать уровень шума, особенно в первом каскаде.

Усиление часто выражается в децибелах. Децибел − это логарифмическая единица, которая выражается отношением между двумя величинами мощности.

V. Render the following in Russian paying attention to the meaning-of the words in bold type:

1. Consider one conducting circuit which forms part of a more complicated network. 2. Metals are generally considered as **ohm**ic conductors. 3. Several approaches to solving this problem are under consideration. 4. Another problem under consideration is the development of new materials which will withstand the battery environment. 5. All other factors remaining the same, the operating time can be considerably reduced. 6. This combination is considered to produce a power supply with a high current capacity. 7. When designing amplifiers miscellaneous noises should be taken into consideration. 8. All things considered, we decided on the

transistorized power supply. 9. The elimination of noise is an important consideration in amplifier operation. 10. A considerable voltage drop is observed in the system. 11. In considering any insulating material for use in an electronic device there are several points which should be taken into consideration. 12. By using special tubes it is possible to obtain considerably higher pressures.

VI. Complete the following sentences:

1. The voltage amplifier builds up minute currents ... 2. The power amplifier delivers ... 3. Multi-stage amplifiers consist of ... 4. The total amplification is limited by ... 5. Volume control should be placed ... 6. The gain drops with ... 7. 1 fie gain of amplifiers is often given in ... 8. A decibel ...

VII. Put questions to which the words in bold-type in the following sentences are answers:

1. Maximum undistorted power output is obtained from triodes when the load equals $2R_p$. 2. Multi-stage amplifiers generally consist of several stages of voltage amplification. 3. It is best to put the volume control in the earliest possible stage.

VIII. State the forms of the verbals and translate the following sentences into Russian:

1. The device is likely to produce trouble. 2. Installing the system requires some care. 3. When installing the power supply unit, choose a cool location. 4. No coupling capacitor is needed if the crystal is connected with the polarity shown. 5. By keeping the heaters of the tubes half-hot all the time, you can cut warm up to a second or less and extend the life of lubes. 6. Integrated stereo receivers, preamplifiers, and power amplifiers on a single chassis, have proved to be one of the most popular components in the high-fidelity field. 7. In selecting the proper diode, the first item to be considered is the application. 8. The spacing between the electrodes in the tube under consideration is not even, the middle one being closer to the cathode. 9. Arcing lowers the tube resistance and allows very high current to flow-in the desired direction. 10. Testing a conventional semiconductor diode with an ommeter to determine its forward and reverse resistance ratio is simple and useful. 11. All other factors remaining the same, the operating time of the device can be reduced. 12. We have found some stages of the amplifier to be overloaded.

IX. State the form of the predicate and translate the following sentences into Russian:

1. A circuit using collector-voltage gain control is shown. 2. When specifying a particular device, current rating curves should be examined. 3. When selecting the device, its properties were considered. 4. To keep the noise down, several methods have been used. 5. In designing the device, different problems will be taken into consideration.

X. Translate the following sentences into Russian, paying attention to the translation of Past Participles:

1. The phenomenon referred to makes the amplifier useless. 2. Several laboratory tests followed by field tests proved the device to be very efficient. 3. The experiment showed that only the materials acted upon by light emitted radiations. 4. The application of lasers has opened out possibilities hardly dreamed of quite recently.

XI. Read the following numerals:

1/5, 3/5, 1/3, 2/3, 3/4, 5/8, 3/8, ¼, ½, 5/7;
0.15, 0.024, 2.375, 236.01, 38.946.

XII. Read without using the dictionary and retell:

TEXT D. CLASSIFICATION OF AMPLIFIERS

There are four distinct classes of amplifier service. These classes are, Class A, Class AB, Class B, and Class C.

Class A Amplifier: The Class A amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows at all times.

Class AB Amplifier: The Class AB Amplifier is one in which the grid bias and alternating voltages are such that plate current in a specific tube flows appreciably more than half, but less than the entire electrical cycle.

Class B Amplifier: A Class B Amplifier is an amplifier in which the grid bias is approximately equal to the cut-off value so that the plate current is approximately zero, when no driving grid voltage is applied. Plate current in a specific tube flows for approximately half of each cycle when an alternating grid voltage is applied.

Class C Amplifier: A Class C Amplifier is an amplifier in which the grid bias is appreciably greater than cut-off value, so that the plate current in each tube is zero when no alternating grid voltage is applied, and so that plate current flows in a specific tube for appreciably less than one-half of each cycle when an alternating grid voltage is applied.

XV. Translate into Russian using a dictionary:

TEXT E. COUPLING METHODS

Let us review briefly the various types of coupling presenting their advantages and disadvantages.

Resistance-coupled amplifiers have the advantage of economy and the frequency response can be made nearly flat. The phase distortion is less than that of other types of coupling except direct coupling. Disadvantages include lower gain than impedance or transformer-coupling with the same tubes and power supply, and the tendency to "motorboating."

Impedance-coupled amplifiers have a lower voltage drop across the load, thus making the plate voltage higher. The frequency response falls off at the low end as well as at the very high frequencies, above the point where parallel resonance occurs. The drop at the low end can be minimized by placing a resistor across the plate choke. If the value of the resistance is 1/3 of the choke reactance at the lowest

frequency, or less, the impedance of the combination will not vary more than a few percent over the audio range.

At present, transformer-coupled triode amplifiers can be designed to have a frequency characteristic as good as that of resistance-coupled amplifier. The gain of such amplifiers is not as high as that of the resistance-coupled amplifiers using pentode tubes, and the cost of transformers is higher. When sensitive amplifiers are used and a transformer is used at the input, the hum problem is much greater than with RC amplifiers. Well-shielded transformers are required, and even the critical orienting is necessary.

Direct-coupling is a special modification of resistance coupling. In such circuits the plate of the first stage is connected directly to the grid of the next, a condition which requires some manipulating with power supplies. Since the load between stages is a resistance and the coupling elements per stage are reduced this type of amplifier can be made to have excellent response. Frequency response at low frequencies is better and delayed distortion is less. The main difficulties are the tendency to drift due to temperature changes and the difficulty in designing amplifiers of many stages. It is possible however, to make an amplifier employing a drift corrector which makes the system practical for amplification of ae signals but not for de.

Notes:

1) motorboating − помехи, аналогичные шуму работающего мотора
2) across the load − на нагрузке;
3) at the low end − на низких частотах;
4) across the plate choke − параллельно анодному дросселю;
5) over the audio range − во всем звуковом диапазоне;
6) at present − в настоящее время;
7) practical – приемлемый.

9 MAGNETISM AND ELECTROMAGNETISM

I. a) Memorize the following words and word-combinations. b) Check if you know their meanings

property – свойство; allow – позволять; bits of iron – железные частички; ferrous – содержащий (двухвалентное) железо; exert – проявлять; magnetic field – магнитное поле; lodestone or magnetite – магнитный железняк или магнетит; suspend – подвешивать (зд. с целью свободного вращения); artificial – искусственный; magnetic force – магнитная сила; repel each other – отталкиваться друг от друга; unlike poles – противоположные полюса; attract each other – притягиваться друг к другу; iron filings – металлические опилки; stretch or tighten – растягиваться или сжиматься; per square inch – на квадратный дюйм; reluctance – магнитное сопротивление; permeability – магнитная проницаемость.

TEXT A. MAGNETS AND MAGNETISM

I. Read the text to yourself and grasp the main idea of it

Magnetism is a property of certain substances that allow them to attract bits of iron and other ferrous materials. The action of a magnet is exerted throughout the space surrounding it. This space around a magnet is called a magnetic field.

Hundreds of years ago, man discovered a natural substance called lodestone or magnetite, which could attract other pieces of the same substance and pieces of iron. If a bit of it was suspended to turn freely, it would always come to rest with one end pointing north. This natural substance came to be used as a direction finder[1]. The lodestone was a natural magnet. Man also learned how to make magnets himself. These are called artificial magnets. Artificial magnets are subdivided into temporary and permanent magnets.

When a lodestone, or artificial magnet, is suspended so that it can turn freely, one end always comes to rest[2] pointing north. This end is called the north-seeking pole, or simply, the north pole. The other end is called the south pole.

There is a law of magnetic forces that is very much like[3] the law of electrical charges. The law of magnetic forces states that like magnet poles will repel each other and unlike poles attract each other.

When a sheet of paper is placed over a magnet and iron filings are dropped on it, they will arrange themselves in a pattern. This shows that magnetic force acts in a definite direction at every point around a magnet. This direction might be shown symbolically by the lines of force or flux lines. The three characteristics of flux lines (lines of force) are: (a) they never cross each other; (b) they pass through almost any material; (c) they are elastic and stretch or tighten like rubber bands.

Flux density[4] is greatest at the poles of a magnet. This simply means that there are more lines of force per square inch at the ends of poles. The force with which poles repel or attract each other depends not only on the strength of the poles, but on the distance between them.

The opposition that a material offers to magnetization is called reluctance. Permeability is the relative ease[5] with which flux lines can be established in a substance. Air has the permeability of 1. Magnetic substances have a permeability thousands of times greater than air. The greater the permeability, the greater is the magnetic flux density.

Notes:

1) came to be used as a direction finder − начали использовать в качестве указателя направления;
2) comes to rest – устанавливается;
3) is very much like − очень похож на;
4) Flux density − плотность потока;
5) relative ease − относительная легкость.

TEXT B. ELECTRICITY AND MAGNETISM

I. a) Read the text. b) Find the part of it dealing with the behaviour of the magnetic field surrounding the wire. Translate it

Electricity and magnetism are very closely interrelated. Both have many similar features. In this section we will discuss some of the ways in which magnetism is related to electricity.

When an electric current flows through a wire, a magnetic field surrounds the wire. The lines of force which surround a current-carrying wire have direction, just as in a bar magnet. The direction of the lines of force is dependent on the direction of current flow. The direction in which current flows is called current polarity. The direction of the lines of force can be related to the direction of current flow i by the left-hand rule.2 The left-hand rule states that if you grasp the current-carrying wire in your left hand with your thumb pointing in the direction of electron-current flow, your fingers will point in the direction of the flux lines. As you know, a current going through a wire creates a magnetic field and, therefore, flux lines. The number of flux lines around the wire and the distance from the wire at which their magnetic influence is felt is directly proportional to the amount of current flowing. The number of flux lines increases as current increases.

A loop of wire as well as a straight piece of wire can carry a current, but the magnetic field around a loop is strengthened. The lines of force in a loop tend to combine and strengthen the field. When current is carried in a loop of wire, the magnetic field is stronger and the loop is considered to have n-s poles.

Notes:

1) The direction of the lines of force can be related to the direction of current flow − Соотношение между направлением силовых линий и направлением движения тока может быть получено;
2) left-hand rule − правило левой руки (магн).

TEXT C. ELECTROMAGNETS

I. a) Read the text. b) Find the part of it describing the essential part of an electromagnet. Translate it

A loop of wire which is carrying a current concentrates the magnetic lines of force that surround a wire and has polarity just like a regular magnet. A magnet that consists of a loop of wire, or a series of loops (coils), is called an electromagnet. Unlike a permanent magnet, an electromagnet has the unique feature of being turned on and off1 by controlling the current that passes through it. The coil which is a series of wire loops represents a simple electromagnet.

Electromagnets are used as relays, solenoids, motors, and other devices. In making such magnets, the proper field strength should be maintained. The field strength of an electromagnet depends upon some factors. There are three factors that determine the field strength of an electromagnet: 1) the field strength of electromagnet is directly proportional to the permeability of the core; 2) the field strength of a coil is also proportional to current; 3) the field strength of a coil is

proportional to the number of turns of the coil. The field strength of electromagnet is equal to the product of current multiplied by the number of turns and expressed as ampere-turns.

The magnetic polarity of a coil can be found by the left-hand coil rule. The coil is grasped with the left hand with the fingers pointing in the direction of current flow. Your thumbnail then will point in the direction of the coil's north pole. One of the most widely used application of electromagnets is the relay. Another widely used application of electro-magnetism is the solenoid. Solenoid is an open coil of wire, its length is great compared with its diameter. The magnetic field intensity at the centre of the solenoid might be given by a specific formula.

Note:

1) the unique feature of being turned on and off − характерное свойство включаться и выключаться.

ASSIGNMENTS

I. a) Choose the key sentences from the Text A and compare them with the title of the text. b) Say what the text is about

II. Skim through the Text C and describe the factors determining the field strength of an electromagnet

III. Answer the following questions embracing the contents of the Text A, Text B and text C:

1. What is the magnetism ? 2. What do we call a magnetic field ? 3. What are artificial magnets subdivided into ? 4. What characteristics of flux lines do you know ? 5. What does the force with which poles repel or attract each other depends on ? 6. Why are electricity and magnetism closely interrelated ? 7. What does the left-hand rule state for ? 8. When will each magnet experience a force of attraction ? 9. Where are the magnetic lines concentrated ? 10. Where electromagnets are used ?

IV. Discuss the information obtained from the Text B

10 ELECRICAL ENERGY AND POWER

I. a) Practice the pronunciation of the following words. b) Make sure that you know these words

1. lift, process, overcome, vanish, convert, transfer, expend, deliver, lose, express, specify, concern, measure, increase, decrease, supply, heat.

2. high, mechanical, thermal, chemical, certain, equal, useful, above, one-thousandth, internal, external, inefficient, energy-converting.

3. height, motion, quantity, amount, fraction, wire, terminal, equation, expression, ability, joule, performance, outside, input, output, eddy.

4. regardless, commonly, consequently, according to, inevitably.

II. a) Memorize the following keyword-combinations to the text. b) Check if you know their meanings

Forms of energy, a closed circuit, certain amount of energy, a piece of equipment, the load terminals, the product of the current and time, none of the above equations, per unit time, over different periods of time, to supply (to consume) electric energy, to transfer the power, to overcome, the internal resistance, from the outside, the energy-converting device, he law of the conservation of energy, the energy losses eddy currents, the efficiency of an energy converter, with respect to, the ratio of the useful output to the input.

III. Read the text to yourself, grasp the main idea of it

Energy is capacity for doing work. For example, a body lifted to a certain height possesses energy since it can do work in moving down. The higher the energy of a body, the more amount of work the body can do in overcoming the resistance to its motion. Energy does not vanish but is converted from one form of energy to another. Thus, electric energy can be transformed into mechanical, thermal, chemical, and other forms of energy. Mechanical energy can be transformed into electric energy, thermal energy, etc.

For charges to be transferred in a closed circuit, the source of e.m.f. expends a certain amount of energy which is equal to the product of the e.m.f. and the quantity of electricity transferred from one point of the circuit to another, *EQ*.

But not all the energy delivered by the source of e.m.f. to a piece of equipment does useful work since a fraction of this energy is lost in overcoming the internal resistance of the source and the resistance of wires. Thus, the source does the useful electrical work equal to $W = U \cdot Q$ where *U* is the voltage between the load terminals.

Since the quantity of electricity is equal to the product of the current and the time it takes the current to pass through the circuit, $Q = I \cdot t$, the equation for work, or energy, can be written in the form:

$$W = U \cdot I \cdot t. \qquad (1)$$

So, *electric energy*, or *work*, is the product of the voltage, the current, and the time it takes the current to flow through the circuit.

If we express the voltage across the terminals of a circuit part as the product of the current and the resistance of this part, $U = I \cdot R$, the expression for energy can be given as $W = I^2 Rt$.

But none of the above equations defines the capacity of an electric generator in delivering the work per unit time because both a small and a large generator can do the same amount of work over different periods of time. It is the power that specifies the ability of a piece of equipment to convert a certain amount of energy per unit time, i.e. its time rate in doing work. This concerns any piece of equipment and machine, regardless of whether it supplies or consumes electric energy.

So, *power* is the time rate of energy transformation, for example, *the work done per second*. The expression for power is:

$$P = W/t = UQ/t = UI = U^2/R = I^2 R. \qquad (2)$$

If in the expressions for energy and power the voltage is in volts, the current is in amperes, the resistance is in ohms, and the time is in seconds, then the energy is in *newton-meters* (N·m) or *watt-seconds* (W·s), or *joules* (J), and the power is in watts (W) or *joules per second* (J/s). So, the watt is the power developed when work is done at the rate of one joule per second. The unit of power that is one-thousandth of a watt is a *milliwatt* (mW) and the unit that is equal to a thousand watts and used to measure large amounts of power is a *kilowatt* (kW).

Since the joule is a small unit, electric energy is commonly expressed in larger units, *watt-hours* (W·h) and kilowatt hours. The relations between these units are the following:

$$1\ \text{W·h} = 3\,600\ \text{J} \quad \text{and} \quad 1\ \text{kW·h} = 1\,000\ \text{W·h}.$$

If the external resistance R is very small, the current in the circuit is large and the voltage U across the generator terminals is low. When R is equal to zero, the voltage U is also equal to zero. Consequently, the power P delivered to the external circuit is zero.

At a very large value of external resistance (when the external circuit is open, R goes to infinity), the current in the circuit is zero and the power transferred to the external circuit is also zero.

So, as the external resistance increases, the power first grows from zero to a certain maximum value and then goes to zero.

To transfer a maximum of power to an external circuit, the external resistance must be equal to the internal resistance of the generator. But one should remember that in this case the useful effect of the generator is low and its performance is inefficient because half of the power developed by the generator is used up to overcome its internal resistance.

The power supplied by a source of energy to the external circuit is the useful output power P_2, and the power received by this source from the outside, for example, from a source of mechanical energy is the input power P_1, or the total power put into the energy-converting device in question. A load consuming electric energy from the supply line converts this energy into the energy of another form, for example, into mechanical energy.

According to the law of conservation of energy, the output power of a source of e.m.f. or of an electric load is lower than the input power since in the course of operation of any energy-converting device, a fraction of the energy transformed is inevitably lost. The energy losses in energy converters arise from the heating of winding conductors when current flows through them, reversal of steel magnetization, eddy currents, and a number of other factors.

The *efficiency of an energy converter* with respect to power is the ratio of the useful output P_2 to the input P_1:

$$\eta = \frac{P_2}{P_1} = \frac{P_2}{\left(P_2 + \Delta P\right)}, \tag{3}$$

where ΔP is the power loss in the energy converter. The above expression shows that the efficiency of an energy converter grows with a decrease in the power loss.

ASSIGNMENTS

I. a) Choose the key sentences from the text and compare them with its title. b) Say what the text is about ?

II. Find the parts in the text containing information about: losses of energy, the capacity of an electric generator in delivering the work, the notion of a watt

III. Answer the following questions embracing the content of the text

1. What is energy ? 2. What is the main principle of energy ? 3. What can mechanical energy be transformed into ? 4. What is the certain amount of energy equal to ? 5. When is a fraction of energy lost ? 6. What is the product of work consist of ? 7. What specifies the conversion of energy ? 8. Can you give the definition of a watt ? 9. Under what circumstances is the current in the circuit large ? 10. Under what circumstances is the voltage law ? 11. What do we do to transfer a maximum of power to an external circuit ? 12. How do you characterize the efficiency of an energy converter ?

IV. Speak on one of the following topics:

1) The capacity of energy.
2) The source expending energy.
3) The electric generator delivering the work.
4) The external resistance.
5) The law of conversion of energy.

V. Translate the text to be sure you understand it well

VI. Make up a plan of the text

VII. Retell the text according to your plan

VIII. Review the text in written form

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