*МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ УКРАИНЫ*

**ГОСУДАРСТВЕННОЕ ВЫСШЕЕ УЧЕБНОЕ ЗАВЕДЕНИЕ «ДОНЕЦКИЙ НАЦИОНАЛЬНЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

*Кафедра электромеханики и ТОЭ*
*Кафедра английского языка*

# УЧЕБНОЕ ПОСОБИЕ
для проведения практических занятий
по английскому языку научных и технических
профессий для направления подготовки
«Электротехника и электротехнологии»,
часть 2

Донецк, 2014

УДК 621.3+811.111.001.85(075.3)

Рекомендовано Вченою Радою ДонНТУ як навчальний посібник (Протокол №5 від 23.05.2014)

Учебное пособие для проведения практических занятий по английскому языку научных и технических профессий для направления подготовки «Электротехника и электротехнологии», часть 2 – Донецк: ДонНТУ, 2014. – 235с.

Пособие предназначено для студентов электротехнического факультета направления подготовки «Электротехника и электротехнологии» групп с углубленных изучением английского языка. Часть 2 пособия является продолжением части 1 и содержит все необходимые материалы по двадцати семи урокам (с 22-го по 48-й) для проведения практических занятий по английскому языку научных и технических профессий. Имеется приложение, в котором по каждой теме приводятся новые слова для запоминания.

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ВВЕДЕНИЕ

Вторая часть учебного пособия предназначена в первую очередь для студентов 3-4 курсов, изучающих дисциплину «Английский язык научных и технических профессий» в группе с углубленным изучением английского языка. Однако оно может быть применено и как пособие по изучению английского языка во время аудиторных занятий со студентами электротехнического направления, а также при самостоятельном изучении английского языка. Пособие может быть полезно аспирантам, изучающим английский язык.

Учебное пособие предполагает интенсивную домашнюю подготовку студентов к занятиям. В связи с этим рекомендуется заготовить рабочую тетрадь по английскому языку и в ней выполнять домашние задания – готовиться к уроку. К этому же уроку относятся и новые слова, приведенные к каждому уроку в разделе APPENDIX. Каждый урок рассчитан на два-три аудиторных занятия.

Отдельные задания помечены «звёздочкой»; они являются необязательными и выполняются по желанию студентами, которые хотят повысить свой уровень знаний английского языка или улучшить оценку.

# UNIT 22. EARLY HISTORY OF ELECTRICITY

**Overview**

- Reading and Vocabulary: Early history of electricity.
- Supplementary Information: Propagation of radio waves.
- Language focus: Reduced time clauses.
- Reading and Speaking: Small is beautiful

## Reading and Vocabulary

**Reading**

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Early history of electricity**

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

History shows us that at least 2,500 years ago, or so, the Greeks were already familiar with the strange force (as it seemed to them) which is known today as electricity. Generally speaking, three phenomena made up all of man's knowledge electrical effects. [ 1 ] The second manifestation of electricity he was more or less familiar with was the following: he sometimes found in the earth a strange yellow stone, that is to say amber, obtained the ability of attracting light objects of a small size. The third phenomenon was connected with the so-called electric fish which possessed the property of giving more or less strong electric shocks which could be obtained by a person coming into contact with the electric fish.

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

As a matter of fact, all of man's knowledge in the field of electricity has been obtained during the last 400 years, or so. [ 2 ] In effect, most of the electrically operated devices, such as the electric lamp, the refrigerator, the tram, the lift, the radio, and so on, are less than one hundred and fifty years old. In spite of their having been employed for such a short period of time, they play a very important part in man's everyday life all over the world. In fact, we cannot do without them at present.

So far, we have not named the scientists who contributed to the scientific research on electricity as centuries passed. However, famous names are connected with its history and among them we find that of Phales, the Greek philosopher. [ 3 ]



However, he could not know that amber was charged with electricity owing to the process of rubbing. Then Gilbert, the English physicist, began the first systematic scientific research on electrical phenomena. [ 4 ] He gave the name "electricity" to the phenomenon he was studying. He got this word from the Greek "electrum" meaning "amber".

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

**Reading comprehension**

**Ex.1.**

A. As early as about 600 B.C. (that is, before our era) he discovered that when amber was rubbed, it attracted and held minute light objects.

B. The first phenomenon under consideration was the familiar lightning flash – a dangerous power, as it seemed to him, which could both kill people and burn or destroy their houses.

C. He proved the electric current is always accompanied with magnetic field.

D. He discovered, that various other substances possessed the property similar to that of amber or, in other words, they generated electricity when they were rubbed.

E. Needless to say, it took a long time before scientists learned how to make use of electricity.

**Ex.2. Give short answers to the following questions.**

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

**Vocabulary**

**Ex.3. Define the following terms.**

manifestation of electricity, light objects, observation, refrigerator, process of rubbing, electrical phenomena, learned men, to be engaged

## Supplementary Information

**Propagation of radio waves**

Radio waves from a transmitting aerial can travel in one or more of three different ways.

**Surface or ground wave.** This travels along the ground, following the curvature of the earth's surface. Its range is limited mainly by the extent to which energy is absorbed from it by the ground. Poor conductors, such as sand, absorb more strongly than water, and the higher frequency the greater the absorption is. The range is about 1500 km at low frequencies (long waves).

**Sky wave.** It travels skywards and, if it is below a certain critical frequency (typically 30MHz), is returned to earth by the ionosphere. This consists of layers of air molecules stretching from about 80km above the earth to 500km. On striking the earth, the sky wave bounces back to the ionosphere where it is again gradually refracted and returned earthwards as if by 'reflection'. This continues until it is completely attenuated.

The critical frequency varies with the time of day and the seasons. Sky waves of high frequencies can travel thousands of kilometers but at VHF and above they pass through the ionosphere into outer space.

**Space wave.** For VHF,UHF, and microwave signals, only the space wave, giving line of sight transmission, is effective. A range of up to 150km is possible on earth if the transmitting aerial is on high ground and there are no intervening obstacles such as hills, buildings, or trees. Space waves are also used for satellite communications.

**Ex.1. Complete table below.** Use information from the text.

| | Surface wave | Sky wave | Space wave |
|---|---|---|---|
| Frequencies | | | |
| Travels | | | |
| Range | | | |
| Difficulties | | | |

## Language focus

**Reduced time clauses**

Study these two actions: 1) Ground waves pass over sand. 2) Ground waves lose energy.



We can link these actions to make one sentence, using a time clause: **When** ground waves pass over sand, they lose energy.

Because the subject of both actions is the same – ground waves – there is a shorter method we can use to link the actions: **When** pass**ing** over sand, ground waves lose energy.

**When** + **-ing** shows that Action 2 happens during the same period as Action 1.

Now study these two actions: 1) The sky wave strikes the earth. 2) The sky wave bounces back again.

Again we can link these actions to make one sentence, using a time clause: **When** the sky wave strikes the earth, it bounces back again.

We can also link the actions in a shorter way: **On** strik**ing** the earth, the sky wave bounces back again.

**On** + **-ing** shows that Action 2 follows immediately after Action 1.

**Ex.1. Link these pairs of actions.** Use short ways when this is possible.

1 a) The switch is closed. b) Current flows through the primary of the transformer.

2 a) The radar signal strikes a plane. b) The radar signal is reflected.

3 a) A cell discharges quickly. b) A cell may become hot.

4 a) The TV receives signals from the remote control. b) The TV follows your instructions.

5 a) The radar receiver receives the reflected signal. b) The signal is compared with the transmitted signal.

6 a) You choose a course in electronics. b) You think carefully about your future.

7 a) Microwave signals strike a high building. b) Microwave signals are deflected.

8 a) You make a recording. b) You should ensure the recording levels are satisfactory.

9 a) The alarm detects an intruder. b) The alarm triggers an audible warning.

10 a) The remote control button is pressed. b) The television set changes channel.

## Reading and Speaking

**Small is beautiful**

**Before you start**

Discuss the question: How are these things carried from one place to another?

a) electricity b) radio signals c) gas

**Ex.1. Read the text and choose the best title,** A, B, or C.

A) The history of cabling and telecommunications.
B) A short introduction to optical fibres.
C) Uses of glass in industry and technology.

Optical fibres started to replace some uses of copper cables in the 1970s. They are made from glass and are usually about 120 *micrometre*s in *diameter*. Some of the most common everyday uses are in telecommunications, close-circuit television (CCTV), and cable television.

1. Optical fibres carry signals more *efficiently* than copper cable and with a much higher bandwidth. This means that fibres can carry more channels of information over longer distances.

2. Optical fibre cables are much lighter and thinner than copper cables with the same bandwidth. This means less space is needed in underground cabling *ducts*.

3. It is difficult to steal information from optical fibres. They are not harmed by electromagnetic interference, for example from radio signals of lightning. They don't *ignite* so they can be used safely in *flammable* atmospheres, for example in petrochemical plants.

4. Optical fibres are more expensive *per* metre than copper. However, one optical fibre can carry many more signals than a single copper cable and the longer transmission distances mean that fewer expensive repeaters are required. Also, copper cable uses more electrical power to deliver the signals.

5. Optical fibres can't be spliced as easily as copper cable. Employees need special training to *handle* the expensive *splicing* and measurement equipment.

**Ex.2. Read the text again and match the headings** (A-E) with the paragraphs (1-5).

A Training and skills  B Size and weight  C Security  D Price  E Capacity

**Ex.3.** Which paragraphs describe *advantages* of optical fibres and which describe *disadvantages*?

**Ex.4. Complete the definitions** (1-9) **below with the words in** *italics* **in the text.**

1. A _____ is one millionth of a metre.
2. The _____ is the distance across a circle.
3. A _____ substance is one that burns easily.
4. _____ means joining the ends of two cables together.
5. To _____ means to start to burn.



6. _____ are tubes for carrying cables.
7. _____ is a common short way of saying 'for each'.
8. _____ means to touch with your hands.
9. _____ means in a way that produces a good result and doesn't waste time, energy, or resources.

# UNIT 23. FROM THE HISTORY OF ELECTRICITY

**Overview**

- Reading and Vocabulary: From the history of electricity.
- Information transfer: Describing a process.
- Language focus: Prepositions of Place – Movement – Time.
- Reading and Speaking: Electric current serves us in a thousand ways.

## Reading and Vocabulary

### Reading

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**From the history of electricity**

There are two types of electricity, namely, electricity at rest or in a static condition and electricity in motion, that is, the electric current. Both of them are made up of electric charges, static charges being at rest, while electric current flows and does work. [ 1 ]

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

As early as 1753, Franklin made an important contribution to the science of electricity. He was the first to prove that unlike charges are produced due to rubbing dissimilar objects. To show that the charges are unlike and opposite, he decided to call the charge on the rubber – negative, and that on the glass – positive.

In this connection one might remember the Russian academician V.V. Petrov. [ 2 ] As a result he was the first scientist in the world who solved that problem.

Who does not know that the first man to get the electric current was Volta after whom the unit of electric pressure, the volt, was named? [ 3 ] Galvani observed that the legs of a dead frog jumped as a result of an electric charge. He tried his experiment several times and every time he obtained the same result. He thought that electricity was generated within the leg itself.



Volta began to carry on similar experiments and soon found that the electric source was not within the frog's leg but was the result of the contact of both dissimilar metals used during his observations. However, to carry on such an experiment was not an easy thing to do. [ 4 ] To increase the effect obtained with the one pair of metals, Volta increased the number of these pairs. Thus the voltaic pile consisted of a copper layer and a layer of zinc placed one above another with layer of flannel moistened in salt water between them. A wire was connected to the first disc of copper and to the last disc of zinc.

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

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

### Reading comprehension

**Ex.1.**

A. Thus, they differ in their ability to serve mankind as well as in their behaviour.

B. He spent the next few years trying to invent a source of continuous current.

C. He was the first to carry on experiments and observations on the electrification of metals by rubbing them one against another.

D. As a result, he invented radio.

E. His discovery developed out of Galvani's experiments with the frog.

**Ex.2. Read the text and find the answers to these questions.**

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

## Vocabulary

**Ex.3. Find synonyms from the text to the following words (in bold).**

to **obtain** electricity, by rubbing **materials**, to **move** trains, difficult **to drive**, **different** objects, to solve **task**, to **execute** an experiment, to **produce** electricity, **analogous** experiment, **quantity** of pairs, **direct** current

**Ex.4. Learn to recognize the following international words.**

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

## Information transfer

**Ex.1. Explain these abbreviations.** Check your answers by looking quickly through the text below: 1) AF; 2) RF; 3) AM; 4) FM.

Radio frequency (RF) waves are used to carry audio frequency (AF) waves over long distances through the air. The audio signals can be combined with the RF carrier wave in such a way that it varies the amplitude of the carrier. This gives an amplitude-modulated (AM) carrier wave (see Fig. 1). In a frequency-modulated (FM) wave, the audio signal is combined with the RF carrier wave to vary the frequency of the carrier (see Fig. 1).

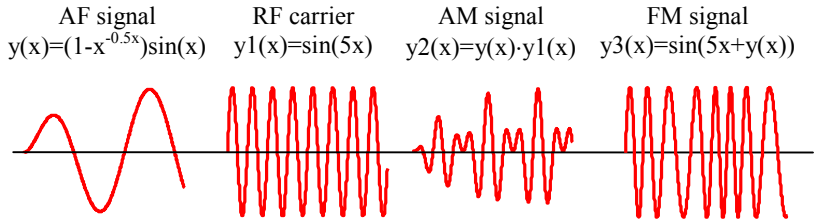



Figure 1

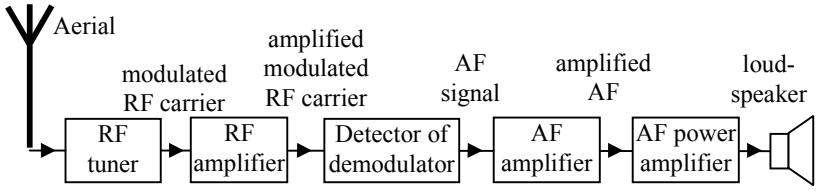



Figure 2



The block diagram of a radio is shown in Fig. 2 below. The tuner selects the required RF wave from those picked up by the aerial. The selected RF wave is amplified and passed to the detector, which separates the audio modulation from the RF carrier wave. The audio frequency amplifier then amplifies the audio signal to make it strong enough to drive the loudspeaker.

A typical radio tuner circuit consists of an inductor and capacitor connected in parallel (see Fig. 3). The size of the aerial inductance coil can be kept small by winding it on a ferrite rod core.

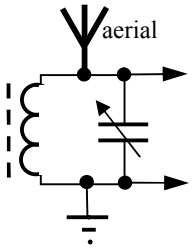



Fig. 3

The RF waves fed to the tuner cause the circuit to oscillate. The impedance of the circuit is smallest and the oscillation is greatest at a particular frequency known as the resonant frequency. This frequency is determined by the values of the inductance and the capacitance. By using a variable capacitor, the circuit can be tuned to the required radio frequency, and the selected RF wave passed on to the RF amplifier.

**Ex.2. Explain what happens at each stage in this flowchart, which shows how a radio works.** The first and last stages are done for you.

Component – Function: 1) aerial – receives weak RF signals; 2) RF tuner - … ; 3) RF amplifier - … ; 4) detector - … ; 5) AF amplifier - … ; 6) loudspeaker – converts the audio signal into sound.

**Ex.3. Read about "Describing a process".**

When describing a process, it can be useful first to make a flowchart like the one in Ex.2, showing the stages in the correct sequence. You can then expand the flowchart to include a brief description of what happens at each stage.

The next step is to turn your flowchart into a written description. You can help your readers by making the order of the stages with sequence markers. The most common markers are: firstly, next, following that, then, after that, finally.

We can summarize this advice with a flowchart:

Make a flowchart showing the main stages – Add a brief description of each stage – Turn the flowchart into a full description – Add sequence markers to guide your readers.

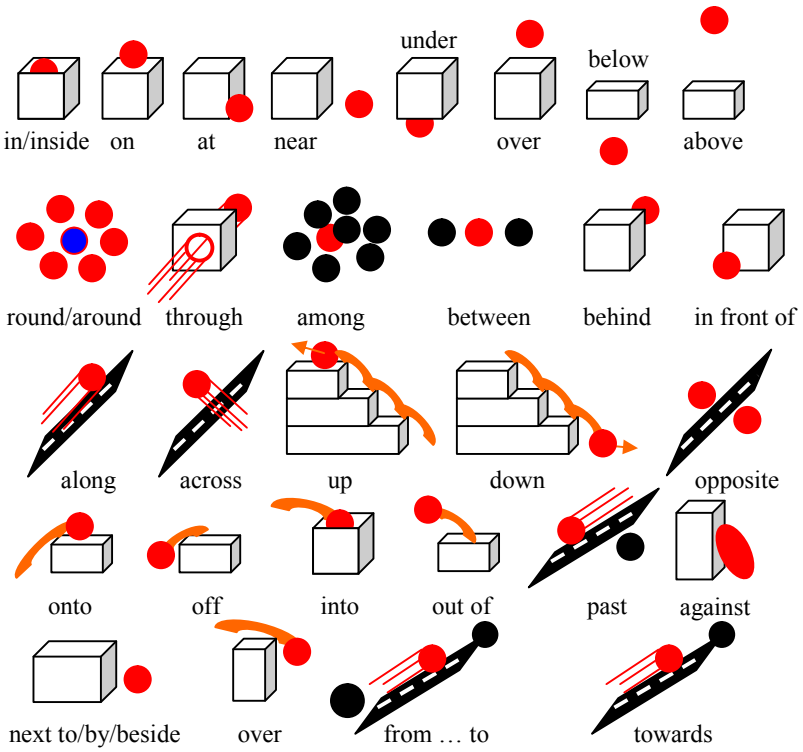
**Ex.4. Describe how a radio deals with a radio signal.** Base your description on the flowchart in the latter Task.

## Language focus

### Grammar and Vocabulary

**Prepositions of Place – Movement - Time**

**Ex.1. Look through the pictures.** Learn to recognize the Place-Movement prepositions.




**Ex.2. Consider the rest prepositions.**

in + cities / towns / streets / the suburbs / an armchair / danger / the middle of / the queue



at + house number (at 23 Oxford st) / home / school / university / work / the bus-stop

on + the floor / the outskirts / a chair / foot / holiday

by + bus / taxi / car / helicopter / plane / train / coach / ship / boat / air / sea

**But** on a/the bus / plane / train / coach / ship / boat – in a taxi / car / helicopter

**Ex.3. Fill in the Place prepositions:** in, inside, outside, at, near, under, below, over, above, round, around, among, between, behind, in front of, opposite, against, next to, by, beside, from … to.

1. The voltaic pile consisted of a copper layer and a layer of zinc placed one … another with layer of flannel moistened in salt water … them. 2. For some years Volta was a teacher of physics … his home town. 3. He carried on experiments on the electrification of metals by rubbing them one … another. 4. The block diagram is shown … figure. 5. The aerial inductance coil is wound … a ferrite rod core. 6. Electrical devices are used … the laboratory. 7. Electric energy finds its most use … industry. 8. Great masses of metal are melted … furnaces. 9. Decimal numbers were invented … India. 10. The temperature … the hotel is usually about -5ºC; … the temperature can be much lower even as low as -40ºC. 11. There are nine planets … the solar system. 12. The temperature … Sun's surface is above 5,500 degrees Centigrade, the temperature … its centre is as high as 20 million degrees Centigrade. 13. Early units of measurement included the distance … the elbow … the fingers. 14. Rods of fixed lengths still varied … country … country. 15. SI units are widely adopted … the world. 16. The British systems of English units are used … Britain. 17. The Soviet Russia initially was … almost all the developed countries as for the power industry. 18. The capacity of secondary battery systems ranges … 100 mAh … 2000 Ah. 19. Their useful life ranges … 2 … 20 years; this will depend, … other things, upon the number of charge–discharge cycles and the type and construction of battery used. 20. Placing a kettle full of cold water … the fire is quite an ordinary thing. 21. The temperature of boiling water is always the same … the same atmospheric pressure. 22. … the Fahrenheit scale the boiling point of water is taken as 212°. 23. Besides the principal components mentioned … there are many additional parts of the plant. 24. … both schemes the exhaust vapour is condensed … condenser. 25. The largest generators used … major power stations are usually turbo-generators. 26. Sky wave travels skywards and, if it is … a certain critical frequency (typically 30MHz), is returned to earth by the ionosphere. 27. Ionosphere consists of layers of air molecules stretching … about 80km … the earth … 500km.

**Ex.4. Fill in the Movement prepositions:** over, through, along, across, up, down, onto, off, into, out of, past, from … to, towards.

1. The electric motor transforms electric energy … mechanical energy. 2. … the end of the eighth century an Indian astronomical textbook was brought to Baghdad. 3. The North American transmission system is interconnected … a large power grid known as the North American Power Systems Interconnection. 4. An air thermometer consisted of a glass bulb and a glass tube, the latter being immersed … a coloured liquid. 5. Water falling … its raised position, energy changes … potential … kinetic energy. 6. The path … which the electrons travel must be complete otherwise no electric power can be supplied … the source … the load. 7. As a current flowing … a conducting medium the heat is produced. 8. Surface wave travels … the ground, following the curvature of the earth's surface. 9. Sky waves of high frequencies can travel thousands of kilometers but at VHF and above they pass … the ionosphere … outer space. 10. Ground waves pass … sand.

**Ex.5. Get to know the prepositions of Time**

| AT | IN | ON |
|---|---|---|
| at 8:15<br>at Christmas/Easter<br>at night/midnight/noon<br>at the weekend | in the morning/afternoon/evening<br>in July (months)<br>in summer (seasons)<br>in 1991 (years)<br>in the 20th century | on Sunday<br>on Monday etc.<br>on March 28th<br>on a winter night |
| Note: on time = at the right time<br>in time = early enough, not late<br>before | at 8:30 = exactly at that time<br>by 8:30 = not later than that time, | |

**Ex.6. Fill in the Time prepositions.**

1. The electric current was born … the year 1800. 2. … that time, the Arabs were still using the Greek numeral system. 3. Shakespeare was born … 23 April, 1564 and he died … the same day … 1616. 4. … early times measurements were made by comparing things with parts of the human body. 5. … 1980-s the Soviet Union has occupied the place behind but the USA. 6. The battery is … present the most widely used means of storing electrical energy.



## Reading and Speaking

**Electric current serves us in a thousand ways**

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

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

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

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

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

A good example which is illustrating an important industrial use of the electric current is the electrically heated furnace. Great masses of metal melted in such furnaces flow like water. Speaking of the melted metals, we might mention one more device using electricity, that is the electric pyrometer.

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

**Ex.1. Give short answers to the following questions.**

1. Does the motor find wide application in industry? 2. Is Volta a Russian scientist? 3. Does your friend go to the institute on foot? 4. Did you go to the theatre yesterday? 5. Is there an electric lamp on your table? 6. Has your friend bought a new bicycle? 7. Are there many trolley-buses and trams in your town? 8.

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

**Ex.2. Form sentences using the words given below.**

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

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

**Ex.3. Put all the possible questions to the following sentences.**

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

**Ex.4. Form sentences using the following expressions.**

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

**Ex.5. Translate the following groups of words.**

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

**Ex.6. Find the wrong statements and correct them in several sentences.**

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

**Ex.7. Find the correct answer out of the three given below.**

What device



1. measures the temperature of hot metals? a) refrigerator; b) pyrometer; c) motor
2. transforms electrical energy into mechanical energy? a) bicycle; b) telephone; c) motor
3. lifts objects weighing hundreds of tons? a) electric crane; b) electric furnace; c) vacuum cleaner
4. lights your room? a) tram; b) lift; c) lamp

**Ex.8*. Speak on:**

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

# UNIT 24. FROM THE HISTORY OF SOVIET ELECTRIFICATION

**Overview**

- Reading and Vocabulary: From the history of soviet electrification.
- Information transfer: Dialogues.
- Language focus: Dialogues.
- Reading and Speaking: Storage batteries.

## Reading and Vocabulary

### Reading

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**From the history of soviet electrification**

Power industry is the economical base of all the industrial states, XX century having been the period of its intensive development.

December, 22 is the red-letter day for all the power industry workers in Ukraine. It started being celebrated from 1920, when State plan to electrify Soviet Russia (ГОЭЛРО) was adopted. [ 1 ] That plan was completely realized before ten years had passed.

| Year | Installed capacity, GW | Electricity production, TW·h |
|---|---|---|
| 1945 | 11 | 43 |
| 1950 | 20 | 91 |
| 1955 | 37 | 170 |
| 1960 | 67 | 292 |
| 1965 | 115 | 507 |
| 1970 | 166 | 740 |
| 1975 | 217 | 1038 |
| 1980 | 284 | 1294 |
| 1985 | 315 | 1545 |
| 1990 | 320 | 1674 |

Such development rate of the power industrial base which took place in the USSR had been never seen in the world yet. While the Soviet Russia initially was behind almost all the developed countries as for the power industry, by 1980-s the Soviet Union had occupied the place behind but the USA.

Development rate of the installed capacity and electricity production in the USSR is illustrated by the following data table.

The tendency was to construct the electric power plants of the big installed capacity. [ 2 ]

Atomic power industry was characterized by fast development. [ 3 ]



Hydro-power engineering was greatly attended. In European part of the USSR, the building of the hydroelectric power station cascade was over upon rivers the Volga and the Kama. Analogous plants were intensively built on the rivers of Caucasia. In Siberia, such powerful hydroelectric plants were built as Ust-Ilimskaya (3.3GW), Sayano-Shushenskaya (6.4 GW), Bratskaya (4.5 GW), Krasnoyarskaya (6 GW).

Electricity supply network developed intensively as well. By 1990, there were 11 energy systems in the USSR, furthermore, 9 of them were connected with each other. [ 4 ] Electric systems were interconnected by the overhead lines having voltage level 500 kV (30348km), 750 kV (2811 km) and 1150 kV (958 km).

There was a tendency to integrate the USSR electric system with electric systems of European countries. By the end of 1980-s the unique intergovernmental energetic association appeared. It joined the states of Council for Mutual Economic Assistance. It was named the power supply system "Mir". It possessed the summary installed capacity more than 400 GW. It was the biggest in the world and occupied huge territory from Berlin to Ulan Bator. It was in 1991 when the USSR disintegrated and the control structure of the supply system changed. In 1993 the power supply system "Mir" fell to pieces.

### Reading comprehension

**Ex.1**.

F. They occupied 2/3 of the state territory with more than 80% of population.

G. Wind power plants developed intensively as well.

H. It provided the building of 30 new region electric power stations with total capacity 1750 MW during 10-15 years.

I. By 1990, there were more than 80 plants each with capacity 1 GW and higher in the USSR, they producing more than halve of electricity.

J. Atomic power industry had passed from the atomic plant of Obninsk with capacity 5 MW (1955) to plants with capacity 4000 MW (1990).

**Ex.2. Read the text and find the answers to these questions.**

1. What is the red-letter day for all the power industry workers in Ukraine? 2. Which plan was completely realized before ten years had passed? 3. What place in the world had the Soviet Union occupied by 1980-s as for the power industry? 4. How many energy systems were in the USSR? 5. What voltage level did the overhead lines interconnecting electric systems have?

## Information transfer

**Dialogues**

**Before you start**

There are different ways to transfer the information. Symbols, pictures, tables, schemes, diagrams, and graphics may be used. However, conversations and dialogues are last but not least ways for information transfer. They allow sharing impressions, expressing opinion and so on. Below, some dialogues touching some aspects of the university life are proposed.

**1.** So, who do you work for?

I work for a large technical university called DonNTU. We have four main areas of business – education, science, delivery of the second education, sports.

And which side of the business do you work in?

Education and science. I work for electrotechnical faculty. We teach students of two fields of study: electrical engineering and electrical technologies as well as electrical mechanics.

Where are DonNTU headquarters?

In Donetsk, in the first campus. But the university has operations in some more cities of Donetsk region.

**2.** What does your university educate in exactly?

We educate students mostly in technical sciences, we specialise in metallurgy, power engineering and mining engineering but we're hoping to diversify into liberal education such as economic science and philosophy.

And where do you sell your graduates to?

We prepare foreign engineers for states of Africa, Asia and the Middle East. However, the domestic market accounts for about 90 per cent of our total preparations.

**3.** How many people does your university employ?

We have over three thousand employees. We have about two thousand professors and teaching people and the rest are admin and maintenance staff. We started off with only dozens of professors and 200 students, so our science force has grown a lot.

What's your annual number of graduates?

It was just over four thousand graduates last year.

**4.** How long has the university been in business?



For over ninety years. The original institute – mining technical school – was founded in 1921 in accordance with the government decision.

When did it become DonNTU?

In 2001 – when it was renamed from the state technical university into the national technical university.

What does DonNTU stand for?

Donetsk national technical university.

## Language focus

**Dialogues**

**Ex.1. Read the notes to the dialogues above.** .

I work for electrotechnical faculty. Note the use of *for*.

We have four main areas of business. This is how we talk about the business directions.

We teach students … Note the use of the present simple for situations which are generally true (NOT we are teaching …)

… the university has operations in some more cities … Another way of talking about parts of the university in other places: We have education facilities in more than five cities.

We educate in … Note the use of *in*.

We specialise in metallurgy … Note the use of *specialise in* to refer to the main business of a university.

… for states of Africa, Asia and the Middle East. Note the use of *for*. Note: the UK, the EU, the Middle East. No *the* with most countries or continents: France, Australia, South America.

The domestic market accounts for about 90 per cent of our total preparations. Note the use of *account(s) for*. Exports account for 60 per cent of our total production. Metallurgical engineers account for about 10 per cent of our range of graduates.

We have over three thousand employees. Other ways of talking about the number of employees: We employ 1000 people in our Gorlovka university branch. There are 200 people working here.

We have about two thousand professors and teaching people … Note the use of *people*: our production people, our maintenance people.

… the rest are admin and maintenance staff. *Admin* is short for *administrative*.

… our science force has grown a lot. *Science force* is used here for people who work for the science purposes: we need to increase our science force.

The original institute was founded in 1921 … *was founded* means *was started*. Note the use of the passive.

What does DonNTU stand for? We use *stand for* when we want to know what letters are in a name represent: USSR stands for the Union of the Soviet Socialist Republics.

## Reading and Speaking

**Ex.1. Read the text in 3 minute and find the definitions of "primary cells", "secondary cells".**

**Storage batteries**

The battery is at present the most practical and widely used means of storing electrical energy. The storage capacity of a battery is usually defined in ampere-hours (Ah); energy is strictly defined in kilowatt-hours (kWh) or joules, but since the voltage of a particular battery system is normally fixed and known, the Ah definition is more convenient. The terms *battery* and *cell* are often interchanged, although strictly a battery is a group of cells built together in a single unit.

Batteries can be classified into *primary* and *secondary* types.

A primary battery stores electrical energy in a chemical form which is introduced at the manufacturing stage. When it is discharged and this chemically stored energy is depleted, the battery is no longer serviceable. Applications for primary batteries are generally in the low-cost domestic environment, in portable equipment such as torches, calculators, radios and hearing aids.

A secondary or rechargeable battery absorbs electrical energy, stores this in a chemical form and then releases it when required. Storage batteries are made up of a number of rechargeable cells, often called secondary cells to distinguish them



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

Once the battery has been discharged and the chemical energy depleted, it can be recharged with a further intake of electrical energy. Many cycles of charging and discharging can be repeated in a secondary battery. Applications cover a wide range. In the domestic environment secondary batteries are used in portable hand tools, laptop computers and portable telephones. Higher powered applications in industry include use in road and rail vehicles and in standby power applications. The capacity of secondary battery systems ranges from 100 mAh to 2000 Ah. Their useful life ranges from 2 to 20 years; this will depend, among other things, upon the number of charge–discharge cycles and the type and construction of battery used.

**Ex.2. Find English equivalents to the following Russian word combinations.**

Широко используемое средство, химически запасённая энергия, принимать электрическую энергию, чтобы отличить их от первичных элементов, на основе обратимого химического действия, изоляционные прокладки, портативные программные средства, резервные энергетические средства.

# UNIT 25. A BRIEF HISTORY OF AMERICAN ELECTRIC POWER SYSTEMS

**Overview**

- Reading and Vocabulary: A brief history of American electric power systems (beginning).
- Information transfer: Dialogues.
- Language focus: Dialogues.
- Reading and Speaking: History of thermometers. Harnessing solar energy.

## Reading and Vocabulary

**A brief history of American electric power systems**

Over the past century, the electric power industry continues to shape and contribute to the welfare, progress, and technological advances of the human race. The growth of electric energy consumption in the world has been nothing but phenomenal. In the United States, for example, electric energy sales grew to well over 400 times in the period between the turn of the century and the early 1970s. This growth rate was 50 times as much as the growth rate in all other energy forms used during the same period. It is estimated that the installed capacity per capita in the U.S. is close to 3 kW.

Edison Electric Illuminating Company of New York inaugurated the Pearl Street Station in 1881. The station had a capacity of four 250-hp boilers supplying steam to six engine-dynamo sets. Edison's system used a 110-V dc underground distribution network with copper conductors insulated with a jute wrapping. In 1882, the first water wheel-driven generator was installed in Appleton, Wisconsin. The *low voltage of the circuits* limited the service area of a central station, and consequently, central stations proliferated throughout metropolitan areas.

The invention of the transformer, then known as the "inductorium," made ac systems possible. The first practical ac distribution system in the U.S. was installed by W. Stanley at Great Barrington, Massachusetts, in 1866 for Westinghouse, which acquired the American rights to the transformer from its British inventors Gaulard and Gibbs. Early ac distribution utilized 1000-V overhead lines. The Nikola Tesla invention of the induction motor in 1888 helped replace dc motors and hastened the advance in use of ac systems.



The first American single-phase ac system was installed in Oregon in 1889. Southern California Edison Company established the first three phase 2.3 kV system in 1893.

By 1895, Philadelphia had about twenty electric companies with distribution systems operating at 100-V and 500-V two-wire dc and 220-V three-wire dc, single-phase, two-phase, and three-phase ac, with frequencies of 60, 66, 125, and 133 cycles per second, and feeders at 1000-1200 V and 2000-2400 V.

The subsequent consolidation of electric companies enabled the realization of economies of scale in generating facilities, the introduction of equipment standardization, and the utilization of the load diversity between areas. Generating unit sizes of up to 1300 MW are in service, an era that was started by the 1973 Cumberland Station of the Tennessee Valley Authority.

Underground distribution at voltages up to 5 kV was made possible by the development of rubber-base insulated cables and paper-insulated, leadcovered cables in the early 1900s. Since then, higher distribution voltages have been necessitated by load growth that would otherwise overload low-voltage circuits and by the requirement to transmit large blocks of power over great distances. Common distribution voltages presently are in 5-, 15-, 25-, 35-, and 69-kV voltage classes.

The growth in size of power plants and in the higher voltage equipment was accompanied by interconnections of the generating facilities. These interconnections decreased the probability of service interruptions, made the utilization of the most economical units possible, and decreased the total reserve capacity required to meet equipment-forced outages. This was accompanied by use of sophisticated analysis tools such as the network analyzer. Central control of the interconnected systems was introduced for reasons of economy and safety. The advent of the load dispatcher heralded the dawn of power systems engineering, an exciting area that strives to provide the best system to meet the load requirements reliably, safely, and economically, utilizing state-of-the-art computer facilities.

Extra higher voltage (EHV) has become dominant in electric power transmission over great distances. By 1896, an 11-kv three-phase line was transmitting 10 MW from Niagara Falls to Buffalo over a distance of 20 miles. Today, transmission voltages of 230 kV, 287 kV, 345 kV, 500 kV, 735 kV, and 765 kV are commonplace, with the first 1100-kV line already energized in the early 1990s. The trend is motivated by economy of scale due to the higher transmission capacities possible, more efficient use of right-of-way, lower transmission losses, and reduced environmental impact.

In 1954, the Swedish State Power Board energized the 60-mile, 100-kV dc submarine cable utilizing U. Lamm's Mercury Arc valves at the sending and

receiving ends of the world's first high-voltage direct current (HVDC) link connecting the Baltic island of Gotland and the Swedish mainland. Currently, numerous installations with voltages up to 800-kV dc are in operation around the world.

In North America, the majority of electricity generation is produced by investor-owned utilities with a certain portion done by federally and provincially (in Canada) owned entities. In the United States, the Federal Energy Regulatory Commission (FERC) regulates the wholesale pricing of electricity and terms and conditions of service.

The North American transmission system is interconnected into a large power grid known as the North American Power Systems Interconnection. The grid is divided into several pools. The pools consist of several neighboring utilities which operate jointly to schedule generation in a cost-effective manner.

A privately regulated organization called the North American Electric Reliability Council (NERC) is responsible for maintaining system standards and reliability. NERC works cooperatively with every provider and distributor of power to ensure reliability. NERC coordinates its efforts with FERC as well as other organizations such as the Edison Electric Institute (EEI). NERC currently has four distinct electrically separated areas. These areas are the Electric Reliability Council of Texas (ERCOT), the Western States Coordination Council (WSCC), the Eastern Interconnect, which includes all the states and provinces of Canada east of the Rocky Mountains (excluding Texas), and Hydro-Quebec. These electrically separate areas exchange with each other but are not synchronized electrically.

The electric power industry in the United States is undergoing fundamental changes since the deregulation of the telecommunication, gas, and other industries. The generation business is rapidly becoming market-driven. The power industry was, until the last decade, characterized by larger, vertically integrated entities. The advent of open transmission access has resulted in wholesale and retail markets. Utilities may be divided into power generation, transmission, and retail segments. Generating companies (GENCO) sell directly to an independent system operator (ISO). The ISO is responsible for the operation of the grid and matching demand and generation dealing with transmission companies as well (TRANSCO). This scenario is not the only possibility, as the power industry continues to evolve to create a more competitive environment for electricity markets to promote greater efficiency.

The industry now faces new challenges and problems associated with the interaction of power system entities in their efforts to make crucial technical decisions while striving to achieve the highest level of human welfare.



**Reading comprehension**

**Ex.1. Read the text and find the answers to these questions.**

1. When was the first power station inaugurated in the USA? 2. When was the first water wheel-driven generator installed in the USA? 3. Why was the service area of the first power station limited? 4. Whose invention helped replace dc motors by induction ones? 5. Where was the first three phase system established? 6. How many electric companies operated in Philadelphia by 1895? 7. What positive subsequences did the consolidation of electric companies result in? 8. What made the underground distribution of electricity to be possible? 9. Why were the interconnections of the generating facilities necessary? 10. What was central control of the interconnected systems introduced for? 11. What is the extra high voltage energy transmission motivated by? 12. Who regulates the wholesale pricing of electricity in the United States? 13. What does the North American Power Systems Interconnection include? 14. Who is responsible for maintaining system standards and reliability? 15. What has the advent of open transmission access resulted in? 16. Why does the power industry continue to evolve? 17. What new challenges and problems does the electric industry now face?

## Information transfer

**Dialogues**

**1.** So, is it difficult to be a university's pro-rector on teaching and educational work?

Not, at all. The principal university task is to provide students with all necessary facilities to obtain proper education. We simply try to meet all the students' requirements.

What does your job involve?

I'm in charge of the educational process running. I have to make sure our educational process runs smoothly.

What does the university propose to its students?

The University has a well-established reputation for providing high quality teaching, learning and research.

All of our programmes are designed to offer students an effective combination of academic study and practical experience. In addition, students also have the opportunity to develop a range of transferable skills, such as computing, languages and communication skills.

Do you teach foreign students?

If you choose to study at DonNTU, you'll benefit from the University's worldwide profile, and have the opportunity to meet and get to know some of the 500 international students who are studying with us. Our international students come from over 70 different countries and bring with them a diversity and enthusiasm which enriches the DonNTU experience for everyone.

Who do you report to?

I report to the university's rector and he reports to Minister of science and education.

**2.** What do you do?

I'm in guard staff of the university.

Tell me about how you work here.

We work in teams. There are about four to six people in each team. Each team member is responsible for the safety at the university territory. I'm training to be a team leader. I'm paid double-time if I work at holidays.

What sort of shift-system do you operate?

We have a two-shift system – that's two twelve-hour shifts each weekday. Today I'm on the day shift.

Do you ever have to do the night shift?

Yes, sometimes. I don't like working nights – I have problems sleeping during the day.

**3.** As a lecturer, do you think, your university provides with high-quality education?

Yes, certainly, the university's academic units are currently in the process of redevelopment. Every lecturer delivers some disciplines. We are multi-skilled so we can rotate jobs. I like that. It stops the work getting boring.

Is the proposed system flexible?

Flexibility and choice are keys to the success of students. The combination of Major/Minor courses allows students to choose in more than one area of study that can be pursued through to the Honours year. Major/Minor degrees are honours degrees combining the study of two disciplines. This modern way of completing honours degree level student is constantly being developed.

How many hours do you work a week?

I do a forty-hour week. However, I'm on flexi-time for my job depends on the classes schedule.

Do you do overtime?

Yes, I work additionally for teaching and methodical department.

And how many weeks holiday do you get a year?



Eight – plus public holidays. I usually take eight weeks off in summer.

**4.** Oh, I see you are a student. Where do you study?

I study at the technical university. DonNTU has grown to become one of the largest universities in Donetsk with over 15,000 students. It is located in the heart of Donetsk.

Can you give additional information? Maybe, I'll enter the university this year.

Check our website for more information about what specialties are available at any particular time. General advice can be sought from the University by giving us a call or visiting any of our Open Days where staff will be happy to give you help.

**5.** Would you explain a way to the entrance examination room?

It is on the second floor, room number 211. The stairs are just to the left of main entrance.

Would you give general information of the university?

Well, DonNTU has grown to be acknowledged as one of the leading vocational educational providers in the country. We offer a wide range of programmes, all of which have a strong focus on ensuring that our graduates have the opportunity to enter a successful career in their chosen discipline. The learning environment which you will find at DonNTU is second to none. All of our facilities have been specially built to meet the specific needs of our students now and in the future.

Is it a comfortable place to study?

DonNTU is rightly regarded as an extremely welcoming and friendly place for studying. You'll be on first name terms with your lectures and will benefit from our small class sizes and working on group projects with your fellow students. The university has students with a wide range of backgrounds, from local school leavers, to PhD students from the other countries of the world and in DonNTU we are proud that we provide a friendly, modern and effective place of learning for all our students.

And what about the faculty for part-time students?

OK, we have corresponding faculty. Our strong commitment to increased access and lifelong learning is illustrated by the fact that we have over 4,000 mature students and one of the largest number of part-time students in Donetsk.

**6.** Oh! We are happy to welcome you for an Open Day in our campus. I'm a member of the student self-government.

And what about free time of students?

I have to liaise very closely with our students. So, I know, that with a lot of universities, Donetsk is not short of places to meet the student pocket. You'll also find that away from the classroom DonNTU students know how to enjoy themselves.

## Language focus

**Dialogues**

**Ex.1. Read the notes to the dialogues above.** .

We … try to meet all the students' requirements. Note the application of *to meet ... the requirements*. It means *to correspond*.

What does your job involve? This is how we ask about job duties. If *involve* is followed by a verb, use *–ing*: My job involves checking the safety of our university.

I'm in charge of the educational process running. This means you are the person in control and you have responsibility. Note: NOT I am the responsible of the workshop.

I have to make sure our educational process runs smoothly. Some other ways of talking about job responsibilities and duties: I take care of after-sales service. I look after the maintenance side of the laboratory. It's my job to check knowledge quality.

Who do you report to? This is how we ask who someone's immediate boss is.

Each team member is responsible for the safety at the university territory. Note the use of *for* after *responsible*. A verb must be in the *–ing* form: He's responsible for ordering spare parts. She's responsible for classes scheduling.

I'm paid double-time if I work at holidays. This means you will earn twice what you normally earn.

We have a two-shift system … Note: NOT *a two-shift**s** system*. Note the use of *hour*, NOT *hour**s***: Three eight-hour shifts. A 40-hour week.

Today I'm on the day shift. Note the use of *on*. Other ways of talking about shifts: I'm doing the night shift this week. I don't like working nights.



… university provides with high-quality education. Note the application of a preposition *with* after the verb *provide*.

We are multi-skilled so we can rotate jobs. This means you are skilled in many areas.

I'm on flexi-time. This means your hours are flexible. You don't work fixed hours.

Do you do overtime? This means to work extra time, in addition to your normal hours: I'm working overtime this weekend.

I usually take eight weeks off in the summer. Note the use of *off* to mean *not working*: She's off sick today. I'm having New Year's Week off this year.

Would you explain … Would you give … This is polite way to ask somebody for help.

Environment … is second to none. It means to be a leader.

… part-time students. It means the students combine their job with learning.

I have to liaise very closely with out students. To *liaise* means to work closely with someone.

*Open Days* means the university organizes the excursions through the university territory such as laboratories, auditoriums for future students to give them additional positive information about the university..

## Reading and Speaking

**Ex.1. Read and translate the text. Answer the question:** which information from the text is known and which is new for you.

**History of thermometers**

Placing a kettle full of cold water on the fire is quite an ordinary thing. This time we will do it to carry out a simple experiment. Placing a finger into the kettle from time to time, we find that the water is gradually becoming hotter and hotter, until it

boils at last. In scientific language we describe this phenomenon by saying that the temperature of the water is rising.

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

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

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

The type of thermometer familiar to everyone at present was first put into general use as early as 1654. Making the first measuring instruments was not an easy thing at all. Needless to say, the most difficult problem of all was that of marking the degrees on the thermometer, in other words, of graduating the scale. It was decided, at last, to take two fixed points and to divide the interval between them into small equal parts or degrees. And then, in 1701, Isaac Newton, the famous English scientist, whose name is known all over the world, constructed a scale in which the freezing point of water was taken as zero and the temperature of the human body as 12°.

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

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

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



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

**Ex.2. Fill in the blanks with suitable words and word combinations given below.**

1. A thermometer is employed for … temperature and for … its changes. 2. The glass tube was immersed into a … liquid. 3. As early as 1602 Galileo invented an … 4. The … scale is employed in Ukraine. 5. The Fahrenheit scale is mainly used in … 6. Galileo's air thermometer was sensitive to … 7. The scientists worked out the plan of their … research.

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

**Ex.3. For the verbs in (a) find suitable nouns in (b).**

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

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

**Ex.4. For the nouns in (a) find suitable attributes in (b).**

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

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

**Ex.5. Translate the following word combinations.**

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

**Ex.6. Answer the following questions.**

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

difference between the mercury thermometer and the pyrometer? 10. When does water freeze?

**Ex.7. Find wrong statements and correct them.**

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

**Ex.8. Read and translate the text.**

**Harnessing solar energy**

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

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

**Ex.9. Point out which of the sentences contains the information from the text.**

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



# UNIT 26. LOMONOSOV. PYOTR KAPITSA

**Overview**

- Reading and Vocabulary: Lomonosov.
- Language focus: Verbs and related nouns. The Gerund.
- Reading and Speaking: Pyotr Kapitsa.

## Reading and Vocabulary

**Reading**

Four sentences have been removed from the text. Choose from the sentences A-E (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Lomonosov**

The great Russian scientist, outstanding poet and enlightener, Lomonosov was born in the village of Denisovka (now Lomonosovo), far off in the North, on November 19, 1711. [ 1 ] The boy longed for knowledge, he longed to master science. That longing was so great that at the age of 19 he left his father's home and started on foot for Moscow in spite of the long distance and the cold winter.

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

[ 2 ] In addition to the Russian language, he had a good knowledge of foreign languages, namely German, French, Greek and, last but not least, Latin which was the international language of science at that time. At the age of 35 Lomonosov was already an experienced professor and an academician.

It is quite impossible to name a scientific problem he did not turn his attention to. [ 3 ] He knew by experience that it was useless and unreliable if it did not find practical application and could not, therefore, serve the good of his people and his country. He always tried to find practical application for the phenomena studied.

Lomonosov possessed an unusual capacity for work. His scientific activity lasted but 25 years, but in these 25 years he carried out an extraordinary amount of useful, educational work in various fields of scientific and cultural life. He carried on scientific research in natural science and made numerous reports on the results of his achievements. He lectured to students and translated the works of various

foreign scientists into Russian for he wanted to educate "our own Newtons". For this very purpose he founded Moscow University and wrote his odes as well as numerous books on the Russian language and literature, on physics and so on.

For many years the great scientist carried on systematic laboratory-experimental work both in physics and chemistry for, according to him, without observation and experiment there could be no progress in science. In this connection, one might ask: "Do you know that Lomonosov organized the first chemical laboratory in our country?" One more question: "Who built the first glass-making factory in Russia?" It was Lomonosov, of course!

As a materialist, Lomonosov studied physical properties of bodies on the basis of the molecular and atomic theory. He developed the kinetic theory of gases, the molecular kinetic theory of heat and first discovered the law of conservation of matter and momentum. [ 4 ] As a result, many of his discoveries became invaluable contribution to world science.

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

**Reading comprehension**

**Ex.1**.

A. He invented the first in the world source of direct current.
B. He also found that light, heat and electricity are different forms of motion.
C. Nevertheless, theory alone left him dissatisfied.
D. He mastered natural science as well as history, philosophy and engineering.
E. He was very young when he easily mastered reading and writing.

**Ex.2. Answer the following questions.**

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



**Vocabulary**

**Ex.1. Translate the following words paying attention to the suffixes and prefixes.**

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

**Ex.2. Learn to recognize the following international words.**

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

**Ex.3. For the words given in (a) find suitable prefixes in (b).**

a) natural; to organize; possible; to satisfy; ordinary; valuable; large; to cover; to write; to charge; usual
b) re; in; im; un; dis; extra; super; en

## Language focus

**Verbs and related nouns**

**Ex. 1. Each of these verbs has a related noun ending in *-er* or *-or* which refers to an instrument or component. Complete the line of nouns. Translate them.** You have met these nouns in this and earlier units.

Example: record – recorder

1 oscillate; 2 transmit; 3 transform; 4 charge; 5 rectify; 6 process; 7 amplify; 8 collect; 9 detect; 10 tune; 11 resist; 12 conduct; 13 protect; 14 protract; 15 convert; 16 break; 17 receive; 18 modulate; 19 translate; 20 produce

**Grammar and Vocabulary**

**The Gerund (verb+ing)**

The **-ing** form is used:

1. as a **noun**. **Inhaling** the fumes is dangerous.
2. as a **participle**. The temperature of hot flowing metals can be measured by the electric pyrometer.
3. as an **adverbial participle**. During the day a student uses some electrical devices **working** in the laboratory, **making** use of the telephone, the lift, the tram and so on.
4. after **love, like, dislike, hate, enjoy, adore**. I **like reading** books best of all.
5. after **start, begin, stop, finish**. Let's **start doing** lab. **Stop talking**!

6. after **go** for physical activities. I **go playing** volleyball every Sunday. I **go consulting** students every Saturday.
7. after certain verbs (**avoid, admit, confess to, deny, look forward to, mind, object to, prefer, regret, risk spend, suggest, etc**). I **can't stand cooking**. I **don't mind helping** you with the lab.
8. after the expressions: **I'm busy, it's no use in, it's (no) good, it's worth, what's the use of, be used to, there's no point (in)**. In order to obtain the better results **it's worth trying** another instrument with less range.
9. after **prepositions**. In case of the data absence you leave the table **without filling** in.
10. after **hear, see, sound** to emphasize an action in progress. I saw her **crossing** the street (I saw her while she was crossing the street). I saw her **cross** the street (I saw her when she had crossed the street).

**Ex.2. Translate the following sentences paying attention to the Participle.**

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

12. Speaking of the electrically operated devices, one can mention the induction motor. 13. Having mentioned the name of Volta, the teacher spoke about his invention. 14. The pyrometer used in industry is a device measuring temperature. 15. The pyrometer showing the temperature of metals melted in furnaces is also an electrical device. 16. Making this instrument, we could not do without a machine operated by electricity. 17. Going along the streets, one can see running trams, trolley-buses, buses and cars. 18. Being widely used in industry, electrical motors are also used in every home.

## Reading and Speaking

**Pyotr Kapitsa**

**Ex.1. Read the text below in 3 minutes and chose the sentences which contain the information about Kapitsa's activities.**



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

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

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

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

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

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

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

**Ex.2. Find in the text English equivalents to the following Russian word combinations.**

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

# UNIT 27. THERMAL POWER STATION. FUNCTION AND ABILITY

**Overview**

- Reading and Vocabulary: Thermal power station.
- Information transfer: Describing diagrams.
- Language focus: Function and ability. The Absolute Participle Construction.
- Reading and Speaking: If there were no electricity.

## Reading and Vocabulary

Four sentences have been removed from the text. Choose from the sentences A-E (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Thermal power station**

Power stations are plants or installations designed for electricity production.

Depending on peculiarities of technological process of energy conversion and kinds of energetic source used the electric power stations are divided onto thermal power stations, nuclear power stations, hydroelectric power stations, hydroelectric pumped storage power plants, gas turbine power plants.

A modern thermal power station is known to consist of four principal components, namely, coal handling and storage, boiler house, turbine house, electric part. Besides the principal components mentioned above there are many additional parts of the plant. [ 1 ] A steam turbine requires a boiler to provide steam. Boilers need a coal-handling plant on the one hand and an ash-disposal plant on the other. Large fans are quite necessary to provide air for the furnaces. Water for the boilers requires the feed pumps. Steam must be condensed after it has passed through the turbines, and this requires large quantities of cooling water. The flue gases carry dust which must be removed by cleaning the gases before they reach open air. A modern thermal power station is equipped with some turbine generator sets which convert heat energy into electric energy. The steam to drive the turbine, which, in its turn, turns the rotor or revolving part of the generator, is generated in boilers heated by furnaces where one of three fuels may be used – coal, oil and natural gas. Coal continues to be the most important and the most economical of these fuels.

Thermal electric power station designed for electricity production only is called condensing plant. [ 2 ]



Condensing power stations possess big power and are designed on high initial parameters of steam and low final pressure (high vacuum). [ 3 ] As higher initial parameters $p_0$ and $t_0$ before turbine are and lower final pressure of steam $p_f$ is as higher efficiency is.

There are two major type heat schemes of steam-turbine condensing plants using organic fuel, namely: without intermediate steam superheating and with intermediate steam superheating. In the first case, supplying with heat during cycle takes place only at steam generation and its superheating to chosen superheating temperature; while in the second case, together with steam superheating before turbine the energy is supplied to steam after it working in high pressure part of turbine. Efficiency of the second scheme is much higher but the scheme is more complex and needs right choosing of initial, final and intermediate steam parameters. However, in both schemes the exhaust vapour is condensed in condenser, which is cooled with technical water circulating in pipes. Turbine steam condensate is fed to deaerator by condensate pump through regenerative heaters. [ 4 ] Deaerated water is fed to steam-generator economizer (waste gas heater) by feed-pump through regenerative heaters.

**Notes and comments**

*The steam to drive the turbine … is generated …* Note the use of *infinitive*. Another way to say the same is as follows: *The steam which drives the turbine … is generated … .*

*As higher ... parameters ... are … as higher efficiency is*. Note the use of *as … as* in order to set the cause-and-effect relation. Another way to say the same is as follows: *The higher parameters are the higher efficiency is*.

*It burns down ... fuel, condensing plant being built close to the place of fuel extraction*. Note the gerund application in order to create a simple sentence. Identical compound sentence is as follows: *condensing plant is built close to the place of fuel extraction because it burns down fuel*.

**Reading comprehension**

**Ex.1.**

A. The largest generators used in major power stations are usually turbo-generators.

B. The most important of them is the turbogenerator where the current is actually generated.

C. It burns down organic fuel, condensing plant being usually built close to the place of fuel extraction.

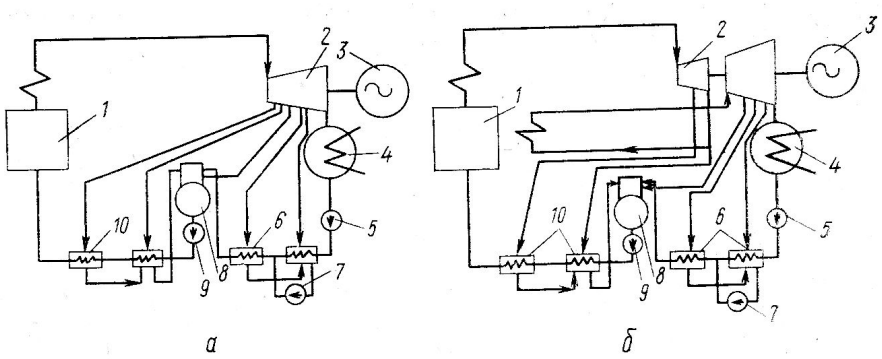
D. Deaerator serves for extraction the gases from water.
E. It allows decreasing heat cost per electricity unit produced.

**Ex.2. Read the text and find the answers to these questions.**

1. What are the main types of the electric power stations?
2. Where is the current actually generated?
3. What does a boiler need for its operation?
4. What is function of the large fans at the thermal power station?
5. What fuel may be used at the thermal power station?
6. Why are high initial parameters of steam and low final pressure necessary?

**Ex.3. Read the statements and mark them true (T) or false (F). Give true statements.**

1. High initial parameters of steam allow decreasing heat cost per electricity unit produced.
2. In both schemes, the superheated steam is condensed in condenser.
3. A condenser is cooled with drinking water.
4. Turbine steam condensate is fed to deaerator by condensate pump through a smoke flue.
5. Deaerator serves for the water enrichment with gases.
6. Deaerated water is fed to steam-generator economizer by feed-pump.




**Vocabulary**

**Ex.1. Look at the figure. It presents two major type heat schemes of steam-turbine condensing plants:** without intermediate steam superheating (а) and with intermediate steam superheating (б). **Using information from the text above, match the figure labels with the following names of elements:** a) turbine; b) condenser; c) drainage pump; d) deaerator; e) regenerative heater of high pressure; f) steam generator; g) regenerative heater of low pressure; h) condensate pump; i) electric generator; j) feed pump.



**Ex.2. Fill in the words from the box below.**

| |
|---|
| vapour, feed-pump, ash-disposal area, turbine, deaerator, fans, dust, heat energy, furnace chamber, superheated steam |

1. … serves to extract the gases from water.
2. Water is fed to an economizer by …
3. The flue gases carry …
4. The steam drives …
5. Large … are necessary to provide air for the furnaces.
6. A turbine generator set converts … into electric energy.
7. The exhaust …. is condensed in condenser.
8. Heat is obtained in a … during combustion.
9. Slag and ashes are delivered to …
10. … is supplied to turbine.

## Information transfer

**Describing diagrams**

**Before you start**

**Ex.1. Discuss the questions below.**

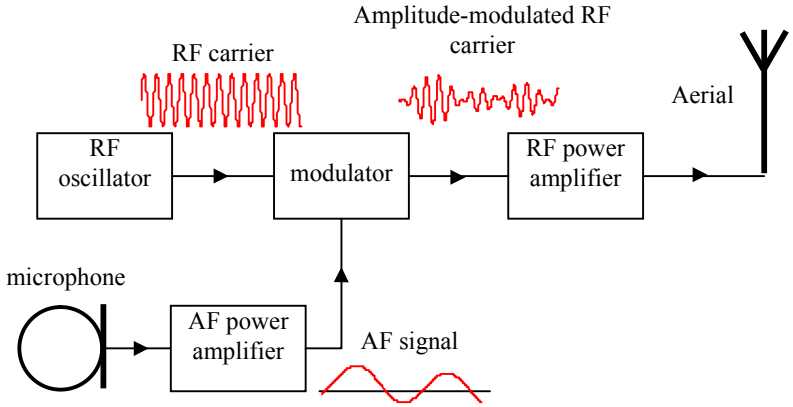
1. Have you ever used the diagrams for description?
2. What types of diagrams do you know?
3. Why are they used?
4. What do they consist of?

**Ex.2. Look at the figure below.** You see a block diagram of an amplitude-modulated (AM) radio transmitter. It consists of a radio frequency (RF) oscillator, a modulator, an audio frequency (AF) amplifier, and an RF power amplifier. The RF oscillator generates an RF carrier wave which is fed into the modulator. The microphone converts sounds into audio frequency signals which are amplified by the AF amplifier. The modulator then uses the amplified AF signal to modulate the RF carrier wave. The power of the modulated carrier wave is increased by the RF

power amplifier. The strong modulated output signals are fed to the aerial which enables them to be transmitted over long distances.

The description should answer these questions:

1. What is the diagram of?
2. What does it consists of in terms of blocks?
3. How are the blocks connected?
4. What is the function of each block?




**Ex.3*. Using material of the main text, describe each type heat scheme of a steam-turbine condensing plant presented in the figure at the preceding page.**

## Language focus

**Function and ability**

**Before you start**

**Ex.1. Discuss the questions below.**

1. Which functions of the electric devices do you know? Name them.
2. What is the difference between *function* and *ability* of an electric apparatus?

**Ex.2. Read and translate the following sentences. In this way we say about functions.**

What does the circuit breaker do? The circuit breaker controls the supply of electricity. What is the circuit breaker used for? The circuit breaker is used for controlling the supply of electricity. The electricity supply provides electricity. The transmission line conducts electricity from the circuit breaker to the consumer.



Now make true sentences from this table:

| | | | |
|---|---|---|---|
| The function of | the generator | is to | produce the electricity |
| | the transmission line | | transmit the electricity |
| | the transformer | | change the electric energy parameters |
| | the boiler | | heat the water |
| | the turbine | | rotate the generator |
| | the condenser | | cool the condensate |
| | the feed-pump | | pump the water |

**Ex.3. Now complete these sentences:**

a) The electricity supply _____ electricity.
b) The bulb _____ light.
c) The wire _____ electricity from the electricity-supply to the switch.
d) The switch _____ the supply of electricity.
e) The burner _____ heat.
f) The pool _____ water.
g) The water-pipe _____ water from the water-supply to the boiler.
h) The water-tap _____ the supply of water.

**Ex.4. Now read the terms in the box and translate them. Then complete the sentences below by adding the names of objects in the box.**

clock; thermometer; phase-meter; burner; water-tap; transformer; furnace chamber; crusher; smokestack; smoke flue; heat exchanger

*Example*: A clock is an instrument for measuring time.

a) …… an instrument for measuring temperature.
b) …… an instrument for measuring the phase shift.
c) …… a device for supplying heat.
d) …… a device for controlling the supply of water.
e) …… an apparatus for changing the electric energy parameters.
f) …… a place for the fuel incineration.
g) …… a device for crushing the coal.
h) …….. a structure for getting rid of smoke and combustion materials.
i) …… a structure for conducting of smoke.
j) …… an installation for heating the water by means of the combustion materials.

**Ex.5. Read and translate (this is how we can describe ability):**

The controls enable the dispatcher to run the processes. *This means*: With the help of the controls, the dispatcher can run the processes.

Now make similar sentences from this table.

| | | |
|---|---|---|
| The temperature gauge | | check the water temperature. |
| The wattmeter | | check the power supply. |
| The circuit breaker switch | enables the dispatcher to | switch on and off the load. |
| The voltage transformer | | operate at full capacity. |
| Keeping the working place in order | | stop the current flowing. |
| The circuit-breaker | | control the high voltage. |

**Ex.6. Read and translate:**

Objects at the thermal power station: turbine; generator; smokestack; smoke flue; combustion materials; drawoff; condensate pump; regenerative heater; crusher; furnace chamber; transformer.

Actions which they can or cannot do: change shape; rotate; consume electric energy; produce electric energy; fly; reproduce; transform electric energy.

Now make questions and answer like the following:

*Examples*: Can a turbine rotate? Yes, a turbine can rotate.
Can a crusher change shape? No, a crusher cannot change shape.

Make true sentences from this table:

| | | |
|---|---|---|
| All | | change shape |
| | | rotate |
| Some | objects, namely …., can | consume electric power |
| | | fly |
| No | | reproduce |
| | | produce electric energy |

**Ex.7. Look at these examples:**

The generator can produce electric energy. = The generator is able to produce e.e.
= The generator has the ability to produce e.e.
= The generator has the capacity to produce e.e.
= The generator is capable of producing e.e.

Now write full sentences in answer to these questions:

a) What device is capable of changing the electric energy parameters?
b) What devices have the capacity to rotate?
c) What object can change shape?



d) What structure is capable of disposing smoke?
e) What things cannot consume electric energy?
f) What structure has the ability to conduct combustion materials?

**Ex.8. Now read and translate sentences illustrated different functions:**

a) The generator serves to produce electric energy.
b) With the help of the crusher we are able to obtain the coal slack.
c) A wattmeter is a device for measuring power.
d) The smokestack enables us to get rid of smoke.
e) The smoke flue acts as a conductor of smoke.
f) A transformer is used for changing the electric energy parameters.
g) The function of the boiler is to boil water.
h) The combustion chamber is a place for burning the fuel.
i) Water pool acts as a water stock.

**Ex.9*. Prepare 5 examples of your own illustrating on the ground of the main text the functions of some different apparatuses working at the thermal power station.**

**Grammar and Vocabulary**

**The Absolute Participle Construction**

It is used in order to make a compound sentence be a simple one. In this case, the predicate in the subordinate part of the sentence is replaced by the absolute participle construction. Furthermore, the tense of this part corresponds to the main part of the sentence while the linking word is omitted. Look at two examples.

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

**Ex.10. Translate the following sentences paying attention to the Absolute Participle Construction.**

1. An object losing its potential energy, that energy is turned into kinetic energy. 2. Water falling from its raised position, energy is changed from potential to kinetic one. 3. My friend was reading an English article, his brother watching television. 4.

Electrical devices find a wide application in every house, a refrigerator being one of them. 5. There being a hydroelectric station at the waterfall, the energy of the falling water is used to drive the turbines. 6. The energy sources of the world decreasing, the scientists must find new sources of energy. 7. There are different sources of energy, the sun being an unlimited source of all forms of energy. 8. Industrial applications of energy increasing, more and more energy is needed every year.

**Ex.11. Learn to recognize the following international words.**

Moment, electricity, voltmeter, wattmeter, economizer, temperature, operation, metal, conveyer, microphone, condensate, fan, hydroelectric, gas, turbine, component, boiler, generator, condenser, vacuum, final, organic, energy, scheme, deaerator, identical, function, drainage, regenerative, radio, signal, distance, diagram, block, modulator, apparatus, transmission, box, structure.

## Reading and Speaking

**Ex.1. Read the following text in 2 minutes without a dictionary.**

**If there were no electricity**

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

What would our everyday life be if there was no electricity?

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

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

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

**Ex.2. Find the English equivalents to the following Russian word combinations.**

1. если бы не было электрического освещения; 2. вы захотели бы посмотреть телевизор; 3. все устройства перестали бы работать; 4. если бы это случилось вечером; 5. это было бы невозможно; 6. вы сидели бы в темноте.



# UNIT 28. ELECTRIC CIRCUIT

**Overview**

- Reading and Vocabulary: Electric circuit.
- Information transfer: Describing diagrams.
- Language focus: Describing diagrams. Structure. The Infinitive.
- Reading and Speaking: Electricity may be dangerous.

## Reading and Vocabulary

**Reading**

Parts of four sentences have been removed from the text. Choose from the sentences A-E (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Electric circuit**

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

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

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

If the circuit is broken or, as we generally say "opened" anywhere, [ 1 ]. Hence, we break the circuit when we switch off our electrical devices. Generally speaking, the current may pass through solid conductors, liquids, gases, vacuum, or any combination of these. It may flow in turn over transmission lines from the power stations through transformers, cables and switches, through lamps, heaters, series circuits, parallel circuits and short circuits.

To understand the difference between the following circuit connections is not difficult at all. When electrical devices are connected so that the current flows from one device to another, [ 2 ]. Under such conditions the current flow is the same in all parts of the circuit, as there is only a single path along which it may flow. The electrical bell circuit is considered to be a typical example of a series circuit. The parallel circuit provides two or more paths for the passage of current. The circuit is divided in such a way that part of the current flows through one path, and part through another. The lamps in your room and your house [ 3 ].

Now we will turn our attention to the short circuit [ 4 ]. The short circuit is produced when the current is allowed to return to the source of supply without control and without doing the work that we want it to do. The short circuit often results from cable fault or wire fault. Under certain conditions, the short may cause fire because the current flows where it was not supposed to flow. If the current flow is too great a fuse is to be used as a safety device to stop the current flow.

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

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

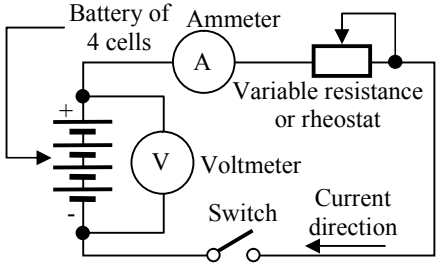


Figure. A simple electric circuit

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

**Notes and comments**

*… the subject to be dealt with …* . Note the use of *infinitive* and *the passive voice*. To *deal* here means to *work with*, to *consider*.

*to carry the current* means *to let current flow*.

*to set fire* means *to ignite*.

**Reading comprehension**

**Ex.1**.

A. are generally connected in parallel.
B. the current is known to stop everywhere.
C. sometimes called "the short".
D. they are said to be connected in series.
E. the input voltage is absent.

**Ex.2. Read the text and find the answers to these questions.**

1. What is discussed in the present article? 2. What do we call an electric circuit? 3. What is function of an electric source? 4. What is the condition to stop



current everywhere? 5. What kinds of circuits do you know? 6. When is a "short" produced? 7. What does a short circuit often result from? 8. What safety device is used in the circuit when the current is too great? 9. What do we mean by the term "short circuit"? 10. What does the term "closed circuit" mean? 11. Why does the current flow when the circuit is closed? 12. What do you call a fuse? 13. Does the current flow when the switch is in open position? 14. How can a current cause fire? 15. When does a wire become hot and set fire to the insulation?

**Ex.3. Read the statements and mark them true (T) or false (F). Give true statements.**

7. If the circuit is shorted the current is known to stop everywhere.
8. If one and the same current flows through all elements they are said to be connected in series.
9. The short circuit is produced when the switch is closed.
10. A fuse protects a circuit of overloading.
11. If the fuse melts it opens the circuit.
12. Inside a battery, current flows from the positive terminal to negative one.

**Vocabulary**

**Ex.1. Learn to recognize the following international words.**

Radio, lamp, result, machine, lift, vacuum, energy, practical, fact, tram, refrigerator, technological, electrical, electron, conductor, motor, parallel, typical, passage, figure.

**Ex.2. Fill in the words from the box below.**

| supply, complete, electric, short, conditions, battery, position, arrow, fire, safety |
|---|

1. … path
2. source of …
3. … circuit
4. 4-cell …
5. … lamp
6. under certain …
7. switch in a closed …
8. direction shown by the…
9. fuse is a … devise
10. great current sets…

## Language focus

**Grammar and Vocabulary**

**The Infinitive (to+verb)**

The **full infinitive** (inf. with to) is used:

1. to express **purpose**. An electric source is used **to produce** an emf.
2. after **would love / like / prefer**. I'**d would prefer to apply** an induction motor to rotate the fan rather than a dc motor.
3. after adjectives (**angry, glad, happy, sorry, pleased, annoyed**, etc). I'm **pleased to use** the reliable ABB switchgear.
4. With **too** or **enough**. The instrument is **too** old **to rely on** its reading.
5. after certain verbs (**advise, agree, appear, decide, expect, hope, manage, offer, promise, refuse, seem, want**, etc). We must **manage to repair** the motor until tomorrow.
6. after question words (**where, how, what, who, which**). **Why** is not used with to+infinitive. I don't know **what to do** with electricity. I don't know **why** it disappeared.

The bare infinitive (inf. without to) is used:

1. after **modal verbs** (can, must, etc). Electricity **may be** dangerous. It **can burn** and **kill**.
2. after **let / make / hear / see + object**. **Let** short-circuit current **flow** and it **make** insulation **ignite**.

**Ex.1. Find infinitives in the sentences below and note their application. Translate the questions and answer them.**

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

**Ex.2. Translate the following sentences using the Infinitive.**

1. Этот двигатель слишком мощный, чтобы крутить вентилятор. 2. Ваттметр используется для измерения мощности. 3. Постоянный ток не может течь через конденсатор. 4. Никто ещё не придумал, как хранить электроэнергию в больших количествах. 5. Замкнутая цепь образует путь для протекания тока. 6. Чтобы получить постоянный ток, необходимо иметь его источник. 7. Пирометр используется для измерения температуры горячих металлов. 8. Человек научился расщеплять атомы для того, чтобы получать большое количество энергии. 9. Ученые пытаются решить проблему, связанную с новыми явлениями электричества. 10. Грозозащитный трос – это стальной провод для защиты опор от молнии. 11. Чтобы намагнитить предмет, его нужно поместить в поле магнита.



**Ex.3. According to the models given below, form sentences combining suitable parts of the sentence given in columns** I, II, III, IV.

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

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

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

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

**Ex.4. Look through the following expressions used in the sentences below and try to memorize them.**

1. to have something up one's sleeve – to have an idea, plan, etc., which one keeps secret for future use;
2. to lend a hand – to help, to assist; same as 'give a hand';
3. to put one's foot down – to be firm; to object; to protest;

4. to have a brainwave – have a sudden inspiration or bright idea;
5. wondering what had hit it – what had happened to it (figurative use of the verb *hit*). Used of a reaction to something quite unexpected;
6. to look on the bright side of things – to look at things optimistically.
7. to look out – be on the watch, be careful.

**Ex.5. Read and translate the sentences below. Find out the infinitives and the gerunds and do try to explain their application.**

1. As a current flowing through a conductor the magnetic field appears in surroundings. 2. As a current flowing through a conducting medium the heat is produced. 3. As charges dividing in isolated system the total charge do not change. 4. While measuring a current and a voltage, do make use of an ammeter and a voltmeter, respectively. 5. The instruments to measure a current and a voltage are named an ammeter and a voltmeter, respectively. 6. Taking off your jacket and rolling up your sleeves is a sign of getting down working in Britain and Holland, but in Germany people regarding it as taking it easy. 7. Happening him to be your teacher is a good deal lucky case for he always has some explaining examples in stock. 8. Happening her to be your examiner would not be easier for you because she always had additional questions up her sleeve. 9. In Soviet times, lending a hand to a student of your group was a usual thing. 10. Foreign students like asking different strange questions, but whenever I want anything done with respect to home task I have to put my foot down. 11. Hoping to have a brainwave while taking an exam is a hopeless idea if you don't work during the term. 12. The motor under trying stopped so unexpectedly that we stood speechless for a moment wondering what had hit it. 13. Looking on the bright side of things is his family trait. 14. To better understand the meaning of this equation, it is helpful to apply it to the simple example. 15. It is time to let us rest. 16. I have the dream of you catching a few at least. 17. We know a real coil to be kind of a mixture of resistance and inductance. 18. To generate the equation under Kirchhoff's voltage law, we begin to circulate along the loop. 19. I take you to be a good student, but may be I mistake. 20. The circuit power is measured by special instrument, it being named a wattmeter. 21. Let's allude to a cheerfuller subject; say, questioning of students. 22. Example will be given to illustrate the computational details of the loop current method. 23. A protractor is an instrument to measure the angles. 24. In the superposition method, the primed variables are used to differentiate the full quantities from their components. 25. If in one circuit an EMF is induced by a current change in a different circuit then the circuits are said to be magnetically coupled. 26. Dependence y versus x is plotted under the latter formula, it being presented in



figure. 27. Look out! The wattmeter gives the down scale reading. It may be dangerous to it. 28. Quantity being characterized by a single number, it is a scalar.

## Reading and Speaking

**Ex.1*. Among the sentences above, do find out the definitions and answer if the English version is longer or shorter than Russian version. Give some your own examples of definitions.**

**Ex.2. Ask your group mate the following questions. Let him/her answer them.**

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

**Ex.3. Speak on the difference between:**

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

**Ex.4. Read the text below in 3 minutes and point out the main idea of each paragraph.**

**Electricity may be dangerous**

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

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

We all use electricity in our homes every day but sometimes forget that it is a form of power and may be dangerous. At the other end of the wire there are great

generators driven by turbines turning at high speed. One should remember that the power they generate is enormous. It can burn and kill, but it will serve us well if we use it wisely.

**Ex.5. Point out which of the sentences contains the information from the text above.**

1. The path along which the electrons travel must be complete. 2. The short circuit often results from the cable fault or wire fault. 3. We must always remember that electricity can be dangerous and one should use it carefully. 4. Water provides a path for the current to flow. 5. The electric power can serve us well if it is used wisely.

**Ex.6*. Give your examples of careless use of the electric energy. What should be done in such cases?**



# UNIT 29. HEATING EFFECT OF AN ELECTRIC CURRENT

**Overview**

- Reading and Vocabulary: Heating effect of an electric current.
- Information transfer: Battery charger.
- Language focus: Word formation. Emphatic Constructions.
- Reading and Speaking: What is heat?

## Reading and Vocabulary

**Reading**

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Heating effect of an electric current**

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

As you know, of course, a metal wire carrying a current will almost always be at a higher temperature than the temperature of that very wire unless it carries any current. [ 1 ] Thus, the current can be detected by the heat developed provided it flows along the wire.

The reader is certain to remember that the heat produced per second depends both upon the resistance of the conductor and upon the amount of current carried through it. As a matter of fact, if some current flowed along a thin wire and then the same amount of current were sent through a thicker one, a different amount of heat would be developed in both wires. When the current is sent through the wire which is too thin to carry it freely, then more electric energy will be converted into heat than in the case of a thick wire conducting a small current.

Let us suppose now that a small current is flowing along a thick metal conductor. [ 2 ] If, however, our conductor were very thin while the current were large the amount of generated heat would be much greater than that produced in the thick wire. In fact, one could easily feel it. Thus, we see that the thinner the wire, the greater the developed heat. [ 3 ]

Needless to say, such heat is greatly desirable at times but at other times we must remove or, at least, decrease it as it represents a waste of useful energy. In

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

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

The production of heat by an electric current is called heating effect. One might also name its light effect provided the heat in the conductor be great enough to make it white-hot, so that it gives off light as well as heat. Take the filament of an electric lamp as an example. [ 4 ] By the way, were we able to look inside a hot electric iron, we should see that its wires were glowing too. A similar statement could be applied as well to almost any electric heating device. All of them give off a little light and a lot of heat.

**Notes and comments**

*that very wire* means *the same wire*.

*… provided …* Here it means *under condition*.

*If our conductor were … while the current were …* . Note plural for verb. This is the property of *if*-sentences.

*to meet … requirements* means *to correspond requirements*.

**Reading comprehension**

**Ex.1**.

A. On the contrary, the larger the wire, the more negligible is the heat produced.

B. It means that an electric current passing along a wire will heat that wire and may even cause it to become red-hot.

C. It is called power loss.

D. Under such conditions the only way to discover whether heat has been developed is to make use of a sensitive thermometer because the heating is too negligible to be detected by other means.

E. We know it to glow because of heat.



**Ex.2. Read the text and find the answers to these questions.**

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

**Ex.3. Ask your groupmate the following questions. Let him/her answer them.**

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

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

**Vocabulary**

**Ex.4. Fill in the words from the box below.**

| overheating, efficiency, appliances, radiant, energy, give off, freely, consumers, red-hot, heating |
|---|

1. You are familiar with … effect of the current.
2. Different electrical … are used.
3. … is most undesirable and even dangerous.
4. Heat loss decreases …
5. It is possible to convert electric … into heat.
6. We can obtain heat from the sun by employing … energy.
7. The great current flowing through a conductor may cause it to become …
8. All heating devices … a little light and a lot of heat.
9. A thick wire carries current more … than a thin one.
10. Electrical … transform electric energy into heat.

## Information transfer

**Battery charger**

**Before you start**

**Ex.1. Discuss the questions below.**

1. What is a battery charger?
2. Why is it necessary to charge the battery?
3. What properties should it have?

**Ex.2. Study the circuit diagram of a battery charger in Fig. 1 and try to name all the components.** The list of components and units in the exercise 3 may help you.

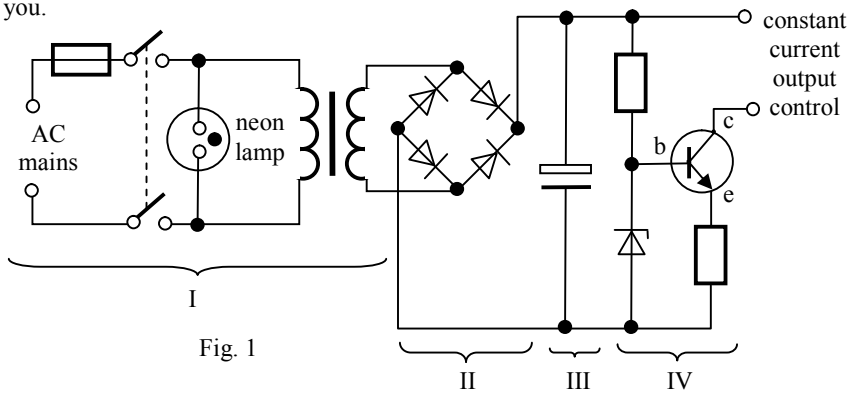



Fig. 1

**Ex.3.** One way of planning your writing is to think of questions which your readers will want to know the answers to. In the task which follows, base your description on the questions set for you.

Describe the block diagram of the battery charger and the function of each building block. Your description should answer these questions:

1. What is the function of a battery charger?
2. What does it consists of in terms of blocks?
3. How are the blocks connected?
4. What is the function of each block?

**Ex.4. Read and translate the passage below about the battery charger.**

The power to drive an electronic circuit is normally provided by an AC mains power supply but batteries are often used for portable equipment. Secondary cells can be recharged to their original voltage and can therefore be used many times over.

Recharging is done using a battery charger which consists of a mains power supply with a DC output slightly larger than the required battery EMF. A current is driven through the battery in the opposite direction to its normal output current. The block diagram of a battery charger is shown in Fig. 2.

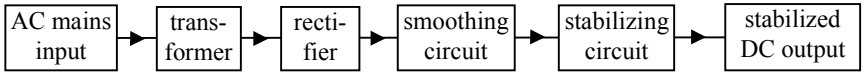



Fig. 2



The first stage consists of a transformer which steps down the voltage of the AC mains. The charger is switched on and off by a double-pole switch connected in series with the mains input. A neon lamp, connected across the primary of the transformer, shows when the charger is on. A fuse is connected in the live side of the supply to protect the transformer.

The second stage is a bridge rectifier which converts the AC voltage to a DC voltage. This can be made from discrete components but more usually consists of four diodes contained in one package. It is mounted on an aluminium heatsink to keep the diodes from overheating.

The third stage is a smoothing circuit. It removes the fluctuations in the DC output of the rectifier. It consists of a large electrolytic capacitor connected in parallel with the rectifier as shown in Fig. 1.

The final stage is a stabilizing circuit consisting of a transistor biased by two resistors and a zener diode. This prevents the output from changing when the load varies. NiCad batteries have such a small internal resistance that the charger must produce a constant current output.

**Ex.5. Match each component or unit with its function in a battery charger.** For example: the transformer steps down the AC mains voltage.

Component/Unit: 1 transformer; 2 double-pole switch; 3 neon lamp; 4 fuse; 5 rectifier; 6 aluminium heatsink; 7 smoothing circuit; 8 stabilizing circuit.

Function in a battery charger: a) steps down the AC mains voltage; b) prevents the output from changing when the load varies; c) keeps the diodes from overheating; d) shows when the charger is on; e) removes the fluctuations in the DC output of the rectifier; f) protects the transformer; g) converts the AC voltage to a DC voltage; h) switches the charger on and off.

## Language focus

**Word formation**

**Ex.1. Study the verb and two related nouns below.** One noun is used for a component. The other is an abstract noun used for a property. For example,

amplify amplifier amplification

With the help of the reading passage, earlier units, and your own knowledge, fill the gaps in this table.

| Verb | Noun (component) | Noun (property) |
|---|---|---|
| Absorb | | |
| Attenuate | Attenuator | |
| | | Communication |
| Conduct | | Conductivity |
| | | Generation |
| | Inductor | |
| Modulate | | Modulation |
| Reflect | Reflector | |
| Resist | | |
| | Revolver | |
| Rotate | | |

**Grammar and Vocabulary**

**Emphatic Constructions**

They are used to underline a part of a sentence or to accent a word. For that this part of sentence is made to be a main part of the compound sentence. At that the additional linking word is used. Look at the model.

Model. **The sun** is an unlimited source of almost all kinds of energy. – It is **the sun that** is an unlimited source of almost all kinds of energy.

**Ex.2. Translate the following sentences and turn them into emphatic construction making stress upon the passages** in **bold**.

1. Electric energy is changed into heat **in the electrical appliances**. 2. **An increase in temperature** increases the molecular motion. 3. **Ampere** showed the difference between the current and the charges. 4. Electricity is produced **at steam power plants**. 5. **The heating effect of the current** is the subject of this article. 6. Overheating **in transmission lines** is most undesirable. 7. **Work** produces heat directly or indirectly. 8. **The heat engine** turns heat into work.

**Ex.3. Learn to recognize the following international words.**

principal, effect, detector, tram, trolley-bus, car, production, neon

**Ex.4. Define the meaning of the prefixes in the following words, translate them**.



Irreplaceable, supernatural, overloaded, reaction, invaluable, discharge, indirectly, outstanding, semiconductor, impossible.

**Ex.5. Translate the following word combinations.**

a) at least, thanks to, because of, as to, in case of, at times, sometimes, in short, by means of, owing to, in spite of, instead of, all over the world, with the aid of, as far as.

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

## Reading and Speaking

**Ex.1. Read and translate the following text.**

**Atmospheric electricity**

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

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

It has already been mentioned that atmospheric electricity is the earliest manifestation of electricity known to man. However, nobody understood that phenomenon and its properties until Benjamin Franklin made his kite experiment. On studying the Leyden jar (for long years the only known capacitor), Franklin began thinking that lightning was a strong spark of electricity. He began

experimenting in order to draw electricity from the clouds to the earth. The story about his famous kite is known all over the world.

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

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

**Ex.2. Translate the following questions and answer them.**

1. Какую роль играет электричество в современной жизни? 2. Какое напряжение необходимо для вспышки молнии? 3. На что похожа молния? 4. Как Франклин доказал, что молния – это разряд электричества? 5. Кто изобрёл молниеотвод?



# UNIT 30. MAGNETISM. DESCRIBING GRAPHS

**Overview**

- Reading and Vocabulary: Magnetism.
- Supplementary Information: Magnetic materials.
- Language focus: Understanding graphs. Describing graphs. Compound nouns.
- Reading and Speaking: Magnetized water.

## Reading and Vocabulary

### Reading

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

### Magnetism

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

Magnetism is mentioned in the oldest writings of man. [ 1 ] However, nobody knew who discovered magnetism or where and when the discovery was made. Of course, people could not help repeating the stories that they had heard from their fathers who, in their turn, heard them from their own fathers and so on.

One story tells us of a man called Magnus whose iron staff was pulled to a stone and held there. He had great difficulty in pulling his staff away. Magnus carried the stone away with him in order to demonstrate its attracting ability among his friends. [ 2 ].

According to another story, a great mountain by the sea possessed so much magnetism that all passing ships were destroyed because all their iron parts fell out. They were pulled out because of the magnetic force of that mountain. The earliest practical application of magnetism was connected with the use of a simple compass consisting of one small magnet pointing north and south.

A great step forward in the scientific study of magnetism was made by Gilbert, the well-known English physicist (1540-1603). He carried out various important experiments on electricity and magnetism and wrote a book where he put together all that was known about magnetism. He proved that the earth itself was a great magnet.

Reference must be made here to Galileo, the famous Italian astronomer, physicist and mathematician. He took great interest in Gilbert's achievements and also studied the properties of magnetic materials. He experimented with them trying to increase their attracting power. [ 3 ].

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

Dividing a bar magnet into two parts, one finds that each of the two parts is a magnet having both a north pole and a south pole. Thus, we obtain two magnets of a smaller size instead of having a single one of a larger size. [ 4 ] Thus, we could continue this process, always getting similar results.

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

**Notes and comments**

*… people could not help repeating … To can't help repeating* means *to can't be without repeating*.

*… a mountain by the sea …* It means *close to the sea*.

**Reading comprehension**

**Ex.1**.

A. One of his magnets, for example, could lift objects weighing 25 times its own weight.

B. Dividing one of these two smaller magnets into two will give us the same result.

C. This unfamiliar substance was called Magnus after its discoverer, this name having come down to us as "Magnet".

D. The simplest electromagnet is a coil carrying current.

E. Romans, for example, knew that an object looking like a small dark stone had the property of attracting iron.

**Ex.2. Translate the following questions and answer them.**

1. Существует ли связь между электричеством и магнетизмом? 2. Знаете ли вы, кто открыл магнетизм? 3. Кто доказал, что наша Земля является большим магнитом? 4. Что вы знаете о магнетизме? 5. Каковы свойства магнита? 6. Кто интересовался достижениями Гильберта? 7. Какие магнитные материалы вы знаете? 8. Какие свойства материалов изучал Галилей?



**Vocabulary**

**Ex.3. Learn to recognize the following international words.**

to transform, volt, kilometer, form, process, magnet, magnetism, to demonstrate, compass, astronomer, molecule, to neutralize, material, observation, practical, physicist, experiment, school, steel

**Ex.4. Fill in the words from the box below.**

| lift, compass, earth, attracting power, iron staff, iron bar, magnetism, rubbing, coil, minute |
|---|

1. … is produced by the current.
2. Magnus' … was pulled to a stone being a large magnet.
3. A simple … consists of one small magnet pointing north and south.
4. Gilbert proved that the … itself was a great magnet.
5. Galileo experimented with magnetic materials trying to increase their … .
6. In magnetic materials, the molecules themselves are … magnets.
7. On placing an unmagnetized … near a strong magnet, we magnetize it.
8. Iron bar is magnetized by the strong magnet without … it.
9. Galileo's magnets could … objects weighing 25 times their own weight.
10. The simplest electromagnet is a … carrying current.

## Supplementary Information

**Magnetic materials**

**Before you start**

**Ex.1. Discuss the questions below.**

1. What magnetic materials do you know?
2. Where are the magnetic materials applied?
3. What their characteristics do you know?

**Ex.2. Read and translate the passage below about the magnetic materials.**

All materials have magnetic properties. These characteristic properties may be divided into five groups as follows: 1) diamagnetic; 2) paramagnetic; 3) ferromagnetic; 4) antiferromagnetic; 5) ferrimagnetic.

Only ferromagnetic and ferrimagnetic materials have properties which are useful in practical applications.

*Ferromagnetic* properties are confined almost entirely to iron, nickel and cobalt and their alloys. The only exceptions are some alloys of manganese and some of the rare earth elements.

*Ferrimagnetism* is the magnetism of the mixed oxides of the ferromagnetic elements. These are variously called ferrites and garnets. The basic ferrite is magnetite, or $Fe_3O_4$, which can be written as $FeO \cdot Fe_2O_3$. By substituting the FeO with other divalent oxides, a wide range of compounds with useful properties can be produced. The main advantage of these materials is that they have high electrical resistivity which minimizes eddy currents when they are used at high frequencies.

The important parameters in magnetic materials can be defined as follows:

- *permeability* – this is the flux density $B$ per unit of magnetic field $H$. It is usual and more convenient to quote the value of relative permeability $\mu_r$, which is $B/\mu_0 H$. The permeability is a variable which is dependent on the magnetic field. The two important values are the *initial permeability*, which is the slope of the magnetization curve at $H = 0$, and the *maximum permeability*, corresponding to the knee of the magnetization curve.
- *saturation* – when sufficient field is applied to a magnetic material it becomes saturated. Any further increase in the field will not increase the magnetization and any increase in the flux density will be due to the added field.
- *remanence, $B_r$ and coercivity, $H_c$* – these are the points on the hysteresis loop at which the field $H$ is zero and the flux density $B$ is zero, respectively. It is assumed that in passing round this loop, the material has been saturated. If this is not the case, an inner loop is traversed with lower values of remanence and coercivity.

Ferromagnetic and ferrimagnetic materials have moderate to high permeabilities. The permeability varies with the applied magnetic field, rising to a maximum at the knee of the $B$–$H$ curve and reducing to a low value at very high fields. These materials also exhibit magnetic hysteresis, where the intensity of magnetization of the material varies according to whether the field is being increased in a positive sense or decreased in a negative sense. When the magnetization is cycled continuously around a hysteresis loop, as for example when the applied field arises from an alternating current, there is an energy loss proportional to the area of the included loop. This is the *hysteresis loss*, and it is measured in joules per cubic metre. High hysteresis loss is associated with permanent magnetic characteristics exhibited by materials commonly termed *hard* magnetic materials, as these often have hard mechanical properties. Those materials with low hysteresis loss are termed *soft* and are difficult to magnetize permanently.

Ferromagnetic or ferrimagnetic properties disappear reversibly if the material is heated above the Curie temperature, at which point it becomes *paramagnetic*, that is effectively non-magnetic.



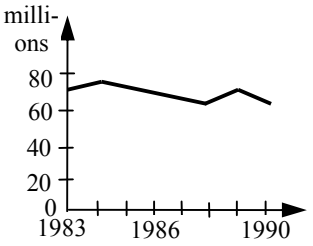
**Ex.3.** Using the material of the text proposed and experience of your own try to illustrate the text with different graphics such as dependence of permeability on $H$, magnetization curve, hysteresis phenomena. Try to describe the dependences obtained.

The material in Language focus may help you.

## Language focus

**Understanding graphs**

In electrical engineering, graphs are a common way of giving information. They allow a great deal of data to be presented easily in visual form. Mostly this information is technical, but we start with a non-technical example.




This graph shows the sales of singles in the UK over a seven-year period some time ago. This was a period of considerable change in people's choice of format when buying recorded music.

**Describing graphs**

Look at the period 1983-1984 on the graph. We can describe sales of singles in two ways: 1) Sales of singles **rose**. 2) There **was a rise** in the sales of singles.

We can make our description more accurate like this: 3) Sales of singles **rose slightly**. 4) There **was a slight rise** in the sales of singles.

Study this table of verbs and related nouns of change. The past form of irregular verbs is given in brackets.

| Direction | Verb | Noun |
|---|---|---|
| Up | climb | |
| | go up (went up) | |
| | increase | increase |
| | rise (rose) | rise |
| Down | decline | decline |
| | decrease | decrease |
| | dip | dip |
| | drop | drop |
| | fall (fell) | fall |
| | go down (went down) | |
| Level | not change | no change |
| | remain constant | |

These adjectives and adverbs are used to describe the rate of change: Adjectives: slight; gradual; steady; steep; sharp; sudden; fast. Adverbs: slightly; gradually; steadily; steeply; sharply; suddenly; fast.

**Grammar and Vocabulary**

**Compound nouns**

**Ex.1. Study these examples of compound nouns:** a signal generator = equipment for generating signals; a cassette player = equipment for playing cassettes; a battery tester = equipment for testing batteries; energy transmission = equipment for transmitting energy; current rectifier = equipment for rectifying current; signal suppressor = equipment for suppressing signals.

What do we call equipment for …

1. playing CDs?
2. receiving radio (signals)?
3. charging batteries?
4. amplifying aerial (signals)?
5. filtering (out) noise?
6. synthesizing speech?
7. cleaning cassette heads?
8. amplifying (the) power (of a signal)?
9. sensing vibration?
10. scanning (the human) body (for disease)?

**Ex.2.** Each word in line A often goes before one word from line B. For example, *integrated circuit* (1f). Find the other word pairs.

A 1) integrated 2) circuit 3) alternating 4) primary 5) Zener 6) remote 7) reed 8) surface 9) vibration 10) reverse 11) mains

B a) sensor b) cell c) switch d) supply e) diode f) circuit g) current h) bias i) control j) diagram k) wave

## Reading and Speaking

**Ex.1. Read the following text in 2 minutes and answer the question** "What changes take place in magnetized water?"

**Magnetized water**

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



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

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

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

**Ex.2. Point out which of these sentences contains the information from the text above.**

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

**Ex.3*. Speak on magnetism.**

# UNIT 31. HYDROELECTRIC POWER-STATION

**Overview**

- Reading and Vocabulary: Hydroelectric power-station.
- Supplementary Information: Metal detector.
- Language focus: Grammar links.
- Reading and Speaking: Big is best.

## Reading and Vocabulary

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Hydroelectric power-station**

Hydroelectric stations apply the energy of water stream (rivers, waterfalls etc.). Water power was used to drive machinery long before Polzunov and James Watt harnessed steam to meet man's needs for useful power.

Modern hydroelectric power-stations use water power to turn the machines which generate electricity. The water power may be obtained from the small dams in rivers or from enormous sources of water power. However, most of electricity still comes from steam power-stations.

In some countries, such as Norway, Sweden, and Switzerland, more electric energy is produced from water power than from steam. [ 1 ] The tendency, nowadays, even for countries that have large coal resources is to utilize their water power in order to conserve their resources of coal. As a matter of fact, almost one half of the total electric supply of the world comes from water power.

The locality of a hydroelectric power plant depends on natural conditions. [ 2 ] That depends on the desirability of using the head supply at the dam itself or the desirability of getting a greater head. In the latter case, water is conducted through pipes or open channels to a point farther downstream where the natural conditions make a greater head possible.

The design of machines for using water power greatly depends on the nature of the available water supply. In some cases great quantities of water can be taken from a large river with only a few feet head. In other cases, instead of a few feet, we may have a head of several thousands of feet. In general, power may be developed from water by action of its pressure, of its velocity, or by combination of both.



A hydraulic turbine and a generator are the main equipment in a hydroelectric power station. Hydraulic turbines are the key machines converting the energy of flowing water into mechanical energy. Such turbines have the following principal parts: a runner composed of radial blades mounted on a rotating shaft and a steel casing which houses the runner. There are two types of water turbines, namely, the reaction turbine and the impulse turbine. [ 3 ] Modified forms of the above turbine are used for medium heads up to 500-600 ft, the shaft being horizontal for the larger heads. High heads, above 500 ft, employ the impulse type turbine.

Hydropower engineering is developing mainly by constructing high capacity stations integrated into river systems known as cascades. Such cascades are already in operation on the Dnieper, the Volga and the Angara.

An electric part of a hydroelectric power station is very similar to that of a thermal power station. [ 4 ] That's why energy from hydroelectric power station is obtained at high voltage (110-500 kV). A peculiar feature is the small auxiliary power because there are no mighty mechanisms among the auxiliary.

Simultaneously with building of hydroelectric power station other economic problems are solved. They are as follows: irrigation, development of navigation, water-supply of towns and plants etc.

Technology of electricity production at hydroelectric power station is simple and may be automated. Starting up a power unit takes not more than 50 sec. So, such aggregates are used as power reserve.

The efficiency of a hydroelectric power station is 85-90%. As the maintenance charges are not very high the electricity cost price is appreciably less in comparison with thermal power stations.

**Notes and comments**

*... to meet ... needs …* This means *to correspond one's needs*.

*... the head supply at the dam ...* . This means the difference in the water levels before and after the dam.

**Reading comprehension**

**Ex.1.**

A. They have been developing large hydroelectric power stations for the past sixty years, or so, because they lack a sufficient fuel supply.

B. The hydroelectric power plant may be located either at the dam or at a considerable distance below.

C. Water is accumulated here and then it is used if necessary to produce electricity.

D. The reaction turbine is the one for low heads and a small flow.

E. Similar to a condensing plant, a hydroelectric power station is remote from the load because their locations depend mainly on natural conditions.

**Ex.2. Read the text and find the answers to these questions.**

1. What kind of energy do hydroelectric power-stations use?
2. What conditions do the locality of a hydroelectric power-station depend on?
3. What are the key machines of a hydroelectric power-station?
4. How many types of water turbines exist?
5. What is the peculiar feature of a hydroelectric power-station?
6. Is it possible to automate the technology of electricity production at hydroelectric power-station?
7. What is efficiency of a hydroelectric power-station?

**Vocabulary**

**Ex.3. Fill in the words from the box below.**

| |
|---|
| locality, water stream, runner, to conserve, impulse, available, reserve, head, cascades, equipment |

1. A … possesses the energy which may be used to produce electricity.
2. The water power is utilized in order … the resources of coal.
3. The … of a hydroelectric power plant depends on natural conditions.
4. The design of water turbines greatly depends on the nature of the … water supply.
5. Usually we must have a … of several thousands of feet.
6. A hydraulic turbine and a generator are the main … in a hydroelectric power-station.
7. A steel casing houses the …. .
8. High heads employ the … type turbine.
9. High capacity stations are integrated into river systems known as …
10. Water power aggregates are used as power …

## Supplementary Information

**Ex.1. Read the text below.**

**Metal detector**

A metal detector is essential for today's amateur treasure hunter. But only the most expensive detector can reveal the difference between worthless items, such as pull-ring tops from soft drink cans or silver foil, and a rare find such as the gold necklace discovered by one enthusiast last year.



Electronic metal detectors use the principle of electromagnetic induction. This means that, if an object is placed in a changing magnetic field, an electrical voltage is created in the object. In a metal detector, an electrical current is passed through a coil of wire, called the search coil, to create a magnetic field. An alternating current (AC) generator converts the direct current (DC) from the battery into the AC needed to drive the coil. As AC regularly reverses direction, it produces the necessary ever-changing magnetic field.

Currents are created in a metal object which comes within this magnetic field by a process known as induction. This is because all metals conduct electricity. When a current is induced in a metal object (for example, a buried coin), this in turn produces its own magnetic fields. These magnetic fields are capable of inducing a small amount of electricity in the detector's search coil itself.

The simplest kind of metal detector is the pulse induction type. A powerful current is passed from the battery through the search coil and then switched off. The pulse of magnetism causes current to flow in any target objects below the ground. But unlike the current in the search coil, the current in the object reactivates the search coil. This voltage is then amplified to indicate with a sound or a flashing light an object has been found.

The effectiveness of a metal detector depends on the size and position of the object and how far beneath the ground it is buried. For example, a coin buried edge-on to the search coil is much harder to detect than the same coin buried face up.

**Ex.2. look at these statements. Are they true or false?** You may need to use your own knowledge as well as information from the text.

1. Any metal detector can discriminate between gold and other metals.
2. Gold necklaces are found quite often.
3. The search coil is connected directly to a battery.
4. Metal detectors require a changing magnetic field.
5. The metal detector can only locate metals which contain iron or are magnetic.
6. Metal detectors are only used by treasure hunters.
7. Passing a current through the search coil and then switching it off, creates a pulse of magnetism round the coil.
8. All metal detectors are fitted with a flashing light to show when an object has been found.
9. Large objects are easier to find than small objects.
10. A coin horizontal to the surface is more difficult to detect than one vertical to the surface.

## Language focus

**Grammar links**

Sentences in a text are held together by grammar links. Note the links in this paragraph:

Metal detectors are used to locate hidden metal objects such as water pipes. They contain a search coil and a control box. The coil is mounted in the search head. When an AC voltage from the box is applied to the coil, a magnetic field is created around it. In turn this induces a current in any metal object the head passes over.

Links between neighbour sentences: metal detectors – they; a search coil – the coil; a magnetic field is created around it – this.

The text illustrates some common grammar links: Nouns become pronouns (*metal detectors* becomes *they*; *the coil – it*); repeated nouns change from *a* to *the* and sometimes words are dropped: *a search coil* becomes *the coil*; clauses and even sentences become *this* or *that*: *a magnetic field is created around it* becomes *this*.

**Ex.1. Now mark the grammar links in this paragraph** by joining the words in italics with the words they refer to:

When an AC voltage is applied to the search coil, a magnetic field is produced around *it*. If there is a metal object under the ground, *the field* induces an electric current in *the object*. *The induced current* in turn creates a magnetic field around the object. *This* induces a voltage in the search coil. *The induced voltage* is converted into an audible note by the circuitry in the control box. *This sound* guides the treasure hunter to *the buried object*.

**Ex.2.** *Converts* means to change something from one form to another. Study the following example.

An AC generator converts the DC from the battery into the AC needed to drive the coil.

**Identify the components from these descriptions**:

1. It converts AF signals into sound waves.
2. It converts electronic pulses into infra-red pulses.
3. It converts digital signals into analogue signals.
4. It converts an electrical signal into a visual signal.

Describe the action of the following, using *convert*:

5. A rectifier.
6. A microphone.



7. An analogue-to-digital converter.
8. An audio amplifier.

**Ex.3. Link each pair of statements using the word or phrase provided.** Omit unnecessary words and make any other changes required.

1. for: A metal detector is a device. A metal detector locates hidden metal objects.
2. to … but: The metal detector was developed for military purposes. The metal detector was developed to find buried explosives. Nowadays the metal detector is also used to locate pipes, cables and lost valuables.
3. to: Special detectors are used at airports. Detectors are used to screen passengers for concealed weapons.
4. which: All detectors work on the same principle. The principle is electromagnetic induction.
5. if: An object is placed in a changing magnetic field. An electrical voltage is created in the object.
6. when: An AC voltage is applied to the search coil. An ever-changing electromagnetic field is created around the search coil.
7. if: The coil passes near a metal object. An electric current is induced in the metal objects.
8. which: the electric current produces a magnetic field around the object. The magnetic field induces a voltage in the search coil.
9. when: The circuitry senses this reaction. The circuitry changes the voltage into an audible note.
10. as: The coil approaches the object. The audible note becomes louder and louder.

## Reading and Speaking

**Big is best**

### Before you start

You have one minute. How many different dams or tunnels can you think of? Compare your answers with the rest of the class.

**Ex.1. Complete the texts by putting one word in each space**. Use the words in the box. Check meaning of any new words in the glossary or your dictionary.

| across | around | between | over | through | under |
|---|---|---|---|---|---|

The Panama Canal is a 64km waterway _____ the Atlantic and Pacific Oceans. Before the canal was opened, ships had to travel thousands of miles _____ South America. To build the canal, engineers had to dam a major river, and dig a channel _____ a mountain ridge.

Tower Bridge is an operable bascule bridge, designed by Horace Jones in 1886. It goes _____ the River Thames in London. Thousands of vehicles drive _____ it every day. Tall ships cannot pass _____ Tower Bridge, instead, the roadway parts and lifts to let them through.

**Ex.2. Read the text and decide which structure it describes.**

A The Hoover Dam B The Arlberg Tunnel
C The Channel Tunnel D The golden Gate Bridge

The …… is between Britain and France. It's more than 20 kilometres long. It was built by British and French engineers. They started on opposite sides and met in the middle under the sea. They used specially-designed tunnel boring machines (TBMs) to dig the tunnels through the rock under the seabed. TBMs are enormous machines for digging tunnels. The machines used to dig the main tunnels were about 8.5 metres in diameter and 250 metres long. Work started in 1987 and the teams met under the seabed in 1991. It is a rail tunnel. The first passenger train went through in 1994.

**Ex.3. Read the text again and answer the questions** (1-9) **below**.

1. Where is it?
2. What is it?
3. How long is it?
4. Who built it?
5. How did they build it?
6. What are TBMs?
7. How big are TBMs?
8. How long did it take to build?
9. When was it opened?

**Ex.4. First, underline the question words in Ex.3. Then use them to complete these questions.**

1. _____ many Roman roads are there in Europe?
2. _____ designed St Paul's Cathedral in London?
3. _____ is the name of the famous bridge in San Francisco?
4. _____ was the Eiffel Tower built?
5. _____ is the Corinth Canal?



# UNIT 32. NUCLEAR POWER PLANT

**Overview**

- Reading and Vocabulary: Nuclear power plant.
- Language focus: Cause and effect.
- Reading and Speaking: Radar.

## Reading and Vocabulary

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Nuclear power plant**

Nuclear power stations widely use saturated steam instead of superheated one. Sure, in this case efficiency is lower. However, usage of superheated steam directly in a nuclear reactor requires complexity of a reactor construction and, hence, additional investment. At the same time, nuclear fuel is much cheaper in comparison with organic fuel. [ 1 ]

The heart of the nuclear power plant is the reactor which contains the nuclear fuel. The fuel usually consists of hundreds of uranium pellets placed in long thin cartridges of stainless steel. The whole fuel cell consists of hundreds of these cartridges. The fuel is situated in a reactor vessel filled with a fluid. The fuel heats the fluid and the super-hot fluid goes to a heat exchanger, i.e. steam generator, where the hot fluid converts water to steam in the heat exchanger. The fluid is highly radioactive, so it should never come into contact with the water that is converted into steam. Then this steam operates steam turbines in exactly the same way as in the coal or oil fired power-plant.

A nuclear reactor has several advantages over a power-plant that uses coal or natural gas. [ 2 ] As to nuclear fuel, it is far cleaner than any other fuel for operating a heat engine. Furthermore, our reserves of coal, oil and gas are decreasing so nuclear fuel is to replace them. [ 3 ] The amount of nuclear fuel which the nuclear power-plant consumes is negligible while the world's uranium and thorium resources will last for hundreds of years. Industry produces two main types of reactors namely vessel-type and channel type reactors. The nuclear power stations are mostly designed for generation of electricity. If a station generates only electric energy, it is equipped with condensing turbines and the station is known as a condensing one. At present the nuclear power stations mainly operate as condensing

plants. The nuclear power stations designed to produce not only electrical energy but also heat are called nuclear heat-and-power plants.

A fast-neutron reactor which supplies both electricity and heat for desalting sea water was put into operation in Shevchenko on the Caspian Sea. [ 4 ] It should be also mentioned that that area has no natural fresh water and was a lifeless desert before the nuclear power plant began operating there.

Scheme of a nuclear power station may be single-, double- or three-circuit.

If a power station works with a single-circuit scheme (fig. a), steam is produced in the reactor core (active area of a reactor) and is supplied to a turbine. Sometimes steam is superheated in special channels of reactor or in a separate nuclear steam superheater.

A single-circuit scheme is the simplest. However, the steam produced in this case is radio-active. That is why the most circuit installation is to have protection

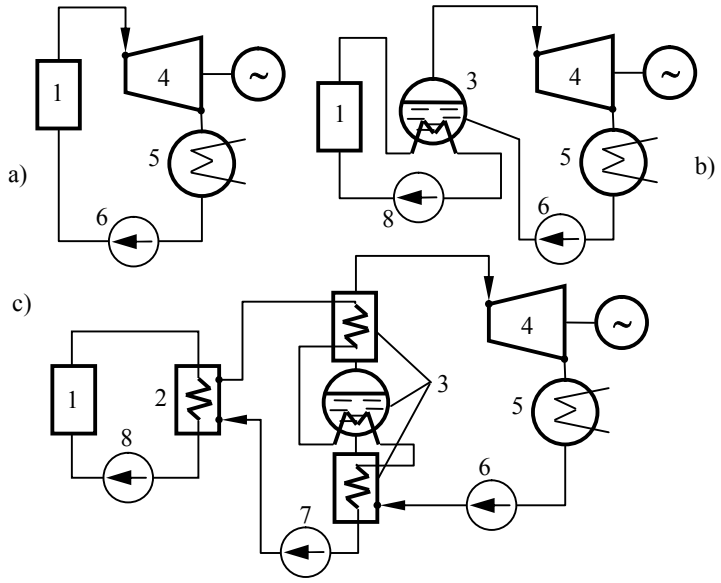



Figure – Single-circuit (a), double-circuit (b) and three-circuit (c) schemes of nuclear power station: 1 – reactor; 2 – intermediate heat exchanger; 3 – steam generator; 4 – turbo-generator; 5 – condenser; 6 – pump; 7 – circulation pump of the II loop; 8 – circulation pump of the I loop



from radiation. During working process the radio-active solids having been removed from a reactor with steam are collected in a steam pipeline, a turbine etc. It is dangerous and this complicates control and repair.

In double-circuit and three-circuit schemes (fig. b and c) heat rejection is realized by a heat-transfer agent, further heat is supplied to working substance directly or through the heat-transfer agent of an intermediate loop. Here, working substance is not radio-active and power station running is appreciably made easier. Moreover, corrosion from steam pipeline, condenser and turbine line does not come into reactor. In this case investments are much higher, especially in case of three-circuit scheme. Such schemes are used to avoid any possibility of water contact with the active heat-transfer agent. Such dangerous active heat-transfer agent is sodium iodide because its contact with water leads to hard accidents.

The technological scheme of the first loop of a double-circuit nuclear power station is as following.

Nuclear fuel stored in the form of fuel elements is supplied to a station in containers and with the aid of lifting crane is loaded into the active part of reactor. Cassettes with exhausted fuel elements are placed into pool and are kept here for a definite period until radioactivity decreases to the sufficiently low level. Then cassettes are taken out to a fuel reprocessing plant. The heat obtained in a reactor is absorbed by a heat-transfer agent and then is delivered to working substance in steam generator. In case of three-circuit scheme there is an intermediate loop between an active heat-transfer agent of the first loop and working substance.

The steam obtained in a reactor (single-circuit scheme) or in a generator (double- or three-circuit scheme) is delivered to a turbine along a steam pipeline.

The subsequent part of the scheme is very similar to the part a thermal power station working with organic fuel.

**Notes and comments**

*... saturated steam instead of superheated...* Unlike the superheated steam, the former contains the water drops.

**Reading comprehension**

**Ex.1.**

A. It results in cheaper electric energy even at low total efficiency.

B. It means that coal and oil can be used for some other purposes.

C. The latter produces considerable air pollution, releasing combusted gases into atmosphere, whereas a nuclear power plant gives off almost no air pollutants.

D. It includes a reactor, a steam generator and a turbo-generator.

E. Its capacity is partly used for generating electricity, the rest going as heat to obtain desalted water.

**Ex.2. Look through the text and find the answers to these questions.**

1. What kind of steam do the nuclear power stations widely use?
2. Is the superheated steam used directly in a nuclear reactor? If not, why?
3. Why is nuclear fuel better than organic fuel?
4. Which is a key part of a nuclear power station?
5. What does the fuel cell consist of?
6. Where does the hot fluid convert water into steam?
7. Why should the hot fluid never come into contact with the water?
8. How long will the world's uranium and thorium resources last?
9. How many different types of reactors does industry produce?
10. Where is steam produced in case of a single-circuit scheme?
11. What is the reason to apply a three-circuit scheme?

**Vocabulary**

**Ex.3. Fill in the words from the box below.** There is one word you shouldn't use.

| fast-neutron, saturated steam, turbo-generator, reactor vessel, heat exchanger, channel type, condensing, reactor core, heat-transfer agent, uranium pellets, sodium iodide |
|---|

1. Nuclear power stations widely use … instead of superheated one.
2. The fuel consists of hundreds of … placed in long thin cartridges of stainless steel.
3. The fuel is situated in a … filled with a fluid.
4. The fuel heats the fluid and the super-hot fluid goes to a … .
5. Industry produces two main types of reactors namely vessel-type and … reactors.
6. If a station generates only electric energy, it is known as a … one.
7. A … reactor supplies both electricity and heat.
8. If a power station works with a single-circuit scheme, steam is produced in the … .
9. In double-circuit schemes heat rejection is realized by a … .
10. Active heat-transfer agent is … .



## Language focus

**Cause and effect**

Study this sentence: Overvoltage causes the insulation break.

It contains a cause and effects. Identify them. We can link a cause and effect as follows:

Overvoltage causes / leads to / results in / is the cause of the insulation break.

We can also put the effect first:

The insulation break is caused / results from / is the effect of / is due to overvoltage.

**Ex.1. Items in List 1 can be causes or effects of items in List 2. Match the pairs.** Compare your answers with you partner.

For example: mains frequency interference – hum.

List 1: 1) distortion; 2) noise generated within components; 3) overheating a transistor; 4) dirty heads; 5) a build-up of oxide on the head; 6) jumping; 7) unwanted signals.

List 2: a) interference on radios; b) too high a recording level; c) the tape rubbing against the head; d) scratches on records; e) hiss; f) damage; g) poor recordings.

**Ex.2. Write sentences to show the relationship between the pairs you linked in ex.1.**

For example: Mains frequency interference results in hum.

Study these statements: 1) The electron beam hits the screen. 2) The phosphor glows.

Why does the phosphor glow? What is the relationship between statement 1) and 2)?

Statement 1) is a cause and statement 2) is an effect. We can link cause and effect statements in a number of ways. Study these ways, which use cause and *make*.

The electron beam hits the screen causing the phosphor to glow. The electron beam hits the screen making the phosphor glow.

Now study these cause and effect statements: 3) The phosphor glows. 4) A spot is displayed.

The effect is in the passive. We can link cause and effect like this: The phosphor glows causing a spot to be displayed.

**Ex.3. Link each of these cause and effect statements to make one sentence:**

1. a) A magnetic field is set up in the speaker coil. b) The coil vibrates.
2. a) The stator of an induction motor creates the revolving magnetic field. b) The rotor rotates.
3. a) A short-circuit current heats the wire. b) The wire insulation melts and ignites.

**Ex.4. List as many instruments used for testing and repair in electronics as you can.** Compare your list with that of another group. How many of these instruments can you identify? Can you explain their use? Check your answers by reading this text.

The following instruments are commonly used for the test and repair of electronic circuits.

*Multimeter.* This instrument can be used to measure a number of different electrical quantities, such as voltage, current, a resistance, i.e. it is a combined voltmeter, ammeter, and ohmmeter. Multimeters can have analogue or digital displays and can be switched to different measuring ranges.

*Logic probe.* This instrument is used for measuring voltage levels and pulses in digital logic circuits. When the probe is placed on the pin of a logic IC, small coloured LEDs light up to indicate if a pulse is detected or whether the pin is at a high or a low logic level.

*Oscilloscope.* This instrument is used to measure fast-moving signals. It shows how a signal varies with time or relative to another signal. It uses a cathode tube to display the waveform of the measured signal on a screen.

*Function generator.* This instrument contains a triangular wave oscillator which can be switched to produce triangular, square, or sine waves over a range of frequencies. It is used to test and adjust a variety of electronic equipment such as audio amplifiers. The function generator provides a known signal which can be injected into a circuit. Often it is used with an oscilloscope so that a visual display of the waveform can be seen.

**Ex.5. Which of the instruments would you use to do the following?**

1) to check a fuse; 2) to determine the frequency response of an audio amplifier; 3) to test for the presence of a control signal on the output pin of a computer chip; 4) to determine the value of the current through a transformer; 5) to measure the frequency of an oscillator.

## Reading and Speaking

**Ex.1. Try to answer these questions about radar.**



a. What is a radar?
b. What are its principles of operation?
c. Where is it used?

**Ex.2. Read text in 3 minutes to see if you are correct having executed ex.1.**

**Radar**

Radio Detection and Ranging or "radar", for short, is one of the outstanding electronic developments of the twentieth century.

Assume that a flying airplane is high above the earth on a dark night. A searchlight station on the ground sends out a narrow light beam. When this beam strikes the airplane, light is reflected from the surface of the plane to the observer's eyes and the plane is detected.

With radar, an invisible narrow radio beam, striking the plane, is reflected to a radio receiver located near the transmitter and, thus, the plane is detected. However, it is not enough to find the target we are interested in. We must know how far the detected plane is, how high up as well as its compass position in relation to the observer.

With the radar equipment assistance, we are able to measure the time it takes the radio wave to travel from the transmitter to the planet and back again to the receiver. Knowing the speed at which the radio wave travels, it is relatively easy to calculate the distance between the plane and the radar station observer.

Because of the great speed of the radio wave, the time intervals are in the order of microseconds. The cathode-ray tube is the very device to be used for determining these small intervals of time.

Assume that at the instant when the transmitter sends its radio beam at the target, the electron stream in the cathode-ray tube is set moving horizontally at the rate which will make the trace across the face of the tube one inch (2.54 cm) per one hundred microseconds. Further assume that the plane is at such a distance from the transmitter that the radio wave requires 100 microseconds to reach it. Since the reflected wave will require the same time to reach the receiver the whole travel will consume 200 microseconds.

During the interval, the trace on the face of the cathode-ray tube will have travelled 2 inches. If we had some method of marking the trace so that it would record the instant at which it was received, we should be able to tell the time required for the round trip. The only thing to be done consists in measuring the distance between the two marks.

The radio wave is sent out as a short pulse of energy usually lasting only about one microsecond. Part of this pulse is sent to the vertical deflecting plates of the

cathode-ray tube. Its effect is to produce a short pip on the trace. When the reflected pulse is received it, too, goes to the vertical deflecting plates of the tube. Thus, a second pip appears on the trace.

By means of a scale printed on the cathode-ray tube face we can translate the distance existing between the two pips of the trace into the distance between the target and the radar station. Since each pulse duration is short and the time between pulses is relatively long the average power consumed is small.

Is there a possibility of employing the radar equipment for peaceful purposes? Yes, there certainly is. Radar developed for war purposes was quickly adapted to peacetime needs, especially in the field of navigation to detect obstacles which normally would not be seen for some reason or other.



# UNIT 33. ACTIONS IN SEQUENCE (beginning)

**Overview**

- Reading and Vocabulary: Technological scheme of the powdered-coal electric power station.
- Supplementary Information: The Carnot cycle.
- Language focus: Actions in sequence.
- Reading and Speaking: Generators.

## Reading and Vocabulary

**Reading**

Parts of four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Technological scheme of the powdered-coal electric power station**

Technological scheme of the powdered-coal electric power station is as follows. Fuel is supplied by train to unloading installation and then [ 1 ] and further to crusher with the aid of the conveyor belt. There is the possibility to supply coal from railroad car directly into crusher. Then coal enters into bunker for raw coal and further [ 2 ] via feed track. Coal powder is transported via separator and whirler into powdered-coal bunker and further [3 ] with the aid of the feed track.

Gases obtained during combustion in furnace chamber pass through a series of smoke flues of steam generator and give up their heat to superheater, waste gas heater and air heater. Then they are cleared from ashes in electric filters and are thrown away through smokestack by smoke sucker.

Slag and ashes fallen under furnace chamber, air heater and electric filters are washed away with water and reach dredging pumps, which pump them across to ash-disposal area.

Air being necessary for combustion is supplied into air heater with the aid of blow fan. [4 ].

Superheated steam from steam generator is supplied to turbine. Condensate from the turbine condenser is supplied by condensate pump through regenerative heaters of low pressure into deaerator and further by feed-pump through heaters of high pressure into waste gas heater.

Water and steam condensate loss is replaced with chemically desalted water, which is supplied into condensate line after turbine condenser.

Water for cooling is supplied to condenser from water source by circulating pumps. Warm water is discharged into the same source far enough from place of drawoff. Warm water is not allowed mixing with cool water.

Electric energy produced is supplied from electric generator to outside consumers through step-up transformers.

To supply energy to motors, lamps etc., electric power station has its own distributing network which is called auxiliary network.

Power stations using organic fuel always apply superheated steam. The higher temperature is the higher efficiency is. However, maximum temperature depends on construction materials used for production of heaters, steam pipeline and some turbine elements. At present, steam temperature before the turbine is usually equal to 540° with steam pressure nearly 235 bar.

**Reading comprehension**

**Ex.1**.

A. it is supplied to burners.
B. air is taken from fireroom.
C. it reaches powdered-coal mill.
D. it is transmitted by overhead lines.
E. it is supplied to coal storage.

**Ex.2. Read the text and find the answers to these questions.**

1. How is fuel supplied to unloading installation? 2. Is it possible to supply coal from railroad car directly into crusher? 3. Where are gases obtained? 4. Where do gases give up their heat? 5. What device are gases cleared in? 6. How are gases thrown away? 7. Where is air necessary for combustion taken from? 8. What is turbine supplied with? 9. How is water and steam condensate loss replaced? 10. Where is cooling water taken from? 11. What is auxiliary network? 12. What does maximum temperature depend on? 13. What are the initial parameters of steam?

**Ex.3. Find the wrong statements and correct them.**

1. Fuel is supplied by conveyor belt to unloading installation. 2. It is impossible to supply coal from railroad car directly into crusher. 3. Coal powder is transported into powdered-coal bunker and further it is supplied to burners. 4. Gases obtained during combustion in furnace chamber are thrown away at once through smokestack. 5. Gases are cleared from ashes in a waste gas heater. 6. Air being necessary for combustion is taken outside for higher efficiency. 7. Superheated steam from turbine is supplied to steam generator. 8. Water and steam condensate



loss is replaced with water taken from the pool. 9. Warm water is not allowed mixing with cool water. 10. Electric energy produced is supplied from electric generator to outside consumers through step-down transformers. 11. Auxiliary network is used to supply outside consumers with energy.

**Vocabulary**

**Ex.4. Define the following terms.**

unloading installation, conveyor belt, railroad car, raw coal, powdered-coal bunker, feed track, furnace chamber, smoke flue, waste gas heater, smokestack, ash-disposal area, superheated steam, heater of low pressure, chemically desalted water, circulating pump, step-up transformer, auxiliary network, high efficiency, steam pressure

**Ex.4. Fill in the words from the box below.** There is one word you shouldn't use.

| unloading installation, whirler, furnace chamber, ashes, smokestack, auxiliary network, heat exchanger, turbine, powdered-coal, deaerator, circulating pumps |
|---|

1. Technological scheme of the … electric power station is rather complex one.
2. Fuel is supplied by train to … .
3. Coal powder is transported via separator and … into powdered-coal bunker.
4. Gases are obtained during combustion in … .
5. Gases are cleared from … in electric filters.
6. Gases are thrown away through … by smoke sucker.
7. Superheated steam from steam generator is supplied to … .
8. Condensate from the turbine condenser is supplied into … .
9. Water for cooling is supplied to condenser from water source by … .
10. An electric power station has its own distributing network which is called … .

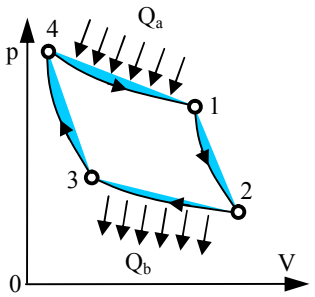
## Supplementary Information

**Ex.1. Read the text and find answer the question:** if a cycle similar to considered one can be used at the thermal power station. **Pay attention how to make references to the figure involved.**

**The Carnot cycle**

If a process can occur both in the direct and reverse sense so that the thermodynamic system returns to its initial state and there occur no changes in the surroundings, it is called a reversible process. If otherwise, it is an irreversible process. Irreversibility can be due to a number of causes. Firstly, some processes

may be non-equilibrium, though classical thermodynamics considers only equilibrium processes. Secondly, irreversibility can be caused by friction which accompanies virtually all processes. Thirdly, this may be heat exchange at the final temperature difference. Irreversibility always results in a decrease of the work performed by a thermodynamic system. The Carnot cycle is very cycle which they try follow at the thermal power stations.




The Carnot cycle consists of two isotherms and two adiabats. The p-V diagram of the Carnot cycle is illustrated in figure. This is a reversible cycle. Along the line 1-2, there occurs adiabatic expansion of the working fluid whose temperature drops down from $T_1$ to $T_2$. The process along line 2-3 is isothermal compression accompanied with removal of heat $Q_b$ to a heat sink. In the process shown by the line 3-4, adiabatic compression is accompanied with an increase of temperature of the working fluid from $T_3$ to $T_4$ (or, what is the same, from $T_2$ to $T_1$). In the process 4-1, isothermal expansion is accompanied with the supply of heat $Q_a$ from the hot source to working fluid. The area of the cycle determines the work of cycle. The thermal efficiency is determined under the formula

$$\eta_t = 1 - T_2/T_1.$$

It is remarkable that the formula has been derived for an arbitrary working fluid. This fact is stressed in Carnot's first theorem: *the thermal efficiency of a reversible Carnot cycle is independent of the properties of working fluid and is equal to* $1 - T_2/T_1$. It follows that, the higher the upper temperature $T_1$ and the smaller the lower temperature $T_2$, the greater is the thermal efficiency of the Carnot cycle.

In thermodynamics it is derived Carnot's second theorem: *the reversible Carnot cycle is the most efficient in a given temperature interval*. The efficiency of real heat engines is always lower, since, firstly, practical cycles differ from the Carnot cycle and, as follows from Carnot's second theorem, have a lower thermal efficiency. Secondly, the thermal efficiency of real heat engines is lower because of irreversibility of the processes. The thermal efficiency of a heat engine with due allowance for the irreversibility of the process is called the internal efficiency:

$$\eta_i = \eta_t \cdot \eta_{ir},$$

where $\eta_t$ is the thermal efficiency of an arbitrary reversible cycle and $\eta_{ir}$ is the internal relative efficiency which takes account of the losses associated with irreversibility of real processes.



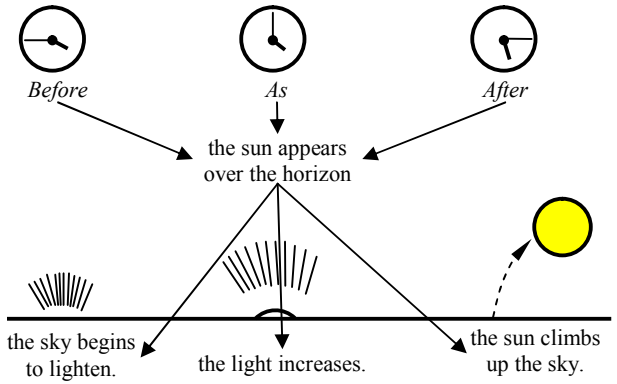
**Ex.2. Find in the text above the English equivalents to the following Russian word combinations.**

1. Примечательно, что формула выведена для … 2. Если не происходит изменений … 3. В противном случае это – … 4. … может быть по ряду причин. 5. … всегда имеет результатом … 6. … это именно тот цикл, которому стараются следовать … 7. В процессе, представленном линией … 8. Этот факт подчёркивается в … 9. … который принимает во внимание …

## Language focus

**ACTIONS IN SEQUENCE.** Preceding, simultaneous and following events

**Ex.1. Look, read and translate:**




*When* the sun rises, the day begins.

The day continues *until* the sun sets.

Each sentence contains two events, X and Y. Read out the sentence which means:

a) X occurs at the same time as Y (simultaneously with Y).
b) X occurs at approximately the same time as, or soon after, Y.
c) X precedes Y.
d) X follows Y.
e) Y is at the end of X.

Now complete these sentences:

f) _____ the sun rises, the air temperature rises.
g) _____ the sun reaches the highest point in the sky, it begins to descend.

h) _____ the sun descends, the air temperature falls.
i) _____ the sun sets, it approaches the horizon.
j) _____ the sun sets, the sky becomes completely dark.
k) _____ the sun sets, the day ends.
l) The night begins _____ the sun sets.
m) The night continues _____ the sun rises.

**Ex.2. Number these events in order in which they occur when water is heated.** Give simultaneous actions the same number.

a) The water becomes hot. b) The gas is lit. c) Bubbles appear.
d) Steam appears. e) The gas is turned on. f) Bubbles burst.
g) Bubbles rise to the surface. h) The water evaporates.

Now look at the two points in this example:
*As soon as* the gas is turned on, *it* is lit. (X follows Y immediately).

Complete these sentences:
a) As the water evaporates, …….
b) As soon as the bubbles burst, ……...
c) When the bubbles rise to the surface, ……..
d) As soon as the gas is turned on, ……...
e) Before the gas is lit, …….
f) After the water becomes hot, ……
g) As soon as the bubbles appear, ……..

**Ex.3. Number these events in order in which they occur.** Give simultaneous actions the same number.

a) The water ceases boiling. b) The flame is extinguished.
c) The water starts to boil. d) The water continues boiling.
e) The gas is turned off. f) The bubbles disappear.

Now write complete sentences joining these pairs of events and making any other necessary changes:
d + *b *e + b *c + d *a + e *b + a *a + f
*Use one of these expressions: when; before; until; after; as soon as.
*Example*: As soon as the gas is turned off, the flame is extinguished.



## Reading and Speaking

**Ex.1. Read the following text in 4minutes and answer the question** "What is principal difference between a generator and an alternator?"

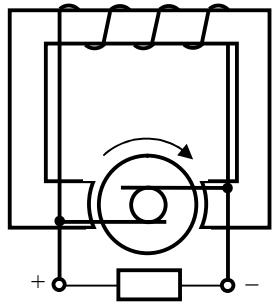
**Generators**

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

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

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

There are two types of dynamos, namely the generator and the alternator. The former supplies d.c. which is similar to the current from a battery and the latter, as its name implies, provides a.c.




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

Both generators and alternators consist of the following principal parts: an armature and an electromagnet. The electromagnet of a d.c. generator is usually called a stator for it is in a static condition while the armature (the rotor) is rotating. Figure shows the principles the construction of an elementary d.c. generator is based upon. We see the armature, the electromagnet, the shunt winding, the commutator and the load. Alternators may be divided into two types: 1. alternators that have a stationary armature and a rotating electromagnet; 2 alternators whose armature serves as a rotor but this is seldom done. In order to get

a strong e.m.f., the rotors in large machines rotate at a speed of thousands of revolutions per minute (r.p.m.). The faster they rotate, the greater the output voltage the machine will produce.

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

**Ex.2. Translate the following sentences paying attention to the subordinate clauses.**

1. The plants which supply electricity over long distances are equipped with large alternators. 2. When asked about the dynamo the student mentioned its inventor. 3. The experiments Oersted made attracted Ampere's attention. 4. The armature and the electromagnet are the principal parts the generator consists of. 5. That the electromagnets are controllable is a very important thing, since they can attract and repel magnetic materials. 6. The alternator is a machine that generates a.c. 7. A bar of iron becomes strongly magnetized if inserted into the solenoid while the current is flowing.

**Ex.3. Answer the questions.**

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

**Ex.4. Read the following abbreviations and give their full forms.**

i.e.; a.c.; d.c.; r.p.m.; e.m.f.; m.m.f.; 317°F, 45°C, 285K; etc.



# UNIT 34. ACTIONS IN SEQUENCE (continuation)

**Overview**

- Reading and Vocabulary: Lightning.
- Information Transfer: Cathode ray oscilloscope.
- Language focus: Actions in sequence. Sequences.
- Reading and Speaking: Transformers.

## Reading and Vocabulary

**Reading**

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Lightning**

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

Take the early Scandinavians as an example. They thought that thunderstorms were produced by Thor, the god of thunder. Besides his throwing both thunder and lightning at some people, he was a hammer-thrower. According to the story, his powerful hammer had the property of always coming back to his hands after it had been thrown. [ 1 ] A story like that invented by those early Scandinavians could be also heard from other peoples.

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

Even now some people do not like being out during a thunderstorm. [ 2 ] There are lightning flashes followed by thunder which can be heard for kilometres around. Needless to say, there is always some danger in a thunderstorm for a very high building or a man standing in the open field.

Many years ago people learned to protect their houses from thunderstorms. Coming down from a charged cloud to the earth, lightning usually strikes the nearest conductor. [ 3 ] That Benjamin Franklin invented the lightning conductor is

a well-known fact. The lightning conductor familiar to everybody at present is a metal device protecting buildings from strokes of lightning by conducting the electrical charges to the earth.

Franklin's achievements in the field of electricity were known to Lomonosov who, in his turn, made experiments of his own. Along with other scientific problems that Lomonosov studied was that of atmospheric electricity. Both Lomonosov and his friend Professor Rihman took great interest in it. [ 4 ] They made numerous experiments and observations without thinking of the possible danger. The first electrical measuring device in the world was constructed by Rihman. Making experiments of that kind was dangerous and Professor Rihman was killed by a stroke of lightning while he was making one of his experiments.

**Reading comprehension**

**Ex.1**.

A. Therefore, it is necessary to provide an easy path along which electrons are conducted to the earth.

B. Assume that a flying airplane is high above the earth on a dark night.

C. The fifth day of the week, that is Thursday, was named after him.

D. Both of them tried to solve the problem in question.

E. Dark clouds cover the sky, turning day into night.

**Ex.2. Read the text and find the answers to these questions.**

1. What was the earliest manifestation of electricity known to man? 2. Is the lightning flash a dangerous phenomenon? Why? 3. How did the early Scandinavians explain a thunderstorm? 4. Where does a lightning usually strike? 5. Who was the first to study lightning? 6. Why is the fifth day of the week named Thursday?

**Ex.3. Find the wrong statements and correct them.**

1. The lightning flash is kind of atmospheric electricity. 2. The early Russians thought that thunderstorms were produced by Thor. 3. Nobody knows that lightning results in a discharge of atmospheric electricity. 4. There are lightning flashes followed by thunder which can be heard for kilometres around. 5. Many years ago people learned to protect their houses from thunder.

**Vocabulary**

**Ex.4. Define the following terms.**

flash, thunderstorm, hammer-thrower, charged cloud, lightning conductor, possible danger



## Information Transfer

**Ex.1.** The task which follows provides further practice in combining information from a diagram and a text when reading.

**Cathode ray oscilloscope**

**Cathode ray tube**. Televisions as well as computers, radar systems, and oscilloscopes use a cathode ray tube (CRT) to produce an output display. The construction and operation of the CRT is similar in each case but the simplest type of CRT is found in oscilloscopes,

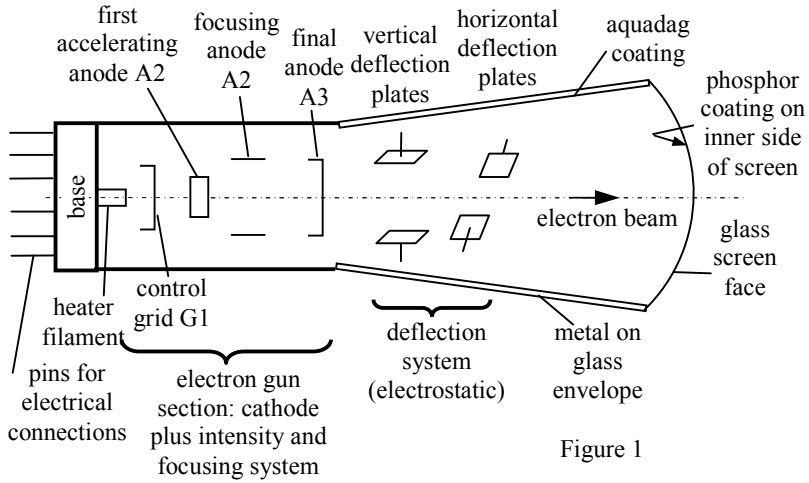



Figure 1

A CRT is really a large vacuum tube valve. It has three main sections (fig. 1). The first section is an electron gun which emits a stream of electrons. The electron gun contains an electron lens which focuses the electrons into a narrow electron beam. The second section is a deflection system, which allows the beam to be moved vertically or horizontally. Oscilloscopes use charged metal plates to give mechanical deflection, whereas television sets use electromagnetic coils to give electromagnetic deflection. The last section is a screen with a phosphor coating. The electron beam hits the screen, making the phosphor glow and causing a spot to be displayed. The colour of the spot depends on the type of phosphor used.

**Electron gun**. A stream of electrons is released from the surface of the cathode when it is heated by the heater filament. The electrons are accelerated towards the screen by a set of three positively-charged cylindrical anodes (A1, A2, A3). Each

anode has a higher charge than the one before. As the electrons move towards the anodes they pass through a hole in a negatively-charged metal disc. This disc is known as the control grid (G1). By adjusting the intensity control on the oscilloscope, the charge on the grid can be varied. This allows the number of electrons reaching the screen, and therefore the brilliance or brightness of the spot on the screen, to be adjusted.

The three anodes form the electron lens. The oscilloscope focus control allows the voltage on the second anode (A2) to be varied and causes the stream of electrons to be focused into a narrow beam. If the oscilloscope has an astigmatism control, it is used to vary the voltage on the third anode (A3). This allows the shape of the spot on the screen to be adjusted to make it perfectly round.

**Deflection system**. After leaving the electron gun, the electron beam is deflected by two pairs of parallel metal plates. The pairs of deflection plates are situated at right angles to each other.

The signal to be measured is amplified by the Y-amplifier in the oscilloscope, then applied to the first set of deflection plates, known as the Y-plates. This causes the electron beam to be deflected vertically in proportion to the magnitude of the input signal.

The oscilloscope has a timebase generator which produces a sawtooth wave output as shown in fig. 2.

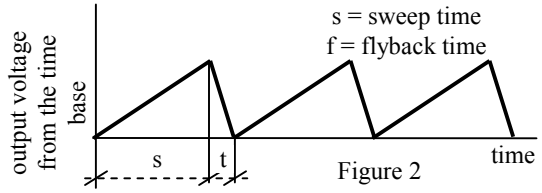


Figure 2

This is fed into the X-amplifier of the oscilloscope, then applied to the second set of deflection plates, known as the X-plates. This causes the electron beam to be deflected in the horizontal direction in such a way that the spot moves from left to right across the screen at a steady rate. When it reaches the right side of the screen, it rapidly returns to the left side again. This allows the screen to show how the measured signal varies with time.

**Phosphor screen**. The X and Y deflections of the electron beam cause the signal being measured to be displayed in the form of a wave, with the magnitude of the signal being given on the vertical axis and the time variation on the horizontal axis. A piece of transparent plastic known as a graticule is attached to the front of the screen. This has a grid of horizontal and vertical lines marked on it and allows accurate measurements of the signal to be made.

A large build-up of negative charge could be caused by the electron beam hitting the phosphor screen. To help prevent this, the inside of the CRT, between



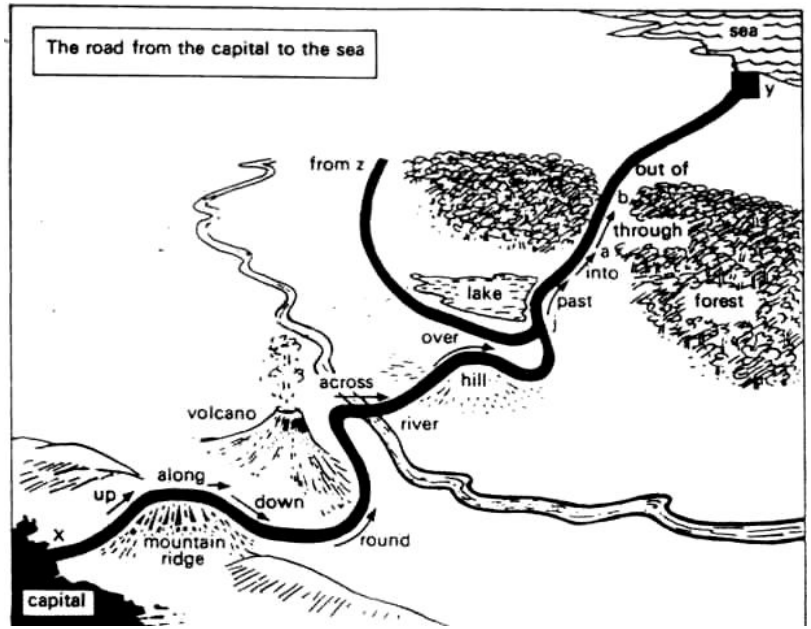
the deflection system and the screen, is coated with a carbon compound known as Aquadag. This is attached to the high voltage anode (A3) to provide an escape path for the excess electrons.

The CRT is enclosed in a metal casing made from an alloy of nickel, known as mu-metal. This has a very high magnetic permeability and prevents external magnetic fields from causing unwanted beam deflections.

## Language focus

**ACTIONS IN SEQUENCE. Sequences**

**Ex.1.** Look at this diagram:




Now complete this description:

A road leaves the capital at X. It goes _____ a mountain, _____ a ridge and _____ the other side. It goes _____ a volcano, _____ a river and _____ a hill. It joins the road _____ Z _____ the junction, J. It goes _____ a lake and _____ a forest. It goes _____ the forest _____ A and comes _____ the forest _____ B. The road reaches the sea _____ Y.

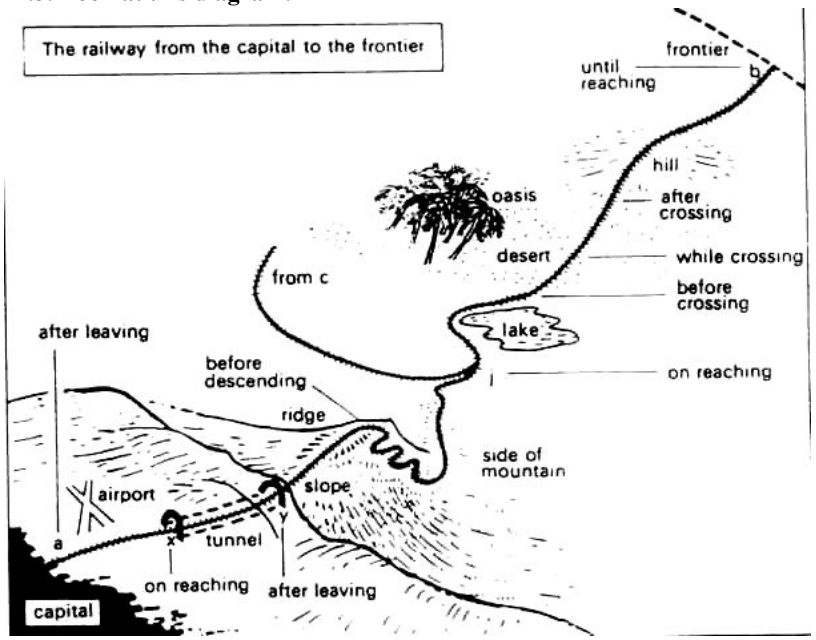
**Ex.2. Look at these sentences:**

After *the road leaves* the capital at X, *it* goes up the mountain.
After *leaving* the capital at X, *the road* goes up the mountain.
When *the road reaches* A, *it* goes into the forest.
*On reaching* A, *the road* goes into the forest.

**Change these sentences into the second form:**

a) After the road goes round the volcano, it crosses the river.
b) Before the road enters the forest, it passes the lake.
c) When the road emerges from the forest, it is near the sea.
d) After the road ascends the hill, it goes along the ridge.
e) Before it goes round the volcano, the road descends the mountain.
f) As it goes between the hill and the lake, the road joins the road from Z. (*While going …*)
g) When the road reaches the volcano, it goes round it.
h) As the road travels from X to Y, it crosses a river.

**Ex.3. Look at this diagram:**






**Now write nine sentences using the opening phrases in the diagram**.

*Example*: After leaving the capital at A, the railway goes past the airport.

**Ex.3. Look at these sentences:**

*While crossing* the desert, the railway *passes* an oasis.
The railway *crosses* the desert, *passing* an oasis.
(X is simultaneous with Y, or occurs during Y).

**Now change these sentences into the second form:**

a) While going through the tunnel, the railway passes under the mountain.
b) While descending the mountain, the railway makes several turns.
c) While passing the lake, the railway travels in a semi-circle.
d) While crossing the desert, the railway passes an oasis.
e) While approaching the frontier, the railway goes over a hill.
f) While traveling between the mountain and the lake, the railway joins the railway line from C.

## Reading and Speaking

**Ex.1. Read the following text in 4minutes and answer the question** "What properties do semiconductors have?"

**Transformers**

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

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

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

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

Transformers are used in stepping up the voltages for distribution or transmission over long distance and then in stepping these voltages down. One could have some other transformers in the system that reduce the voltage even further.

All radio sets and all television sets are known to use two or more kinds of transformers. These are familiar examples showing that electronic equipment cannot do without transformers. The facts you have been given above illustrate the wide use of transformers and their great importance.

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

Inefficiency in a transformer is caused mainly by heat losses due not only to current flowing in the coils but also to unwanted currents induced in the core of the transformer. Currents induced in the core are generally called “eddy currents”. The flow of eddy currents is stopped in its progress and the efficiency of the transformer is increased by constructing the transformer core of flat sheets of soft iron.

**Ex.2. Find the English equivalents to the following Russian word combinations.**

нежелательные токи, наводимые в сердечнике трансформатора; создаёт переменный магнитный поток; изготовление сердечника трансформатора; вышеописанный процесс нуждается в незначительном количестве энергии; важно отметить, что рассматриваемое устройство не работает на постоянном токе.

**Ex.3. Compare:**

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



# UNIT 35. SYSTEM OPERATION. ACTIONS IN SEQUENCE (completion)

**Overview**

- Reading and Vocabulary: System operation.
- Language focus: Actions in sequence. Cycles and stages.
- Reading and Speaking: The carbon cycle.

## Reading and Vocabulary

**System operation**

A transmission system may be *vertically integrated*, in which case the generating plant belongs to the same utility, or more commonly it may be *unbundled*, in which case it has only transmission capacity, with no generation plant. In either case, the main tasks for the transmission operator are to maintain a constant frequency and voltage for all consumers, and to operate the system economically and securely. Security in this context means maintaining voltage within limits, staying within a prescribed stability margin and operating all circuits within their thermal rating. This requires adequate monitoring of all the transmission components, with sufficient communication and control facilities to achieve these desired goals. Most transmission systems will, therefore, have a coordinating room and possibly a number of manned outstations for local or regional devolvement of responsibility.

For frequency control, some of the synchronized generators are equipped with sensitive governors which use a frequency signal rather than a speed signal. The output of these generators is dependent upon the balancing power required to achieve a steady frequency over the whole system. The transmission system operator, backed up by computer forecasts of load variations and knowledge of the available plant and their offer prices, may have the authority to instruct generators to start up or to shut down (*unit commitment*) and to set their output (*loading* or *dispatching*) so that over a prescribed hourly, daily or weekly period they generate energy to meet the consumer demand at the minimum overall cost. In the UK however, the system operator only has the authority to select offers and bids from generators and energy purchasers to effect a *balancing market*, whereas the bulk unit commitment and dispatch of generation and demand is accomplished by a *bilateral market*. In a bilateral market, generators contract directly with energy purchasers and are responsible for their own output scheduling. The balancing market operates over a short time period (one hour in the UK) imposing any

adjustments necessary to obtain balanced supply and demand and technical satisfaction of any transmission system constraints.

There is a considerable scope for minimization of the losses in an interconnected system through the control of the compensation devices. This control is guided by the use of optimal load flow programs, security assessments and calculations of transient stability margin. One of the main concerns is to arrange patterns of generation, including some plant which may otherwise be uneconomic, to maintain voltage despite outages of circuits and other components for maintenance, extension and repair. Safety of utility personnel and the operation of the system to avoid risk to the public is at all times paramount.

**Reading comprehension**

**Ex.1. Read the text and find the answers to these questions.**

1. How is a transmission system termed in case the generating plant belongs to the same utility? 2. In which case a transmission system is unbundled? 3. What are the main tasks for the transmission operator? 4. Why is the monitoring of all the transmission components required? 5. Why are the synchronized generators equipped with sensitive governors? 6. What signal do they use? 7. What difference is between a balancing market and a bilateral one?

**Vocabulary**

**Ex.2. Translate the following sentences and define the function of the word *provided*.**

1. A transmission system is provided with sufficient communication and control facilities to monitor all the transmission components. 2. A transmission system provided with no generation plant is called to be unbundled. 3. The synchronized generators work properly provided they are equipped with sensitive governors which use a frequency signal. 4. The transmission system operator has the authority to instruct generators to start up or to shut down provided there are computer forecasts of load variations. 5. The computer facilities provided the possibility to set the energy output so that to meet the consumer demand provided the system operator had the authority to select offers and bids from generators and energy purchasers.

## Language focus

**ACTIONS IN SEQUENCE. Cycles and stages**

### Before you start

Discuss the questions below.



1. Which process is termed “a cycle”?
2. Can you give the examples of life-, or production-, or any other cycles?

**Ex.1. Read the stages in the life-cycle of a plant.**

1 sowing of seed; 2 the seed is watered; 3 germination: the seed swells; 4 growth: roots and leaves develop; 5 buds form; 6 flowering; 7 pollination: the stigma receives pollen, the flower is fertilized; 8 formation of fruit; 9 the seeds fall; 10 death of the plant; 11 decay: the plant decomposes.

**1. Look at these examples:**

*Preceding actions*: Before the plant germinates, it is watered.
Before (prior to) germination, the seed is watered.

*Following actions*: After the plant germinates, the roots and leaves develop.
After germination, the roots and leaves develop.
After the seed is watered, germination occurs (takes place).

*Simultaneous actions*: As the plant germinates, the seed swells.
During germination, the seed swells.
While geminating, the seed swells.

**2. Look again at the life-cycle of a plant and then read this description:**

*First*, the seed is sown. *Next*, it is watered. *Then*, the seed begins to swell. *At this stage*, germination begins. *Subsequently*, the roots develop. *Meanwhile*, the leaves also develop. *Later*, flowers appear. *Then*, pollination takes place. *During this process*, the stigma receives pollen. *Afterwards*, the fruit forms.

**Ex.2. Now answer these questions:**

a) What happens prior to germination?
b) What occurs during growth?
c) What happens before flowering?
d) What takes place after pollination?
e) What happens after the seeds fall?
f) What occurs before the plant decomposes?
g) What occurs as the plant decomposes? .

**Ex.3. The words in *italics* mark stages in a process. Now give the following:**

a) A word which marks the opening, or initial, stage.
b) A word which marks the last, or ultimate, stage.
c) Two words which mark next or following stages.
d) Three expressions which mark events occurring some time later.
e) Three expressions which mark simultaneous events.
f) One word which marks an event occurring after a long process.

**Ex.4. Put these stages in building a house in the right order and then match them with expressions on the left:**

| | |
|---|---|
| First, | the drains are dug. |
| Then, | the materials are bought. |
| Meanwhile, | the house is painted. |
| Subsequently, | the walls are built. |
| At this stage, | the site is bought. |
| Next, | the site is leveled. |
| Afterwards, | the foundations are laid. |
| Then, | the house is ready to live in. |
| Later, | the roof is made. |
| Eventually, | the doors and windows are put in. |
| Finally, | the electricity and water systems are installed. |

## Reading and Speaking

**The carbon cycle**

All plants and animals need carbon for growth. Carbon is present in the atmosphere in the form of carbon dioxide gas. But it is present only in small amounts. This means it has to be used again and again. Animals and plants continually take in and give out carbon during respiration. They also take it in when they feed, and give it out when they die. This continual process is called the carbon cycle.

Plants take in carbon from the air during photosynthesis. In this process, plants use energy from the sun together with carbon dioxide from the air. They then make sugars, and other carbohydrates. The carbohydrates are needed for the growth of roots, stems and leaves.

The leaves may subsequently be eaten by animals, which digest the carbohydrates. The carbon is then used for building muscles and bones. Some of the carbon, however, is returned to the atmosphere after respiration, when carbon dioxide is released from the body.

When an animal eventually dies, decomposition of the body tissue takes place. Through the action of bacteria and other organisms, the chemicals are broken down, or decomposed, and carbon dioxide is released.

Some dead plants are buried under earth. Over millions of years, the pressure of the earth turns them into coal. When coal is burned to produce heat, carbon is released.

Many tiny animals living in the sea have carbon in their shells, in the form of calcium carbonate. When these animals die, their shells form layers of calcium carbonate at the bottom of the sea. These eventually turn into a rock, called limestone. After movements of the earth, the limestone may reach the surface. The wind and rain then wear away the limestone, and some of its carbon is once more released into the atmosphere.



**Ex.1. Look at these questions and then read the text. Which paragraph answers each question?**

a) How do animals take in carbon?
b) How is limestone formed?
c) What is the carbon cycle?
d) How do plants take in carbon?
e) How is coal formed?
f) How do animals give up carbon?

**Ex.2. Try to retell the text.**

**Ex.3. In accordance with your variant, prepare your own description of a cycle.** Use the auxiliary words and expressions given in brackets. At description, use the words marking stages (first, at this stage, afterwards, finally, then, etc.).

1) The water cycle in nature (evaporation of sea water, formation of vapour, rise and cooling of vapour, condensation and formation of clouds, movement of clouds, fall in temperature, atmospheric precipitation, absorption by soil, flow back to the sea).
2) The water cycle at the heat power station (addition of desalted water, feed-pump, heating of cool water in economizer (waste gas heater), heating in pipes of steam boiler, superheater, steam into the turbine, exhaust vapour (waste steam), steam condensate, steam condenser).
3) The cycle of events in a refrigerator (the gas is passed round by the pump, is compressed, liquefaction, change into liquid, heat – out to the atmosphere, liquid – through an expansion valve, the pressure is reduced, evaporation, change into gas, heat is taken in, the air becomes cold).
4) The cycle of plastic bottles (production at the plant, are filled with a drink, transportation to the shop, selling, drinking, becomes empty, into metallic box shaped like a tetrahedron, delivery to the plant, cutting down into pieces, melting).
5) The cycle of currency (delivery of notes to a bank, selection of exhausted notes and addition of new ones, receipt of deposit by plant, paying a salary, shopping and purchasing, packing of notes for delivery to a bank).
6) The blood cycle in a human body (two loops, heart, aorta, artery, to conduct blood away from the heart, capillary, delivery of oxygen, organs, exhausted blood, vena (vein), to conduct blood back to the heart, lung, to oxygenate the blood).

# UNIT 36. INSULATING MATERIALS. PERFORMANCE OF THE TERM PAPER

**Overview**

- Reading and Vocabulary: Insulating materials.
- Supplementary Information: Performance of the term paper.
- Language focus: Linking the sentences.
- Reading and Speaking: Semiconductors.

## Reading and Vocabulary

### Reading

Parts of four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

### Insulating materials

The reason for using insulating materials is to separate electrically the conducting parts of equipment from each other and from earthed components. Earthed components may include the mechanical casing or structure that is necessary to enable the equipment to be handled and to operate. Whereas the 'active' parts of the equipment play a useful role in its operation, [ 1 ]. For example in an electric motor the copper of the winding and the steel core making up the magnetic circuit are the active components and both contribute to the power output of the motor; the insulation which keeps these two components apart contributes nothing, in fact it takes up valuable space and it may be considered by the designer as not much more than a nuisance.

For these reasons, insulating materials have become a design focus in many types of electrical equipment, with many companies employing specialists in this field and carrying out sophisticated life testing of insulation systems. Such is the importance attached to this field that [ 2 ], for instance by the IEEE in USA, IEE and Electrical Insulation Association (EIA) in UK and the European Electrical Insulation Association (EEIM) in Europe, all of which publish the papers presented. Conferences are also held in Canada, India and South Africa.

The simplest way to define an insulating material is to state what it is not. It is not a good conductor of electricity and [ 3 ], unlike conductors. The following are the most important properties of insulating materials:

- *volume resistivity*, which is also known as specific resistance;



- *relative permittivity* (or dielectric constant), which is defined as the ratio of the electric flux density produced in the material to that produced in vacuum by the same electric field strength. Relative permittivity can be expressed as the ratio of the capacitance of a capacitor made of that material to that of the same capacitor using vacuum as its dielectric;
- *dielectric loss* (or electrical dissipation factor), which is defined as the ratio of the power loss in a dielectric material to the total power transmitted through it. It is given by the tangent of the loss angle and is commonly known as *tan delta*.

The most important characteristic of an insulating material is its ability to withstand electric stress without breaking down. This ability is sometimes known as its *dielectric strength*, and [ 4 ]. Typical values may range from 5 to 100 kV/mm, but it is dependent on a number of other factors which include the speed of application of the electric field, the length of time for which it is applied, temperature and whether ac or dc voltage is used.

Another significant aspect of all insulating materials that dominates the way in which they are categorized is the maximum temperature at which they will perform satisfactorily. Generally speaking, insulating materials deteriorate over time more quickly at higher temperatures and the deterioration can reach a point at which the insulation ceases to perform its required function. This characteristic is known as ageing, and for each material it has been usual to assign a maximum temperature beyond which it is unwise to operate if a reasonable life is to be achieved. The main gradings or classes of insulation as defined in IEC 60085:1984 and its UK equivalent BS 2757:1986(1994) are listed in Table. Where a thermal class is used to describe an item of electrical equipment, it normally represents the maximum temperature found within that product under rated load and other conditions. However, not all the insulation is necessarily located at the point of maximum temperature, and insulation with a lower thermal classification may be used in other parts of the equipment.

| Thermal class | Operating temperature (°C) |
|---|---|
| Y | 90 |
| A | 105 |
| E | 120 |
| B | 130 |
| F | 155 |
| H | 180 |
| 200 | 200 |
| 220 | 220 |
| 250 | 250 |

The ageing of insulation depends not only on the physical and chemical properties of the material and the thermal stress to which it is exposed, but also on the presence and degree of influence of mechanical, electrical and environmental stresses. The processing of the material during manufacture and the way in which it is used in the complete equipment may also significantly affect the ageing process. The definition of a useful lifetime will also vary according to the type and usage of

equipment; for instance the running hours of a domestic appliance and a power station generator will be very different over a 25-year period. All of these factors should therefore influence the choice of insulating material for a particular application.

There is therefore a general movement in the development of standards and methods of testing for insulating materials towards the consideration of combinations of materials or *insulating systems*, rather than focusing on individual materials. It is not uncommon to consider life testing in which more than one form of stress is introduced; this is known as *multifunctional* or *multifactor testing*.

*Primary* insulation is often taken to mean the main insulation, as in the PVC coating on a live conductor or wire. *Secondary* insulation refers to a second 'line of defence' which ensures that even if the primary insulation is damaged, the exposed live component does not cause an outer metal casing to become live. Sleeving is frequently used as a secondary insulation.

Insulating materials may be divided into basic groups which are *solid dielectrics*, *liquid dielectrics*, *gas* and *vacuum*.

**Notes and comments**

*IEEE* stands for *Institute of Electrical and Electronics Engineers*. It is an association which approves its own standards.

*IEC* stands for *International Electrotechnical Commission*.

*PVC* stands for *polyvinyl chloride*.

*Sleeving* means a placement of a conductor into the case shaped like the sleeve.

**Reading comprehension**

**Ex.1**.

A. is usually quoted in kilovolts per millimetre (kV/mm).
B. major international conferences on the subject are held regularly.
C. it has great influence upon the final result.
D. the insulation is in many ways a necessary evil.
E. it has a high electrical resistance that decreases with rising temperature.

**Ex.2. Read the text and find the answers to these questions.**

1. What components of an installation must be earthed? 2. Which parts of the equipment are called the 'active' parts? 3. What does the insulation do in an electric motor? 4. Why have insulating materials become a design focus in many types of electrical equipment? 5. What are the most important properties of insulating materials? 6. How is relative permittivity defined? 7. How is dielectric loss defined?



8. How are insulating materials categorized? 9. What is ageing of insulating material? 10. How does ageing affect the insulating material?

**Ex.3. Find the wrong statements and correct them.**

1. The reason for using insulating materials is to separate magnetically different parts of equipment. 2. The mechanical casing is necessary to enable the equipment to be handled and to operate. 3. The simplest way to define an insulating material is to state what it can do. 4. The most important characteristic of an insulating material is its dielectric strength. 5. Boiling temperature is a significant aspect of all insulating materials. 6. A thermal class represents the maximum temperature allowable for an insulating material.

**Vocabulary**

**Ex.4. Define the following terms.**

earthed component, mechanical casing, active components, design focus, electric field strength, live conductor

**Ex.5. Learn to recognize the following international words.**

active component, role, designer, focus, company, association, conference, dielectric constant, category, classification

## Supplementary Information

**Before you start**

Discuss the following questions.

1. What is a term paper?
2. What does it contain?
3. What requirements to a term paper do you know?

**Ex.1. Read the extractions from the DonNTU standard concerning performance of a term paper.** Search out new strange words. Try to remember the rules presented.

**Requirements to performance of the term paper**

1 Principal statement

1.1 Term paper should not have more than 40-50 pages. It is divided onto parts, namely: introduction part; main part; appendices (if necessary).

Introduction part includes the following elements: title page; task page and timetable; abstract; contents; list of symbols, units, abbreviations, terms (if necessary).

1.2 Main part is to contain: introduction; work essence; conclusions; reference list.

1.3 Abstract is to contain: information about paper volume, number of illustrations, tables, appendixes, number of sources in the reference list; text of abstract; list of key words.

The text of the abstract corresponds to the information presented in the term paper and, as a rule, obeys to the definite order: subject of investigation; work aims; investigation methods; results and their novelty.

Abstract has not more than 500 words and is presented on one page of A4-size.

Key words are essential for the term paper matter and are formed on the **ground of the abstract text** and are placed at the end of abstract. List of key words includes 5 – 15 words (phrases).

1.4 Contents are given after the abstract on a new page.

1.5 Conclusions are placed after the work essence on a new page. The text of conclusions may be divided onto steps.

1.6 Appendices contain the material necessary to perform the work, however its insertion into main part can break the order of the paper presentation.

2 Rules to perform the term paper

2.1 The term paper is performed on the pages of format A4 (210x297 *mm*). If necessary it is allowed to use the format A3 (297x420 *mm*). The term paper may be performed in handiwork form as well as with the computer aid. It is performed on one side of white paper. There must be not more than 40 lines per a page. Height of letters is not less than *h*=2.5 *mm*. Sizes of fields are as follows: top, left and bottom one – not less than 20 *mm*, right field – not less than 10 *mm*.

2.2 Indentations are equal to 5 blanks (10-15 *mm*). Each point, sub point and so on is presented with indentation.

2.3 The text of a term paper is to be clear, accurate, monosemantic. To perform a compulsory requirement the following words are used: «must be», «it follows», «it is necessary», «it needs, it requires that», «it permits only», «it is barred from», «it is suppressed». Otherwise the following words are involved: «as a rule, generally, usually», «at necessity», «may be», «it is recommended» and so on.

2.4 Sections, subsections, points, subpoints are to be numerate with Arabic numerals. Sections are to have numeration in boundaries of the main part, for example, 1, 2, 3 and so on. Subsections are to have numeration in boundaries of



each section. Number of subsection consists of number of section and number of subsection separated by point.

2.5 The term paper pages are to be numerated with Arabic numerals, continuous numbering being observed all around the text. Page number is shown at the top right corner of a page without point at the end.

«Title page», «Task» are included into general numbering of pages. Page number is not shown at the title page.

Illustrations and tables covering the whole page are included into common numbering of pages.

2.6 Illustrations (figures, plots, schemes diagrams, photos) are presented just after the text where they are mentioned first time or at the next page. All illustrations are to be mentioned in text. While referring to illustration one should write down: «... in accordance with fig. 3» if continuous numbering is involved or «... in accordance with fig. 1.2» if numbering is realized in boundaries of section.

2.7 Numeric data are presented as a rule, in a tabular form.

Depending on its size a table is placed below the text with reference to it or at the next page, if necessary it can be placed in the appendix. It is allowed to place a table along the long side of a page.

2.8 Formulae and equations should be numerated with continuous numbering in boundaries of a section. For instance:

Absolute electric efficiency of installation is determined under the formula:

$$\eta_{TV}^{a} = \frac{3600 N_E}{Q_{TV}}, \qquad (2.1)$$

where: 3600 – scale factor;

$N_E$ – electric power, *kW*;

$Q_{my}$ – heat consumption by installation, *kJ/h* [23].

2.9 Material to expand the term paper text may be placed in an appendix. The appendix may be the graphical material, tables of a big format, calculations, description of installation, description of algorithms and programs if it is not a principal task of the work.

Appendixes are performed as continuation of the work at the next pages. Appendixes have the page numbering common with the whole work. In the text there must be references to all the appendixes.

## Language focus

**Linking the sentences**

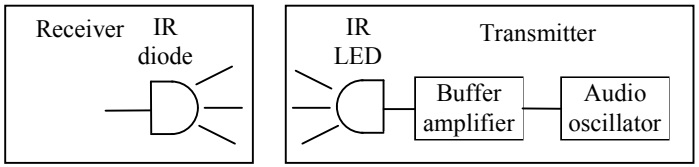
**Ex.1. Read the text below and propose its headline.**

The widespread use of television remote control units has turned the British into a nation of couch potatoes (people who spend most of their time sitting on a couch (sofa) watching television.

The remote control unit contains keys and electronic components similar to those of a calculator. The keys are connected by a matrix of wires which cross beneath each individual key. Pressing a key completes an electrical circuit, and a signal is sent to a microchip which, in turn, sends a series of on-off electrical pulses to a light-emitting diode (LED) at the front of the handset. A code spelt out by the length and spacing of these pulses switches on the LED. The LED flashes on and off to send an infra-red beam to the receiving 'eye' on the television set.

When a photodiode picks up rays from the remote control, it feeds them into a decoding microchip. After it feeds them into a decoding microchip, they are interpreted and verified. Once they are interpreted and verified, your instructions are carried out.

The block diagram of a simple remote control system is shown in Figure. When the transmitter is switched on, infra-red signals are sent from the transmitter to the receiver. Pulsed signals are used to prevent interference from any constant infra-red background 'noise'.




Figure

To obtain these pulsed signals, electrical pulses are first generated at a frequency in the upper audio range by the audio oscillator in the transmitter. They are then amplified by the buffer amplifier to enable them to drive the light-emitting diode (LED). Finally, the electrical pulses are converted by the LED into pulsed infra-red radiation which is directed at the receiver. Almost no visible light is emitted from the LED.

**Ex.2 Study this flowchart, which describes what happens when the signals are received from the remote control.**

1) A photodiode picks up rays from the remote control. 2) It feeds them into a decoding microchip. 3) They are interpreted and verified. 4) Your instructions are carried out.

We can link two stages in the flowchart to show the sequence of events like this: 1+2) **When** a photodiode picks up rays from the remote control, it feeds them into a



decoding microchip. 2+3) **After** it feeds them into a decoding microchip, they are interpreted and verified. 3+4) **Once** they are interpreted and verified, your instructions are carried out.

The part of each sentence beginning with a time word – **when**, **after**, **once** – is called a time clause. *When* shows that one stage is followed immediately by the next stage. *After* simply shows the sequence of stages – 1 comes after 2. *Once* emphasizes that one stage is complete before the next stage begins.

## Reading and Speaking

**Ex.1. Read the following text in 3minutes and answer the question** "What properties do semiconductors have?"

**Semiconductors**

The periodic law of elements discovered by Mendelyeev had a number of important scientific and industrial results, one of them being the discovery of germanium. Germanium is the semiconductor used in most transistors available at present.

But what are semiconductors? They include almost all minerals, many chemical elements, a great variety of chemical compounds, alloys of metals, and a number of organic compounds. Like metals, they conduct electricity but do it less effectively. In metals all electrons are free and in insulators they are fixed. In semiconductors electrons are fixed, too, but the connection is so weak that the heat motion of the atoms of a body easily pulls them away and sets them free.

It is not difficult to understand that the term "semiconductor" has been used because the material in question really occupies a place between the conductors of the electric current and the non-conductors, that is insulators. The term shows that they conduct electricity less readily than conductors but much better than insulators.

Minerals and crystals appear to possess some unexpected properties. For instance, it is well known that their conductivity increases with heating and falls with cooling. As a semiconductor is heated, free electrons in it increase in number, hence, its conductivity increases as well. However, heat is by no means the only phenomenon influencing semiconductors. They are sensitive to light, too. Take germanium as an example. Its electrical properties may greatly change when it is exposed to light. With the help of a ray light directed at a semiconductor, we can start or stop various machines, effect remote control, and perform lots of other useful things. Just as they are influenced by falling light, semiconductors are also influenced by all radiation. Generally speaking, they are so sensitive that a heated object can be detected by its radiation.

As previously mentioned, such dependence of conductivity on heat and light has opened up great possibilities for various uses of semiconductors. The semiconductor devices are applied for transmission of signals, for automatic control of a variety of processes, for switching on engines, for the reproduction of sound, protection of high-voltage transmission lines, speeding up of some chemical reactions, and so on. On the other hand they may be used to transform light and heat energy directly into electric energy without any complex mechanism with moving parts, and on the other hand, they are capable of generating heat or cold from electricity.

Engineers and scientists turned their attention to semiconductors more than sixty years ago. They saw in them a means of solving an old engineering problem, namely, that of direct conversion of heat into electricity without boilers or machines. Semiconductor thermocouples can convert heat directly into electricity just as a complex system consisting of a steam boiler, a steam engine and a generator does it.

**Ex.2. Point out which of these sentences contains the information from the text above.**

1. Semiconductor materials are used in diodes to create a rectifier, in transistors to make an amplifier and in integrated circuits to produce a computer. 2. Dependence of conductivity on heat and light has opened up great possibilities for various uses of semiconductors. 3. Semiconductors with excess of electrons possess the electronic conductance (n-type conductivity) and those with shortage of electrons are characterized with hole conductance (p-type conductivity). 4. Semiconducting material occupies a place between the conductors of the electric current and the non-conductors, that is insulators.

**Ex.3. Answer the questions.**

- Which element possesses the semiconducting properties?
- How does a conducting material depend upon heat?
- What devices may be made with application of conducting materials?

**Ex.4*. Speak on the difference between** the electronic conductance and hole conductance.



# UNIT 37. CABLES (beginning)

**Overview**

- Reading and Vocabulary: Cables (beginning).
- Supplementary Information: Giving advantages and disadvantages.
- Language focus: Impersonal Constructions.
- Reading and Speaking: Power transmission.

## Reading and Vocabulary

**Reading**

**Cables**

The voltage designation used by the cable industry does not always align with that adopted by users and other equipment manufacturers, so clarification may be helpful.

A cable is given a voltage rating which indicates the maximum circuit voltage for which it is designed, not necessarily the voltage at which it will be used. For example, a cable designated 0.6/1 kV is suitable for a circuit operating at 600 V phase-to-earth and 1000 V phase-to-phase. However it would be normal to use such a cable on distribution and industrial circuits operating at 230/400 V in order to provide improved safety and increased service life. For light industrial circuits operating at 230/400 V it would be normal to use cables rated at 450/750 V, and for domestic circuits operating at 230/400 V, cable rated at 300/500 V would often be used. Guidance on the cables that are suitable for use in different locations is given in BS 7540.

The terms LV (Low Voltage), MV (Medium Voltage) and HV (High Voltage) have different meanings in different sectors of the electrical industry. In the power cable industry, the following bands are generally accepted:

*LV* – cable rated from 300/500 V to 1.9/3.3 kV;

*MV* – cables rated from 3.8/6.6 kV to 19/33 kV;

*HV* – cable rated at greater than 19/33 kV.

*Multi-core cable* is used to describe power cable having two to five cores. Control cable having seven to 48 cores is referred to as *multi-core control cable*.

Cable insulation and sheaths are variously described as *thermoplastic*, *thermosetting*, *vulcanized*, *cross-linked*, *polymeric* or *elastomeric*. All extruded plastic materials applied to cable are *polymeric*. Those which would re-melt if the temperature during use is sufficiently high are termed *thermoplastic*. Those which are modified chemically to prevent them from re-melting are termed thermosetting,

cross-linked or vulcanized. Although these materials will not re-melt, they will soften and deform at elevated temperatures, if subjected to excessive pressure. The main materials within the two groups are as follows:

- *thermoplastic*

– polyethylene (PE)
– medium-density polyethylene (MDPE)
– polyvinyl chloride (PVC)

- *thermosetting, cross-linked or vulcanized*

– cross-linked polyethylene (XLPE)
– ethylene-propylene rubber (EPR)

Elastomeric materials are polymeric. They are rubbery in nature, giving a flexible and resilient extrusion. Elastomers such as EPR are normally cross-linked.

**Notes and comments**

*... BS 7540… BS* stands for *British Standard*.

**Reading comprehension**

**Ex.1. Read the text and find the answers to these questions.**

1. What does a cable voltage rating indicate? 2. Is it possible to use a cable in networks with lower voltage level than that accepted to be normal for the cable? 3. Where is the guidance on the cables given? 4. What does 'MV' stand for? 5. How many cores does a multi-core cable contain? 6. What materials is the cable insulation made of?

**Ex.2. Find the wrong statements and correct them.**

1. A cable voltage rating indicates the voltage at which the cable will be used. 2. For light industrial circuits operating at 230/400 V it would be normal to use cables rated at 450/750 V. 3. Thermoplastic insulation is able to withstand the extremely high temperatures without melting. 4. There are four voltage bands in the power cable industry, namely: low voltage, medium voltage, high voltage and super high voltage.

## Supplementary Information

**Giving advantages and disadvantages**

**Before you start**

1. Have you had an experience of writing articles, or expressing opinion, or making a speech before audience, or simply taking part in discussion?
2. What arguments did you use?



3. What are the rules for construction of such composition?
4. Read the pieces of advice below and express your opinion if you agree with them or not.

When giving arguments for and against a topic you should present both sides in a fair way by discussing them objectively in equal detail. Start your composition by making a general statement about the topic, and then give the advantages and disadvantages in two separate paragraphs. Remember to start a new paragraph for each new topic and to make a plan before writing your composition. Finally, end your composition with a well-balanced consideration of the points discussed. It is possible to state an opinion without using strong, emotional or personal expressions. (Do not use words such as: *I know*, *I believe*, etc. Use words such as: *It seems that …*, *It can be seen that …*, etc.) If you believe that the advantages outweigh the disadvantages, write them just before the final paragraph so that it will be easier for you to lead the reader to the conclusion.

**Vocabulary**

Read, translate and learn by heart *Useful Phrases for Writing Argumentative Essays*

**To list points**: one major advantage/disadvantage of, a further advantage, one point of view in favour of/against, in the first place, first of all, to start with, secondly, thirdly, finally, last but not least, etc.

**To add more points to the same topic**: what is more, furthermore, also, in addition to, besides, apart from this/that, not to mention the fact that, etc.

**To make contrasting points**: on the other hand, however, in spite of, while, nevertheless, despite, even though, although, it can be argued that, one can argue that, etc.

**To conclude**: to sum it up, summarizing, summing it up, all in all, all things considered, in conclusion, on the whole, taking everything into account, above all, as was previously stated, finally, in the long run, etc.

**Ex.1. Read two texts one after another** and give the paragraph plan, writing brief notes about the for and against arguments. Then, underline all the linking words in the texts and try to replace them with other similar ones.

**Working Mothers Have Positive Effects on the Family**

Nowadays, more and more women work outside the home, causing people to wonder whether this is a positive change. Germaine Greer, the Australian feminist, said: "Most women still need a room of their own and the only way to find it may be outside their own homes." If this is true, can it be done without having a negative effect on the family?

One point in favour of mothers working is that their children often learn to be independent from an early age, which can only help them in the future. Also, in many families, the man's salary alone is not enough to cover all household expenses. Thus, the need for extra income arises, and the woman has to work. Moreover, working outside the home gives a woman a sense of her own personal identity and self-confidence. A woman who stays at home will always be known as "John's wife" and not as a person in her own right.

On the other hand, child care is expensive. Therefore, a large proportion of the money a working mother earns will be spent on childcare. What is more, if both parents are working all day, they only see their children for a few hours in the evening. This can have a negative effect, as children may start to see their parents as strangers. Finally, a working mother usually has to look after both the children and home in her spare time, so she is actually doing two jobs instead of one, which can be tiring. She may also miss out on important events in her children's lives, such as their first steps and first words.

To sum up, there are many arguments both for and against mothers working. Every family is different and what is good for one family may not be necessarily be good for another. Taking everything into account, it should be left to the individual mother to decide whether working or not is something that she wants to do.

**Which side are you on?**

And so, for good or bad, computers are now part of our daily lives. With the price of a small home computer now as low as $500, experts predict that before long all schools and businesses and most families in the richer parts of the world will own a computer of some kind. Among the general public, computers arouse strong feelings – people either love them or hate them.

The computer lovers talk about how useful computers can be in business, in education and in the home – apart from all the games, you can do your accounts on them, learn languages from them, write letters on them, use them to control your central heating, and in some places even do your shopping with them. Computers, they say, will also bring more leisure, as more and more unpleasant jobs are taken over by computerized robots.

The haters, on the other hand, argue that computers bring not leisure but unemployment. They worry, too, that people who spend all their time talking to computers will forget how to talk to each other. And anyway, they ask, what's wrong with going shopping, using pens and paper and typewriters, and learning languages in classrooms with real teachers? But their biggest fear is that computers may eventually take over everything's from human beings altogether.



And so the arguments continue. Have you decided which side you're on?

**Ex.2. Give points for and against phenomenon taken from the list below in accordance with your variant.** Then, using these points and the useful phrases above, write sentences based on the topic. Finally, give a paragraph plan and write a composition about the advantages and disadvantages of the phenomenon under your consideration.

1. Tourism; 2. Building of new atomic power stations; 3. Further usage of heat power stations; 4. Usage of powerful hydroelectric stations; 5. Usage of unconventional power; 6. Morning gymnastics; 7. Mobile phone; 8. To be a wife of a "New Russian".

## Language focus

**Impersonal Constructions**

Application of a pronoun which does not substitute the noun from the matrix clause as a subject in the sentence is termed 'Impersonal construction'. While translating it is omitted.

**Ex.1. Translate the following sentences paying attention to the Impersonal Constructions.**

a) 1. It is easy to understand Ohm's law. 2. It was desirable to compare the results obtained. 3. It is necessary to find new sources of energy. 4. It was difficult for Oersted to find out why the compass needle was deflected.

b) 1. One can say that there are unlimited sources of energy. 2. One could not obtain good results without repeating the test. 3. There are so many atoms in a water drop that if one could count one atom a second, day and night, it would take one hundred milliard years. 4. One may mention here that the first industrial nuclear power plant in the world was constructed in the USSR.

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

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

**Ex.2. Translate the following sentences into English using the Impersonal Constructions.**

1. Говорят, что это изобретение увеличит к.п.д. машины. 2. Теперь можно считать наше исследование завершённым. 3. Полагают, что результаты опять подтвердили теоретические расчёты. 4. Следует упомянуть, что учёные давно работают над проблемой передачи энергии с помощью лазера. 5. Очень важно, что новое оборудование не дорогое. 6. Рабочему было трудно понять причину повреждения установки. 7. Желательно использовать все виды энергии для получения электричества.

## Reading and Speaking

**Power transmission**

They say that about a hundred years ago, power was never carried far away from its source. Later on, the range of transmission was expanded to a few miles. And now, in a comparatively short period of time, electrical engineering has achieved so much that it is quite possible, at will, to convert mechanical energy into electrical energy and transmit the latter over hundreds of kilometers and more in any direction required. Then in a suitable locality the electric energy can be reconverted into mechanical energy whenever it is desirable. It is not difficult to understand that the above process has been made possible owing to generators, transformers and motors as well as to other necessary electrical equipment. In this connection one cannot but mention the growth of electric power generation in our country. The longest transmission line in pre-revolutionary Russia was that connecting the Klasson power-station with Moscow. It is said to have been but 70 km long, while the present Volgograd-Moscow high-tension transmission line is over 1000 kilometres long. (The reader is asked to note that the English terms “high-tension” and “high-voltage” are interchangeable.)

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



is dangerous, however, to use power at very high voltages for anything but transmission and distribution. For that reason, the voltage is always reduced again before the power is made use of.

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

**Ex.1. Find Impersonal Constructions in the text and explain their application.**

**Ex.2. Answer the following questions.**

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

**Ex.3. Complete the following sentences.**

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

# UNIT 38. CABLES (completion)

**Overview**
- Reading and Vocabulary: Cables (completion).
- Supplementary Information: Expressing opinions.
- Reading and Speaking: Magnetic effect of an electric current.

## Reading and Vocabulary

**Reading**

Parts of four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Cables**

Certain design principles are common to power cables, whether [ 1 ].

For many cable types the conductors may be of copper or aluminium. The initial decision made by a purchaser will be based on price, weight, cable diameter, availability, the expertise of the jointers available, cable flexibility and the risk of theft. Once a decision has been made, however, [ 2 ], without being influenced by the regular changes in relative price which arise from the volatile metals market.

For most power cables the form of conductor will be solid aluminium, stranded aluminium, solid copper (for small wiring sizes) or stranded copper, although [ 3 ]. Solid conductors provide for easier fitting of connectors and setting of the cores at joints and terminations. Cables with stranded conductors are easier to install because of their greater flexibility, and for some industrial applications a highly flexible conductor is necessary.

Where cable route lengths are relatively short, a multi-core cable is generally cheaper and more convenient to install than single-core cable. Single-core cables are sometimes used in circuits where high load currents require the use of large conductor sizes, between 500 $mm^2$ and 1200 $mm^2$. In these circumstances, the parallel connection of two or more multi-core cables would be necessary in order to achieve the required rating and this presents installation difficulties, especially at termination boxes.

Single-core cable might also be preferred where duct sizes are small, where longer cable runs are needed between joint bays or where jointing and termination requirements dictate their use. It is sometimes preferable to use 3-core cable in the



main part of the route length, and to use single-core cable to enter the restricted space of a termination box. In this case, a transition from one cable type to the other is achieved using trifurcating joints which are positioned several metres from the termination box.

Armoured cables are available for applications where the rigours of installation are severe and [ 4 ]. *Steel Wire Armour (SWA)* cables are commonly available although *Steel Tape Armour (STA)* cables are also available. Generally, SWA is preferred because it enables the cable to be drawn into an installation using a pulling stocking which grips the outside of the oversheath and transfers all the pulling tension to the SWA. This cannot normally be done with STA cables because of the risk of dislocating the armour tapes during the pull. Glanding arrangements for SWA are simpler and they allow full usage of its excellent earth fault capability. In STA, the earth fault capability is much reduced and the retention of this capability at glands is more difficult. The protection offered against a range of real-life impacts is similar for the two types.

**Reading comprehension**

**Ex.1**.

A. they are used in the industrial sector or by the electricity supply industry.
B. they work at high voltage level.
C. that type of conductor will generally then be retained by that user.
D. the choice may be limited in certain cable standards.
E. where a high degree of external protection against impact during service is required.

**Ex.2. Read the text and find the answers to these questions.**

1. How is a decision made by a purchaser while choosing a cable type? 2. What advantages do solid conductors have in comparison with stranded ones? 3. When are the cables with stranded conductors mostly used? 4. How is a transition from one cable type to the other achieved? 5. Where are the armoured cables applicable?

**Ex.3. Find the wrong statements and correct them.**

1. Application of stranded conductors makes a cable to be more flexible. 2. A multi-core cable is cheaper and is used for long routes. 3. Small duct sizes dictate the multi-core cable application. 4. Trifurcating joints are used to provide a transition from one cable type to the other. 5. Armoured cables are necessarily used in case of high voltage level.

**Vocabulary**

**Ex.4. Fill in the words from the box below.** There is one word you shouldn't use.

| |
|---|
| multi-core cables, copper, solid conductors, earth fault capability, stranded conductors, auxiliary network, termination box, trifurcating joints, design principles, armoured cables |

1. Certain … are common to power cables.
2. For many cable types the conductors may be of … or aluminium.
3. … provide for easier fitting of connectors.
4. Cables with … are easier to install because of their greater flexibility.
5. The parallel connection of … presents installation difficulties.
6. It is preferable to use a single-core cable to enter the restricted space of a … .
7. A transition from one cable type to the other is achieved using … .
8. … are available for applications where the rigours of installation are severe.
9. In STA, the … is much reduced.

## Supplementary Information

**Expressing opinions**

**Before you start**

1. Is it important to have own opinion? When is it important?
2. What are the ways of expressing own opinion?
3. Read the pieces of advice below and express your opinion if you agree with them or not.

"Expressing Opinion" type of argumentative composition uses personal expressions, unlike the "For and Against" composition, which does not include them. Your personal opinion should be expressed in the introduction and again in the conclusion, using phrases such as "In my opinion", "I believe", "I think", "I strongly believe", and "In my view". You should support your opinion by including examples and reasons for what you have said. When expressing the other side of the argument, you may include it in a separate paragraph. End your composition by restating your opinion.

Paragraph Plan for Expressing Opinions: *Paragraph 1* (introduction) – state topic and your opinion clearly without using too many personal opinion words; *Paragraphs 2-3-4* – give the first, second, third arguments, etc. and examples or reasons to support your opinion; *Paragraph 5* – give the other side of the argument



and reasons; *Final Paragraph* (conclusion) – re-state your opinion, using different words.

**Vocabulary**

Read, translate and learn by heart *Useful Phrases for Writing Opinion Essays*

**To list points**: in the first place, first of all, to start with, etc.

**To add more points to the same topic**: what is more, another major reason, furthermore, also, moreover, in addition to, besides, apart from this/that, not to mention the fact that, etc.

**To introduce conflicting viewpoints**: it is argued that, people argue that, opponents of this view say, there are people who oppose, etc.

**To express opinion**: I believe, in my opinion, I think, in my view, I strongly believe, etc.

**Ex.1. Read the text**, propose the headline and circle the linking words. Then, underline the reasons given to support each point raised.

Cigarette advertising is a popular topic for discussion, as an increasing number of people believe that it is immoral and should be banned. I support this view for a variety of reasons.

In the first place, cigarette advertising should be stopped because an unhealthy product is being promoted. According to many medical reports, tobacco is a major cause of lung cancer and is sometimes responsible for heart disease. What is more, smoking can have harmful effects on non-smokers: when in the presence of smokers, they have no choice but to breathe in second-hand smoke.

Another major reason for banning cigarette advertising is the fact that it targets young people. Cigarette adverts show young, beautiful, successful people smoking and having fun. This is an image which is appealing to teenagers. In other words, they become attracted to this glamorous representation of smoking, which leads to them taking up the habit. Furthermore, the average teenager does not consider the harmful effects of smoking or the fact that it is addictive.

In their defence, however, tobacco companies argue that since their products are legally sold they have the right to communicate information about them, in other words, advertising. They also argue that their advertisements are not intended to cause people to start smoking, but rather are an attempt to cause smokers to switch brands. They strongly deny that they target young people in their adverts, stating that all the models whose photographs they use are adults.

In conclusion, I believe that cigarette companies are only interested in making money, as their advertising campaigns are unethical and aimed at teenagers. It is not

good to promote an unhealthy product, so in my opinion, cigarette advertising should be banned.

**Ex.2. Read the text again and answer the T/F statements.**

1. Each paragraph has a topic sentence. T/F
2. The writer gives only one side of the argument. T/F
3. In the conclusion the writer gives a balanced consideration of the topic. T/F
4. The writer disagrees with the idea of banning cigarette advertising. T/F
5. The writer gives his opinion in the fourth paragraph. T/F
6. The writer supports his view by giving examples. T/F

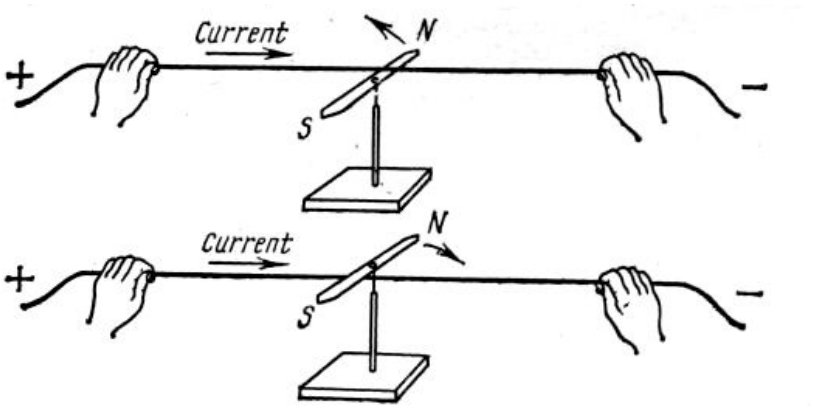
**Ex.3. Express your opinion in written form on the topic from the list below in accordance with your variant**.

1. General computerization; 2. Computer games; 3. General installation of mobile phones; 4. Virtual laboratory works; 5. Human ability to calculate without calculator; 6. Morning gymnastics; 7. Early marriage; 8. Advertising of chewing gum; 9. Advertising of alcoholic drinks; 10. Any advertising.

## Reading and Speaking

**Magnetic effect of an electric current**

The invention of the voltaic cell in 1800 gave electrical experiments a source of




Influence of an electric current on a compass needle



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

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

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

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

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

It is not difficult to understand that the greater the number of turns of wire, the greater is the m.m.f. (that is the magnetomotive force) produced within the coil by any constant amount of current flowing through it. In addition, when doubling the current we double the magnetism generated in the coil. A solenoid has two poles which attract and repel the poles of other magnets. While suspended, it takes up a north and south direction exactly like the compass needle. A core of iron becomes strongly magnetized if placed within the solenoid while the current is flowing.

When winding a coil of wire on an iron core, we obtain an electromagnet. That the electromagnet is a controllable and reliable magnet is perhaps known to everyone. It is, so to say, a temporary magnet provided by electricity. Its behaviour is very simple. The device is lifeless unless an electric current flows through the coil. However, the device comes to life provided the current flows. The iron core will act as a magnet as long as the current continues to pass along the winding..

**Ex.1. Answer the following questions.**

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

**Ex.2. Fill in the blanks with suitable words given below:**

where, which, when, who, that

1. We know … Oersted established the relation between the flow of electric current and a magnetic needle. 2.The great scientists Volta, Ampere and Yablochkov may be named among those … have greatly contributed to electrical engineering. 3. The end … the lines of force leave the coil after passing through its core will act like a north magnetic pole. 4. … there is a certain connection between electricity and magnetism was proved by experiments. 5. … he placed the wire parallel to the needle he saw … the needle deflected. 6. A wire … is wound in the form of a solenoid acts like a magnet as long as it is carrying a current.

**Ex.3. Translate the following sentences and define the functions of the word** *that*.

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

**Ex.4. Translate the following sentences paying attention to the words in bold type.**

a) 1. Ampere's contribution to electrodynamics **as** he called the new science began in 1820. 2. **As** it is impossible to detect electricity by our physical senses, we generally detect it by its effects. 3. An electromagnet loses its magnetic properties **as soon as** the current is turned off. 4. In certain branches of industry, chemical energy is not so widely used **as** mechanical energy. 5. The average speed of all molecules remains the same **as long as** the temperature is constant. 6. In order to



produce electricity more economically the generators must be **as large as** possible. 7. **As** a gas is cooled, it loses heat **as well as** energy. 8. The magnetic effect of an electric current is the subject of the present article, **as for** the heating effect it was dealt with before.

b) 1. Rubber is a **very poor** conductor of electricity. 2. This is the **very** appliance which I need for my experiment. 3. Lomonosov was born in the family of a **poor** peasant. 4. All metals are **poor** insulators of electric current. 5. China is a great **country**. 6. Next summer I will have a **rest** in the **country**. 7. The **rest** of the story should be translated at home. 8. Electricity at **rest** or in a static condition does no work. 9. Heat **causes** many chemical reactions. 10. What **causes** the electrons to flow along the wire? 11. A short circuit may be the **cause** of fire.

# UNIT 39. MAIN GENERATOR TYPES. ON TRANSLATION OF TECHNICAL TEXTS

**Overview**

- Reading and Vocabulary: Main generator types.
- Supplementary Information: On translation of technical texts.
- Language focus: Relatives.
- Reading and Speaking: Grounding of electric circuits.

## Reading and Vocabulary

**Reading**

Parts of four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Main generator types**

The two main types of generator are *'turbo'* or *cylindrical-rotor* and *salient-pole* generators. Both these types are *synchronous* machines [ 1 ]. Since most generators fall under this class, it forms the basis of this topic.

The largest generators used in major power stations are usually turbo-generators. They operate at high speeds and [ 2 ]. The general construction of a turbo-generator is as following. The rotor is made from solid steel for strength, and embedded in slots within the rotor are the field or excitation windings. The outer stator also contains windings [ 3 ], this is again for mechanical strength and so that the teeth between the slots form a good magnetic path. Most of the constructional features are very specialized, such as hydrogen cooling instead of air, and direct water cooling inside the stator windings, so only passing reference is made to this class of machines in the following descriptions.

More commonly used in smaller and medium power ranges is the salient-pole generator. Here, the rotor windings [ 4 ]. The stator construction is similar in form to the turbo-generator stator.

Less commonly used are *induction generators* and *inductor alternators*.

Induction generators have a simple form of rotor construction, in which aluminium bars are cast into a stack of laminations. These aluminium bars require no insulation and the rotor is therefore much cheaper to manufacture and much more reliable than the synchronous generators. The machine has characteristics which suit wind turbines very well, and they also provide a low-cost alternative for



small portable generators. The operation of the machine is very similar to the induction motor.

Inductor alternators have laminated rotors with slots, producing a flux pulsation in the stator as the rotor turns. These machines are usually used for specialized applications requiring high frequency.

**Notes and comments**

*The rotor is made from …* . Note the use of *from*. More frequently the synonym *be made of* is applied.

*… construction … is as following…* The passage means that it follows immediately by descriptions. Another possible application: *… is as follows*.

*hydrogen cooling.* Note the application of the Gerund as a noun.

*Less commonly used are induction generators*. Note the inversion of the word order. It is accompanied with inversion in compound predicate. E.g.: More commonly used … is the salient-pole generator.

**Reading comprehension**

**Ex.1**.

A. which are located in slots.

B. in which the rotor turns in exact synchronism with the rotating magnetic field in the stator.

C. which produce the magnetic field rotating with speed 3000 revolutions per minute.

D. are usually directly coupled to a steam or gas turbine.

E. are wound around the poles which project from the centre of the rotor.

**Ex.2. Read the text and find the answers to these questions.**

1. What are two main types of generator? 2. Why is a *synchronous* machine so called? 3. Where are the turbo-generators used? 4. Where are the stator windings located? 5. Why are the stator windings located in slots? 6. When is a salient-pole generator used? 7. What is the difference in the rotor windings of a salient-pole generator in comparison with a turbo-generator? 8. Why are the induction generators used less commonly? 9. Where do the inductor alternators find their application?

**Ex.3. Find the wrong statements and correct them.**

1. Induction generators have rather a simple form of the rotor construction. 2. In induction generators, the rotor aluminium bars require perfect insulation. 3. The induction generators have characteristics which suit steam turbines very well. 4. The basic action of the induction generator is very similar to the induction motor. 5.

The rotor of a turbo-generator is made from solid steel for electric strength. 6. The teeth between the slots form a good magnetic path.

**Vocabulary**

**Ex.4. Define the following terms.**

slot, magnetic path, solid steel, laminated rotor, mechanical strength, salient pole

**Ex.5. Learn to recognize the following international words.**

magnetic, steel, rotor, stator, turbo-generator, synchronism, synchronous machine, centre, rotor construction, project, application

## Supplementary Information

**On translation of technical texts**

**Before you start**

Although much of your reading in electrical engineering science will be from textbooks, do not neglect the journals – they are a valuable source of information, particularly, on up-to-date developments in this rapidly changing and growing field.

1. Have you ever translated the technical texts?
2. If you have, answer once more question. Is it easy or rather hard task?
3. What difficulties did you meet with?

**Ex.1. Read the underwritten text concerning the principal rules of language and style of the scientific and technical literature. Search out new strange words. Try to remember the rules presented.**

Translation of the scientific and technical literature is a specific procedure existing at the interface of linguistics on the one hand and of science and engineering on the other hand.

In order to translate scientific and technical texts, it is not sufficient to be master of speaking. Nowadays, standards of the written language with definite specific characteristics underlie in foundation of language and style of the modern scientific and technical literature. A *term* is the most capacious carrier of the special scientific information, it being characterized by high responsiveness, mobility and ability to modify continuously and to improve its meaning by means of addition of new left and right definitions. It leads to appearance of new composite terminological groups, this causing numerous translation difficulties. A term may be both a single-word and a terminological group including the base word and one or some left or right definitions.



Examples: 1) computer-aided design system; 2) very high-speed integrated circuit; 3) permanent-magnet synchronous motor; 4) commutation torque ripple minimization; 5) direct wave lifetime; 6) aerial two-wire copper 4mm communication line; 7) overhead three-phase four-wire transmission line 0.4kV voltage; 8) overhead transmission line secondary parameters; 9) tiristor electric drive; 10) signal discretization; 11) multidimensional system.

The development process of a composite term may be presented in form of the following scheme: system – control system – aircraft control system.

Translation procedure of such terminological group is executed in the following definite order:

1) Identification of the terminological group. It includes the revelation of the base word and definition of the left and right group limits, i.e. its extremely left and right words.
2) Translation of the base word as primary meaningful element of group.
3) Translation of the base word together with the first left attribute.
4) Translation of the word group after addition of the subsequent attribute and so on.

**Ex.2. Using proposed rules on translation of the technical text, translate the following terminological groups from the main text:**

1) excitation winding; 2) direct water cooling; 3) medium power range; 4) salient-pole generator; 5) stator construction; 6) inductor alternator; 7) aluminium bar; 8) wind turbine; 9) induction motor; 10) flux pulsation.

## Language focus

**Grammar and Vocabulary**

**Relatives**

Relative Pronouns (**who, whose, whom, which, that**) introduce relative clauses.

| | Subject of the verb of the relative clause (can't be omitted) | Object of the verb of the relative clause (can be omitted) | Possession (can't be omitted) |
|---|---|---|---|
| used for people | who / that | who / whom / that | whose |
| | She's the teacher **who/that** delivers us English this term. | These are the students (**whom/that**) we have waited for. | That's Tesla's portrait **whose** inventions we use until now. |
| used for things / animals | which / that | which / that | whose / of which |
| | This is superposition principle **which/that** suits the linear circuits very well. | Here's the lamp (**which/that**) you forgot to turn off. | That's the motor the stator **of which** we must rewind. |

1. **That** replaces **who** or **which** but is never used after commas or prepositions. **That** usually follows superlatives and words like *something, anything, all, none, many, few*.

Lomonosov, **who** was great scientist, built the first glass-making factory in Russia. ("**That**" is impossible here.)

Faraday's law is the first **thing that** you must know studying a transformer.

Kirchhoff's laws are the most important **laws that** are applied in the circuit theory.

2. **Prepositions in Relative clauses**. We avoid using prepositions before relative pronouns.

That's the instrument **with which** we executed the lab. (very formal)

That's the instrument (**which/that**) we executed the lab with. (less formal, more usual)

3. **Who, whom, which, that** can be omitted when there is a noun or a pronoun (I, you, etc.) between the relative pronoun and the verb, that is, when they are the objects of the relative clause.

The generator (**which/that**) we put into operation yesterday does not work properly. (**which/that** can be omitted.)

Where are the wires (**which/that**) we will use during the lab? (**which/that** can be omitted.)

A person **who** repairs electric circuits is an electrician. (**who** can't be omitted.)

**Ex.1. Fill in: who, whose, which or where.**

1. The machine has characteristics …… suit wind turbines very well. 2. Lomonosov, …… was the famous Russian scientist, founded Moscow university. 3. The turbine condenser, ……. the exhaust vapour is condensed, is cooled with technical water circulating in pipes. 4. It was Ampere, …… name was given to the current unit.



**Ex.2. Fill in the correct relative pronoun. Then write S for subject and O for object. Finally state if the relatives can be omitted or not in the box provided.**

| | S | not omitted |
|---|---|---|
| 1. Here there are students …… have not prepared term paper yet. | | |
| 2. The report …… you've performed is not good. | | |
| 3. While working, make use of the voltmeter …… is on the table. | | |
| 4. What's the name of the professor …… delivers lectures to you. | | |
| 5. Is that the ammeter ……. you worked with? | | |
| 6. Have you prepared answers to questions ….. I asked yesterday. | | |
| 7. How old is the professor ….. guides your diploma work? | | |
| 8. Have you seen the transformer …… they are going to switch on? | | |
| 9. Let's all look at the figure … is on page 9. | | |
| 10. What colour is the bus bar …. we are going to mark 'A'? | | |
| 11. Repair service has disassembled the motor … had fault. | | |
| 12. The voltmeter ….. is on the table can't be used. | | |
| 13. We will order the supply service …….delivers our repair parts an extra wire reel. | | |
| 14. Is he the person ….. executed lab with you? | | |
| 15. I was in the computer room ….. was on the third floor. | | |
| 16. The student …. won the mathematical competition is from our group. | | |

## Reading and Speaking

**Ex.1. Read the text below in 3 minutes and point out the main idea of each paragraph. Propose a headline.**

Grounding of electric circuits and electrical equipment frames are two subjects which at the first glance seem simple. However, the application of the calculation techniques sometimes occurs complex and confusing. Grounding in electrical terms also carries a dual meaning. It can refer to how an electric circuit or system is connected to earth or it can refer to how an enclosure of an electric circuit or system is connected to earth. It is because of this dual meaning of grounding carries with it is that grounding is performed to provide safety to personnel. Providing safety to personnel is usually interpreted to mean that any electrical equipment frame a

person touches or comes in contact with will not be an electric shock hazard. By properly grounding frames, voltages that may be hazardous to personnel are eliminated. When large power systems are operated at high voltages, merely interconnecting all the frames of the electric equipment to ground may not be enough to protect personnel from hazardous voltages. It may require that the grounding circuit of the power system be designed and constructed in a manner to limit exposure voltages to safe levels and durations.

Many accidents can be cited where electrical equipment frames were connected to earth but the frames presented a shock hazard. This is dramatically illustrated in the following fatal accident that occurred at a sand and gravel operation. Two hours prior to the accident an electrical contracting firm had finished grounding the crusher. The grounding consisted of a driven ground rod and a conductor connecting it to the crusher. When the three-phase electric motor developed a grounded phase in its junction box, the frame of the hopper became energized. When the employee touched the hopper frame he was electrocuted.

These accidents occur because the electrical principles of safety grounding are not followed. Today electrical codes and handbooks go into great detail as to how a grounding conductor should be mechanically and physically installed. It is for these reasons that a performance approach to grounding should be taken.

**Ex.2. Search out and extract the terminological groups** consisting of a) a base word and one left attribute; b) a base word and two left attributes; c) a base word and three or more left attributes. Underline the base words of the groups, do translate the group.

**Ex.3. Answer the questions.**

- What is the grounding of electric circuits?
- What is function of the grounding of electric circuits?
- Is the simple grounding of electric circuit sufficient for safety? Why not?

**Ex.4*. Speak on the difference between the grounding and the neutral grounding.**



# UNIT 40. MAIN CLASSES OF TRANSFORMER. ON TRANSLATION OF TECHNICAL TEXTS

**Overview**

- Reading and Vocabulary: Main classes of transformer (beginning).
- Supplementary Information: Scientific word formation with the aid of prefixes and suffices.
- Language focus: Adding information to a text.
- Reading and Speaking: Pumping of water.

## Reading and Vocabulary

**Reading**

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Main classes of transformer (beginning)**

Transformers are used for a wide variety of purposes, with the complete range of voltage and power ratings as well as many special features for particular applications. The following covers the main types.

**Transformers for electronics** or for low-voltage power supplies are used to match the supply voltage to the operating voltage of components or accessories, or to match the impedance of a load to a supply in order to maximize power throughput. [ 1 ].

The core is usually constructed in low-power transformers from C- and I-laminations or from E- and I-laminations. The windings are usually of round enamelled wire, and the assembly may be varnished or encapsulated in resin for mechanical consolidation and to prevent ingress of moisture. Increasing numbers of this type operate at high frequencies in the kilohertz range and use laminations of special steel often containing cobalt to reduce the iron losses.

**Small transformers** are used for stationary, portable or hand-held power supply units, as isolating transformers and for special applications, such as burner ignition, shavers, shower heaters, bells and toys. [ 2 ] These transformers are usually air insulated, the smaller units using enamelled windings wires and ring cores and the larger units using C- and I- or E- and I-laminated cores.

Safety is a major concern for these transformers and they are identified as class I, class II or class III. Class I units are insulated and protected by an earth terminal. Class II transformers have double insulation or reinforced insulation. Class III

transformers have outputs at Safety Extra-Low Voltages (SELV) below 50 V ac or 120 V dc.

**Distribution transformers** are used to distribute power to domestic or industrial premises. They may be single-phase or three-phase, pole-mounted or ground-mounted, and they have ratings ranging from 16 kVA up to 2500 kVA.

[ 3 ] The primary (high-voltage) winding has a highest voltage ranging from 3.6 kV to 36 kV; the secondary (low-voltage) winding voltage does not exceed 1.1 kV. The high-voltage winding is usually provided with off-circuit tappings of ± 2.5 per cent, or +2×2.5 per cent, – 3×2.5 per cent.

The preferred values of rated output are 16, 25, 50, 100, 160, 250, 400, 630, 1000, 1600 and 2500 kVA, and the preferred values of short-circuit impedance are 4 or 6 per cent. Losses are assigned from lists, for instance from BS 7281-1, or by using a loss- capitalization formula.

**Supply transformers** are used to supply larger industrial premises or distribution substations. Ratings range from 4 MVA to 30MVA, with primary windings rated up to 66 kV and secondary windings up to 36 kV.

[ 4 ] Most supply transformers use mineral oil; but for applications in residential buildings, oil rigs and some factories, the coolant may be synthetic esters, silicone fluid or some other fluid with a higher fire point than mineral oil.

**Transmission (or intertie) transformers** are among the largest and highest voltage transformers in use. They are used to transmit power between high-voltage networks. Ratings range from 60 MVA to 1000MVA and the windings are rated for the networks which they link, such as 33, 66, 132, 275 and 400 kV in the UK, or voltages up to 500 kV or 800 kV in other countries. The impedance of a transmission transformer is usually 18 per cent in the UK, or 8 per cent in continental Europe, but for some system conditions, an impedance of up to 30 per cent is used.

Transmission transformers are oil filled, and are usually fitted with oil pumps and radiator fans to assist cooling of the windings and cores. They are usually fitted with OLTCs, but some networks at 400 kV and 275 kV are linked by transformers without regulating windings.

**Notes and comments**

*C-*, *I-*, *E-laminations*. Note the application of letters to present the thing form, in case under consideration, the form of a transformer core or its parts. In Russian language, the letters *U*, *I* and *Ш* are used, respectively.

*OLTC* stands for *on-line testing control*. It means that a transformer may be tested in dialog mode with computer aid.



**Reading comprehension**

**Ex.1**.

A. They may be used to match impedances in primary and secondary circuits.

B. The windings and core are immersed in mineral oil, with natural cooling, and there are two windings per phase.

C. They may be used to supply three-phase power up to 40 kVA at frequencies up to 1 MHz.

D. These transformers are characterized by the equal number of primary and secondary turns.

E. Transformers in this class are fluid cooled.

**Ex.2. Read the text and find the answers to these questions.**

1. What does the expression “to match impedances” mean exactly? 2. What types of laminations are used in small transformers? 3. Where are the distribution transformers mounted? 4. Which transformers are the largest? 5. How are they cooled? 6. How is voltage regulated at the distribution transformers? 7. Which transformers are fluid cooled?

**Vocabulary**

**Ex.1. Explain the following terms.**

feature, enamelled wire, air insulated transformer, domestic premises, off-circuit tapping, radiator fan, power throughput

**Ex.2. Learn to recognize the following international words. Answer if their meaning coincides with Russian analogue.**

maximize, resin, consolidation, type, per cent, radiator, fan, assist, continental, regulator, control, application.

## Supplementary Information

**Scientific word formation with the aid of prefixes and suffices**

**Before you start**

Study this term from electronics: semiconductor. We can divide it into three parts: *semi-conduct-or*. *Semi-* is a prefix which means ‘half’, while *-or* is a suffix added to the verb *conduct* to make a noun. From this we can work out that a semiconductor is a component which half conducts, i.e. its conductivity is found between conductivities of a conductor and an insulator. Knowledge of common

prefixes can help us to work out the meaning of some unfamiliar terms in technical texts.

1. What English prefixes and suffices do you know?
2. What are their meanings?

**Ex.1. Read the underwritten text concerning the term formation in English with the aid of prefixes and suffixes. Search out new strange words. Try to remember the rules presented.**

Speaking of the term formation in English it is necessary to remember of the availability of prefixes and suffices as well as of their application importance in technical language, they having great influence on the word meaning. One may emphasize the following most active prefixes:

- *pre* is used to perform an idea of the time or position leading: precritical mode; predesign; preload; precooler; preheating;
- *de* possesses some negative meanings – a) downward, b) liberation or disconnection, c) separation or removal, d) reverse the action: descent; derate; deaerate; decoupling; deenergize;
- *non, un* is a negative prefix: nonexpendable; nonaxiality; nonavailability; un-steady; unable;
- *inter* means "between", "among": interchangeability; interstage transformer; intersection point;
- *re* is commonly used in scientific-technical practice to mean "again", "once more", "backwards": reentry; reducer; reforest; rebuild; reconstruct; renewable;
- *trans* means "through", "beyond", "across". Sometimes, the last letter is omitted keeping the meaning of the prefix: transmitter; transducer; tranquillizer; transition; transform;
- *pro* commonly means "forward", "for benefit", "instead": processing; production; proficiency;
- *mis* provides "wrong", "incorrectly", "falsely", "mistakenly": misadjust; misadventure; mistake; misalign;
- *micro* means "small": microchip;
- *multi* means "many": multimedia;
- *dis* provides "not", "separately", "opposite of": disconnection; discrepancy; disability; disadvantage; disaffirm; discharge:
- *in* pretends to have two different meanings 1) "not" and 2) "in", "to contain": inaccessible; inaccuracy; instability; inboard engine; inboard rotor; inbound;



- *com* is sometimes used without *m*, sometimes *n* is substituted for *m*: compart; compression; collapse; correlation; configuration;
- *sub* has meaning "under", "before" in the status sense: suburb; subassembly; submechanism; submarginal; submarine;
- *tele* means "far"; "remote": television; teleaction; teleammeter.

New scientific terms may be formed with the aid of the right additions, i.e. suffixes. Such suffixes as -ion, -ation, -ment, -ure, -age, -ance, -ence, -ing give possibility to turn a verb into a noun: to conclude – conclusion; to pass – passion (Passion Sunday); to translate – translation; to identify – identification; to develop – development; to expose – exposure; to pass – passage; to perform – performance; to infer – inference; to guess – guessing; to mean – meaning. Next suffixes (-able, -ible) convert a verb into an adjective: to reuse – reusable; to solve – soluble; to convert – convertible. There are suffixes to convert a noun into an adjective as well. They are -al, -ous, - ful, -ary. Examples: computation – computational; identity – identical; danger – dangerous; meaning – meaningful; element – elementary. It is possible to obtain new nouns from adjectives with the application of the following suffixes – -ty, -ness, -ency: safe – safety; hard – hardness; frequent – frequency; discrepant – discrepancy.

## Language focus

**Adding information to a text**

Study this brief text about noise.

Noise can be a problem with amplifiers. There are several types of noise. One is crackle and another is hum.

Study this additional information: Noise is any unwanted signals. Crackle is produced randomly inside circuit components. Hum is produced by the mains supply.

We can add the additional information like this: Noise, **which is any unwanted signals**, can be a problem with amplifiers. There are several types of noise. One is crackle, **which is produced randomly inside circuit components**, and another is hum, **which is induced by the mains supply**.

When the information is additional, it is put in commas. Without the words in bold, the sentence makes good sense.

When the information is essential to the meaning of the statement, commas are not used. For example: Noise **which is produced inside components** is called crackle. Without the words in bold, the sentence would not make sense

## Reading and Speaking

**Ex.1. Read the text below in 7 minutes and point out the main idea of each paragraph. Propose a headline.**

Pumping of water for irrigation purposes or domestic use by employing solar power is quite common in some parts of the world. In order to make the pumping system as simple as possible often the DC drive technology is selected. This paper reports about an electronic subsystem for improving the pumping capacity. It is shown how subsystems are matched in order to optimize the overall behaviour.

The solar generator is still the most expensive subsystem and therefore the point of operation should be in the maximum power point (MPP) or at least close to it. The coordinates of the MPP in the I-U-plane depend on parameters such as: insolation, temperature, shadowing. The maximum power locus varies according to temperature- and insolation-changes. For a specific application, a locus may be defined, in which the optimum power points may be found.

In order to utilize the solar generator best, the operating points of the pump should also fit into the MPP-range. For applications in remote areas, the complex circuit required for an AC drive is not advantageous. Therefore, the focus is on a DC drive in combination with a simple circuit.

For the calculation of the power flow, it is of interest to have information on the efficiency of the solar generator. The suppliers often give this figure only for standard conditions ($\theta = 25°C$, AMO, 1000 $W/m^2$).

Careful adjustment between the productivity of the well and capacity requirements is always necessary. It is often more advantageous to build a storage tank using concrete than implementing a battery into system. Such a storage tank is also useful to satisfy peak demands. Solar pumps are competitive under the following conditions: static head < 20 m; monthly water peak demand < 2 times average water demand; diesel fuel cost > 0.40 $/L. For the selection of the pump, either a piston pump or a centrifugal pump may be chosen.

Submerging or floating pump systems are used. In the case of DC motors driving the pump, the approach of a floating system is advantageous in order to avoid problems with the brushes. A typical system with the main components is shown in figure.

To exploit the power from the solar generator in an optimal way, it makes sense to use a centrifugal pump because the torque-speed characteristic better fits the



range of the optimum power points. In order to reduce losses and to achieve a high efficiency, the excitation of a DC motor is realized by permanent magnets.

Once the system components are selected, the pumping capacity depends on system parameters and insolation. System changes are costly. As the DC motor has a permanent magnet field excitation, no electronic circuitry can be used to control the speed. Due to specific torque versus speed characteristic of a pump drive, such a control system would not be good anyway, as the torque increases rapidly as speed goes up, which is a contradiction with the decreasing torque offered by the field weakening.

However, there is an opportunity to improve the pumping capacity by introducing a few electronic components in the armature circuit. A transistor in combination with a freewheeling diode is introduced. In order to limit the harmonic components of the current flowing to the motor, the coil L is used for increasing the inductance in the circuit. The power transistor is operated as a switch by a simple control unit.

Conclusions. These results demonstrate the improvements of a pumping system using power electronic components. In order to maintain the level of reliability the electronic components have to be selected carefully and some derating for the power switch might be necessary. It is also evident that the matching of subsystems (solar generator – power electronic converter – motor – pump) is essential for optimizing the overall efficiency.

The experimental and theoretical analysis clearly demonstrates that a serious improvement of the output of the system is found, especially at low power levels. The increase of efficiency is far less at high power levels. The introduction of the power electronic components can be employed to extend the use of the pumping systems in periods with a lower level of insolation.

**Ex.2. Answer the questions.**

- What energy does the practical solar pump system use?
- What factors does the successful work of the solar pump system depend on?
- What are the main components of the practical solar pump system?
- What is function of the electronic circuitry?
- What function do a storage tank and a pump perform?

**Ex.3*. Ask your own questions.**

# UNIT 41. MAIN CLASSES OF TRANSFORMER. ON TRANSLATION OF TECHNICAL TEXTS

**Overview**

- Reading and Vocabulary: Main classes of transformer (completion).
- Supplementary Information: Comprehension of the scientific technical texts.
- Language focus: Defining / non-defining relative clauses. Linking facts and ideas.
- Reading and Speaking: Evaluation of Condition Monitoring of Bearings.

## Reading and Vocabulary

**Reading**

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Main classes of transformer (completion)**

**Generator (or step-up) transformers.** Power is usually generated in large power stations at typically 18–20 kV, and generator transformers are used to step up this voltage to the system voltage level. These transformers are usually rated at 400, 500, 630, 800 or 1000 MVA.

Generator transformers are usually fitted with regulating windings and OLTCs.

**Phase-shifting transformers.** Where power is transmitted along two or more parallel transmission lines, the power flow divides between the lines in inverse proportion to the line impedances. [ 1 ] Phase-shifting transformers are used to link two parallel lines and to control power flow by injecting a voltage 90° out of phase *(in quadrature)* with the system voltage into one line, at either leading or lagging power factor. Where the transformer controls the phase angle but not the voltage, the unit is known as *a quadrature booster.* Where the voltage is also controlled, the unit is known as *a phase-shifting transformer.*

**Converter transformers.** Where power is transmitted through an HVDC system, a converter station is used to change ac power to dc using multiple rectifier bridges. [ 2 ] Converter transformers handle ac power and power at mixed ac/dc voltages by combining the power flow through 12 phases of rectifier/inverter bridges through dc valve windings.

The insulation structure must withstand all normal and abnormal conditions when ac voltage is mixed with dc voltage of differing polarities over the operating



temperature range. The presence of dc currents may also cause dc saturation of the core, leading to abnormal magnetizing currents and variations in sound.

A phase of a three-phase converter transformer bank typically comprises a high-voltage primary winding and two secondary ac/dc valve windings. Three such transformers together form the two secondary three-phase systems; one is connected in delta and the other in star. Each secondary system feeds a six-pulse bridge and the two bridges are connected in series to form a 12-pulse arrangement. Two such transformer banks are used with the secondary circuits connected in opposite polarity to form a ±215 kV dc transmission system.

**Railway transformers.** Transformers for railway applications may be trackside units to supply power to the track, or on-board transformers in the locomotive or under the coaches, to power the drive motors.

[ 3 ] On-board transformers are designed for the lowest possible weight, resulting in a high-loss performance. Modern train control systems using thyristors, GTOs or IGBTs subject the transformers to severe harmonic currents that require special design consideration.

**Rectifier and furnace transformers.** Special consideration is needed for transformers in industrial applications involving arc furnaces or heavy-current dc loads in electrochemical plant. The primary windings in such cases are usually rated at 33 kV or 132 kV in the UK, but the secondary windings carry many thousands of amperes and are rated at less than 1 kV. Current sharing between parallel paths in the transformer becomes important because of the magnetic fields created by the high currents. [ 4 ] To reduce this excess heating, non-magnetic steel is often used to form part of the tank or the cover.

The OLTCs in furnace transformers are subject to a heavy duty; they may perform hundreds of thousands of operating cycles a year, which is more than a lifetime's duty for many transmission transformers.

**Dry-type transformers.** A dry-type construction is possible where a higher-temperature class of insulation is required than is offered by cellulose and a class 'O' or class 'K' fluid. Dry-type transformers use non-cellulosic solid insulation and the windings may be varnish dipped to provide a class 'C' capability, or vacuum encapsulated in epoxy resin to form a class 'F' or class 'H' system. Ratings are generally up to 30 MVA at voltages up to 36 kV, but cast resin transformers have recently been successfully manufactured at 110 kV using a novel winding design. Overload performance is limited but it can be augmented by the use of cooling fans.

This type is more expensive than a fluid-filled equivalent, and because of the reduced fire risk they are used in special applications where the public are involved, such as underground tunnels, residential blocks of flats or oil-rigs.

**Gas-filled transformers.** For applications where low flammability is paramount, designs have been developed in which the transformer is insulated and cooled with $SF_6$ gas. This provides an alternative to dry-type construction where the risk of fire must be eliminated and the possible contamination of the environment by oil spillage must be avoided. High-voltage $SF_6$ transformers are available at ratings up to 300 MVA at 275 kV and prototype designs have been tested at up to 500 kV. Gas-filled transformers and reactors are more expensive than oil-filled units but the costs may be justified to eliminate a risk of fire, particularly at a site where the cost of land is high and where the overall 'footprint' of the unit can be reduced by the elimination of fire-fighting equipment.

**Notes and comments**

… *HVDC system*. HVDC stands for *high voltage direct current*.

*GTO*. This one stands for *guide to operations* (руководство по эксплуатации).

… *the overall 'footprint' of the unit* … Here *'footprint'* intends the space which is occupied by the unit.

**Reading comprehension**

**Ex.1.**

A. Trackside transformers are subjected to uneven loading depending upon the position of the train in the railway system.

B. The high-voltage winding is usually provided with off-circuit tapping.

C. These strong magnetic fields can cause excess heating in magnetic steels if these are used in the structure of the transformer, because of the flow of proximity currents in the steel.

D. Direct current power is converted back to ac using inverter bridges.

E. Higher power is therefore transmitted through the line with lowest impedance and this can result in overload on that line, when the parallel line is only partly loaded.

**Ex.2. Read the text and find the answers to these questions.**

1. What are the generator transformers usually fitted with? 2. What case are the phase-shifting transformers used in? 3. What special conditions do the railway transformers meet? 4. How is the secondary winding of an furnace transformer designed? 5. Why is the tank of a furnace transformer made of non-magnetic steel? 6. When is a transformer dry-type construction possible? 7. How are the gas-filled transformers correlated with the oil-filled units in the cost terms?



**Ex.3. Find the wrong statements and correct them.**

1. Generator transformers are used to step down the generator voltage to the system voltage level. 2. Where power is transmitted along two or more parallel transmission lines, the power flow divides between the lines in direct proportion to the line impedances. 3. Phase-shifting transformers are used to link two parallel lines. 4. To be in quadrature means 45° out of phase. 5. A HVDC-link is used to connect any two distribution nets. 6. The presence of dc currents causes dc saturation of the transformer core, leading to abnormal magnetizing currents. 7. Transformers for railway applications are usually pole-mounted. 8. To reduce the excess heating in a furnace transformer, non-magnetic steel is used to form the tank and the cover.

**Vocabulary**

**Ex.4. Define the following terms.**

quadrature booster, rectifier bridge, converter station, abnormal conditions, trackside unit, lifetime's duty, vacuum encapsulated, residential block

**Ex.5. Learn to recognize the following international words.**

proportion, block, risk, construction, prototype, test, site, design, reactor, cellulose, polarity, cover

## Supplementary Information

**Comprehension of the scientific technical texts**

**Ex.1. Read the underwritten text concerning some peculiarities of the technical translation. Search out new strange words. Try to remember the rules presented.**

Ability to find out and to extract the sense from the foreign technical text is the principal skill, each translator having to master it. Term *sense* being the most important thing in the translation technique is defined as a text idea which is to be understood. In order to solve the idea problem there are the following means:

- Recognition of the well-known and familiar words, terms and expressions in text, knowledge of the particular dictionary, skills to apply the literature while translating the unknown new terms.
- Ability to see the structure of a sentence or a paragraph of the text, skill to make use of tools of the grammatical and structural analysis of the text.
- Understanding of the scientific and technical essence of the problem of question, skill to make use of the reference literature close to the scientific area of the text.

In the modern scientific and technical articles, the most commonly used predicate form is a combination of the auxiliary or modal verb with the main verb in the corresponding form. In the proposed examples, these combinations are underlined.

- The composite materials are used to save weight of primary structures. – Композитные материалы используются для снижения веса каркасов.
- 10-in tape may allow wastage to be reduced for some device components. – Возможно, что применение ленты шириной 10 дюймов приведёт к уменьшению отходов для некоторых частей устройства.

Since the subject group is always translated after the predicate group and referring the predicate, it is easy to determine it. In modern scientific and technical language the subject is mostly expressed by the following parts of speech:

a) noun: Laser printers are extremely fast, printing a complete page at a time.
b) gerund: Inputting large amounts of data using a keyboard may take up a lot of computer time if the keyboard is on line i.e. connected to and controlled by CPU.
c) infinitive or infinitive clause: Volta is known to have developed a galvanic element.

## Language focus

### Grammar and Vocabulary

### Defining / non-defining relative clauses

A **defining relative clause** gives necessary information and is **essential** to the meaning of the main sentence. The clause is not put in commas. **Who, which** and **that** can be omitted when they are the object of the relative clause.

E.g.: That's the instrument **(which/that) we executed the lab with**. Students **who learn at full capacity** do their the best.

A non-defining relative clause gives extra information and it is not essential to the meaning of the main sentence. In non-defining relative clauses the relative pronouns cannot be omitted. **That** cannot replace **who** or **which**. The clause is put in commas.

E.g.: Alessandro Volta, **who first produced a source of continuous current**, initially was an Italian teacher of physics.

**Ex.1. Fill in the appropriate relative, say whether the relative clauses are essential or not to the meaning of the main sentence, then add commas where necessary.**



| | not essential |
|---|---|
| 1. Alessandro Volta, … first produced a source of continuous current, initially was an Italian teacher of physics | |
| 2. The circuit … you left switched on was burnt. | |
| 3. The electrician … repairs our wiring is very experienced. | |
| 4. Chohlova … studied in English group speaks fluent English. | |
| 5. Eight campus building… the electrotechnical department is situated is an eight-storied building. | |

### Linking facts and ideas

Study these statements about resistors:

1. Resistors are electronic components.
2. Resistors are used to add resistance to a circuit.

We can link the statements like this:

Resistors are electronic components **which** add resistance to a circuit.

**Which add resistance to a circuit** is a relative clause. This clause helps to define resistors. It is an essential part of the sentence.

Study these statements:

3. Very accurate resistors are used in instruments.
4. These resistors are expensive.

We can link the statements like this:

Very accurate resistors, **which** are expensive, are used in instruments.

**Which are expensive** is also a relative clause, but it contains information that is not essential to the sentence. Relative clauses that carry inessential information are separated from the rest of the sentence by commas.

Study these statements:

5. Each resistor is marked with colours.
6. The colours indicate the value of the resistor.

Statement 6 explains the purpose of the colours. We can link these statements like this:

Each resistor is marked with colours **to indicate** the value.

**Ex.2. Match the phrases as in the example:**

Example: A voltmeter is an instrument you measure the voltage with it.

| | | |
|---|---|---|
| 1. A voltmeter | an instrument | you measure the voltage with it. |
| 2. A deaerator | a path at the side of the road | we protect a circuit from surge current with. |
| 3. A fuse | a piece of furniture | you relax in it. |
| 4. A conductor | a facility | the gases are extracted from the water with it. |
| 5. An armchair | an equipment | people walk along it. |
| 6. A pavement | a material | a current can flow through it. |
| 7. An ammeter | an instrument | you measure current with it. |
| 8. Xerox | a path | where a fuel is burnt. |
| 9. A cylinder | something | current flows along it. |
| 10. Safety measures | an apparatus | you can make copies with it. |
| 11. A circuit | such piece of engine | you must know and follow them. |

**Ex.3. Now join the following groups of statements to make longer sentences.** Use the words printed in *italics* ahead of each group. You may omit words and make whatever changes you think are necessary in the word order and punctuation of the sentences.

1 *which* A resistor is a component. A resistor is used to add resistance to a circuit.

2 *which* Carbon resistors are made of compressed graphite. The graphite is formed into small tubes.

3 *to* A ceramic coating is applied over the graphite. The ceramic coating insulates the graphite.

4 *to* The ends of the graphite are sprayed with metal. This forms contacts.

5 *which* End caps are forced on the metal-sprayed ends. The caps have connected wires attached.

6 *to* The ceramic is marked with colour bands. The bands indicate the value and tolerance.

7 *which* Resistors are made in a range of preferred values. These values meet all the needs of circuit designers.

## Reading and Speaking

**Ex.1. Read and translate the text below.**

**Evaluation of Condition Monitoring of Bearings of 15 kW Induction Motor Based on Statistical Stator Current Analysis**



**Abstract**. Bearing fault detections based upon the stator current measurement provides many advantages compared to detection based on the vibration monitoring. This paper addresses some of the factors that may have effect on the feasibility of stator current measurement. The factors presented are the influence of the grid impedance, the effect of vibration caused by other factors than a bearing fault, the effect of non-sinusoidal time varying air gap permeance and the influence of internal radial clearance of the rotor supporting bearing.

**Introduction**. A stator current measurement has an important role in a condition monitoring of the induction motors. Unbalanced rotor, rotor bar damages and damaged stator windings can be indicated with analyses based on the stator current measurement. The stator current measurement would be sufficient as the only condition monitoring "sensor" if bearing damages were found by analyses based on this measurement. In this paper we present some simulations and experiments that clarify some of the factors that may affect the possibilities to indicate an outer race defect of ball bearing by the time frequency representation of the stator current. The main purpose is to clarify the influence of the radial clearance of the bearing, the influence of non-sinusoidal time varying air gap flux and the influence of the rotor vibration caused by other factors than the bearing damage.

**Measurements and results**. The influence of the sudden change in the air gap length was tested when the stator windings of the stand still motor were magnetized with DC-current. The end shield of the D-end of the motor was removed and the rotor was supported with copper stripes installed to the air gap. The radial movement of the rotor was produced with the pendulum coated with rubber.

The relationship between the acceleration level or the stator transient and the degree of radial movement of the rotor was analyzed with simultaneous measurements of acceleration, stator current and the radial movement of the rotor.

The measurement principle is to test if the difference between healthy bearing case and outer race defect case is significant. The results of bearings with normal radial clearance are presented in figure 1 and the results with bearings with abnormally large radial clearance are presented in figure 2.

The outer race defect was clearly indicated in the case of the large internal radial clearance of the bearing. Unfortunately, defected bearings with normal radial clearance could not be classified and normal wear could not be distinguished from the bearing damage.

**Ex.2. Search out and extract the massive terminological groups from the text.**

**Ex.3. Conclude and explain if the application of the massive terminological groups helps to understand material better or doesn't.**

**Ex.4. Answer the questions.**

- What is the above-described method to control an induction motor based on?
- What problems may one deal with using the described method?
- What is the main purpose of the investigation presented?

**Ex.5*. Ask your own questions.**



# UNIT 42. THE POWER SYSTEM (beginning)

**Overview**

- Reading and Vocabulary: The power system (beginning).
- Supplementary Information: Introduction into the translation theory. Read the classic literature!
- Language focus: On the application of the passive voice constructions in technical texts.
- Reading and Speaking: R&M advertisement.

## Reading and Vocabulary

**Reading**

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**The power system (beginning)**

All countries now have a power system which transports electrical energy from generators to consumers. In some countries several separate systems may exist, but it is preferable to interconnect small systems and to operate the combination as one, so that economy of operation and security of supply to consumers is maximized. This integrated system (often known as the 'grid') has become dominant in most areas and it is usually considered as a major factor in the well-being and level of economic activity in a country.

All systems are based on alternating current, usually at a frequency of either 50Hz or 60Hz. [ 1 ]

Systems are traditionally designed and operated in the following three groupings:

- the source of energy – *generation*;
- bulk transfer – *transmission*;
- supply to individual customers – *distribution*.

Generators are required to convert fuels (such as coal, gas, oil and nuclear) and other energy sources (such as water, wind and solar radiation) into electrical power. [ 2 ]

The total power output of all operating generators connected to the same integrated system must at every instant be equal to the sum of the consumer demand and the losses in the system. This implies careful and coordinated control such that the system frequency is maintained, because the majority of generators in an ac

power system are synchronous machines and their rotors, which produce a magnetic field, must lock into the rotating magnetic field produced by alternating currents in the stator winding. [ 3 ]

As the demand of domestic, commercial and industrial consumers varies, so the generated power must also vary, and this is normally managed by transmission system control which instructs some generators to maintain a steady output and others (particularly hydro and gas turbine plant) to 'follow' the load; load 'following' is usually achieved by sensitive control of the input, dependent upon frequency. It is desirable to run the generating plant such that the overall cost of supplying the consumer at all times is a minimum, subject to the various constraints which are imposed by individual generator characteristics.

[ 4 ].

**Reading comprehension**

**Ex.1.**

A. Any excess of generated power over the absorbed power causes the frequency to rise, and a deficit causes the frequency to fall.

B. The 50Hz is used in Europe, India, Africa and Australia, and 60Hz is used in North and South America and parts of Japan.

C. Nearly all generators are rotating machines, which are controlled to provide a steady output at a given voltage.

D. In de-regulated or privatized power systems this is achieved by competition among generators combined with additional regulated markets for ancillary services and use of the transmission system.

E. Higher power is therefore transmitted through the line with lowest impedance and this can result in overload on that line, when the parallel line is only partly loaded.

**Ex.2. Read the text and find the answers to these questions.**

1. What does a power system do with electrical energy? 2. Why are small systems to be interconnected? 3. Where are other energy sources converted into electrical power? 4. How is the mains frequency controlled? 5. Where is the main frequency 60Hz used?

**Ex.3. Find the wrong statements and correct them.**

1. It is preferable to interconnect small systems and to operate the combination as one. 2. All systems are based on direct current. 3. Generators are required to convert fuels and other energy sources into heat. 4. The total power consumption is



controlled such that the system frequency is maintained. 5. The rotors of synchronous machines must lock into the rotating magnetic field produced by alternating currents in the stator winding. 6. As the demand of consumers varies, so the mains frequency must also vary.

**Vocabulary**

**Ex.1. Define the following terms.**

ancillary service, integrated system, bulk transfer, consumer demand, domestic consumer, commercial consumer, to 'follow' the load, overall cost

**Ex.2. Learn to recognize the following international words.**

system, transmission, distributor, security, sum, manager, individual, deficit, service, result

## Supplementary Information

**Ex.1. Read the underwritten text concerning the principal rules of translation.** Search out new 7words. Try to remember the rules presented.

**Introduction into the Translation Theory**

There is the gold rule of the metrology: do measure as precisely as possible, however, do never measure with higher accuracy than necessary. Similarly, at translation, one may follow the motto: extra accuracy is very similar to extra inaccuracy. It is important just to deliver the text spirit. Thus, an opinion exists that the faithful translation is impossible. Furthermore, an exact translation complicates the information perception and that's why it is not necessary. However, it is always possible to find sufficient linguistic facilities.

While translating, do keep to the following statements: 1) absolutely any text may be translated; 2) do try to understand the essence of the text under translation; 3) a creative approach to translation is necessary, do pay attention to the author's emotions, do try to save them at translation; 4) do never translate word for word.

However, there may be an equivalent and analogous translation as well as adequate substitution. *Equivalent* means the coincidence of the original with its translation. *Analogue* is close to original. The latter is found through the analysis of the synonymic series of appropriate terms, the necessary being chosen in accordance with the original. *Adequate substitution* is realized in three steps: explanatory step; antonymic translation; compensation – expression of the same thought by means of other words.

Sometimes, an author's thought is not complete. Do find and guess the underlying theme! Do remember, English is very short-spoken language in comparison with Russian. At translation from English to Russian, additional explanations and descriptions happen almost without fail.

Speaking of the correct understanding of the text under translation, one may mention the difficulties of both lexical and grammatical character.

1) multiple-meaning subordinate words: *yet* – means "still" staying in the middle or at the end of a sentence, while at the beginning, it means "however"; *however* is translated "однако", while being used with adjectives it presents "как бы ни"; usual definite article *the* being used with adjectives is translated "чем, тем" (the more …); *as* means "так как", but frequently it is "в качестве, в виде" (the raw material is received as …), sometimes it is "в тот момент, когда"; *as ... as* – "так же … как и" or "настолько, насколько"; the main meaning of *but* is "но", possible meanings are "только", "всего лишь", "кроме", "за исключением"; *but for* – "если бы не"; *anything but* – "всё, что угодно, только не"; *where* is sometimes translated as "в тех случаях, когда"; *which* concerning the whole sentence means "что"; *whether* means "independently on", "будь то";
2) multiple-meaning conjunctions result in advice: do not translate the preceding expression, having not translated the subsequent expression, first;
3) neologisms. Sometimes, they are formed by means of the word shortening, sometimes, owing to application of the prefixes or suffixes. There are productive prefixes-suffixes which change the word meaning as well as nonproductive ones which don't change the meaning;
4) the language figurativeness;
5) idioms and idiomatic expressions;
6) undisclosed allusion and insinuation;
7) simplifications and primitives;
8) titles, especially the newspaper's headlines. It is recommended to translate them after the article has been read.

Correct choice of the translation structure allows underlining the secondary elements and saving the original style. As regard to translation, there are the following types of sentences:

1) Translated very close.
2) Translated by means of the word order reversion.
3) Requiring partially both lexical and syntactical changes.
4) Requiring full reconstruction.
5) Extremely hard sentence.



Sentences of the 1st type occur rarely. They are statements without accent on but single word. E.g.: I see a picture – Я вижу картину.

The 2nd type are the informational sentences, where one or another element is stressed: a lecture on geology was delivered at our institute yesterday – Вчера в нашем институте состоялась лекция по геологии.

In the 3rd case, we deal with inverted sentence. It may perform a communicative or expressive function when a personal attitude is expressed. It is realized by means of the word order inversion to emphasize an element: often shall I remember this aura; never can I remember what this word means. The inversion for dynamic is widespread. Here, an adverb or a preposition related to an action is placed at the sentence beginning, it follows by the verb-predicate and finally – the subject is placed. Do compare: the flag wakes up (флаг поднимался) – up wakes the flag (взвился флаг).

Idiomatic sentences require the full reconstruction while translating for its components separately have other meaning as if they are considered together: I can't help laughing (не могу удержаться от смеха); I want to wet my whistle (хочу выпить (промочить горло)). In this case it is possible **a)** substitution of idioms by idioms: to make both ends meet/сводить концы с концами; I wash my hands of all further responsibility/умываю руки; **b)** translation with the aid of the idiomatic analogue: it's the first step that cost/лиха беда – начало; this is to my heart/это мне по душе; **c)** descriptive translation.

In case of the extremely hard sentence it is necessary to make an analysis; to translate roughly, word by word; to design the expression skeleton; to edit finally.

**Read the classic literature!**

Rules of English phrase construction for both technical language and classic literature are commonly the same. To master the translation specialty you must read much any literature starting with newspapers and finishing with textbooks and manuals. Let's call your attention to the book fragments.

**Ex.2. Translate the sentences, characterizing them** if they are usual or unusual, if they use Gerund or Infinitive, Active or Passive, if they have wrong word order and so on. Answer which constructions are possible and useful in technical language.

1) The sledge was shaped like a great golden swan, and between the swan's wings laid the little Princess herself. 2) So pale was she that as she drove through the streets all the people wondered. 3) King gave orders that the Page's salary was to be doubled. As he received no salary at all this was not of much use to him, but it was considered a great honour, and was duly published in the Court Gazette. 4)

After the banquet there was to be a Ball. 5) Just look at those yellow tulips. If they were real crackers they could not be lovelier. I am very glad I have traveled. Travel improves the mind wonderfully, and does away with all one's prejudices. 6) The world is enormous place, and it would take you three days to see it thoroughly. Any place you love is the world to you. 7) Love is not fashionable any more, the poets have killed it. They wrote so much about it that nobody believed them, and I am not surprised. True love suffers, and is silent. Romance is a thing of the past. 8) Romance never dies. It is like the moon, and lives for ever. 9) She was of those people who think that, if you say the same thing over and over a great many times, it becomes true in the end. 10) He always coughed before he made any observations, so as to attract attention. 'Ahem! Ahem' he said, and everybody listened except the poor Catherine Wheel, who was still shaking her head, and murmuring, 'Romance is dead.' 11) As soon as there was perfect silence, the Rocket coughed a third time and began. He spoke with a very slow, distinct voice, as if he were dictating his memories, and always looked over the shoulder of the person to whom he was talking. In fact, he had a most distinguished manner. 12) How fortunate it is for the King's son, that he is to be married on the very day on which I am to be let off! Really, if it had not been arranged beforehand, it could not have turned out better for him but Princes are always lucky. 13) It may be so with you. Indeed, I have no doubt that it is, but with me it is different. I am a very remarkable Rocket, and come of remarkable parents. 14) He flew so high that the people were afraid that he would never come down again. He did, though, for he was of a kindly disposition, and he made a most brilliant descent in a shower of golden rain. The Court Gazette called him a triumph of Pyrotechnic art. 15) 'I said Pyrotechnic art,' answered the Rocket, in a severe tone of voice, and the Bengal Light felt so crushed that he began at once to bully the little squibs, in order to show that he was still a person of some importance. 16) I hate rudeness and bad manners of every kind, for I am extremely sensitive. No one in the whole world is so sensitive as I am, I am quite sure of that. What is a sensitive person? A person, who, because he has corns himself, always treads on other people's toes. 17) Pray, what are you laughing at? I am laughing because I am happy. That is a very selfish reason. What right have you to be happy? You should be thinking about others. In fact, you should be thinking about me. I am always thinking about myself, and I expect everybody else to do the same. That is what is called sympathy. It is a beautiful virtue, and I possess it in a high degree. 18) I hate people who cry over split milk. You are the rudest person I ever met. 19) I never said I knew him. I dare say that if I knew him I should not be his friend at all. It is a very dangerous thing to know one's friends. 20) He must have a truly romantic nature, for he weeps when



there is nothing at all to weep about. 21) But the Roman Candle and the Bengal Light were quite indignant, and kept saying, 'Humbug! Humbug!' at the top of their voices. They were extremely practical, and whenever they objected to anything they called it humbug. 22) The next day the workmen came to put everything tidy. 'This is evidently a deputation,' said the Rocket; 'I will receive them with becoming dignity;' so he put his nose in the air, and began to frown severely, as if he were thinking about some very important subject. But they took no notice of him at all till they were just going away. 23) 'A new arrival, I see!' said the Frog. 'Well, after all there is nothing like mud. Give me rainy weather and a ditch, and I am quite happy. Do you think it will be a wet afternoon? I am sure I hope so, but the sky is quite blue and cloudless. What a pity!' 24) I am off to look for my daughters. I have six beautiful daughters, and I am afraid the Pike may meet them. He is a perfect monster, and would have no hesitation in breakfasting off them. 25) There is no good talking to him; no good at all, for he has gone away. Well, that is his loss, not mine. I am not going to stop talking to him merely because he pays no attention. I like hearing myself talk. It is one of my greatest pleasures. I often have long conversations all by myself, and I am so clever that sometimes I don't understand a single word of what I am saying. (Oscar Wilde. The Remarkable Rocket).

## Language focus

**Before you start**

1. What do you know of the passive voice constructions?
2. When are they used?

**On the application of the passive voice constructions in technical texts**

**Ex.1. Read the underwritten text concerning peculiarities of the technical texts. Search out new strange words. Try to remember the rules presented.**

Having considered numerous scientific and technical texts, it is possible to choose the lexical and grammatical peculiarities typical to these texts.

- Broad occurrence of the massive terminological groups including up to 6-8 attributes.
- Preferred usage of the passive constructions. However, contrary to the existing opinion, scientists prefer the passive constructions not to eliminate a personnel element but to impart a high status to the most important idea and to put forward just the subject of question.

- Frequent application of the linking words to set the arguments in the logical sequence, to produce the logical passage from one statement to another.

Let's perform, in this connection, a list of the most generally used in the technical literature the linking words and expressions: albeit (from *all though it be*); accordingly; again; also; aside; as a consequence; at the same time; besides; but; correspondingly; finally; for example; for instance; further; furthermore; e.g. (exempli gratia, L); henceforth; however; if and only if; in accordance with; so far as; as much as; likewise; moreover; notwithstanding; otherwise; on the one hand, on the other hand; similarly; since; still; subsequently; then; therefore; thus; viz. (videlicet, L); whereas; yet.

**Grammar and Vocabulary**

**The Passive**

The passive is formed with the appropriate tense of the verb **to be + past participle**. The **Passive** is used:

1. when the **agent** (= the person who does the action) is **unknown, unimportant** or **obvious** from the context. E.g.: The president Kennedy **was shot** (we don't know who shot him). Many years ago it **was found** that lightning could kill and burn (unimportant agent). The influence of the sudden change in the air gap length **was tested** (obviously by experimenters).
2. to make more **polite** or **formal** statements. E.g.: The report on lab **hasn't been performed** (more polite). (You haven't performed the report on lab. – less polite)
3. when the **action is more important**. E.g.: The results **are presented** in figure.
4. to put **emphasis on the agent**. E.g.: The law of electromagnetic induction was discovered **by Faraday**. The effect of vibration is caused **by many factors**.

**Ex.2. Find the application of the passive in the main text. Explain the reasons of its application in each case.**

## Reading and Speaking

**Ex.1. Read the text below in 1 minute and point out the main idea of each paragraph. Guess what it is about and propose a headline.**



The growing installed base of electronic devices that operate with very low signal levels is highly susceptible to surge voltages caused by atmospheric fields and discharges (thunderstorms), switching transients, or electrostatic discharges.

An additional problem is electrical coupling (contact of low-power circuits with high-voltage circuits).

Failure to take adequate protective steps can lead to the destruction of semiconductors, ICs, etc. But the principal objective is to effectively protect the personnel and the installed equipment.

R&M have carefully considered these problems and provide you on the following pages with an introduction to the concept of overcurrent and overvoltage protection.

**Ex.2. Answer the questions.**

- What is overcurrent and overvoltage?
- When is the protection from overcurrent and overvoltage important?
- What are the causes of the overcurrent and overvoltage appearance?

**Ex.3*. Ask your own questions.**

# UNIT 43. THE POWER SYSTEM (continuation)

**Overview**

- Reading and Vocabulary: Distributed and renewable generation.
- Supplementary Information: Title of a scientific paper.
- Reading and Speaking: Metal detectors.
- Language focus: Linking what you read with what you know. Transitive verbs.

## Reading and Vocabulary

**Reading**

Parts of four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Distributed and renewable generation**

The worldwide imperative to reduce greenhouse gases, particularly $CO_2$, and to secure energy supplies for the long-term future has prioritized the development of electricity generation from renewable energy sources. Renewable generators and other high-efficiency schemes, such as *Combined Heat and Power (CHP)* are [ 1 ]. Consequently, these generators are often embedded or distributed in the network at voltages, such as 11kV or 33kV.

As the penetration of renewables into the system increases there are [ 2 ]. Some renewables, such as biomass can be regarded as providing firm capacity, or others, such as tidal power may be predictable but periodic, but most, including wind, wave and photovoltaic, have to be regarded as intermittent. Hydroelectric power is also a renewable and apart from the run-of-river plant, it offers a valuable energy storage capability. The various plant characteristics can have a significant impact for the system operator, especially in determining the required level of spinning reserve, and/or demand management, required within the system to cover the increased intermittence of supply. At present, the higher capital cost of renewable generation needs to be compensated through government subsidy to seek the total levels of renewable energy desired.

*Distributed Generation* (DG) also poses serious technical issues for the distribution network. These include [ 3 ], and the inability of many DGs to 'ride-through' voltage dips (thereby exacerbating the problem). The DGs also affect fault levels in networks, either by contributing excess fault current in the case of directly connected induction generators or by not contributing sufficient fault current, where



generators are connected through power electronic converters. Further issues include the possibility of bi-directional power flow in low-voltage networks and whether 'islanded' sections of the network could become a safe and acceptable operational option in the future. These technical issues are [ 4 ], but they pose an interesting and important challenge for power system engineers.

**Notes and comments**

… *imperative* … This is something which is obligatory.

… *greenhouse gases* … These are such gases which produce hothouse effect to the environment.

… *renewables* … Here, this informal term includes all possible renewable sources.

… *spinning reserve* … means the units are ready to be loaded at any instant moment.

**Reading comprehension**

**Ex.1**.

A. relatively small in capacity compared with large thermal power stations.
B. hard problems, such as hum in electric networks.
C. major issues for the planning and operation of the power system.
D. power quality problems, such as harmonic current injection.
E. certainly solvable using present day technology.

**Ex.2. Read the text and find the answers to these questions.**

1. Which imperative has prioritized the development of electricity generation from renewable energy sources? 2. Why are the renewable generators distributed in the rather low voltage network? 3. What problems do the renewables offer to the system? 4. Which renewables have to be regarded as intermittent? 5. Why does government subsidy compensate the renewable expenditures? 6. What is the modern important challenge for power system engineers?

**Vocabulary**

**Ex.3. Define the following terms.**

long-term future, renewable energy source, biomass, firm capacity, photovoltaic, intermittent, run-of-river plant, energy storage capability, spinning reserve, technical issue, to exacerbate the problem, bi-directional power flow

**Ex.4. Learn to recognize the following international words.**

imperative, secure, biomass, operator, spinning, reserve, management, capital, subsidy, section, safe, system engineer

## Supplementary Information

**Before you start**

1. What do you think of the rules to perform a title of the scientific paper?
2. What function does a paper title perform?
3. From your viewpoint, which requirements has a paper title to meet?

### Title of a scientific paper

**Ex.1. Read the underwritten text concerning the translation and performance of the scientific paper title. Search out new strange words. Try to remember the rules presented.**

A scientific paper title reflecting its general subject-matter, it gives just general-most idea of the paper's true contents. That's why it is read first of all to gain some insight; however, it is translated in the end after the article translation has been over. The most common title structure is a term with some left and one right prepositional attributes. Look through the following examples with their translation.

- Quasisinusoidal principle of contactless position commutation of armature windings of permanent magnet synchronous motor in direct electric drive. – Квазисинусоидный принцип бесконтактной позиционной коммутации обмоток якоря синхронных машин с постоянными магнитами в безредукторном электроприводе.
- Study of work of the railway point electric drive considering load features. – Исследование работы электропривода железнодорожной стрелки с учетом характеристики нагрузки.
- Crankshaft mechanism electric drive control system. – Система управления электроприводом кривошипно-шатунного механизма.
- Electric motor assistant for uphill riding. – Электрический мотор помогает преодолевать крутые подъёмы.
- Relay regulation in the excitation system of asynchronous generator. – Релейный регулятор в системе возбуждения асинхронного генератора.
- Power station in Timelkam – one of the most efficient and ecologically safe. – Электростанция в Тимелькаме является одной из самых эффективных и экологически безопасных.
- Development, manufacturing and maintenance of solar electric supply systems: practical experience. – Разработка, изготовление и эксплуатация системы солнечного электроснабжения: практический опыт.

Another widespread title form is a prepositional form. The examples are as follows.



- On translation of technical texts. – К вопросу о переводе технических текстов.
- On the effects of continuous active work on pilot's performance. – К вопросу о воздействии длительной работы лётчика в полёте на технику пилотирования.
- On the interferometric method of stress analysis. – Об интерферометрическом методе исследования нагруженного состояния композитных материалов.

In some proposed examples, translation of the scientific paper titles has been performed with involving of the additional information drawn from the abstract or annotation or introduction etc. In comparison with English original, the Russian translation is much bulkier and possesses the explanation character because of the absence of the Russian equivalent. It is necessary to try avoiding the mistakes and the sense distortion.

Let's perform a very indicative example of translation of the title with unavailable equivalent term, translation having explanatory character.

Yo-yo despin.

To translate above-mentioned title, let's read the article abstract.

**Abstract**. Analytical treatment of the problem of despinning a rotating rigid body by a yo-yo device, both for the two-dimensional model and the three-dimensional model. A rigid yo-yo experiment was conducted to verify the theory. The equations of motion of the system are derived for the rigid yo-yo and the stretch yo-yo, and are solved for several specific cases to make comparisons with experimental results. Theory and experiment agree satisfactorily, and data are presented.

After the abstract has been read it is clear the paper talks of the stopping rotating of the rigid solid in space. The main words in abstract are a noun "despin" (to stop rotating) and the left attribute 'yo-yo' which is absent in traditional dictionaries. However, in modern reference books it is possible to find this word 'yo-yo' meaning "to move from one position to another repeatedly". Finally, we obtain Russian version of the title: yo-yo despin – использование вынужденного возвратно-поступательного движения для прекращения авторотации жесткого тела в космосе.

**Ex.2. Translate the following paper titles.**

a) High power density evaporative cooling.

b) Vector processing in Computational Fluid Dynamics.

c) Determination of stationary pull-out torque based on dynamic torque characteristic.
d) Die-cast Copper Rotor Motors via Simple Substitution and Motor Redesign for Copper.
e) An Accurate Method for the Study of Inter-Turn Short Circuits in the Stator Windings of Induction Machines.
f) A New Possibility for the Determination of the Induction Machines' Parameters.
g) Study on Frequency Characteristics of Synchronous Generator Damper Circuit.
h) Symmetrization of the asynchronous condition caused by excitation loss of a turbogenerator in electrical system.
i) Skew Effect. Parameters of AC Machines with Skewed Slots.

**Ex.3. Translate the following paper titles from Russian to English.**

a) Исследование возможностей реализации векторной ШИМ при частотном управлении асинхронным приводом.
b) Исследование переходных процессов в линиях с распределёнными параметрами при подключении к энергосистеме.
c) Численный анализ магнитного поля турбогенератора в режиме нагрузки.
d) Матричные методы анализа и расчета разветвлённых электрических цепей.
e) Современные подходы к проблеме охлаждения микросхем центральных процессорных устройств управляющих ЭВМ.
f) Моделирование переменного магнитного момента электрооборудования.
g) Надёжность электрооборудования как критерий оценки состояния безопасности.
h) Моделирование электрической сети в программе SIMULINK.
i) Оптимизация переходных процессов режимов электропривода механизмов грузоподъёмного крана.

**Ex.4*. Answer if your own translation is briefer than Russian original.**

## Reading and Speaking



**Ex.1. Read the short text below, then discuss these questions:** 1) How can you create a changing magnetic field? 2) How can you detect a voltage created in a buried object?

**Metal detectors**, despite their technical complexity, are based on a few very simple principles. The most important is that of electromagnetic induction. This means that if an object is placed in a changing magnetic field, an electrical voltage is created in the object.

Alternating current (AC) is applied to the coil in the search head from the battery in the control box. This creates an ever-changing electromagnetic field around the coil. An electric current is induced in any metal object the coil passes near.

The current induced in the metal object produces its own magnetic field, which in turn induces a voltage in the search coil, as the alternating current changes direction.

The circuitry in the control box senses this reaction and converts the voltage into an audible note, which is sent to the headset. As the metal object is approached, the sound in the headset becomes louder, or changes pitch.

**Ex.2. Label each step in this flowchart with the correct letter from the list below. The first one is done for you.**

1-b; 2- ; 3- ; 4- ; 5- ; 6- .

a- Magnetic field around the object; b- AC voltage in the search coil; c- Electric currents in the metal object; d- Induced voltage in the search coil; e- Note heard in headset; f- Magnetic field around the coil.

## Language focus

**Linking what you read with what you know**

Not everything in a text is clearly stated. When reading, we have to make links between what we read and what we already know about the subject.

**Ex.1. Read this brief text and try to answer this question:** Can metal detectors be used to trace water pipes under a street?

Metal detectors can find buried metal. They were developed for military purposes to locate hidden explosives. They operate on the principle of electromagnetic induction.

To answer the question, you have to link knowledge from the text and knowledge of you own.
From the text we know: Metal detectors can find buried metal.
From your own knowledge you know: Most water pipes are metal. They are buried under streets.

The more knowledge we have about our subject and about the world in general, the easier it is to learn new things when we read.

**Grammar and Vocabulary**

**Transitive verbs**

Note these verbs, which are used often in electrical engineering: generate, induce, detect.

They are transitive verbs. This means they are followed by a direct object and can be used in the passive (when the object becomes the subject). Active verb: the magnetic field **induces** a voltage. Passive verb: a voltage **is induced** by the magnetic field.

In electrical engineering these verbs take a limited range of objects. Study the following examples from this book: induce + an emf / a voltage / a noise / hum / a current; generate + electrical pulses / a large EMF / signals; detect + a movement / a voltage / a form of energy / sound / heat.

**Ex.2. Complete each sentence with** *generate*, *induce* or *detect*.

1. The magnetic field … an electric current in the metal objects.
2. A microphone may be used to … sound.
3. The oscillator … pulses at a fixed frequency of 32768 Hz.
4. The magnetic field … a voltage in the search coil.
5. Noise is also … by the low-frequency mains supply.
6. Motion sensors may use microwave energy to … movement within their range.
7. Electrical pulses are first … at a frequency in the upper audio range by the audio oscillator.
8. The first stage is a sensing device that changes its resistance when it … a particular form of energy.



# UNIT 44. THE POWER SYSTEM (completion)

**Overview**

- Reading and Vocabulary: Transmission.
- Supplementary Information: Annotation of a scientific paper.
- Language focus: Giving advice.
- Reading and Speaking: Damping of transients.

## Reading and Vocabulary

**Reading**

Parts of four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Transmission**

Many large generators require easy access to their fuel supply and cooling water, so [ 1 ]. Environmental constraints may also preclude siting close to areas of consumption. A bulk power transmission system is therefore needed between the generators and the consumers.

Large generating plant produces output ranging from 100MW to 2000MW and for economic reasons this normally operates with phase-to-phase voltages in the range 10 kV to 26 kV. In order to reduce transmission losses so that transmission circuits are economic and environmentally acceptable, [ 2 ]. Phase-to-phase transmission voltages of up to 765 kV are used in sparsely populated large countries, such as Brazil, USA and Canada, but 380–400 kV is more prevalent in Europe. The standard voltages recommended by IEC are 765 kV, 500 kV, 380-400 kV, 345 kV, 275 kV, 220–230 kV, 135–138 kV and 66–69 kV.

Most transmission circuits are carried overhead on steel pylons. They are suspended from insulators which provide sufficient insulation and air clearance to earth to prevent flashovers and danger to the public. Each country has tended to have its own acceptable tower and conductor design. At higher voltages, Aluminium Conductor Steel Reinforced (ACSR) conductor is used, [ 3 ]. For voltages over 200 kV two or more conductors per phase are used. This results in lower losses because of the large conductor cross section and lower radio interference and corona because of the lower voltage stress at the conductor surface.

In cases where an overhead line route is impossible because of congestion in an urban area or for environmental amenity reasons, buried cables may be employed, but [ 4 ]. On sea crossings an underwater cable is the only solution, but these are often dc.

A high-voltage transmission system interconnects many large generators with areas of high electricity demand; its reliability is paramount, since a failure could result in loss of supply to many people and to vital industry and services. The system is therefore arranged as a network so that the loss of one circuit can be tolerated. In many countries, three-phase lines are duplicated on one tower, in which case a tower failure might still result in a partial blackout. Mixed-voltage systems are often carried on a single tower, but this is not the practice in the UK.

In order to achieve flexibility of operation, circuits are marshalled at substations. The substations may include transformers to convert from one voltage level to another, and switchgear to switch circuits and interrupt faults. Substations are normally outdoors and they occupy an extensive secure area, although compact indoor substations using $SF_6$ have become more prevalent recently because of their improved reliability in adverse weather and a more compact layout.

An interconnected transmission network can comprise many substations which are all remotely controlled and monitored to ensure rapid reconnection after a disturbance or to enable maintenance.

**Notes and comments**

… *phase-to-phase voltage* … Another term for this three-phase voltage is '*line voltage*'.

… *IEC* … This stands for *International Electrotechnical Commission*.

… *steel pylons*… Synonym to 'pylon' is 'tower'.

… *air clearance*… This is minimum distance between the overhead line wires and the earth.

*For voltages over 200 kV two or more conductors per phase are used*. This procedure is called 'phase splitting'.

… *a partial blackout* … This means that the line cannot transmit energy for definite time.

**Reading comprehension**

**Ex.1**.

A. they cannot necessarily be sited close to areas of major consumption.
B. a core of steel strands providing the required strength.
C. the cost is 15–20 times higher than that of an equivalent overhead line.
D. direct current link is necessarily used.
E. a higher voltage is necessary.



**Ex.2. Read the text and find the answers to these questions.**

1. Can large generators be sited close to areas of major consumption? Why not? 2. When is a bulk power transmission system needed? 3. Why is a higher voltage necessary in transmission circuits? 4. Phase-to-phase transmission voltages of up to 765 kV are used in Greece, aren't they? 5. How are transmission circuits suspended while applying the steel pylons? 6. When and why are the line conductors split? 7. What could low reliability of the transmission system result in? 8. Are mixed-voltage systems often carried on a single tower in UK? 9. What gas do compact indoor substations use in their installation? 10. How are the substations controlled and monitored?

**Ex.3. Find the wrong statements and correct them.**

1. Large generators are sited close to fuel areas or water reservoir. 2. A bulk power transmission system is always needless. 3. A higher voltage is necessary to ensure high efficiency of the transmission circuits. 4. Most transmission circuits are carried the buried cables. 5. Splitting of the conductors in high-voltage lines is involved to increase the conductor cross section. 6. A high-voltage transmission system interconnects all large generators. 7. The system is therefore arranged as a network so that the loss of one circuit is impossible. 8. Circuits are marshalled at substations in order to ensure the high efficiency of the energy transmission. 9. A compact indoor substation occupies much less area than an outdoor one. 10. Substations are all remotely controlled. It is the government requirement.

**Vocabulary**

**Ex.1. Explain the following terms.**

environmental constraints, bulk power transmission system, environmentally acceptable, sparsely populated, to prevent flashover, radio interference, lower voltage stress, environmental amenity reasons, tower failure

**Ex.2. Learn to recognize the following international words.**

transmission, phase, economic, to recommend, pylon, clearance, public, interference, corona, urban, vital, mixer, marshal, compact, monitor

## Supplementary Information

**Before you start**

1. What is an annotation of the scientific paper?
2. What function does an annotation perform?
3. From your viewpoint, which requirements has an annotation to meet?

## Annotation of a scientific paper

**Ex.1. Read the underwritten text concerning the annotations. Search out new strange words. Try to remember the rules presented.**

An annotation is brief and at the same time comprehensive representation of the paper matter, it being placed immediately after the paper title and being to be understood to as wide circle of readers as it is possible. As a rule, an annotation contains neither formulae nor numerical data, it being of volume not exceeding 1000-1600 printed symbols. It has to be a logically complete unit giving to a reader the possibility to decide if he needs to read the proposed article. In comparison with text, the annotation is printed in different type (usually, italics, or bold, or small print).

The annotation contains information of general direction, tasks and aims of investigations, description of the work subject-matter is given, the investigation methods are explained, theoretical and experimental results obtained are briefly stated, the most general conclusions are formulated.

On the results of analysis of numerous annotations, one may give the most used lexical stylistic verb groups: is/are arrived at, developed, discussed, introduced, involved, formulated, outlined, made, considered, summarized and so on.

The annotation of an article containing the results of the scientific investigations includes the following expressions and structures:

- The results of the theoretical (experimental) study of … are presented.
- It is shown that …
- A theoretical/experimental dependence of … on … is formulated.
- Recommendations for … are presented.
- Conclusions regarding … are made.

The annotation of a generalizing scientific article may contain the following structural forms which are specific for this type of articles:

- In this general paper the role of … in … is discussed.
- Subject matter relating to … as well as to … is considered.

The annotation of a review scientific article containing the analysis of results obtained by other researchers is characterized by the availability of the following expressions and structural forms:

- A review of … essential for … is presented. – Приводится обзор, представляющий интерес для …
- The current research programs for … are outlined. – Приводится обзор проводимых в настоящее время исследований по …



- Special attention is given to … methods (techniques, solutions) used by … for … – Особое внимание уделяется методам (способам, решениям), применяемым … для …
- The factors/parameters considered include … – Рассмотрено влияние таких факторов/параметров как …

It may be concluded that while translating the word structural forms from English to Russian the word order inversion takes place.

When writing an annotation the following expressions are frequently used: it is described in short; it is introduced; it is shown that; it is given; it is dealt with; it is provided for; it is designed for; it is examined; it is investigated; it is analyzed; it is formulated; the need is stressed to employ; attention is drawn to; data are given about; attempts are made to analyze (formulate); conclusions are drawn; arrive at a conclusion (decision); recommendations are given.

The following advices may be given when writing an annotation:

1. An annotation is performed in one's own words, simply and briefly. One should avoid the composite constructions and sentences.

2. It is recommended to start the annotation statement with the article matter, do not repeat the article headline.

3. One should not make use of the additional sentences like as follows: "The aim of the article is ...", "The author writes ...", "The article describes ...". While summarizing the information, it is recommended to use the following words: "it is proposed, ... described, ... reported, ... stated" and so on.

4. It is recommended to perform the original names of the firms, scientific centers, institutes, companies.

5. One should use the conventional abbreviations only.

**Ex.2. Translate the following annotations, paying attention to the word order reversion while translating the terminological groups from English to Russian.**

a) In this paper, issues connected with the subject of 'Fundamentals of Machine Components Design' are presented. In particularly, we describe the main features of this subject and origins of its coming into being. We pay the special attention to the share of Leonardo da Vinci in the mentioned subject. Moreover, some examples and figures presented in this paper emphasize his contribution. The briefly review of his accomplishments in the design as well as analysis and synthesis of machines allow us to state that Leonardo da Vinci was the precursor of the 'Fundamentals of Machine Components Design' subject.

b) Motors manufacturers offer torque-speed characteristic in steady state. The important points of the curve are: starting torque, pull-up torque and pull-out torque

with its respective speeds. In order to find this characteristic there are different forms standardized by the different international committees, but all of them are of difficult application when they are large motors (from 100 kW).

c) This paper describes design approaches for high efficiency copper rotor motors. The first alternative employed here for a 1.5 kW motor is fundamentally a simple replacement of the aluminum squirrel cage of the rotor by copper using the same rotor lamination design. Other measures like higher quality iron and stack length increase are used to meet motor performance objectives. The latter section of the paper describes in more detail design issues for an 18.5 kW motor. In that context the choice of stator/rotor slot numbers are investigated and FEM calculations are presented.

d) This paper deals with an accurate method enabling the study of inter-turn short circuits in the stator windings of induction machines. This method is based on the coupled magnetic circuit theory. The differential equations system of the induction machine in presence of inter-turn short circuits is described where the calculation of mutual inductances is based on an energetic approach using the winding functions method and a doubly slotted air-gap permeance analytical model. The simulation results of the proposed model are validated by means of a 4 kW specially rewound motor loaded by a DC generator.

**Ex.3*. Translate the following annotations from Russian to English.**

a) Работа посвящена исследованию гармонического состава входного тока многофазных схем выпрямления при активно-емкостной нагрузке. Получены упрощенные соотношения для определения гармоник тока при пренебрежении индуктивностью входной цепи, которые позволяют анализировать основные закономерности процесса формирования тока.

b) Показано, что современные требования к электрическим аппаратам предусматривают комплексный подход к решению задач по определению износа коммутационных узлов, в том числе вакуумных и элегазовых выключателей.

c) Исследовано влияние ферромагнитного сердечника на работу линейного импульсного электромеханического преобразователя при возбуждении от ёмкостного накопителя. На основе математической модели выполнены расчёты магнитных полей, рабочих параметров и характеристик электромеханического преобразователя при наличии и отсутствии ферромагнитного сердечника. Показано, что ферромагнитный сердечник позволяет повысить ряд показателей преобразователя, но основные удельные показатели при этом существенно ухудшаются.



d) Рассмотрены принципы построения гелиоэлектрической станции. Для передачи энергии в систему регулятор передачи энергии повышает напряжение конденсатора до напряжения сети и подключает к нему вход инвертора напряжения. Инвертор преобразует постоянное напряжение конденсатора в переменное и передаёт энергию в сеть на частоте напряжения сети.

## Language focus

**Giving advice**

The text above mentions things to do and the things not to do when writing a scientific paper or annotation. Sometimes it is necessary to give advice or to make instructions. For example:

Things to do: Leave it for a bit before you make the final copy.

Things not to do: Make sure you don't go into the red or you'll get distortion.

Here are some other ways in which we can give advice in an informal way. Note how we can make the advice stronger.

Things to do:

1. You **should** keep an eye on the recording level.
2. **Always** keep an eye on the recording level.
3. You **must always** keep an eye on the recording level.

Things not to do:

1. You **shouldn't** put the microphone too close to the drums.
2. **Never** put the microphone too close to the drums.
3. You **must never** put the microphone too close to the drums.

## Reading and Speaking

**Ex.1. Before reading the short text below, discus the following topics:** 1) transient processes in electric circuits; 2) behaviour of an inductance during a transient process; 3) mechanical oscillations of the rotor of a synchronous machine.

**Ex.2. Read the text in 3 minutes.**

**Damping of transients**

Transient changes in stator load result in a change of flux in the rotor pole, and if it can be arranged that this flux change induces a voltage and a flow of current in the pole face, this current will oppose the change in stator flux. To achieve this, it is normal to insert into the pole face a set of aluminium or copper 'damper' bars,

connected at either end by a ring or end plate to form a conducting cage in the pole faces.

The *damper cage* has a considerable influence on the transient current flow in the stator, particularly in the case of a short circuit. In addition, if the load in the three phases is unbalanced, the induced currents in the damper cage will act to reduce distortion of the waveform and to reduce asymmetry in the output phase voltages. A single-phase generator represents a severe case of asymmetry, and this requires very careful damper cage design because of the high induced currents.

The cage also helps to damp mechanical oscillations of the rotor speed about the synchronous speed when the generator is connected in parallel with other machines. These oscillations might otherwise become unstable, leading to the poles 'slipping' in relation to the frequency set by other generators, and resulting in a loss of synchronism. Such a condition would be detected immediately by the generator protection circuits and the generator would then be isolated from the network.



# UNIT 45. MANKIND AND ENVIRONMENT (beginning)

**Overview**

- Reading and Vocabulary: Mankind and environment.
- Supplementary Information: Abstract of a scientific paper.
- Reading and Speaking: Environmental matters.
- Language focus: Environmental matters.

## Reading and Vocabulary

**Reading**

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

Let's consider the influence of power industry on environment. Electricity production is energy-intensive process and its contribution into the environment damage is quite sufficient.

Thermal power stations burn down organic fuel. Oxygen is consumed and carbonic acid is discharged. Moreover, they discharge sulfuric anhydride $SO_3$, which being connected with water forms sulfuric acid ($H_2O + SO_3 = H_2SO_4$). It falls on Earth surface in form of acid-rain. [ 1 ]

At high temperature in boiler furnace nitric oxide NO appears. [ 2 ] At incomplete combustion the toxic hard particles and carbon monoxide CO reach atmosphere. Having inhaled with this gas a man can lose consciousness or even die.

In addition, the big amount of ash appears at the thermal power station. [ 3 ] Then they create the radioactivity background around ash-disposal area.

Excess of pollutants in atmosphere over limits is dangerous for health. For example, in London in 1952 because of smog staying during 10 days 4000 people died.

Some power stations (thermal and nuclear) pollute pools with different poisonous substances – ammonia, hydrofluoric acid, oxalic acid, arsenic etc. They appear at the chemical treatment of water for boilers and treatment of pipes and boilers during repair works. These poisonous substances affecting the pool flora and fauna are accumulated in plants and fish.

"Heat pollution" is harmful too. Water as it is known is used for condensate cooling. The heat discharge into pool may be sufficient (up to 2/3 of heat obtained

at the fuel combustion). In case of small pool, water is heated greatly and all pool inhabitants may die and water becomes poisonous.

Nuclear power stations do not discharge pollutants into atmosphere like thermal ones. However, they have other harmful pollutants: radioactive nuclides of iodine or rare gases. They have little half-life period, that's why they are taken for definite time in gas-holder and then they are thrown out through chimney-stalk into atmosphere. Radioactive waste is evaporated and solid residual is filled up with concrete or glass and is placed into metal container and then it is buried at the ground disposal. Thus nuclear power station is cleaner and less dangerous than thermal power station for environment but there are other special problems such as treatment and storage of radioactive waste, the rise of safety level.

Hydroelectric power stations do not pollute atmosphere with poisonous substances, do not pollute hydrosphere and do not rise temperature of pool and environment. [ 4 ]

A station is necessarily designed with water reservoir. So, in case of flat country the large area of dry land is flooded out. But there may be agricultural land, dwelling houses etc. Rise of water level in upstream water results in rise of underground water level, water-sloughing of ground, mud accumulation. Construction of dam troubles the fish migration. The dam construction in highlands may disturb geological balance and this may result in earthquake. At last, large pool results in higher evaporation and in climate change.

Thus, the power industry development being the main source of comfortable human life touches upon as science as society as a whole. Quick population upsurge, intensive development of all branches of the industry, increasing affection the environment, exhaustion of the primary energy sources etc. – these are the problems mankind is to solve.

**Reading comprehension**

**Ex.1**.

A. However, they can kill and burn.

B. It occupies large territory, pollute atmosphere and even has radioactive elements.

C. However, they affect the environment as well.

D. It kills fauna, damages soil, results in corrosion of metal construction.

E. It has bad influence on living organisms too.

**Ex.2. Look through the text above and choose the most suitable title:**

- Features of the electric power stations.



- The electric power industry influence on the environment.
- Which power station is the most harmful to environment.
- Propose your own different title.

**Ex.3. Read the text and find the answers to these questions.**

1. What is type of fuel thermal power stations burn down? 2. Where is carbonic acid discharged? 3. Where does nitric oxide NO appear? 4. What happens to a man having inhaled with carbon monoxide CO? 5. Why is excess of pollutants in atmosphere over limits dangerous? 6. How do ammonia, hydrofluoric acid, oxalic acid, arsenic appear at the thermal power station? 7. How is "heat pollution" harmful? 8. Are nuclear power stations more friendly to the environment than thermal ones? 9. How is a hydroelectric power station harmful to the environment? 10. What are the problems mankind is to solve?

**Vocabulary**

**Ex.4. Define the following terms. Find their application in text.**

quite sufficient, carbonic acid, sulfuric acid, incomplete combustion, toxic hard particles, to inhale with gas, ash-disposal area, chemical treatment of water, rare gas, half-life period, solid residual, flat country, upstream water, population upsurge

**Ex.5. Learn to recognize the following international words.**

toxic, radioactivity, limit, smog, flora, fauna, to accumulate, condensate, atmosphere, container, reservoir, migration, climate

## Supplementary Information

**Before you start**

1. What is an abstract of the scientific paper?
2. What is the difference between an annotation and an abstract?
3. From your viewpoint, which requirements does an abstract have to meet?

**Abstract of a scientific paper**

**Ex.1. Read the underwritten text concerning the abstracts. Search out new words. Try to remember the rules presented.**

An abstract is a compact statement of the research paper matter provided with the basic data, conclusions and recommendations.

1. An abstract is grounded upon the key fragments taken out from the original text.

2. An abstract is to be performed with application of the literary language and abbreviations, symbols, physical units generally adopted.

3. When performing an abstract, the scientific terminology generally accepted in the scientific literature on corresponding branch of science and engineering is used.

4. An abstract reflects strictly and impartially the matter of the origin; it is not allowed to make any changes or improvements concerning the matter of the paper under consideration; it is not allowed to perform the proper viewpoint or critical notes, to enter into dispute with the author.

5. The abstract beginning should not repeat the paper headline. One should not resort to unclear wordings as well as to different reiterations.

6. The abstract text is to be divided onto paragraphs.

7. The main idea of the paper has to be defined concretely and underlined or stressed in any way.

8. The abstract size is determined by the degree of the paper significance. However, practically, the average size of an abstract does not exceed 2000 printed symbols.

When writing an abstract the following expressions are frequently used: the article (text) is head-lined; the head-line of the article is; the author of the article (text) is; the article is written by; it is (was) published in; it is (was) printed in; the mane idea of the article (text) is; the article is about; the article is devoted to; the article deals with; the article touches upon; the article presents some results which illustrate; the purpose of the article (text) is to give the reader some information on; the purpose of the article is to compare (to determine); the aim of the article is to provide the reader with some material (data) on; the author starts by telling the readers (about, that); the author writes (states, stresses, thinks, points out) that; the article describes; according to the article (text); further the author reports (says) that; the article goes on to say that; the article is (can be) divided into 4 (5-7) parts; the first part deals with; the second part is about; the third part touches upon; the fourth part of the article includes the fact on; in conclusion the article reads; the author comes to the conclusion that; I found the article (text) interesting (important, dull, of no value, easy, (too) hard to understand).

**Ex.2. Translate the following abstract,** paying attention to the word order reversion while translating the terminological groups from English to Russian.

**Stator Winding Resistance Measurement of Inverter-Fed Induction Machines**
**Extended Abstract**

The winding temperature of electrical machines is essential for the insulation performance. It is known that an increase by 10°C over the specified limit reduces



the expected lifetime to roughly one half. International standards establish limits of temperature or temperature rise. A common method to determine the temperature rise is by the resistance method [1]. This method makes use of the linear temperature dependence of a conductor resistance: $R_\theta = R_0 \cdot [1+\alpha \cdot (\theta - 0°C)]$.

When procedures to measure the winding resistance of the machine at alternating voltage are available, the resistance method can be extended to monitor the temperature during operation. This can be made by injecting a small DC winding current supercomposed to the AC current. Conventional procedures described in [2] require however numerous and bulky equipment such as inductors, capacitors and filters. Except for testing small motors in laboratories they have not found much practical application.

For three-phase line-connected motors a method of stator winding resistance measurement is described in [3]. Using a special injection device with a MOSFET semiconductor a DC component is injected into the stator voltage, and the winding resistance is then calculated from the measured current component.

The purpose of the present paper is to apply the DC injection method to induction machines fed by an inverter. Its main advantage is that there is no need for additional injection devices, because the effect can be achieved by adding a DC bias to the reference signals.

Stator winding resistance measurement methods for motors under PWM and six-step operation are proposed. Experimental results for these and for conventional methods are presented (fig. 1) and analyzed. Reasons for deviations are investigated.

**Ex.3*. Translate the following abstract from Russian to English.**
Реферат курсовой работы по ЭСиС.

## Reading and Speaking

**Ex.1*. Organize the discussion concerning advantages and disadvantages of different kinds of the power stations.** Propose your own way of the solving the problem to supply mankind with energy.

**Ex.2. Match the words and expressions given with formulae below. Find Russian translation of English expressions.**

1. oxygen; 2. carbonic acid; 3. sulfuric anhydride; 4. sulfuric acid; 5. nitric oxide; 6. carbon monoxide; 7. ammonia; 8. hydrofluoric acid; 9. oxalic acid; 10.

arsenic; 11. ozone; 12. iodine; 13. nitrogen; 14. carbon dioxide; 15. liquid ammonia; 16. nitric acid.

$O_2$, $H_2CO_3$, $H_2SO_4$, $SO_3$, $NH_3$, $NH_4OH$, CO, As, $O_3$, $N_2$, HF, $HNO_3$, I, $H_2C_2O_4$, $CO_2$, $N_2O_5$.

**Ex.3. Read short dialogues** (between A and B) **below concerning environmental matters.**

**Recycling.** A: Recycling is big business these days, isn't it? B: Yes, it's definitely a growing business. A: What do you recycle in your plant? B: Mainly plastics. Plastics aren't bio-degradable – they don't break down easily in the environment – so they shouldn't be thrown away. A: How is plastic recycled, then? B: Well, there are basically two methods. One is to break down the chemicals in the plastic into smaller chemical particles. These can be used in the production of new chemicals. A: Is that the method you use here? B: No, we don't do that here. We recycle polyethylene and we make it into other products. A: How do you do that? B: By melting it down and then reforming it. Our main products are bin liners for kitchen bins and carrier bags for supermarkets.

**Environmentally-friendly products.** A: You say your products are aimed at the green consumer. In what ways are they environmentally-friendly? B: We produce household cleaning products – detergents and so on. They all phosphate-free, which minimizes damage to the environment. A: What about the packaging? B: We try to use as little packaging as possible. Also, all our bottles are made of recyclable plastic and we use recycled fibre in our boxes. That's what our customers want.

**Energy.** A: We've managed to reduce our energy consumption in our factory by about 15 per cent in the last two years. B: That's excellent. How have you managed that? A: Mainly because we've invested in a heat recovery system. A: What does that mean exactly? B: Well, we use the exhaust gases from our printing presses to provide energy to heat our dryers. A: What other sources of energy do you use? B: We don't use any fossil fuels. Most of our power comes from hydro-electric plants. We're hoping to use even more energy from alternative sources in the future – perhaps even wind power.

## Language focus

**Ex.1. Read the following notes to the dialogues above.**



*Plastics aren't bio-degradable…*Note the use of *-able*, which means that something is possible. *All our bottles are recyclable. Wood is a renewable resource. We produce disposable cigarette lighters.*

*…they don't break down easily in the environment…* When a substance *breaks down*, it changes into a different form because of a chemical or biological process. *… in the environment* here means *outside* (after being thrown away). Note the use of *the.*

*We make it into other products*. Note the use of *into* to indicate change. *Wind power can be converted into energy.*

*By melting it down …*Note the use of *by*+verb+*ing* to talk about how something is done: *We've reduced our energy bill by investing in good insulation.*

*In what ways are they environmentally-friendly? Environmentally-friendly* means not so damaging to the environment: *It's environmentally unacceptable to dump waste in rivers.* Before a noun we use *environmental*: *Our environmental policy needs to be reviewed. Pollution is causing big environmental changes.*

*They are all phosphate-free …*This means they don't contain *phosphates* (chemical compounds which are harmful to the environment). Other examples with *–free*: *Our paper is totally chlorine-free. The engine runs on lead-free petrol.*

*…we use recycled fibre in our boxes.* This means that the board used for the boxes contains pulp made from paper or cardboard products.

*We've managed to reduce our energy consumption… energy consumption* is the amount of energy used. Note the verb *consume*: *We consume far too much fuel.*

*…by about 15 per cent … by* is used to indicate the amount of increase or decrease in something.

*…we've invested in a heat recovery system.* To *recover* means to *get back. Heat recovery* is a way of re-using heat or steam generated in the production process. Also note the use of *in* after *invest*.

*We don't use any fossil fuels.* A *fossil fuel* is a fuel as coal, oil or peat. When these fuels are burnt, they give off *greenhouse gases*, which contribute to *global warming.*

*…energy from alternative sources…*This refers to energy from more natural sources, e.g. wind power, solar energy (from the sun), hydro-electric power (from fast running water).

**Ex.2. Complete the sentences with** *are allowed to / aren't allowed to* or *have to.*

1. Factories …… dump rubbish in the river. They can be fined if they do.
2. Manufactures …… follow strict environmental guidelines.

3. The Governments sets strict limits on landfill. We …… send only 50 per cent of our waste to landfill sites. We …… recycle the rest.
4. Paint producers …… use lead in their paint any more because it's a health hazard.
5. We …… exceed the permitted levels.

**Ex.3. Match the two parts of the sentences.**

| | |
|---|---|
| 1. You can be fined | a by using a heat recovery process. |
| 2. We can save energy | b for breaking pollution laws. |
| 3. Most plastics don't bio-degrade | c to the environment. |
| 4. Our products minimize damage | d from alternative sources. |
| 5. We're hoping to use more energy | e in the environment. |

**Ex.4. Complete each sentence with a preposition or leave blank if no preposition is needed.**

1. We must get rid …… our waste in an acceptable way.
2. The new legislation will affect …… everyone in the packaging industry.
3. Is it harmful …….. the environment?
4. Safe disposal …… toxic substances is very important.
5. Ozone is not emitted …… the atmosphere.
6. Radiation from the sun can be converted …… electricity.
7. Incineration is better …… the environment than landfill.
8. Our budget for environment projects will have to increase …… 10 per cent.



# UNIT 46. MANKIND AND ENVIRONMENT (completion)

**Overview**

- Reading and Vocabulary: Mankind and environment.
- Supplementary Information: Certainty.
- Reading and Speaking: Mankind and environment.
- Language focus: Mankind and environment.

## Reading and Vocabulary

**Reading**

Parts of four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

Every year there are changes in climate in different parts of the world. Some of these changes are due to natural causes. However, some climatic changes are [ 1 ]. One kind of pollution results from burning oil and coal in transport and in factories.

If the pollution affects the level of carbon dioxide in the atmosphere, the results are [ 2 ]. Carbon dioxide constitutes only a small part of the atmosphere. But it has an important function in maintaining the balance between radiation from the sun entering the atmosphere and radiation leaving the Earth. Some of the radiation is [ 3 ] and some is radiated back into the atmosphere. The carbon dioxide in the atmosphere prevents some of the radiation from leaving the atmosphere. Thus the heat remains in the atmosphere and carbon dioxide helps to prevent the temperature of the Earth from falling.

If the proportion of carbon dioxide in the atmosphere is increased as a result of air pollution, the temperature of the atmosphere may rise. This might eventually cause the ice in the north and the south poles to melt. If this happened, the sea level would rise and parts of the Earth would be flooded. The likelihood of this happening is remote, but the possibility exists.

There is also a fairly strong possibility that the dust level in the atmosphere will rise as a result of industrial pollution. This dust pollution will reflect sunlight back into space. If this happens, less sunlight will reach the Earth and the temperature will fall.

Another danger comes from the destruction of the Earth's vegetation, such as the forest of Brazil, which are [ 4 ]. Trees use carbon dioxide and their destruction may upset the balance of carbon dioxide in the atmosphere.

**Notes and comments**

… *affects the level* …; … *entering the atmosphere* … Note the application of the verbs *to affect* and *to enter* with no preposition after them.

*If this happened, the sea level would rise*. Here the second type of *if*-condition is used. The sentence is translated with application Russian *бы*.

*If this happens, less sunlight will reach the Earth*. Here the first type of *if*-condition is used. The sentence is translated with application of Present or Future tenses.

**Reading comprehension**

**Ex.1**.

A. caused by air pollution and these changes may increase.
B. being cleared to make way for farmland and cities.
C. likely to be serious.
D. absorbed by the Earth.
E. very undesirable.

**Ex.2. Look through the text above and choose the most suitable title:**

- The function of carbon dioxide in the atmosphere.
- The future of man.
- Possible effects of technology on the environment.
- The control of temperature in the environment.

**Ex.3. Read the text and find the answers to these questions.**

1. Why are there changes in climate? 2. How do transport and factories produce air pollution? 3. What can the pollution affect in the atmosphere? 4. What part of the atmosphere does carbon dioxide constitute? 5. Why the proportion of carbon dioxide in the atmosphere may increase? 6. What possibility concerning the dust level in the atmosphere exists? 7. Why is the destruction of the Earth's vegetation dangerous?

**Vocabulary**

**Ex.4. Define the following terms.**

air pollution, to cause eventually, little/great likelihood, in all likelihood, destruction of the vegetation, to upset the balance

**Ex.5. Learn to recognize the following international words.**

natural, transport, function, radiation, destruction, balance, oxide



## Supplementary Information

**Certainty**

A man is confident about some developments and less confident about others. What difference can you see between these statements?

1) By the turn of the century such sets **may** be offering programmes in a choice of languages. 2) Picture quality **will** be excellent. 3) The move towards HDTV is **likely** to be very gradual.

We cannot measure certainty in language with precision, but the following table provides a guide to how certain a writer is about a future development.

| Certainty (%) | Verb | Adjective | Adverb |
|---|---|---|---|
| 100 | will | certain | certainly |
| 85 | | likely | unlikely |
| 75 | | probable | probably |
| | | improbable | |
| 50 | could/may | possible | possibly |

Study these ways of showing how necessary something is:

| | |
|---|---|
| 100% positive | is essential/necessary |
| | is needed/required |
| | you must have |
| 50% | is useful (but not essential/necessary) |
| 100% negative | is not necessary |
| | is not needed/required |
| | you need not have |

## Reading and Speaking

**Before you start***

1. Give some examples of productions which are harmful to the environment.
2. Why aren't they environmentally-friendly?
3. What are the ways to reduce the harmful effect of production to the environment?
4. What are the ways to dispose of the waste in your town?

**Ex.1. Look at these notes on possible future events and their effects.** Using information from the main text, discuss whether they are certain, probable, possible or unlikely. Then put them in the order in which they occur in the text.

a) temperature of atmosphere ↑ → polar ice ↓

b) new cities and farmland → destruction of vegetation
c) air pollution ↑ → level of $CO_2$ in atmosphere ↑
d) air pollution → climate changes
e) destruction of vegetation → balance of $CO_2$ upset
f) industrial pollution ↑ → dust in atmosphere ↑
g) $CO_2$ ↑ → level of radiation ↑
h) polar ice ↓ → sea level ↑
i) burning oil and coal → air pollution ↑
j) dust in atmosphere ↑ → sunlight reflected back
k) sunlight reflected back → earth's temperature ↓
l) level of radiation ↑ → temperature of atmosphere ↑
m) sea level ↑ → parts of earth flooded

**Ex.2. Read short dialogues** (between A and B) **below concerning environmental matters.**

**Disposing of waste.** A: How do you dispose of the waste in your factory? B: We try to recycle as much as we can. A: What about the rest? How do you get rid of it? B: We have to send it to landfill. It's very expensive because the government recently introduced a landfill tax so we're planning to build a new incineration plant next year to burn our waste. A: But doesn't incineration produce carbon monoxide? B: Yes, you're right, it does. But we believe it's less harmful to the environment than landfill.

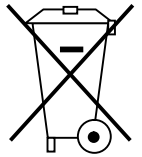
**Air pollution.** A: I've heard of ground-level ozone but can you explain what it is exactly? B: Yes, it's one of the main air pollutants. Factories don't emit it directly into the air. It's actually formed when nitrogen oxides and VOC emissions come into contact with heat and sunlight. A: Sorry? What does VOC stand for? B: Oh, VOCs are volatile organic compounds. That's a technical term for solvents or other chemicals found in things like paint. A: So, what damage does ozone do to the environment? B: Well, it can cause smog, which can affect people's health – especially people with breathing difficulties.

**Water pollution.** A: Is the lake very polluted? B: Well, I wouldn't swim in it – but the water is much cleaner than it was a few years ago. A: Are local factories allowed to discharge waste water into the lake? B: Yes, but it must be treated in an effluent treatment plant first.

**Legislation.** A: Has your company been affected much by government legislation? B: Yes, we have. We've had to clean up our production process a lot to meet tough government standards. A: What about your use of raw materials? B:



Well, we've had to cut down the amount of solvents we use and we're not allowed to use lead in our products any more. A: What happens if you exceed the limits? B: We try not to because you might have to pay quite a heavy fine.



**Correct disposal of the product.** A: Where are the products you produce applicable? B: Our products are applicable in the European Union and other European countries with separate collection systems. A: Explain, please, the marking on your products. B: Well, this marking on the products, accessories or literature indicates that the product and its electronic accessories (e.g. charger, headset, USB cable) should not be disposed of with other waste at the end of their working life. To prevent possible harm to the environment or human health from uncontrolled waste disposal, please separate these items from other types of waste and recycle them responsibly to promote the sustainable reuse of material resources. A: At the end, give an advice to household users with respect to your products. B: Household users should contact either the retailer where they purchased this product, or their local government office, for details of where and how they can take these items for environmentally safe recycling. A: And what about business users? B: These should contact their supplier and check the terms and conditions of the purchase contract. This product and its electronic accessories should not be mixed with other commercial wastes for disposal.

## Language focus

**Ex.1. Read the following notes to the dialogues above**.

*How do you dispose of the waste in your factory?* You could also say: *How do you get rid of your waste?* Note also *disposal*: *Safe disposal of waste is important.*

*We have to send it to landfill.* A *landfill site* is a hole in the ground for rubbish.

*…we're planning to build a new incineration plant next year…*An *incineration plant* is where rubbish is burnt.

*…it's less harmful to the environment than landfill.* The same in other words: *It doesn't damage the environment as much as landfill. It's better for the environment than landfill.*

*…can you explain what it is exactly?* Note the word order. Note: NOT *Can you explain what is it?*

*…it's one of the main air pollutants.* Other major industrial air pollutants are sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$) and carbon dioxide ($CO_2$).

*Factories don't emit it directly into the air.* To *emit* means to release gases into the air. Note also *emissions*: *We need to reduce $CO_2$ emissions.*

*... what damage does ozone do to the environment?* You could use *harm* for *damage*: *What harm does ozone do.*

*...it can cause smog, which can affect people's health... Smog* is a mixture of fog and smoke, found in polluted industrial areas. Note there is no preposition after *affect* (vb). The noun is spelt: *effect.*

*Are local factories allowed to discharge waste water into the lake? Be allowed to* is used here for permission: *We're allowed to send some of our waste to landfill. We're allowed to use lead in our products.*

*... it must be treated in an effluent treatment plant first. An effluent treatment plant* is where liquid waste material (*effluent*) is cleaned up before being released.

*Has your company been affected much by government legislation? Legislation* means *laws*: *New packaging legislation will be brought in next year.*

*...to meet tough government standards. Tough* here means *difficult.* You could also say *strict. Meet* here means to *satisfy: That product doesn't meet our requirements.*

*...we've had to cut down the amount of solvents we use...Cut down* here means the same as *reduce*. Note the use of *we've had to* to show that something is obligatory.

*What happens if you exceed the limits? Exceed the limits* means to break the law or the rules by going over the permitted level.

**Ex.2. Complete the sentences with the correct verb.** Example: When fossil fuels are burnt, they …give… off $CO_2$. *give / take / clean*

1. We need to …… up our production process. *clear / take / send*
2. We are trying to …… down the amount of packaging we use. *put/cut/bring*
3. You can……down plastic and make it into a different product. *heat/cut/melt*
4. It's better to recycle glass bottles than to …… them away. *throw/put/take*
5. Most hamburger boxes don't……down in the environment. *take/bring/break*
6. The EU will …… in new legislation next year. *bring / put / call*

**Ex.3. Complete the sentences with a word from the box below.**

| recycling | pollution | environmentally | disposable |
|---|---|---|---|
| environmental | dispose | recyclable | pollutants |

Example: Most types of paper are …recyclable…

1. There are six main air ……
2. We are setting up an …… management system.



3. We need to find a better way to …… of our waste.
4. It's an …… friendly product.
5. We have an office-paper …… scheme in our company.
6. …… is having an effect on the world climate.
7. They manufacture cheap …… cigarette lighters.

**Ex.4. Rearrange these words to form questions.**

1. plastic / how / be / can / recycled?
2. you / limits / happens / if / permitted / the / what / exceed?
3. of / you / waste / how / products / your / dispose / do?
4. VOCs / explain / are / can / you / what?
5. affected / recent / your / been / by / company / much / legislation / has?
6. you / of / what / sources / use / other / energy / do?
7. ways / environmentally / products / are / in / your / what / friendly?
8. does / ozone / environment / what / do / the / damage / to?
9. heat / explain / is / recovery / what / could / you?

# UNIT 47. SAFETY IN THE WORKPLACE (beginning)

**Overview**

- Reading and Vocabulary: Injuries from electricity (beginning).
- Language focus: Comparison and contrast.
- Reading and Speaking: Safety in the workplace.

## Reading and Vocabulary

**Reading**

Parts of four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Injuries from electricity** (beginning)

Every year people are injured or killed as a result of hazardous defects in electrical systems or because they adopt unsafe working practices on electrical systems. The most common types of injury are [ 1 ], with the burn injuries arising from either current passing through the body or from the effects of arcing and flashovers. In addition to these direct forms of electrical injury, the following secondary types of injury can occur:

- burn injuries and the adverse effects of smoke or fume inhalation from fire of electrical origin;
- the effects of an explosion that has an [ 2 ];
- physical injuries arising from the reaction to electric shock, such as being thrown off a ladder as a result of electric shock and suffering impact injuries from the fall.

**Electric shock.** Electric current passing through the body, particularly alternating current at power frequencies of 50 Hz and 60 Hz, may disrupt the nervous system, causing muscular reaction and the painful sensation of electric shock. The most common reaction is to be thrown off the conductor as a result of the [ 3 ]. However, in a small number of instances, the consequence is death from cardiac arrest, or from ventricular fibrillation (where the heart muscle beats in a spasmodic and irregular fashion) or from respiratory arrest.

The physiological effects are largely determined by the magnitude and frequency of the current, the waveform (for example, continuous sine wave, or half wave rectified sine wave, or pulsed waveform), its duration, and the path it takes through the body. The following text concentrates on the most common situation of a shock from a continuous power frequency ac waveform.



The magnitude of the current is the applied voltage divided by the impedance of the body. The overall circuit impedance will comprise the body of the casualty and the other components in the shock circuit, including that of the power source and the interconnecting cables. For this reason, the voltage applied to the body, which is commonly known as the *touch voltage,* will often be lower than the source voltage.

The impedance of the body is determined by the magnitude of the touch voltage (there being an inverse relationship between impedance and voltage) and other factors, such as the [ 4 ], the cross-sectional area of contact with the conductors, and whether or not the skin is broken or penetrated by the conductors. As a general rule of thumb, at an applied voltage of 230 V at 50 Hz, the total body impedance for a hand-to-feet path will be in the range 1000 Ω to 2500 Ω for most of the population, falling to around 750 Ω at voltages in excess of about 1000 V.

The path that the current takes through the body has a significant effect on the impedance. For example, the impedance for a hand-to-chest path is in the order of 50 per cent of the impedance for a hand-to-foot path. Moreover, the current's path through the body is a significant determinant of the effect on the heart.

Table summarizes the physiological effects of current passing through the body. The effects relate to a hand-to-hand shock exceeding 1 s for a person in good health. If the duration were less than 1 s, greater currents could be tolerated without such adverse reactions.

**Table.** The effect of passing alternating current (50 Hz) through the body from hand-to-hand

| Current, mA | Physiological effect |
|---|---|
| 0.5-2 | Threshold of perception |
| 2-10 | Painful sensation, increasing with current. Muscular contraction may occur, leading to being thrown-off. |
| 10-25 | Threshold of 'let go', meaning that gripped electrodes cannot be released once the current is flowing. Cramp-like muscular contractions. May be difficulty in breathing leading to danger of asphyxiation from respiratory muscular contraction. |
| 25-80 | Severe muscular contraction, sometimes severe enough to cause bone dislocation and fracture. Increased likelihood of respiratory failure. Increased blood pressure. Increasing likelihood of ventricular fibrillation (unco-ordinated contractions of the heart muscles so that it ceases to pump effectively). Possible cardiac arrest. |
| Over 80 | Burns at point of contact and in internal tissues. Death from ventricular fibrillation, cardiac arrest, or other consequential injuries. |

Electric shock accidents are most common on low-voltage systems and are usually subdivided into two categories of direct contact and indirect contact shocks. A direct contact shock occurs when conductors that are meant to be live, such as bare wires or terminals, are touched. An indirect contact shock occurs when an exposed conductive part that has become live under fault conditions is touched. Examples of an exposed conductive part are the metal casing of a washing machine and the metal casing of switchgear. This type of accident, which requires two faults to occur (the loss of the earth connection followed by a phase-to-earth fault), is quite common.

When providing first aid to an electric shock casualty, the first action should be to remove the cause by switching-off the supply or otherwise breaking contact between the casualty and the live conductor. Cardiopulmonary resuscitation may be required. If the casualty is suffering from ventricular fibrillation, the only effective way to restore normal heart rhythm is by the use of a defibrillator. Where a defibrillator is not immediately available, the first aider should carry out cardiopulmonary resuscitation until either the casualty recovers or professional assistance arrives.

**Notes and comments**

… *arising from* … Note the application of the preposition *from* after the verb *to arise*.

… *conductors … are meant to be live*. Here, it is supposed the conductors are under voltage or may occur under voltage any time moment.

**Reading comprehension**

**Ex.1**.

A. electrical source of ignition.
B. muscular contraction.
C. effect on the heart.
D. wetness of the skin.
E. electric shock and burns.

**Ex.2. Read the text and find the answers to these questions.**

1. Which defect in an electrical system is called a hazardous one? 2. What are the most common types of injury in electric systems? 3. What is the secondary type of injury in electric systems? 4. What are the physiological effects of passing alternating current part determined by? 5. How is the current magnitude through a body determined? 6. What is a touch voltage? 7. What is the difference between a direct contact shock and an indirect one?



**Vocabulary**

**Ex.3. Fill in the words from the box below.**

| hazardous defects, burn injuries, ventricular fibrillation, magnitude, overall circuit impedance, touch voltage, hand-to-chest, direct contact shock, hand-to-foot, switchgear |
|---|

1. Every year people are injured or killed as a result of … in electrical system.
2. The … arise from current passing through the body.
3. During … , the heart muscle beats in a spasmodic and irregular fashion.
4. The … of the current is the applied voltage divided by the impedance of the body.
5. The … comprises the body and the other components in the shock circuit.
6. The voltage applied to the body is commonly known as the… .
7. The impedance for a … path is in the order of 50 per cent of the impedance for a … path.
8. A … occurs when conductors are touched.
9. Example of an exposed conductive part is the metal casing of … .

## Language focus

**Comparison and contrast**

**Ex.1. Read the following passage and pay attention how we can make comparison and contrast.**

We can describe similarities like this:

1. **Both** instruments belong to D'Arsonval system.
2. **Like** a voltmeter, an ammeter is used for the circuit measurements.
3. An electrodynamic voltmeter **is similar to** a wattmeter in that it has two measuring coils.

We can describe differences like this:

1. An electrostatic voltmeter has much bigg**er** resistance **than** an electromagnetic one.
2. A magnetoelectric voltmeter with a diode is able to measure alternating voltages **but** it is used only in case of sinusoidal waveforms.
3. Instruments of accuracy rating 2.5 are used for everyday measurements **whereas** ones having accuracy rating 0.1 are used as standard instruments.

We will examine some other ways to describe differences: to **make contrasts**.

On the lesson, the lecturer contrasted: 1) single-phase and three-phase transformers; 2) transformers and autotransformers; 3) transformers with and without a ferromagnetic core.

Here are some of the things he said: High-voltage transformers are three-phase **rather than** single-phase. A transformer has no electric connection between windings **while** an autotransformer has it. A transformer without a ferromagnetic core is a linear element that's why it may be calculated **with greater accuracy than** a nonlinear transformer having a steel core.
Here are some other expressions used to make contrasts: differ from; is/are different from; in contrast to; whereas; unlike.

**Ex.2. Read the statements and mark them true (T) of false (F). Give true statements.**

1. Electricity produced by a thermal power station is much cheaper than that one produced by a hydroelectric power plant.
2. A thermal power station releases many chemicals into the surrounding air while a nuclear power station is rather clear plant.
3. Like a synchronous machine, an induction motor is able to produce electricity.
4. Stabilized voltage after the rectifier is similar to that obtained from the battery.
5. In contrast to the alternating current, a direct current does not change its direction.
6. Both thermal power stations and nuclear power plants use the turbogenerators.

**Ex.3. Translate sentences from Russian into English with the aid of words** 'but, while, rather than, whereas, unlike, both, like, similar to'.

1. В электрической цепи индуктивный элемент учитывает наличие магнитного поля, а ёмкостный – электрического.
2. И индуктивное, и ёмкостное сопротивления являются реактивными.
3. По принципу действия асинхронный двигатель подобен трансформатору.
4. В отличие от лампы накаливания люминесцентная лампа потребляет реактивную мощность.
5. В отличие от индуктивной реактивной мощности ёмкостная мощность берётся с минусом.
6. Реостат представляет собой в большей степени резистивное сопротивление, чем индуктивное.
7. Катушка с сердечником является примером скорее индуктивного сопротивления, чем резистивного.



8. Солнце и ветер являются возобновляемыми источниками энергии, в то время как уголь и газ – невозобновляемыми.

**Ex.4. Read the following notes to the dialogues below.**

*It's quite a hazardous environment…*Something that is *hazardous* is dangerous to people's health or safety. Note also *hazard*: The workshop is full of hazards.

*You should put your ear plugs in … Should* is used to show that something is recommended (but not compulsory). Some other ways of doing this: *I recommended you put your ear plugs in. I suggest you wear goggles in this area.*

*You mustn't smoke here*. Some other ways of saying this: *You can't smoke here. You're not allowed to smoke here. Smoking is prohibited here. Smoking isn't allowed here.*

*You must wear goggled in that area …*We can also say: *Goggled must be worn. Goggled are compulsory / obligatory.*

*Mind out! Don't get too close*. Some other expressions with *mind* to warn someone of a possible danger: *Mind you don't trip! Mind your head!*

*…please be careful when you walk across the floor*. *Please be careful when …*is another way of giving a warning.

*It might be slippery*. Note *might / may* indicates that something is possible. *It might / may be* is used with an adjective: *It might be hot. It may be noisy.*

*There might be a fork-lift truck reversing into the storage area. There might / may be* is used with a noun: *There might / may be oil on the floor.*

*…some of you are already familiar with the safety procedures …*You can also say: *Some of you already know about the safety procedures. Some of you have already been shown the safety procedures.* A *procedure* is the correct way of doing things, usually in a fixed order.

*…make sure you know how to stop the machine…*Note other ways of talking about safety regulations: *Never attempt to clean a machine that's in motion. Tell your supervisor immediately. Check that the area around the machine is clean and tidy. Wear goggles when you are welding. Don't throw tools in the workshop.* Note *do not* would be used in a written notice or in a strong spoken instruction. Usually in speech we used the contracted form, *don't*.

*…always check that all the safety guards are fitted correctly…if you don't, someone might have a bad accident.* Note the use of *if* to talk about possible consequences if safety procedures aren't followed: *Always wear goggles when welding. If you don't, you might damage your eyes. Never smoke in the workshop. If you do, you might start a fire*.

## Reading and Speaking

**Before you start**

1. Are you familiar with any safety procedures at the workplace?
2. Why safety procedures are important?
3. What warning signs do you know? Try to describe them.
4. What protective means do you know? Name them.
5. Where would you find the notices below? How do you say these things in your language?
   a) Don't lean out of the windows.
   b) Now wash your hands.
   c) Beware of the dog.

**Ex.1. Read short instructions below concerning safety in the workplace.**

**A noisy environment.** "OK, so let's look round the factory now. It's quite a hazardous environment so you need to take care. By the way, you should put your ear plugs in when we go down to the factory. It's not compulsory but some of the machines are a bit noisy."

**Warning signs.** "This is the machine hall. Do you notice that sign over there – the red circle with a diagonal line through it? It means you mustn't smoke here. A blue circle shows something is compulsory – so that sign over there means you must wear goggles in that area to protect your eyes. The yellow triangle with a black border over there is a warning sign. It means the floor might be wet."

**Hazards.** "Mind out. Don't get too close. It's very hot. We don't want you to burn yourself. And please be careful when you walk across the floor. It might be slippery." "So, if you follow me into the Finished Goods Area now ... Mind you don't trip when you go past the packing area. Someone has left some wooden pallets on the floor. And be careful when you walk across the warehouse. There might be a fork-lift truck reversing into the storage area."

**Machine safety.** "I realize some of you are already familiar with the safety procedures for this type of machine but I'll just explain some of the basics again. First of all, make sure you know how to stop the machine before you start it. That seems obvious but it's important." "Now on this machine always check that all the safety guards are fitted correctly before you operate the machine because if you don't, someone might have a bad accident. What else? Oh, yes, never try to clean a machine that's in motion. Switch it off and unplug it." "And finally, tell your supervisor immediately if you think the machine is not working properly or if you think there are any problems. Okay, so has anyone got any questions?



**Ex.2. Match the hazard with the possible result.**

| | | |
|---|---|---|
| 1. | a live wire | a you might be hit |
| 2. | a loose piece of flooring | b you might slip over |
| 3. | a sharp blade | c you might damage your hearing |
| 4. | steam | d you might burn yourself |
| 5. | a careless truck driver | e you might electrocute yourself |
| 6. | a greasy floor | f you might cut yourself |
| 7. | a very loud noise | g you might trip over |

**Ex.3. Complete the sentences with words from the box below.**

| when | you | mind | oil | out | tools | don't | careful | hot | sharp | floor | low |
|---|---|---|---|---|---|---|---|---|---|---|---|

1. Mind …… don't trip. There are lost of …… lying around.
2. Be …… ! Don't touch the blades. They're very …….
3. Mind …… ! Someone's left some boxes on the …… .
4. …… your heads! The doorway is very …… .
5. Be careful …… you walk across the factory. There are often patches of …… on the floor.
6. Mind you …… burn yourself. The metal is very …… .

**Ex.4. Match the two parts of the sentences.**

| | | |
|---|---|---|
| 1. | Always wear ear protection | a check electrical installations regularly. |
| 2. | Don't leave | b emergency exits clear. |
| 3. | Keep | c a machine without checking the safety procedures first. |
| 4. | Never place | d when using a pneumatic drill. |
| 5. | Make sure you | e bottles of chemicals carefully. |
| 6. | Check that | f a ladder near an electricity line. |
| 7. | Do not operate | g tools lying on the floor. |
| 8. | Label | h the safety guard is in place. |

**Ex.5. Choose *It* or *There*. Example: *It* might be slippery.**

1. …… might be very noisy.
2. …… might be a lot of dust.
3. …… might be live.
4. …… might be trucks unloading.
5. …… might be very sharp.
6. …… might be bits of broken glass on the floor.

**Ex.6. What might happen if you don't follow safety procedures?**

First match the sentences.

1. Never store cylinders by naked flames. a Someone might slip over.
2. Always wear gloves when welding. b Someone may get poisoned.
3. You must wipe spillages up immediately. c They may explode.
4. You mustn't store chemicals in milk bottles or jam jars. d Someone might trip over them.
5. Never leave bits of wood lying around on the floor. e You might burn your hands.

Now choose *If you do*, or *If you don't*, to join the two sentences. Write out the whole sentences below. Example: Never store cylinders near naked flames. If you do, they may explode.



# UNIT 48. SAFETY IN THE WORKPLACE (completion)

**Overview**

- Reading and Vocabulary: Injuries from electricity (completion).
- Language focus: Allowing and preventing verbs.
- Reading and Speaking: Safety in the workplace**.**

## Reading and Vocabulary

**Reading**

Parts of four sentences have been removed from the text. Choose from the sentences A-E (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

**Injuries from electricity** (completion)

**Contacts and internal burns.** In addition to causing electric shock, current flowing through the body may cause burn injuries at the points of contact and in the muscle and other internal tissues and organs.

The extent of any burn injuries is determined by the [ 1 ]; the higher the current density the more severe will be the injuries.

It is uncommon to see significant burn injuries when the touch voltage is low, including mains voltage of 230 V ac. The usual physical evidence is [ 2 ] and exit points but there have been accidents where more severe burns have been experienced. At higher voltages, especially in incidents involving contact with an overhead high-voltage power line, the burning is invariably severe and can be the main cause of death.

**Arc and flashover burns.** Arc burns, also known as flashover burns, are commonly associated with the [ 3 ], leading to an arc developing in the air between adjacent conductors.

A common cause is metal objects, such as screwdrivers, spanners and other foreign objects forming a short circuit between a phase conductor and earth, or across conductors at different voltages. More often than not the initial fault is between two adjacent conductors, such as a phase conductor and earthed metalwork, but the ionized gases created by the fault allow arcs to develop between other conductors. In three-phase systems, the result is often described as a full three-phase flashover. The typical consequence is the expulsion from the short circuit of a highly energetic arc and hot gases, with temperatures in the plasma typically exceeding 1000°C. A person in the immediate vicinity of the arc will suffer burn injuries which are often severe and life-threatening.

The amount of power that can be supplied into the fault is determined by the [ 4 ], and is quoted in megavoltampere or kiloampere (strictly, the second of these parameters is a measure of short-circuit current rather than power). Modern systems, even at low voltage, often have very high fault levels. A typical fault level in a low-voltage domestic installation is 6 kA or 2.4MVA and in an 11 kV high voltage installation, it can be as high as 13 kA or 250MVA.

**Fire injuries.** Electrical systems that are poorly designed, or that have certain fault conditions, may overheat due to excess current flowing to such an extent that adjacent flammable materials may be ignited. Fires may also be started by arcs and sparks evolved from short-circuit faults, most frequently resulting from a breakdown in insulation. Hot spots in circuits can develop, for example, when poorly made connections have sufficiently high resistance to cause localized heating, which may lead to fire.

Most people caught in fire situations who are killed or seriously harmed are affected by the smoke and toxic fumes emitted from the burning substances, including electrical cables and components, rather than by being burned.

**Explosion injuries.** If standard electrical equipment is installed in places, called hazardous areas, where a flammable or explosive atmosphere exists, the arcs, sparks, electrostatic discharges or hot surfaces created during normal operation or under fault conditions may have enough energy for them to act as an ignition source, leading to an explosion. Anybody in proximity to the explosion may suffer burns and physical injuries, which may be serious enough to be fatal.

### Notes and comments

… *systems … poorly designed*; … *poorly made connections* … Here '*poorly*' means that something is not perfect done.

### Reading comprehension

**Ex.1**.

A. electric and magnetic field intensities.
B. voltage and impedance in the fault circuit.
C. small white blister-like marks on the skin on the entry.
D. current density at the point of contact and in the internal tissues.
E. failure of insulation in electrical equipment.

### Vocabulary

**Ex.2. Fill in the words from the box below.**



| |
|---|
| in proximity, cause burn injuries, failure of insulation, full three-phase flashover, immediate vicinity, a low-voltage domestic installation, severe, results in, flammable materials, sparks |

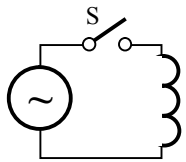
1. Current flowing through the body may … at the points of contact.
2. At high voltages, the burning is invariably … and can be the main cause of death.
3. Arc burns, also known as flashover burns, are commonly associated with the ... in electrical equipment.
4. In three-phase systems, the result of a phase conductor – earthed metalwork short-circuit is often described as a … .
5. A person in the … of the arc will suffer burn injuries.
6. A typical fault level in … is 6 kA or 2.4MVA.
7. Electrical systems may overheat due to excess current flowing to such an extent that adjacent … may be ignited.
8. Fires may be started by arcs and … .
9. A breakdown in insulation … fires.
10. Anybody … to the explosion may suffer burns and physical injuries.

## Language focus

**Grammar and Vocabulary**

### Allowing and preventing verbs

**Ex.1. Look at the figure.**




What happens as a result of closing the switch? / opening the switch?

We can describe the results using these verbs:

Closing the switch allows / permits / enables current to flow through the coil.

Opening the switch prevents / stops current from flowing through the coil.

Note that verbs like *allow* are followed by *to* and the infinitive; verbs like *prevent* are followed by *from* and the *–ing* form.

**Ex.2. Now fill in the gap in each sentence with an allowing or preventing verb.** Also put each verb in brackets in the correct form.

1. A graphic equalizer … the user (adjust) the amplification of different frequency ranges.
2. A fuse … a sudden rise in current (damage) equipment.

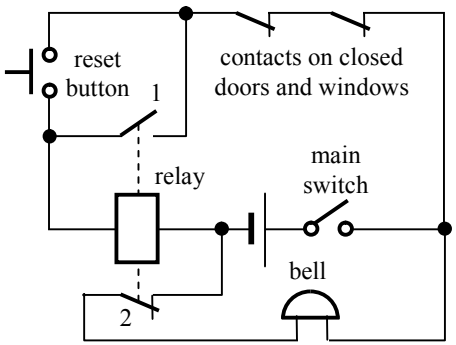
3. A mixing desk … the sound engineer (improve) the quality of the sound recorded.
4. A heatsink … output transistors (overheat).
5. A surge suppressor … large current fluctuations (damage) computers.
6. Special effects like reverb … the engineer (alter) the sound of the recording.
7. Different inputs on the music centre … the user (play) CDs.
8. A safety tab … the user (erase) the tape by accident.

**Ex.3. Study this circuit of a burglar alarm**. It contains a relay. The relay is shown in its unenergized form. Now fill in the gaps in this description with appropriate verbs like *allow* or *prevent*, and put each verb in brackets in the correct form. Compare your answers with your partner.

Closing the main switch … current (pass) from the battery through the bell. As a result the bell rings. Pressing the reset button … current (flow) through the relay coil. This energizes the coil so that switch 1 closes and switch 2 opens. Opening switch 2 … current (flow) through the bell. When any contact on a door or window is opened, this … current (pass) through the relay coil. As a result switch 1 opens and switch 2 closes. This … current (flow) from the battery to the bell, and the alarm rings.

**Explanations**

**Ex.4.** Explanations provide answers to *Why?* And *How?* questions. Try to answer these questions about the diagram above. 1) What does the diagram show? 2) How does it operate? 3) Why does the relay work?




**Explain what this diagram shows and how it operates**. Your explanation should include answers to these questions: 1) What are the components? 2) How are they connected? 3) What is the state of the system when the door is closed? 4) What happens if the door is opened? 5) Why does this happen?

**Ex.5. Read the following notes to the dialogues below**.



*...some of the materials we use are highly-flammable…*Instead of *are flammable* you could say: *catch fire / ignite / burn easily. Some of the materials we use burn easily.* Sometimes the word *inflammable* is used (e.g. *highly inflammable aircraft fuel)* with the same meaning as *flammable.*

*...the fumes they give off can be very dangerous…Produce / emit* can be used for *give off.*

*Could you just run through the evacuation procedure?* You could use *go through* or *explain* for *run through*: *Could you explain / go through the safety instructions again?* To *evacuate* means to move people from a dangerous place.

*When you hear the fire alarm, ...go to the nearest fire exit or fire escape*…Note these expressions with *fire*. Also: *a fire drill, the fire service, fire fighters.*

*...always shut the fire doors to prevent the fire spreading.* You can also use *stop* for *prevent*: *The best thing is to stop the fire starting in the first place. Prevent* can be used with just a noun: *We must try to prevent accidents.*

*Raise the alarm by breaking the glass… Raise the alarm* means warn people of danger.

*...you can try to put it out with a fire extinguisher…*To *put out* and to *extinguish* mean the same. Note the word order: *Try to put out the fire.* or: *Try to put the fire out.* Be careful with the word order with *it*: *Try to put it out* (Note: NOT *put out it*).

*Your hand is bleeding.* Some other injuries: *I've twisted my ankle. I've got something in my eye.*

*I'll get the first aid box.* Note we use *I'll* to show that the speaker is going to take immediate action. A *first aid box* contains items such as scissors, plasters etc. to treat minor injuries.

*...it really hurts. It hurts* means something is painful: *My arm hurts.*

*I'd better call the company doctor.* Note the use of *I / you / we had better* to talk about the correct thing to do in a difficult situation. *Had* is usually shortened to *'d*. We don't use *to* after *had better* (Note: NOT *I'd better to call…*)

*I think he's hurt his back.* We can also say: *I think he's injured his back*.

*What shall we do?* Note the use of *shall I / we* to ask for an opinion on the correct thing to do. *Shall I call an ambulance?*

*We'd better not move him.* Note the negative form.

*I'll get the first-aider.* A *first-aider* is someone in the workplace who has been given basic medical training to help people who have an accident or are ill at work.

## Reading and Speaking

**Ex.1. Read short dialogues** (between A and B) **below concerning safety in the workplace.**

**Flammable materials.** A: Is that a no-smoking sign? B: Yes, it is. As you know, some of the materials we use are highly-flammable so we have a very strict non-smoking policy in the factory. A: What does that sign mean? B: It means there must be no naked flames or sparks anywhere near flammable materials. If the materials ignite, it could cause a serious fire and the fumes they give off can be dangerous if you inhale them.

**The evacuation procedure.** A: Could you just run through the evacuation procedure? B: Yes, of course. When you hear the fire alarm, which is a very loud, continuous ringing noise, you should go to the nearest fire exit of fire escape as quickly as possible. A: Should we use the stairs? B: Yes, don't use the lifts. We have regular fire drills so you'll soon become familiar with the procedure. And always shut the fire doors to prevent the fire spreading.

**Dealing with a fire.** A: What should I do if I notice a fire? B: Raise the alarm by breaking the glass of the nearest fire alarm. Call Security, say "Fire" and give your name and exact location. At night you should phone the fire service from the nearest telephone. A: Should I try to put the fire out? B: If you discover a small fire, you can try to put it out with a fire extinguisher but only do this if you have been trained. Make sure you use right extinguisher. They are all colour-coded and contain different substances to put out the fire.

**Accident 1: A cut hand.** A: Your hand is bleeding. What have you done to it? B: I cut it on that blade. A: I'll get the first aid box. There's some antiseptic cream and a bandage in there.

**Accident 2: An ankle injury.** A: Ow! I've twisted my ankle. I slipped on that greasy patch over there. I don't think it's broken but it really hurts. B: Sit down here – don't put any pressure on it. I'd better call the company doctor.

**Accident 3: A fall.** A: Marco has fallen off a ladder. I think he's hurt his back. What shall we do? B: We'd better not move him. I'll get the first aider.

**Ex.2. Rearrange these words to form questions.**

1. it / where / hurt / does?
2. happen / it / did / how?
3. injured / anyone / been / has?
4. move / arm / you / can / your?
5. anyone / ambulance / has / yet / called / an?
6. get / the / I / shall / first-aider?
7. keep / first aid / where / we / box / do / the?
8. your / to / what / done /have / you / hand?



**Ex.3. Match the sentences on the left with the responses on the right.**

| | |
|---|---|
| 1. I think I've twisted my ankle. | a We'd better take her out into the fresh air. |
| 2. I've cut my finger. | b You'd better wash it off immediately. |
| 3. Look! The warehouse is on fire. | c We'd better not use it. Switch it off! |
| 4. Maria has inhaled some fumes. | d You'd better not put any pressure on it. |
| 5. We haven't got any bandages. | e You'd better put a plaster on it. |
| 6. Jose has fallen and hurt his back. | f We'd better order some more. |
| 7. The machine is making a funny noise. | g We'd better not move him. |
| 8. I've splashed some chemical on my skin. | h We'd better call the fire service. |

**Ex.4. Read sentences below and explain what safety rules were violated.**

In 1885 a young woman jumped off the Clifton Suspension Bridge. Her large, fashionable, nineteenth-century skirt acted as a parachute and she landed safely after a 75m fall. She lived into her seventies.

The first aeroplane flew under the Clifton Suspension Bridge in 1911. The last plane was a jet traveling at 720kph in 1957; the pilot crashed the plane and died.

**Ex.5. Read and translate** *Caution* **and** *Safety Precautions*. **What peculiarities of their presentation do you find out?**

Caution

The manufacturer do not take the responsibility of the accident happened because the air conditioner is not fixed firmly or installed securely, during installing or using the product. In case you have difficulty in installation, you must ask for an installation specialist help. The accident will be happened in case of installing improperly.

Safety Precautions

The following safety precautions must be taken when using your air conditioner.

1. Make sure that the indoor unit is correctly ventilated at all times; do NOT place clothing or other materials over it.
2. NEVER spill liquid of any kind into the indoor unit. Should this happen, switch off the breaker used for your air conditioner and contact your installation specialist.
3. Do NOT insert anything between the air flow blades, as the inner fan may be damaged and you may be hurt. Keep children away from the indoor unit.
4. Do NOT place any obstacles in front of the outdoor unit.
5. If the remote control will not be used for a long time, remove the batteries.

6. Users of this product are cautioned not to attempt repair of this product at their own discretion. Instead, they are requested to directly contact a designed service center or the outlet at which the product was purchased.

7. If the supply cord is damaged, it must be replaced by a special cord or assembly available from the manufacturer or its service agent.

8. This device must be installed according to the national electrical rules.

9. Before throwing out the device, it is necessary to pull back the battery cells and get rid of them safely.

10. The appliance is not intended for use by young children or infirm person without supervision; young children should be supervised to ensure that they do not play with the appliance.

11. Max current is measured according to IEC standard for safety and current is measured according to IS0 standard for energy efficiency.

**Ex.6*. Propose and describe the warning signs:**

a Be careful.
b Beware of industrial vehicles.
c Don't smoke here.
d Don't walk here.
e Risk of death.
f This material is corrosive.
g This material is explosive.
h This material is flammable.
i Wear a hard hat.
j Wear ear defenders.
k Wear goggles to protect your eyes.

**Ex.7*. Find five examples of warning signs in your own language.** Translate them into English. Can your partner translate them back into your language?

**Ex.8*. Choose one of the places in the brackets** (computer room, engineering workshop, school sports hall, your bedroom), **or another place**. Write two rules, one thing you *must* and one thing you *mustn't* do.

For example. *In a school sports hall you mustn't wear outdoor shoes and you must return equipment*.

Design and draw a sign for each rule.

Show your sign to another person. Can he work out the meaning?



## APPENDIX. WORD LIST
## UNIT 22

| | | |
|---|---|---|
| as a matter of fact | | фактически, на самом деле |
| to absorb | | поглощать |
| absorption | | поглощение |
| aerial<br>- transmitting a. | 'єərıəl | антенна<br>- передающая а. |
| alarm | | тревога |
| amber | | янтарь |
| attract | | притягивать |
| bandwidth | | диапазон частот |
| to bounce | | подпрыгивать, отскакивать |
| curvature | | кривизна |
| duct<br>- cable d. | | тоннель, канал<br>- кабельный канал связи |
| engage | | подвергаться |
| extent | | протяжённость, степень |
| fibre<br>- optical f. | | волокно<br>- оптическое волокно |
| flammable | | легковоспламеняющийся |
| to harm | | причинять вред |
| to ignite | | воспламеняться |
| interference | | вмешательство, помеха |
| to intervene | | вклиниваться |
| intruder | | оператор-перехватчик |
| light | | лёгкий, светлый, свет |
| lightning<br>- lightning flash | | молния<br>- вспышка молнии |
| minute | maı'nju:t | крошечный |
| obstacle | | препятствие |
| rubbing | | трение, натирание |
| sand | | песок |
| sight transmission | | передача видеоизображения |
| spark | | искра |
| to splice | | сращивать, соединять |
| to steal | | воровать |

| | | |
|---|---|---|
| to stretch | | тянуться, растягиваться |
| to strike | | ударять |
| to trigger | | запускать, включать |
| wave<br>- surface/ground w.<br>- sky w.<br>- space w. | | волна<br>- поверхностная в.<br>- пространственная в.<br>- пространственная радиоволна. |
| warning<br>- audible w. | | предупреждение<br>- звуковая сигнализация |

**UNIT 23**

| | | |
|---|---|---|
| amplifier | | усилитель |
| to boil | | кипятить |
| bulb | | колба |
| dissimilar | | отличный, непохожий |
| ferrite rod core | | ферритовый стержневой сердечник |
| flannel | | фланелевая ткань, тряпка |
| flowchart | | блок-схема, граф |
| furnace | | печь |
| to immerse | | погружать |
| to invent | | изобретать |
| to invite | | приглашать |
| layer | | слой |
| loudspeaker | | громкоговоритель |
| to moisten | | смачивать |
| newly | | заново, недавно |
| to oscillate | | колебаться |
| outskirts | | окраина, пригород |
| pile<br>- voltaic p. | | столбик<br>- вольтов столб |
| suburb | | пригород |
| tuner | | настройщик, тюнер |
| vacuum cleaner | | пылесос |
| wave<br>- carrier w. | | волна<br>- несущая в. |



| | | |
|---|---|---|
| weak | | слабый |

**UNIT 24**

| | | |
|---|---|---|
| to attend | | уделять внимание |
| to deplete | | истощиться |
| employee | | работник |
| headquarters | | главный орган управления, штаб |
| intake | 'ınteık | приём, поглощение, потребление |
| maintenance<br>- maintenance people | | поддержка<br>- обслуживающий персонал |
| market<br>- domestic m. | | рынок<br>- внутренний р. |
| portable | | переносной |
| red-letter day | | праздничный день |
| release | | высвобождать |
| standby | | резервный |

**UNIT 25**

| | | |
|---|---|---|
| acquire | | получать |
| advent | | наступление, прибытие |
| bore | | скука |
| consolidation | | объединение |
| crucial | | ключевой |
| dawn | | рассвет, начало, исток |
| distinct | | чёткий, ясный |
| diversity | | разнообразие |
| entity | | суть, сущность |
| to evolve | | развиваться |
| hasten | | спешить, торопиться |
| to herald | | глашатай, вестник |
| hp (horse power) | | л.с. (лошадиная сила) |
| guard staff | | охрана |
| interruption | | задержка, приостановка |
| jute | | джут |

| | | |
|---|---|---|
| in charge | | на дежурстве |
| kettle | | чайник |
| to liaise | lı'eız | поддерживать связь |
| mercury | | ртуть |
| to necessitate | | делать необходимым, влечь за собой |
| outage | | старение |
| per capita | | на душу населения |
| to proliferate | | распространяться, разрастаться |
| to promote | | продвигать, способствовать |
| shift<br>- day/night shift | | смена<br>- дневная/ночная смена |
| smoothly | | плавно, гладко |
| to sophisticate | | извращать, подделывать |
| to strive | | стараться, бороться |
| transferable<br>- t. skills | | могущий быть переданным<br>- навыки по передаче |
| to undergo | | испытывать, переносить |
| vocational | | профессиональный |
| welfare | | благосостояние |
| wheel | | колесо |
| wrapping | | намотка |

**UNIT 26**

| | | |
|---|---|---|
| ball lightning | | шаровая молния |
| countless | | бесчисленный |
| enlightener | | просветитель |
| to experience | | испытать, перенести |
| fume | | дым, продукты горения |
| hardship | | лишения, трудности |
| to inhale | | надышаться |
| to long | | тянуться |
| nevertheless | | тем не менее |
| outstanding | | выдающийся |
| protract | | чертить, продлевать, тянуть |
| scholarship | | стипендия |



| | | |
|---|---|---|
| want | | нуждаться |

**UNIT 27**

| | | |
|---|---|---|
| ash<br>- ash-disposal plant | | зола<br>- золоудаление |
| circuit breaker | | выключатель |
| coal<br>- c. handling<br>- c. slack | | уголь<br>- углеподготовка<br>- угольная пыль, шлам |
| combustion<br>- c. materials | | сжигание<br>- продукты сгорания |
| condenser | | конденсатор |
| crusher | | дробилка |
| deaerator | | деаэратор |
| drawoff | | водозабор |
| fan | | вентилятор |
| flue gas | | уходящий газ, продукты сгорания |
| heater<br>- regenerative h.<br>- waste gas h. | | подогреватель<br>- регенеративный нагреватель<br>- подогреватель, экономайзер |
| heat exchanger | | теплообменник |
| house<br>- boiler h.<br>- turbine h. | | зал<br>- котельная<br>- турбинный зал |
| furnace<br>- f. chamber | | печь, топка<br>- камера сгорания |
| gauge<br>- temperature g. | | датчик<br>- д. температуры |
| to get rid of | | избавляться |
| incineration | | сжигание |
| peculiarity | | особенность |
| power plant<br>- hydroelectric pumped storage p. p.<br>- gas turbine p. p. | | электрическая станция<br>- гидроаккумулирующая ЭС (ГАЭС)<br>- газотурбинная ЭС |
| pump | | насос |

| | | |
|---|---|---|
| - feed p.<br>- drainage p. | | - питательный н.<br>- дренажный н. |
| slag | | шлак |
| smokestack | | дымовая труба |
| stock | | запас |
| vapour<br>- exhaust v. | | пароводяная смесь, испарения<br>- отработавший пар |
| wave<br>- carrier w. | | волна<br>- несущая в. |
| water-tap | | кран |

**UNIT 28**

| | | |
|---|---|---|
| to annoy | | раздражаться |
| cheerful | | весёлый |
| fault | | повреждение |
| fuse | | предохранитель |
| insulation | | изоляция |
| to lend | | протягивать |
| to roll up | | закатывать |
| overloading | | перегрузка |
| protractor | | транспортир |
| to refuse | | отказываться |
| questioning | | опрос |
| seldom | | редко |
| skin | | кожа |
| sleeve | | рукав |
| solid | | твёрдый, сплошной |
| stroke of lightning | | удар молнии |
| surroundings | | окружение |
| wet | | влажный |
| wisely | | мудро |

**UNIT 29**

| | | |
|---|---|---|
| appliance | | прибор, применение |



| | | |
|---|---|---|
| as a matter of fact | | по сути |
| as far as | | поскольку |
| at least | | по крайней мере |
| battery charger | | зарядное устройство |
| because of | | из-за |
| to bias | | склонять, оказывать влияние |
| by means of | | посредством |
| energy<br>- radiant e. | | энергия<br>- лучистая э. |
| fluctuation | | колебание, неустойчивость |
| heatsink | | тепловой радиатор |
| to glow | | светиться |
| groupmate | | напарник, коллега по группе |
| in spite of | | несмотря на |
| instead of | | вместо |
| Leyden jar | | Лейденская банка |
| loss<br>- heat loss | | потеря<br>- тепловые потери |
| owing to | | благодаря |
| portable | | переносной |
| proof | | доказательство |
| smoothing circuit | | сглаживающая цепь |
| stormy day | | штормовой день |
| thanks to | | благодаря |
| thunderstorm | | гроза |
| waste | | трата, потеря |
| with the aid of | | при помощи |
| zener diode | | стабилитрон |

**UNIT 30**

| | | |
|---|---|---|
| alloy | | сплав |
| bar | | брусок |
| to climb | klaım | карабкаться, взбираться |
| coercivity | | коэрцитивная сила |
| compound | | составной, смесь |
| decline | | снижение, снижаться |

| | | |
|---|---|---|
| eddy current | | вихревой ток |
| entirely | | полностью |
| flux density | | магнитная индукция |
| garnet | | гранат |
| gradual | | плавный, постепенный |
| integrated circuit | | интегральная микросхема |
| knee | | колено (точка перегиба кривой) |
| magnetite | | магнетит |
| magnetization curve | | кривая намагничивания |
| oxide | | оксид |
| permeability | | магнитная проницаемость |
| to pull out | | вытаскивать |
| rare earth element | | редкоземельный элемент |
| to rearrange | | перестраивать |
| reed | | тростник |
| remanence | | остаточная намагниченность |
| to quote | | цитировать, ссылаться |
| saturation | | насыщение |
| sharp | | острый, резкий |
| signal suppressor | | подавитель сигнала |
| slightly | | слегка |
| slope | | наклон |
| solution | | раствор, решение |
| steep | | крутой |
| sudden | | внезапный |
| surface tension | | поверхностное натяжение |
| to traverse | | |
| visual form | | наглядный вид |
| to withdraw | | выдержать, выстоять |

**UNIT 31**

| | | |
|---|---|---|
| amateur | | аматор, любитель |
| available | | доступный |
| auxiliary power | | мощность собственных нужд |
| bascule bridge | | разводной мост |



| | | |
|---|---|---|
| beneath | | внизу, ниже |
| blade | | лезвие, лопатка |
| to bore | | сверлить, бурить |
| to bury | | закапывать |
| can | | консервная банка |
| casing | | кожух |
| coin | | монета |
| dam | | дамба |
| desirability | | желательность |
| to dig | | копать |
| enormous | | огромный |
| foil | | фольга |
| head | | напор, перепад высот |
| hunter | | охотник |
| to house | | вмещать, давать приют |
| lack | | нехватка |
| locality | | местоположение |
| machinery | | механизмы |
| to mount | | монтировать, устанавливать |
| necklace | | ожерелье |
| to reveal | | раскрыть, обнаружить |
| rock | | скала |
| runner | | рабочее колесо |
| shaft | | ось, вал |
| stream<br>- downstream | | поток<br>- вниз по течению |
| treasure | | сокровище |
| waterfall | | водопад |
| worthless | | нестоящий, бесполезный |

**UNIT 32**

| | | |
|---|---|---|
| to avoid | | избегать |
| desert | | пустыня |
| fuel element | | топливный элемент |
| fuel reprocessing plant | | топливоперерабатывающее |

| | | |
|---|---|---|
| | | предприятие |
| heat rejection | | теплоотвод |
| logic probe | | логический пробник |
| noise | | шум |
| obstacle | | препятствие |
| pellet | | таблетка, пилюля |
| pip | | пятно, точка |
| sodium iodide | | иодид натрия |
| stainless steel | | нержавеющая сталь |
| steam<br>- saturated s.<br>- superheated s | | пар<br>- насыщенный пар<br>- перегретый пар |
| vessel | | сосуд |

**UNIT 33**

| | | |
|---|---|---|
| arbitrary | | произвольный |
| armature | | якорь |
| ash-disposal area | | золоотвал |
| bubble | | пузырь |
| burner | | горелка |
| to burst | | лопаться |
| circulating pump | | циркуляционный насос |
| conveyor belt | | конвейерная лента |
| crusher | | дробилка |
| dredging pump | | багерный насос |
| equilibrium process | | уравновешенный процесс |
| to evaporate | | испаряться |
| to extinguish | | тушить |
| feed track | | питатель |
| furnace chamber | | топка, камера сгорания |
| horizon | | горизонт |
| powdered-coal | | пылеугольный |
| powdered-coal mill | | мельница |
| railroad car | | железнодорожный вагон |
| reversibility | | обратимость |



| | | |
|---|---|---|
| seldom | | редко |
| smoke flue | | дымоход |
| superheater | | пароперегреватель |
| waste gas heater | | экономайзер |
| whirler | | центрифуга |

**UNIT 34**

| | | |
|---|---|---|
| aquadag | | аквадаг (проводящее покрытие) |
| to ascend | | подыматься, идти вверх |
| brightness | | яркость |
| cathode ray tube (CRT) | | электронно-лучевая трубка (ЭЛТ) |
| coating | | покрытие |
| control grid | | управляющая сетка |
| core | | сердечник |
| deflection | | отклонение |
| to descend | | спускаться, идти вниз |
| eddy current | | вихревой ток |
| electron gun | | электронная пушка |
| to emerge | | появляться, выныривать |
| to emit | | испускать, излучать |
| enclose | | окружать |
| former | | предыдущий, предшествующий |
| hammer-thrower | | метатель молота |
| hill | | холм |
| graticule | | координатная сетка |
| latter | | последний |
| lightning conductor | | молниеотвод |
| to misuse | | неправильно использовать |
| pin | | булавка, ножка |
| ridge | | гряда, водораздел, горная цепь |
| sawtooth | | пилообразный |
| spot | | пятнышко, точка, солнечный зайчик |
| thunder | | гром |
| thunderstorm | | гроза |
| timebase generator | | генератор развёртки |

| | | |
|---|---|---|
| transparent | | прозрачный |
| valve | | вентиль |
| whereas | | в то время как |

**UNIT 35**

| | | |
|---|---|---|
| adequate | | соответствующий |
| afterwards | | впоследствии, позже |
| assessment | | оценка |
| to back up | | поддерживать, давать задний ход |
| bud | | бутон |
| carbon dioxide | | углекислый газ |
| carbohydrate | | углеводород |
| concern | | отношение, касательство |
| commitment<br>- unit c. | | обязательство, вручение<br>- ввод блока |
| constraint | | ограничение |
| cost<br>- overall c. | | стоимость<br>- полная стоимость |
| to decompose | | распадаться, разлагаться |
| to equip | | оборудовать |
| to fertilize | | удобрять |
| forecast | | предсказывать |
| to germinate | | порождать, вызывать к жизни |
| germination | | прорастание |
| governor | | регулятор |
| to impose | | помещать, облагать |
| limestone | | известняк |
| to man | | управлять вручную |
| margin | | поле, пределы |
| market<br>- balancing m.<br>- bilateral m. | | рынок<br>- уравновешенный р.<br>- двусторонний р. |
| meanwhile | | тем временем |
| occur | | случаться |
| outage | | простой, бездействие, выход из |



| | | |
|---|---|---|
| | | строя |
| paramount | | главный, первостепенный |
| pollen | | пыльца |
| pollination | | опыление |
| prior to | | перед, до, прежде |
| purchaser | | покупатель |
| respiration | | дыхание |
| scope | | сфера, область действий |
| seed | | семя |
| sensitive | | чувствительный |
| shell | | оболочка, скорлупа, раковина |
| to sow | | сеять |
| stigma | | пестик |
| to swell | | набухать |
| tissue | | ткань |
| to unbundle | | устанавливать отдельную цену |
| utility<br>- u. personnel | | полезность, выгодность<br>- коммунальный персонал |

**UNIT 36**

| | | |
|---|---|---|
| apart | | в сторону, отдельно |
| blank | | пробел |
| to cease | | прекращать, переставать |
| compulsory | | обязательный |
| control<br>- remote c. | | управление<br>- дистанционное у. |
| couch potatoes | | диванный картофель, лежебока |
| to deteriorate | | ухудшать, распадаться |
| deterioration | | ухудшение, износ |
| dielectric strength | | электрическая прочность диэлектрика |
| to dominate | | доминировать |
| essence | | сущность, суть |
| to expose | | подвергать |
| handiwork | | ручная работа |

| | | |
|---|---|---|
| to handle | | рукоятка, трогать руками |
| handset | | пульт |
| hole conductance | | дырочная проводимость |
| idiom | | фраза |
| indentation | | отступ (абзац) |
| light-emitting diode | | светоизлучающий диод |
| nuisance | | досада, неприятность |
| sophisticated life | | сфальсифицированная жизнь |
| to spill out | | разболтать, всё выложить |
| stress<br>- electric s. | | давление, напряжение, ударение<br>- электрическая напряженность |
| widespread | | широко распространённый |

**UNIT 37**

| | | |
|---|---|---|
| align | | присоединяться |
| although | | хотя |
| band | | диапазон |
| cross-linked | | поперечно связанный |
| designation | | назначение |
| elastomeric | | эластомерный |
| to earn | | зарабатывать |
| to extrude | | выдавливать |
| extrusion | | выдавливания, прессование |
| even though | | даже если, хотя |
| fear | | страх |
| furthermore | | более того |
| guidance | | руководство |
| leisure | | досуг |
| multi-core | | многожильный |
| outweigh | | перевешивать |
| re-melting | | переплавка |
| resilient | | пружинистый, упругий |
| rubbery | | резиновый |
| salary | | зарплата |
| sheath | | оболочка, кожух |



| | | |
|---|---|---|
| thermosetting | | термическое твердение |
| vulcanized | | вулканизированный |

**UNIT 38**

| | | |
|---|---|---|
| advertising | | реклама |
| aarmoured | | армированный, усиленный |
| availability | | работоспособность |
| to ban | | запрещать |
| to breathe | | дышать |
| expertise | | экспертиза |
| habit | | привычка |
| glanding | | уплотнение |
| to grip | | схватить, сжать |
| jointer | | соединительная муфта |
| joint bay | | соединительная муфта |
| lung<br>- l. cancer | | лёгкое<br>- рак лёгких |
| needle | | игла |
| rigour | | строгость, точность |
| stocking | | накопление |
| stranded | | скрученный |
| tape | | лента |
| termination | | завершение |
| trifurcating joint | | трёхвильчатая муфта |
| volatile<br>- v. metals market | | летучий<br>- быстро реагирующий рынок металлов |

**UNIT 39**

| | | |
|---|---|---|
| capacious | | ёмкий |
| to cast | | отливать, лить |
| to embed | | вставлять, врезать |
| hazard | | опасность |
| glance | | взгляд |

| | | |
|---|---|---|
| merely | | просто |
| responsiveness | | способность к реагированию |
| ripple | | колебания |
| salient-pole generator | | явнополюсный генератор |
| stack | | груда, куча, масса, пакет |
| superlative | | превосходный |
| torque | | вращающий момент |

**UNIT 40**

| | | |
|---|---|---|
| accessory | | принадлежности |
| contradiction | | противоречие |
| coolant | | охлаждающий агент |
| crackle | | потрескивание |
| to disaffirm | | отрицать, аннулировать |
| discrepancy | | несоответствие, расхождение |
| to emphasize | | подчеркивать |
| to enamel | | эмалировать |
| to encapsulate | | помещать внутрь, заключать в капсулу |
| ester | | сложный эфир |
| hum | | жужжание |
| ingress | | вход, право входа |
| insolation | | освещение |
| interstage transformer | | межкаскадный трансформатор |
| misadventure | | несчастный случай |
| misalign | | Не лежать на оси, не совпадать |
| moisture | | влага, влажность, сырость |
| premises | | помещение, недвижимость |
| proficiency | | опытность, сноровка |
| pump<br>- centrifugal p.<br>- piston p. | | насос<br>- циркуляционный н.<br>- плунжерный н. |
| randomly | | беспорядочно |
| residential | | жилой |
| rig | | приспособление, механизм |



| | | |
|---|---|---|
| shadow | | тень |
| shaver | | бритва |
| storage tank | | накопительный бак |
| submarginal | | предшествующий предельному |
| tap | | отпайка, отвод |
| transducer | | преобразователь |
| tranquillizer | | успокоитель |
| varnish | | лак, покрывать лаком |
| well | | родник |

**UNIT 41**

| | | |
|---|---|---|
| arc furnace | ə'fekt | дуговая печь |
| bank<br>- transformer bank | | батарея<br>- трансформаторная б. |
| booster | | бустер, побудитель, усилитель |
| contamination | | загрязнение, порча |
| to dip | | окунать |
| feasibility | | осуществимость |
| footprint | | опорная поверхность |
| justify | ,lə'rıfık | оправдывать |
| oil-rig | | нефтяная вышка |
| overall | | полностью, в общем и целом |
| pavement | | мостовая, дорожное покрытие |
| proximity | prɔk'sımıtı | близость, соседство |
| spillage | | утечка |
| trackside | Λvtel | путевой |
| transformer<br>- phase-shifting t.<br>- converter t. | | трансформатор<br>- фазосдвигающий т.<br>- |
| uneven | ıg'z:st | неуравновешенный |
| to withstand | | выдерживать |

**UNIT 42**

| | | |
|---|---|---|
| adequate | 'ædıkwıt | адекватный |

| | | |
|---|---|---|
| allusion | | ссылка |
| ancillary | | подсобный, вспомогательный |
| attitude | | отношение |
| be off | | освобождаться от работы |
| bulk transfer | bʌldʒ | общая передача |
| bully | | задира, забияка, хвастун, хулиган |
| corn | | мозоль |
| cough | | кашлять |
| cracker | | хлопушка, петарда |
| dignity | | достоинство |
| distinct | dɪs'tɪŋkt | отчетливый, индивидуальный |
| ditch | | котлован, канава, ров |
| duly | | правильно, надлежащим образом |
| humbug | | жульничество |
| faithful | | точный, совпадающий, верный, преданный |
| figurativeness | | образность |
| frown | | хмурить брови |
| guess | | гипотеза, догадываться |
| idiom | 'ɪdɪəm | идиома, стиль, манера выражения |
| indignant | | возмущенный |
| to imply | | подразумевать |
| to impose | ɪm'pəuz | навязывать |
| insinuation | | намёки |
| motto | dʌvtel | девиз |
| murmur | | шепот, шептать |
| perception | | восприятие |
| pike | | щука |
| precisely | | точно |
| prejudice | | предубеждение |
| primitive | | первобытный, первичный, основной |
| to privatize | 'praɪvətaɪz | приватизировать |
| shower | | душ |
| squib | | хлопушка, петарда |
| sledge | | сани |
| spirit | | дух |



| | | |
|---|---|---|
| swan | | лебедь |
| thoroughly | | тщательно |
| tidy | | аккуратный |
| tulip | | тюльпан |
| virtue | | добродетель |
| weep | | плакать, рыдать |

**UNIT 43**

| | | |
|---|---|---|
| to embed | | вставлять, врезать |
| to exacerbate | ɪg'zæsəbeɪt | обострять, усложнять |
| imperative | | повеление |
| intermittent | | пульсирующий |
| to pose | | ставить, предлагать |
| to prioritize | praɪ'ɔrɪtaɪz | отдавать предпочтение |
| renewable | | возобновляемый |
| spinning reserve | | горячий резерв |

**UNIT 44**

| | | |
|---|---|---|
| adverse | | неблагоприятный |
| amenity | ə'mi:nɪtɪ | мягкость, любезность |
| blackout | | затмение, провал |
| comprehensive | | всесторонний |
| congestion | | скопление |
| damper cage | | успокоительная сетка |
| layout | dɪ'kla | расположение, планировка |
| to marshal | ɪɪne | располагаться в определённом порядке |
| to preclude | | препятствовать |
| prevalent | | общепринятый |
| pylon | | опора, столб |
| sparsely | | малонаселенно |
| to tolerate | | выносить, терпеть |

**UNIT 45**

| | | |
|---|---|---|
| acid<br>- carbonic a<br>- sulfuric a.<br>- hydrofluoric a.<br>- oxalic a. | | кислота<br>- угольная к.<br>- серная к.<br>- фтористоводородная к.<br>- щавелевая к. |
| arsenic | 'α:snık | мышьяк |
| background | | фон |
| detergent | | моющее средство |
| iodine | 'aıədi:n | йод |
| mud | | ил |
| nuclide | | нуклид |
| pollutant | | загрязняющий агент |
| reiteration | | повторение |
| sloughing | | заиливание |

**UNIT 46**

| | | |
|---|---|---|
| to affect | | подвергать физическому воздействию |
| confident | | уверенный |
| disposal | | избавление |
| to flood | | затапливать |
| incineration plant | | мусоросжигающий завод |
| landfill | | свалка |
| likelihood | | вероятность |
| to recycle | | перерабатывать |
| retailer | | розничный торговец |
| solvent | | растворитель |
| to upset | | опрокидывать |
| vegetation | | растительность |
| waste | | отходы |

**UNIT 47**

| | | |
|---|---|---|
| adverse | 'ǽdvə:s | неблагоприятный |



| | | |
|---|---|---|
| arrest<br>- cardiac a.<br>- respiratory a. | | остановка<br>- остановка сердца<br>- остановка дыхания |
| cardiopulmonary | | сердечно-лёгочный |
| casualty | 'kǽʒjultı | пострадавший человек |
| to cease | | переставать, прекращаться |
| chest | | грудная клетка |
| contraction | | сжатие |
| cramp | | спазм, судорога |
| to disrupt | | разрушать |
| ear plug | | ушная затычка (беруши) |
| flashover | | перекрытие дугой |
| fork-lift truck | | вильчатый погрузчик |
| fracture | | перелом |
| hazardous | | опасный |
| goggle | | защитные очки |
| greasy | | жирный, скользкий |
| to injure | | ранить, повредить |
| ladder | | приставная лестница |
| muscular | 'mʌskjulə | мышечный |
| pallet | | поддон |
| resuscitation | | оживление, реанимация |
| to suffer | | страдать |
| threshold | | порог |
| unco | | сверхъестественный, значительный |
| ventricular fibrillation | | фибрилляция (трепетание) желудочка |

**UNIT 48**

| | | |
|---|---|---|
| adjacent | 'ǽdvə:s | смежный |
| expulsion | | выталкивание, выделение |
| fire drill | | пожарные учения |
| to hurt | | болеть, причинять боль |
| obstacle | | помеха |
| precaution | | мера предосторожности |

| | | |
|---|---|---|
| to quote | | котировать |
| screwdriver | | отвёртка |
| spanner | | гаечный ключ |
| to spill | | проливать |