
НАВЧАЛЬНИЙ ПОСІБНИК
ДЛЯ
СТУДЕНТІВ-ЕЛЕКТРИКІВ

В епоху інформатизації суспільства соціальні пріоритети зміщуються в бік впровадження в життя інновацій, винаходів науковців, працівників промисловості, організаторів технологічних процесів економіки. Це особливо актуально для енергетики, яка в сучасному суспільстві є базовою галуззю господарства будь-якої країни, важливим гарантом взаємодії з іншими країнами.

Даний методичний посібник розроблений для студентів спеціальності5.05070104 «Монтаж і експлуатація електроустаткування підприємств і цивільних споруд» напряму підготовки 6.050701 «Електротехніка та електротехнології». Перспективність енергетичної спеціалізації освіти при відсутності навчальних посібників з англійської мови на основі сучасних аутентичних матеріалів визначають реальну необхідність даного посібника.

Мета посібника – допомогти студентам орієнтуватися у великому потоці інформації на англійській мові, навчитися виділяти головне та другорядне в питаннях енергетики, сформувати у студентів вміння та навички різних видів читання, говоріння, перекладу, вміння інтерпретувати інформацію, яка міститься у наукових англомовних текстах. У посібнику також приділяється значна увага розширенню словникового запасу студентів, він створює додаткові можливості для вивчення термінологічних особливостей сучасної англійської мови. Завдання розраховані як на аудиторну, так і на самостійну роботу студентів. Посібник відповідає програмним вимогам з іноземної мови для немовних технічних навчальних закладів 1-2 рівня акредитації.

Навчальний посібник для студентів-електриків. – Костянтинівка: КІТ ДВНЗ «ДонНТУ», 2014. – 252с. Упорядник - І.А.Тубольцева викладач іноземної мови першої категорії Костянтинівського індустріального технікуму ДВНЗ «ДонНТУ».

Методичний посібник для студентів спеціальності 5.05070104 «Монтаж і експлуатація електроустаткування підприємств і цивільних споруд» напряму підготовки 6.050701«Електротехніка та електротехнології».
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Розглянуто та схвалено до друку цикловою комісією гуманітарних дисциплін КІТ ДВНЗ «ДонНТУ».
Протокол № 2 від 25 вересня 2014 року.

## EVERYDAY ENGLISH AND TECHNICAL ENGLISH

At present the contacts between people of different countries are increasing. This enhances the importance of the study of foreign languages. However, sometimes we don't even know which of the world's languages we should take into consideration. The matter is that the total number of languages in the world is very large. In different reference books it varies from five to eight thousands. The numerical distribution of people speaking different languages is extremely uneven. There are not many languages in the world each of which has more than 50 million people. On the other hand, there are languages spoken by only several thousands of people.

Everyone should understand that for the linguist there are no big or small languages. For each people the language is not only a means of communication, but also an embodiment of national and cultural values. English is native or the first language for the most population of Great Britain, USA, Canada, Australia and New Zealand. English is the most widely spread of the world's languages.

English is one of the five official languages of the UNO (alongside of French, Russian, Spanish and Chinese). It is the working language during the meetings of the General Assembly and Security Council of the UNO. No wonder that so many people in different countries spare no efforts to acquire English for communication.

Technical English is often said to be difficult to understand. At first sight this may seem true. There are a number of reasons why technical writing is rather difficult. It concerns first of all its vocabulary. The scientific and technological progress has enriched the vocabulary with a great deal of new words, new

meanings and new word-combinations. Each branch of science and technology has its own vocabulary (terminology). Many of them are formed on the basis of Greek and Latin words and are often international.

As to the familiar grammatical patterns and models, they are the same as in everyday English. There is, certainly, a difference in the frequency with which certain grammatical forms occur. Scientific and technical writing is usually about things, matter, natural processes, and it is impersonal in style. The Passive Voice of the verb forms, the constructions Subject and Complex Object are frequently used. The first person singular is not generally used.

Simple sentences are rarely used, for isolated facts or events are seldom dealt with by the engineer. He has to show what the connection is, not only what happens, but also how it happens, when it happens, why it happens, and what is being affected. The style of most scientific texts, besides being impersonal, is also very concise. It is because the author-scientist is writing primarily for other scientists.

In order to master technical English the learner must first acquire a thorough knowledge of everyday literary English with its grammar, vocabulary and rules of word formation. Then it will be easy for him to learn, step by step, the peculiarities of technical English. It should be born in mind, however, that understanding and translation of scientific-technical literature requires an additional training connected with knowledge of specific terminology.

**Vocabulary notes**

1. UNO (United Nation Organization) – ООН (Організація Об’єднаних Націй)

2. General Assembly (of the UNO) – генеральна асамблея ООН
3. Security Council of the UNO – Рада Безпеки ООН
4. This may seem true – це може видатися правильним
5. It should be born in mind – слід пам'ятати

**Active words and expressions**

**the matter is that** – справа в тому, що
**uneven** – нерівний
**extreme** – протилежність
**to acquire thorough knowledge** – набути (ґрунтовних) знань
**peculiarity** – особливість
**embodiment** – втілення
**everyday (literary English)** – розмовна(літературна) англійська мова
**to take into consideration** – брати до уваги
**concise** – стислий
**enhance** – підвищувати
**to spare no efforts** – не жаліти зусиль
**value** – цінність
**approximate**– приблизний
**primarily**– у першу чергу

## Answer the following questions

1. What enhances the importance of the study of foreign languages?
2. Do we know the total number of languages in the world?
3. Are there big or small languages?
4. What can you say about the social and functional status of English?
5. Is technical English completely different from literary English?
6. What distinguishes technical English from everyday English?
7. How can you master technical English?

## Exercises

1. **Finish the sentences according to the text:**

1. The total number of languages …

2. The numerical distribution of people speaking different languages …

3. For each people the language is not only …
4. The English language is spoken by more …
5. English is the working language …
6. Each branch of science and technology has …
7. The scientific and technological progress has …
8. The style of the most scientific texts …
9. Scientific and technical writing is usually …
10. In order to master technical English…

**2. Translate the following sentences taking into account the Participle:**

1. There are languages spoken by only several thousands of people. 2. The data obtained should be carefully analyzed. 3. If given opportunity our economy will rapidly develop. 4. Do you know the man speaking English? 5. Having finished his experiment the researcher began to analyze the data obtained? 6. Being a very industrious pupil he worked hard, managed to make great progress in English. 7. Having returned to Oakland, Martin Eden lived in poverty, devoting every minute all his time to literary work. 8. We know Byron as the author of many lyrical poems devoted to nature and love.

**3.Use the appropriate tense forms of the verbs in brackets.**

More than two hundred years ago, people *(make)* … their own clothes. They *(have, not)* … machines for making clothes. There *(be, not)* … any clothing factories. People *(wear)* … homemade clothes that were sewn by hand. Today, very few people *(make)* … their own clothes. Clothing *(come)* … ready-made from factories. People *(buy)* … almost all their clothes from stores. The modern clothing industry *(be)* … international. As a result, people from different countries often *(wear)* … similar clothes. For example, people in many different countries throughout the

world *(wear)* … jeans and T-shirts. However, regional differences in clothing still *(exist)*… . For instance, people of the Arabian deserts *(wear)* … loose, flowing robes to protect themselves from the heat of the sun. In northern Europe, fur hats *(be)* … common in the winter. In the future, there *(be, probably)* … fewer and fewer differences in clothing in the world. People throughout the world *(wear)* … clothes from the same factories. We all *(dress)*… almost alike in the future? TV shows and movies about the future often (show) … everybody in a uniform of some kind. What you *(think)*..?

## ELECTRIC CURRENT

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

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

Some people are more familiar with the various applications of the electric current in their everyday life than they are with its numerous industrial applications. However,

electric energy finds its most important use in industry. Take, for example, the electric motor transforming electric energy into mechanical energy. It finds wide application at every mill and factory. As for the electric crane, it can easily lift objects weighing hundreds of tons.

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

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

**Active Words and expressions**

**application** - використання
**as for** - стосовно
**current** - струм
**device** - прилад
**electrical** - електричний
**electricity** - електрика
**furnace** - піч
**inventor** - винахідник
**laboratory** – лабораторія
**to measure** - вимірювати
**scientist** - науковець
**to serve** - служити
**temperature** - температура
**to transform** - переробляти

## Exercises

**1. Translate the following sentences using a participle:**

**A.** 1. The student is translating an article on refrigerators. 2. The student has translated an article. 3. The article is translated by the student. 4. The article is being translated by the student. 5. The student translating the article is student Novikov. 6. The article translated by the student is difficult. 7. The translated article is devoted to electrical furnaces. 8. Translating an article,

the student used a dictionary. 9. Having translated the article, the student gave it to the teacher. 10. Having been asked to translate the article, the student translated it with great interest.

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

**2. Translate the following sentences:**

1.Електричний мотор, який перетворює електричну енергію на механічну, використовується у повсякденному житті. 2. Кажучи про електричний струм, ми можемо згадати ім’я Вольта. 3. Електричний пірометр вимірює температуру розплавлених металів. 4. Попрацювавши на фабриці, мій товариш вступив до інституту. 5.Вимірюючи температуру гарячих металів, студент користувався пірометром. 6. Вимірявши температуру метала, ми почали вимірювати температуру води.

**3. Form four 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, a
**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

**4. Put all possible questions to the following sentences:**

1. The electric motor finds wide application in industry.
2. Lomonosov is the great world famous scientist.
3. The students of our technical school were at this plant last week.

**5. Form six sentences combining suitable parts of the sentence**

| | |
|---|---|
| 1. The electric current is | 1. the energy of position |
| 2. Kinetic energy is | 2. electricity at rest. |
| 3. Static electricity is | 3. the flow of moving electrons. |
| 4. Potential energy is | 4. the energy of motion. |
| 5. The direct current is | 5. a discharge of electricity. |
| 6. Lightning is | 6.the flow of electrons in one direction |

**6. Read and translate the text**

**Electric fish**

The electric fish is mentioned in the oldest writings of man. History tells us that the Greeks and the Romans knew about it. They knew, for example, that any man coming into contact with the electric fish could obtain an electric shock. In later years, experiments were made to find out the nature and amount of the shock given by one of them called the electric eel. The so-called electric eel is found in the tropical waters of South America.

Small electric eels, only one inch long, can give a small shock. However, by the time they are 6 inches long their

internal battery gives as much as 200 volts. When it is quite grown a good electric eel can generate 600 volts. When it is short circuited, a current of 1 ampere can be obtained. A two-meter long eel could light a dozen 50 watt lamps.

The electricity in the electric eel seems to be produced at will. Besides, the discharges take place at speeds from 10 to 100 per second. It is interesting to mention here, that the eel's head end is positively charged and the opposite end is negatively charged. By the way, the electric eel has some ability for finding polarity. Thus, if two charged electrodes are placed in water, even in the dark, the electric fish which is somewhere near the electrodes, will move towards the positive electrode, possibly thinking that it is the head of a friend.

## ELECTRICITY IN OUR LIFE

Electricity is considered to be the basis of our civilization. Electric energy is widely used in industry to power a great variety of mechanisms and directly in production processes, for transportation and residential purposes. Such modern means of communication as telegraph, telephone, radio, television depend for their operation on electric power.

The greater part of electricity goes to industrial usage. However, there has been a marked increase in residential and commercial usage of energy. In agriculture electric energy finds a great variety of applications, especially in electrification of mobile agricultural equipment, primarily tractors. Besides, electric energy is employed in agricultural processes, using high-frequency current, ultra-violet and infra-red rays, ultra-sound, etc.

Commercial and residential usage of electric energy is growing at an ever increasing rate. In the past electricity was mainly used for lighting. The progress in electrical engineering has led to the development of such sophisticated and convenient household appliances as refrigerators, TV-sets, washing machines, etc. The wider use of these appliances has resulted in a growing consumption of electric energy.

It is essential not only to increase the amount of consumed electric power but also to improve the efficiency of its usage.

The amount of electricity going to industrial and residential usage from the power system varies both during a day and during a year. In the morning, when work begins at enterprises, the light is turned on in apartments and public transport starts running, energy consumption considerably increases, which is referred to as the morning peak demand. During the day, the demand on the power system decreases. In the evening, the demand on the system is, as a rule, at maximum because this is the time when the electric vehicles of public transport run at the shortest interval, street and apartment lights are turned on as there are numerous electric appliances, such as TV and radio sets, heaters, etc. During the same hours some enterprises go on working. In the night-time most electric power users do not operate and the power demand «drops» low.

The change of seasons is another factor affecting the consumption of electric energy. For instance, in winter a larger amount of energy is used for lighting and heating. Energy usage

is also dependent on weather conditions. A snowfall increases the amount of power used for transportation.

An unforeseeable change in energy consumption may occur in industrial enterprises where the number of units of electrical equipment operating at the moment and their power may vary due, for instance, to the re-orientation of a production process or the introduction of design modification in the articles being manufactured, etc.

It is impossible to predict exactly the countless number of factors affecting energy consumption in the power system, since for objective reason these factors are random in nature. Yet the time-variation of energy usage is very desirable information if the performance of an electric power system is to be controlled.

### Active Words and Expressions

**coal** – вугілля
**communication**–зв'язок
**conventional** – традиційний
**to convert** – перетворювати
**fuel** – паливо
**heat** – тепло
**to heat** – обігрівати
**to light** – освітлювати
**to note**– помічати
**to obtain** – отримувати
**to require** – вимагати
**power** – енергія
**to run** – направляти
**residential** – житловий
**ultra-violet** – ультрафіолетовий
**source** – джерело
**ultra-sound** – ультразвук
**to increase** – збільшувати
**sophisticated** – складний
**appliance** – апарат, прилад
**consumption** – споживання
**to improve** – поліпшувати
**unforeseeable** – непередбачений
**vary** – змінювати
**countless** – багаточисельний
**infra-red rays**– інфрачервоні промені

## Answer the following questions

1. In what spheres of life is electricity widely used?
2. What way is electric energy used in industry?
3. Is there the problem of electric power consumption?

4. How does the amount of electricity we use vary during a day and during a year?
5. Do the change of seasons and weather conditions affect the consumption of electric energy?
6. Why is it important to predict the number of factors affecting energy consumption in the power system?
7. Why is the information about time-variation of energy usage important?
8. What electric devices do you use at home (at work)?
9. What do the students of Electricity Supply specialty study?
10. What modern computer technology is used to design electricity supply systems?

## Exercises

**1.Translatethe following word combinations into Ukrainian:**
residential usage;a great variety;modern means of communication;high-frequency current;an increasing rate;sophisticated;convenient household appliances;consumption of electric energy;an unforeseeable change;the countless number of factors;to improve the efficiency.

**2.Finish the sentences according to the text:**
1. Electric energy is widely used in...
2. The greater part of electricity goes...
3. ...growing at an ever increasing rate.
4. The progress in electrical engineering has led to the...
5. The amount of electricity going to industrial and...
6. The change of seasons...
7. ...may occur in industrial enterprises...
8. ...reason these factors are random in nature.

**3. Translate the following sentences:**

1. Energy issues couldn't be solved by industrial countries alone, working in isolation.
2. The need to strengthen cooperation is further underlined by recent events and developments taking place within as well as outside the Union.
3. Despite recent economic setbacks, many of the newly emmerging world economies are being fuelled by massive increases in energy use.
4. This brief description of some methods used in our work covers only a few of the problems encountered.
5. The resistance being very high, the current in the circuit is low.
6. The test referred to above can be easily made.
8. There is always water vapour in the air, the amount depending upon various conditions.
9. Until now we have been discussing reactors from which no power is being taken.
10. Some of the effects produced by an electric current are discussed in the following chapter.

**4. Fill in the blanks with the correct prepositions *(in, on, next, to, under, over, between).***

1. The dresser is … the bedroom. 2. The shoes are … the bed. 3. The clock radio is … the photo. 4. The night table is … the bed and the dresser. 5. The sink is … the toilet. 6. The mirror is … the sink. 7. The table is … the sofa. 8. The sofa is … the living room. 9. The pictures are … the sofa. 10. The flowers are … the television. 11. The telephone is … the wall. 12. The bowl is … the table. 13. The clock is … the refrigerator. 14. The cabinets are … the kitchen. 15. The toaster is … the refrigerator.

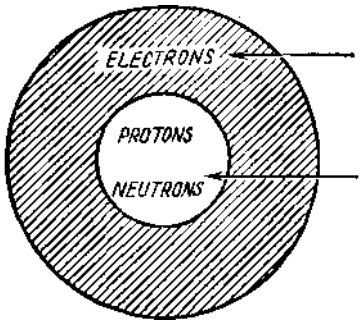
# SOME FACTS ABOUT ATOMS

An atom may be spoken of as the smallest particle of a substance.

If atoms cannot be seen it does not necessarily mean that they do not exist. It indicates that any particles, if present, must be extremely small. There are methods by means of which the sizes of atoms and their arrangement in molecules can be determined. One of these methods uses X-ray diffraction.

The results of a number of investigations show that when atoms are in contact with other atoms in molecules, their radius is as much as $0.1\times10^{-9}$ m (0.1 nm).

Some idea of how small atoms are can be obtained by imagining one million copper atoms (radius=$0.13\times10^{-9}$ m (0.13 nm)). If these copper atoms are stacked one on top of the other, the pile will be as high as the full stop at the end of this sentence.




In the course of many investigations, chemists came to a conclusion that the atoms of different elements are all made essentially of three simple types of units, which were referred to as protons, neutrons, and electrons.

Electrons fill the space around the nucleus.

Number of electrons=Atomic number.

Number of protons = Atomic number. Very small nucleus.

Number of protons + Number of neutrons = Relative atomic mass.

The numbers of electrons, protons, and neutrons in an atom of an element can be calculated if the atomic number and relative atomic mass of the element are known:

Number of electrons = Number of protons = Atomic

number of element.

Number of protons + Number of neutrons = Relative atomic mass of element.

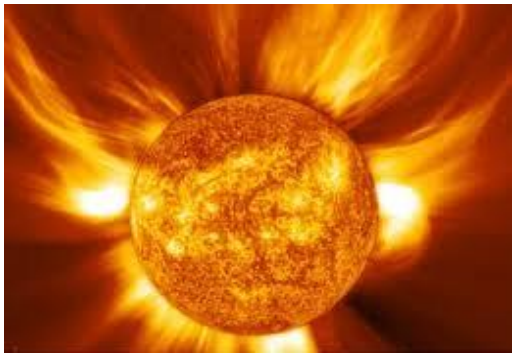
It was also found that many elements and compounds are composed of small numbers of atoms which are held together in a regular arrangement. These groups of atoms are referred to as molecules. The gas hydrogen, for example, is composed of pairs of hydrogen atoms and each pair is called a molecule and its formula is $H_2$.

Another example is the compound carbon dioxide which is composed of molecules, the formula is $CO_2$.

## The Atomic Model

The electron, the proton, and the neutron gather together into what can be called the atom.

Our concept of the atom derives from a series of observations. As a result of these observations, we now believe that an atom is composed of a cloud of electrons that revolve about a central core of protons or of protons plus neutrons. Repeated experiments, which were referred to above, show that every atom has the same number of electrons as well as protons. The positively charged protons form the nucleus of the atom, and balance the positive charges of the protons in the core of the atom. The neutrons are also found in the nucleus of the atom.



An atom has already been spoken of as the smallest unit of an element.

It is known that ninety-two elements occur in nature, and a

number of others have been made by man in the laboratory. Every element is a special combination, of protons, neutrons, and electrons. Each element is identified by the number of protons in its nucleus and is designated by a name and a symbol.

Element Number 1 is a combination of one proton and one electron. Long before its atomic structure was known, this element was referred to as hydrogen, or "water-former", because water forms when hydrogen burns in air. Its symbol is H. Hydrogen has first place in the list of elements because it has one proton in its nucleus. Element 1 is followed by Element Number 2. It consists of two protons and two electrons. It was named helium, with the symbol He.

**Active Words and Expressions**

**mean** – означати
**diffraction** – дифракція
**to indicate** – вказувати
**to determine** – встановлювати
**extremely** – надзвичайно
**nucleus** – ядро
**size**– розмір
**to show** – демонструвати
**as much as** – так багато як
**to stack** – нагромаджувати
**to fill** – заповнювати
**to obtain** – досягати
**statement** – твердження
**essentially** – суттєво
**to compose** – складати
**constituent**– суттєвий
**to derive** – видобувати
**unit** – одиниця
**evidence** – очевидно
**relative** – відносний
**to charge** – заряджати

## Answer the following questions

1. What is an atom?
2. What does it mean if atoms cannot be seen?
3. What methods are used to determine the sizes of atoms?
4. What is the radius of an atom?
5. What structural units do the atoms contain?
6. What space do the electrons fill?

7. How can the numbers of electrons, protons and neutrons in the atom be calculated?
8. How many elements occur in nature?

## Exercises

**1. Translate the following sentences into Ukrainian:**

1. The rate of this reaction can be strongly influenced by high temperature. 2. The changes in these parameters during decomposition were followed by a number of other changes. 3. Common salt was acted upon by sulphuric acid and hydrogen chloride was produced. 4. His work in this field can be relied on. 5. They were told about the new discoveries in oil production. 6. The change in colour was followed by the change of other properties. 7. Fermi is looked upon as an outstanding physicist of our time. 8. The results of their investigation can be referred to. 9. I was asked to attend his lecture on chemistry.
10. Liquid solutions will be dealt with in this chapter. 11. The qualitative examination of this compound is followed by the quantitative one.

**2. Translate the following sentences paying attention to the meanings of the word «mean»:**

1. In mechanics, force does not mean strength. 2. Electrolysis is a process by which a chemical reaction is carried out by means of the passage of an electric current. 3. This means that all the atoms of any element have the same properties. 4. It is generally possible by suitable means to separate the constituents of solutions. 5. Dissociation means the separation of a molecule into its original constituent atoms. 6. A number of various complicated problems have been solved by means of computers.
7. At any given temperature the molecules of gases have the same mean kinetic energy.

**3. Open the brackets choosing the correct form of the adjective. Translate the sentences.**

1. Atoms are not ***(smaller, the smallest)*** particles, but they are very small. 2. This discovery is ***(more important, the most important)*** than the previous one. 3. It is much ***(easier, the easiest)*** to make parts of plastics than of metal or wood. 4. This is ***(better, the best)*** laboratory in our Institute. 5. Aluminium is ***(lighter, the lightest)*** known metal. 6. Hydrogen is ***(lighter, the lightest)*** of the elements. 7. Beryllium is ***(less, the least)*** active member of the group, and there is a regular increase in activity from metal to metal in the order of increased atomic numbers. 8. Kiev University is ***(larger, the largest)*** University in Ukraine. 9. ***(More, the most)*** characteristic chemical property of hydrogen peroxide is its great oxidizing power.

**4. Read the text and retell it:**

**The Nuclei of Atoms**

In 1911 the British physicist Ernest Rutherford carried out some experiments which showed that every atom contains, in addition to one or more electrons, another particle, called the nucleus of the atom. Every nucleus has a positive electric charge. It is very small. It is about as big as an electron. It is very heavy.

There are many different kinds of nuclei. The nuclei of the atoms of one element are different from the nuclei of the atoms of every other element.

**5. Choose the Ukrainian and English equivalents:**

| | |
|---|---|
| like | ретельно |
| because of | звертати увагу |
| closely | ядро |
| to result in | ядра |

| | |
|---|---|
| to pay attention | той же заряд |
| nucleus | подібний |
| the same charge | значення |
| nuclei | з-за |
| means | засіб |
| meaning | призводити |

## 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 sparkles could kill people or strike their houses and destroy them. Trying to understand that dangerous phenomenon, they imagined things and invented numerous stories.

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

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

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

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

Franklin's achievements in the field of electricity were known to Lomonosov who, in his turn, made experiments of his own. Along with other scientific problems that Lomonosov studied was that of atmospheric electricity. Both Lomonosov and his friend Professor Rihman took great interest in it. Both of them tried to solve the problem

in question. They made numerous experiments and observations without thinking of the possible danger. The first electrical measuring device in the world was constructed by Rihman. Making experiments of that kind was dangerous and Professor Rihman was killed by a stroke of lightning while he was making one of his experiments.

**Active Words and Expressions**

**charge** – заряд
**to name after** – назвати на честь
**to conduct** – проводити
**observation** – спостереження
**to destroy** – руйнувати
**path** – шлях
**discharge** – розряджений
**phenomenon** – феномен
**electron** – електрон
**property** – властивість
**experiment** – дослід
**provide** – забезпечувати
**to invent**– винаходити
**scientific** – науковий
**lightning** – блискавка
**solve a problem** – вирішувати проблему

## Exercises

**1. Translate the following sentences, paying attention to the gerund:**

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

**2. Translate the following sentences paying attention to the gerundial construction:**

1. We didn’t know about his being sent to the power station. 2. I remember my having told her about the experiment. 3. His

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

**3. Put questions to the words in bold type:**

1. For thousands of years ***people*** knew nothing about ***thunderstorms.*** 2. The fifth day of the week was ***named after Thor.***3. ***Lightning*** is a discharge of atmospheric electricity.

4. The ***lightning conductor*** provides an easy ***path*** for conducting electric charges to the earth. 5. ***Rihman*** constructed the first electrical measuring device. 6. ***Experiments*** on atmospheric electricity were made by ***Lomonosov.*** 7. Many years ago ***people*** learned to protect their houses from ***thunderstorms.*** 8. ***We*** use atomic energy for ***peaceful purposes.***

**4. Form verbs from the following nouns:**

observation, achievement, protection, production, installation, operation, application, development, heat, generator, inventor, reader.

**5. Translate the following sentences paying attention to the words in bold type:**

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

heard at the lesson yesterday? 8. Lightning is an atmospheric phenomenon **that** greatly interested some scientists of the past.

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

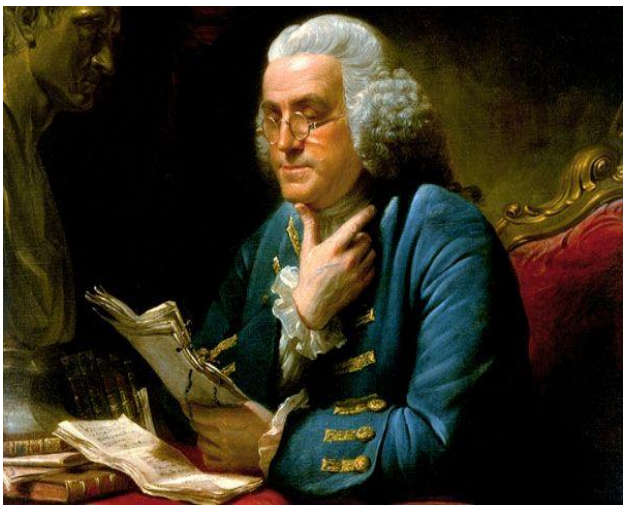
## ATMOSPHERIC ELECTRICITY

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 mimed instead of its being mainly used, as a source of valuable chemical substances which it contains. Therefore, finding new sources of electric energy is the 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 kilometer 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.

Benjamin Franklin (January 17, 1706 – April 17, 1790) was one of the Founding Fathers of the United States. A noted polymath, he was a leading author, printer, political theorist, politician, postmaster, scientist, musician, inventor, satirist, civil activist, statesmen and diplomat. As a scientist, he was a major figure in the American Enlightenment and the history of physics for his discoveries and theories regarding electricity. He invented the lightening rod, bifocals, the Franklin stove, a carriage odometer, and the glass armonica. He facilitated many civil organizations, including a fire department and a university.



Franklin gained international renown as a scientist for his famous experiments in electricity and for his many inventions, especially the lighting rod. He played a major role in establishing the University of Pennsylvania and was elected the first president of the American Philosophical Society. As accomplished diplomat, he was widely admired among the French as American minister to Paris and was a major figure in the development of positive Franco-American relations.

On studying the Leyden jar (for long years the only known

condenser), Franklin began thinking that lightning was a strong spark of electricity. He began experimenting in order to draw electricity from the clouds to the earth. The story about his famous kite is known all over the world.

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

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

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

**Active Words and Expressions**

**lightning rod** – громовідвід
**because of**– з-за
**to burn** – спалювати
**to connect** – поєднувати
**to develop** – розвивати
**engineer** – інженер
**instead of** – замість
**in this connection** – у поєднанні
**to mention** – згадувати
**power** – потужність

**discovery** – відкриття
**to protect** – захищати
**to electrify** – електрифікувати
**substance** – речовина

## Answer the following questions

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

## Exercises

**1. Translate the following sentences, paying attention to the gerund:**

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

**2. Complete the following sentences using the gerund:**

*Model:* She cannot read English without...

She cannot read English without consulting a dictionary.

1. My friend went home instead of ... 2. The students went on ... 3. When the teacher entered the classroom, the students stopped ... 4. Have you finished...? 5. I went to bed after ... 6. The friends spoke of ... 7. You must turn the light off before...

**3. Translate the following sentences using the gerund:**

1. Перш ніж проводити дослідження, необхідно провести спостереження. 2. Багато років тому, люди навчились захищати свої домівки від ударів блискавки. 3. Існує багато різноманітних способів здобування електричного струму. 4. Науковці продовжували вивчати нове явище. 5. Пірометр – це пристрій, що використовується для вимірювання температури гарячих металів. 6. Франклін винайшов громовідвід для захисту будівель від ударів блискавки. 7.Ходити пішки дуже корисно. 8. Атомний реактор використовують для здобування атомної енергії.

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

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

energy can be transformed into electricity.

**5. Fill in the blanks with prepositions:**

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

## FROM THE HISTORY OF ELECTRICITY

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

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

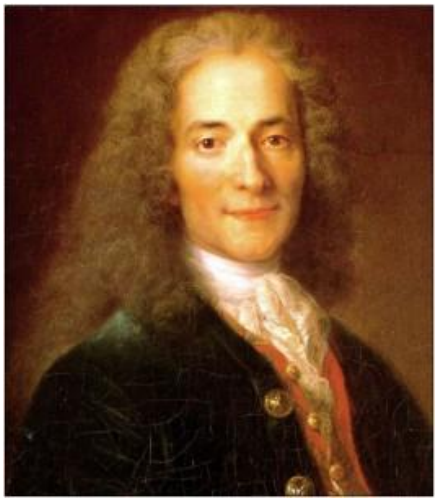
to control; besides it discharges in no time.

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.

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

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

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



## VOLTA'S SHORT BIOGRAPHY

Volta was born in Como, Italy, 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 lecture 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.

### Active Words and Expressions

**as well as**– також, як і
**at rest** – у спокої
**to control**– контролювати
**behavior**– поведінка
**condition** – умова
**copper**– мідь
**flow** – потік
**in motion**– у русі
**negative**– негативний
**opposite** – протилежний
**positive**– позитивний
**previously**– спершу
**to remember**– пам'ятати
**the rest of**– решта
**to travel**– поширювати
**to try**– намагатися
**unlike**– несхожий
**charge**– заряд

## Answer the following questions

1. What types of electricity do you know?
2. What is the difference between electricity at rest and electricity in motion?
3. What kind of experiments did Galvani carry on?
4. What did Franklin prove?
5. What are the two kinds of electrical charges?
6. Who was the first to produce a steady, continuous current?
7. What was Volta?

8. What can you say about the behavior of static charges?
9. What did Volta take interest in?
10. What did Volta's discovery result in?
11. What did Volta's device consist of?
12. Where did he spend the rest of his life?

## Exercises

**1. Translate the following sentences paying attention to the infinitive:**

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

**B.**1. This is the device to be used in our experiment. 2. The thermometer is a device to measure the temperature. 3. Where are the articles to be translated by the students? 4. The letter to be answered was given to me. 5. The generator is a device to change mechanical energy into electric energy. 6. Petrov was the first scientist to study the electrification of metals by rubbing them. 8. I was the last to answer the teacher's questions.

**2. Translate the following sentences paying attention to the words in bold type:**

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

**3. Fill in the blanks with the words *one* or *for*:**

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

**4. Give antonyms for the following words:**

North Pole, dark, on the one hand, small, arrangement, larger, magnetized, unfamiliar, like, positive, similar, to rest, in motion.

# EARLY HISTORY

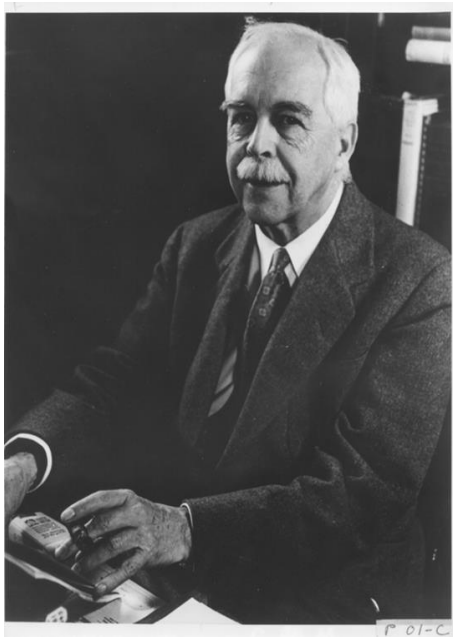
History shows us that at least 2,500 years ago, or so, the Greeks were already familiar with the strange force (as it seemed to them) which is known today, as electricity. Generally speaking, three phenomena made lip all of man's knowledge of electrical effects. The first phenomenon under consideration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

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

As a matter of fact, all of man's knowledge in the field of electricity has been obtained during the last 370 years, or so. Needless to say, it took a long time before scientists learned how to make use of electricity. In effect, most of the electrically operated devices, such as the electric lamp, the refrigerator, the tram, the lift, the radio, and so on, are less-than one hundred years old. In spite of their having been employed for such a short period of time, they play a most important part in man's everyday life all over the world. In fact, we cannot do

without them at present.

So far, we have not named the scientists who contributed to the scientific research on electricity as centuries passed. However, famous names are connected with its history and among them we find that of Phales, the Greek philosopher. As early as about 600 B.C. he discovered that when amber was rubbed, it attracted and held minute light objects. However, he could not know that amber was charged with electricity owing to the process of rubbing. Then Gilbert, the English physicist, began the first systematic scientific research on electrical phenomena. He discovered that various other substances possessed the property similar to that of amber or, in other words, they generated electricity when they were rubbed. He gave the name "electricity" to the phenomenon he was studying. He got this word from the Greek "electrum" meaning amber.



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

**Active Words and Expressions**

**at least**– у крайньому разі
**to come into contact**–вступають в контакт
**due to**– завдяки
**under consideration** – той, що розглядається
**to generate** –виробляти
**to mean**– означати
**to turn one's attention to** – привертати увагу до
**more or less**–більше чи менше
**needless to say** –необхідно зазначити
**famous**–відомий

**in spite of** – незважаючи на
**research** – дослідження
**that is to say** –інакше кажучи
**neither... nor** – ні… ні
**to take time** –забирати час
**various** – різноманітний

## 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 ancient people?
5. Did Gilbert work in the field of electricity?
6. Do you carry out experiments on lightning?
7. Is lightning a strong spark of electricity?
8. Can atomic energy be used for the good of mankind?
9. Do you know the history of electricity?
10. Was Phales a German philosopher?
11. Did you study the history of electricity?
12. Have you ever come into contact with an electric fish?
13. Can you do without electricity?

## Exercises

**1. Fill in the blanks with the following words and expressions:**

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

1. The discovery ... was made by a well-known scientist. 2. Moscow University...Lomonosov. 3. Franklin ... making experiments with atmospheric electricity. 4. ... the electric current, it is used both in industry and in our homes. 5. The first atomic power plant in the world ... in June 1954. 6. Professor Rihman was killed by a stroke of lightning ... he did not think of

possible danger. 7. Atom finds a wide application ... its ability of producing heat and energy. 8. The scientists of all over the world... the use of nuclear power for peaceful purposes.

**2.Translate the following sentences and define the non-finite forms of the verb:**

1.The students went on studying the properties of that new substance. 2. A long time ago people noticed the attracting ability of the magnet. 3. We heard of that experiment having been made last week. 4. The pole of the magnet pointing to the North is called the north pole of the magnet, the South Pole pointing to the South. 5. There are different ways of producing electric current. 6. The magnet having the North Pole and the South Pole, we can use it in the compass. 7. Working at his new device, the inventor carried out an important research. 8. We know of his starting some laboratory experiments. 9. An iron bar placed in the field of a magnet becomes magnetized.

**3. Translate the following sentences into English:**

1. Розщеплюючи атоми, людина може отримати велику кількість енергії. 2. Існують різні види електростанцій, при чому парові знаходять широке використання в Україні. 3. Розташовуючи металеву річ у полі дії магніту, ми її намагнічуємо. 4. Працюючи в галузі електрики, вчені зробили значний внесок у науку. 5. Він знає про те, що Галілей створив перший в світі телескоп. 6. Коли вода падає, то енергія перетворюється з потенціальної в кінетичну. 7. Я чув, що в вашому місті будується атомна електростанція.

# STATES OF MATTER

Among the most important effects of heat is that of changing the state of matter from a solid to a liquid, from a liquid to a gas, from a gas to plasma. In effect, some substances are capable of existing in each of the four possible states under suitable conditions of temperature and pressure. It is obvious that the process under consideration also depends on the quality of the substance as well as on its volume. To effect a change of state under ordinary atmospheric pressure, it is necessary either to add or to remove a certain definite quantity of heat. On adding heat, one may expect a solid to change into a liquid, and the latter is turned into a gas. In some cases a solid body may change directly into a gas. Gas, in its turn, may be heated to a plasma state.

We generally find that each substance exists mainly in one given state. Iron, for instance, is usually thought of as a solid body, water as a liquid, and air as a gas. Nevertheless, we are also familiar with the transformation of the same kind of matter from its usual state to another and that transformation is effected by supplying or decreasing heat.

For example, we know water to exist in three possible states, namely: as solid ice which can melt to form the liquid that we call “water”, water in its turn evaporates to form a gas, that is to say, first vapour and then steam, when heated to the boiling point. The student is unlikely to distinguish between the English terms “steam” and “vapour”. As long as there is still some water left unevaporated in the container, the steam formed will not be pure steam but will have some particles of

water in suspension. Such steam is said to be wet steam and one may classify it as a vapour.

If we take a certain quantity of ice below the freezing point that is below 0°C and gradually heat it at a uniform rate, the temperature may be observed to rise steadily until the freezing point is reached. At this point the temperature stops rising and remains unchangeable while melting takes place. A considerable amount of heat is absorbed in order to effect the change of state from solid ice to water, while the temperature remains steady. This heat is said to be latent.

The ice having melted, the water again rises steadily in temperature until it begins to boil, turning rapidly into steam or water-gas. Then, again there is no rise in temperature and an even larger amount of «latent heat» is required but to effect the transformation from water to steam, without rise of temperature. Besides, this rapid change at boiling, one may observe as well a gradual change into steam, even at ordinary temperatures. The process in question takes place on the surface when water is in an open container, or any other open place. It follows that in the open there will be a constant loss from the surface of the liquid and this loss will increase as the temperature rises. The above phenomenon is known as evaporation.

**Active Words and Expressions**

**to absorb–** поглинати
**container –** посуд, контейнер
**to effect –** впливати
**surface –** поверхня
**vapour –** випаровуватися
**pure –** чистий

**evaporation –** випаровування
**rapid –** швидкий
**state –** стан
**in suspension –** у підвішеному стані
**solid –** тверде тіло
**latent heat –** приховане тепло
**wet steam –** волога пара
**volume –** об’єм

## Answer the following questions

1. What are the four states of matter?
2. Can a liquid be changed into a gas?
3. Under what conditions does a substance changed?
4. When is a solid changed into a liquid?
5. What substance exists in three possible states?
6. What is the difference between vapour and steam?
7. What is the freezing point of water?
8. At what temperature does melting take place?
9. What does the term “latent heat” mean?
10. What do we call evaporation?
11. What is the boiling point of water?
12. When does a liquid boil?

## Exercises

**1. Translate the following sentences:**

1. Many substances can exist in more than one of the four possible states, that state depending on the substance itself as well as on its volume, temperature, and pressure. 2. Adding heat we change a solid into a liquid, the latter being changed into a gas. 3. Efficiency may be defined as output divided by input. 4. There is always water vapour in the air, the amount depending upon various conditions. 5. The resistance having been very high, the current in the circuit was low. 6. Steam is a gas into which boiling water changes, vapour consisting of the pure gaseous state together with particles of the liquid in suspension.

**2. Translate the following sentences and define the function of the gerund:**

1. The ampere is the electric unit used for measuring the electric current. 2. When the boiling point is reached, water temperature stops increasing. 3. Boiling takes place when the temperature of water reaches 100°C. 3. It is possible to add a considerable quantity of heat without changing the temperature of a given substance. 4. Various liquids have different boiling points. 5. Melting this metal will not take much time. 6. Even a schoolboy knows of the ohm being the practical unit of resistance. 7. One cannot study the early steps of atmospheric electricity without mentioning professor Rihman who constructed the first electrical measuring instrument. 8. The student certainly remembers Volta's having constructed the first source of continuous current. 9. When water reaches 100°C, it starts boiling, in other words, the process of boiling begins.

**3. Put the words in these sentences in correct order.**

1. putting / Donna / on / is / food / tray / a.
2. line / Mr. and Mrs. Bell / in / standing / are.
3. hot / cooking / in / Ken and Ray / are / kitchen/ the food.
4. paying for / Patty / lunch / is / her.
5. lunch / children/ Kim / eating / with / is / her.
6. hamburgers / children / Kim's / eating / are.
7. eating / Bob / lunch/ isn't.

**4. Complete the sentences with *do, does, is,* or *are.***

1. Jack … not work at his father's store. 2. …you have a job? 3. Kate …works at a restaurant. 4. Tom … working this afternoon. 5. …you working today? 6. Emily and Sara… working at the ice cream store this summer. 7. …Eric planning to get a job this summer? 8. … you plan to get a job, too? 9. Dennis …wears

jeans to work every day. 10. She … a carpenter.

## GASES, SOLIDS, LIQUIDS AND PLASMA

According to the molecular theory a gas consists of a large number of molecules which are far apart in comparison to their diameter. Each molecule moves freely and rapidly in the straight line except when it meets another molecule or collides with the walls of its container. As a result of numerous collisions, the speed of any one molecule constantly changes in direction and, generally, in amount. A gas being compressed, these collisions become more frequent. In addition, the speed a given molecule travels with is greatly increased when a gas is heated.

The law explaining gas pressure on the walls of a container due to the collision of separate molecules was first established and stated by Daniel Bernouilli, a Petersburg academician, as early as 1738. Even today the «Bernouilli effect» is considered to be one of the basic laws of thermodynamics.

The principal physical property distinguishing a gas from a liquid and a solid consists in its ability to expand and occupy all the space available to it. Gases, therefore, have neither definite volume, nor definite shape, on the contrary, they take both the volume and shape of the container into which they are placed. They readily diffuse. The ease with which the molecules of a gas diffuse shows not only that they are in rapid motion but also that the distance between them is large compared with the space occupied by the molecules themselves, in other words,

compared with their own size.

It is not difficult to distinguish the property of a solid from that of a gas. It may be stated as follows: in the solid phase or condition the molecules attract each other strongly and, hence, they are unable to move about freely and rapidly as in the case of a gas. Of course, they are also in motion but they are limited both in the manner and range of movement. In fact, they are limited to vibrational and sometimes rotational motions. This explains the definite size and shape of solid bodies which neither flow as do liquids, nor occupy all available space as gases do. We may consider them as vibrating about their mean positions with a motion like that of a weight vibrating at the end of a spring. It is these vibrations which produce the sensation of temperature. In a hot body the energy of the vibrations is large and the speed of the molecules, in passing through their mean positions, is found to be rather high. On the other hand in a cold body the energy of the vibrations is less, the speed of molecular motion being greatly reduced.

What feature distinguishes a liquid from the two other states of matter? We find that a liquid is not as compressible as a gas. The reason for a certain degree of compressibility of liquids is easily understood. The molecules of a liquid are much closer together than those of a gas. They are free to move but owing to the closeness of different molecules to each other they are unable to travel far without colliding with other molecules. Under such conditions on the one hand the molecules of a liquid are freer to move than the molecules of a solid but on the other

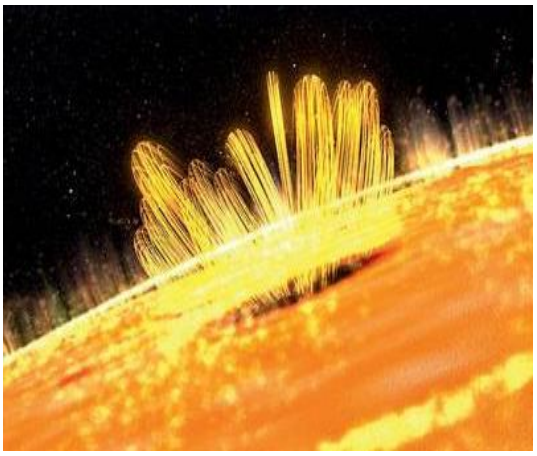
hand they are less free to travel than those of a gas.

In short, the molecule of a liquid is in a state of constant motion without any definite direction. It is quite free to travel from place to place within the liquid itself; but it cannot easily leave its surface, i.e. evaporates, because of a rather strong force of attraction observed between the molecules of any liquid. This force serves to fix the volume of a given liquid although its shape is changeable. In other words, liquids have a definite volume at a given temperature but they do not occupy all the available space and always take the shape of the container. They are found, in general, to diffuse much more slowly than gases do.

The fourth state of matter is considered below.

One of the oldest fields of science is the one of electrical discharges in gases. Considering special properties of matter in discharge tubes William Crookes put forward the idea that such gases should be considered a fourth state of matter namely the plasma state.

The plasma is first of all an ionized gas in which the charges of both signs are approximately equal. The plasma is caused by heating the matter to very high temperatures. Under such conditions the so-called ionized gas is produced with a great mass of free electrons forced away from the atoms.



The production of the plasma can take place in a number of ways. Among them we find: spark discharge, arc discharge, chemical reactions of high energy and nuclear reactions. One should also mention here the bombardment of

electromagnetic fields or particles of any other origin provided sufficient energy is available to provide the required work of the neutral atoms and ions.

An electrical conductivity which can be compared to that of some metals and strong electrolytes exists in the plasma.

**Active Words and Expressions**

**freely** – вільно
**rapidly** – швидко
**to compress** – стискати
**colliding** – зіштовхуватися
**definite volume** – певний об'єм
**speed of the molecules** – швидкість молекул
**spark** – іскра
**solid**– тверде тіло
**electrolytes** – електроліти
**liquid** – рідина
**approximately** – приблизно

## Answer the following questions

1. What states of matter do you know?
2. What does gas consist of?
3. Who first established and stated the law of gas pressure?
4. What is «Bernouilli effect»?
5. What is one of the oldest fields of science?
6. Who was William Crookes?
7. What is plasma?
8. The production of the plasma can take place in a number of ways, isn't it?

## Exercises

**1. Translate the words and word combinations:**

the fourth state of matter; chemical reactions; nuclear reactions; electromagnetic field; special properties of matter; very high temperatures; take the shape of the container; vibrations; to expand; to change a direction; gas pressure; to fix the volume.

**2. Finish the sentences according to the text:**

1. Each molecule moves…

2. As a result of…
3. …a Petersburg academician, as early as 1738.
4. The principal physical property distinguishing…
5. In the solid phase or condition the molecules…
6. …fourth state of matter namely the plasma state.
7. The plasma is first of all…
8. …of high energy and nuclear reactions.
9. …fields or particles of any other origin provided…
10. An electrical conductivity which can be…

**3. Complete the sentences with the prepositions of time.**

1. Jack goes shopping … Sundays. 2. Mary and I had a light lunch …noon, and then we played tennis … the afternoon. 3. A: Hi, Jake. It's good to see you again. When I saw you … December, you were working at the department store. Are you still working there? B:No. I quit … March 1st…present, I'm working at Music Shop. …the future, I hope to have my own shop. 4. … 1997, we moved to this city. We arrived …night and couldn't find our new house. We got a hotel room and found the house in themorning.5. I like to visit friends … the evening. I don't like to stay home by myself…night. 6. Excuse me. Are you busy…the moment? 7. A: When did you and your family go to Copenhagen? B: … 1991. A: … the spring or fall? B: We arrived … May 10 and left … the 25th. 8. What are the most important events that occurred … the 19th century?

## ENERGY

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

kinetic, potential energy being the energy of position while kinetic energy is the energy of motion. It is well-known that one form of energy can be changed into another.

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


When an object loses its potential energy, that energy is turned into kinetic energy. Thus, in the above-mentioned example when water is falling from its raised position, it certainty loses its potential energy, that energy changing into kinetic energy. We have already seen that energy of some kind must be employed to generate the electric current. Generally speaking, the sources of energy usually employed to produce current are either chemical, as in the battery, or mechanical, as in the electromagnetic generator. Chemical sources of current having a limited application the great quantities of electric energy generated today come from various forms of mechanical energy.

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

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

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

**Active Words and Expressions**

**application** – застосування
**battery** – батарея
**to change** – змінювати
**chemical** – хімічний
**to drive** – приводити в рух
**to employ** – застосовувати
**energy** – енергія
**semiconductor** – напівпровідник
**motion** – рух
**generator** – генератор
**kinetic** – кінетичний
**kind** – вид
**potential** – потенціал
**to produce** – виробляти
**source** – джерело
**to turn** – повертати

## Answer the following questions

1. Can one form of energy be changed into another form?
2. Does a generator produce mechanical energy?
3. Is the sun an unlimited source of energy?
4. Can we employ solar energy directly?
5. Have scientists transformed solar energy into electric energy?
6. Is potential energy the energy of motion?

7. Do we need more and more electric energy every year?
8. Are there various forms of energy?
9. Do you use electric energy every day?
10. Can the energy of falling water be used to drive turbines?
11. Is kinetic energy the energy of position?

## Exercises

**1. Translate the following sentences into Ukrainian:**

1. The girl is finishing her work. 2. The work is being finished by the girl. 3. The girl finishing her work is my sister. 4. Finishing her work, the girl spoke to her friend. 5. The work having been finished, the students went home. 6. Having finished her work, the girl went for a walk. 7. Having been finished in time, the work was given to the teacher. 8. My brother finished his work, his friend having helped him. 9. An object losing its potential energy, that energy is turned into kinetic energy. 10. Water falling from its raised position, energy is changed from potential to kinetic energy. 11. My friend was reading an English article, his brother watching television. 12. Electrical devices find a wide application in every house, a refrigerator being one of them. 13. There being hydroelectric station at the waterfall, the energy of the falling water is used to drive the turbines. 14. The energy sources of the world decreasing, the scientists must find new sources of energy.

**2. Translate the following sentences:**

1. Вода, що падає, може приводити турбіну в дію. 2. Кажучи про енергію, ми могли б згадати потенціальну та кінетичну енергію. 3. Працюючи в лабораторії, студент користувався електричними приладами. 4. Прочитавши наукову статтю, ми почали її перекладати. 5. Хімічні джерела струму знаходять лише обмежене використання в

промисловості.

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

1. Useful energy can be got from a nuclear reactor. 2. After Aristotle there was little change in the number and kind of machines in use for nearly twenty centuries.3. Electrical devices find a wide application in every house.

**4. Read and translate the text**

**Man and his machines**

In all his activities man now makes use of a lot of machines. Although most of these are of quite recent origin, a few simple ones have come down from ancient times.

The arrow, for example, has been well known to man since prehistoric times, since it was only by hunting that he could get his food. The wheel, one of the greatest inventions ever made by man, is also of prehistoric origin. A two-wheeled carriage is represented widely in his art and literature. The lever is probably of equally ancient origin. It is mentioned by the Greek philosopher Aristotle as a means of lifting a great weight by using a very small force.

After Aristotle there was little change in the number and kind of machines in use for nearly twenty centuries. Since then one new device after another has come to displace others that were less efficient only to be displaced in turn by other devices still faster or better. Let us have a look at a few of these changes.

In going from his home in Mount Vernon to New York to be inaugurated as the first President of America, Washington travelled in a horse-drawn carriage. The roads were extremely difficult to travel. The travel of a little over two hundred miles required seven hard days. That is a speed of about 35 miles a day. Men could travel by land in only two other ways - on foot

and on horseback. Within half a century of that time a few short railways had been built in three different parts of the country. At first the trains were drawn by horses; in1831 the first steam locomotive in America was put into use. The «iron horse» soon proved its efficiency. New lines were designed and old ones extended. The speed of 35 miles a day had given way to regular schedules exceeding 35 miles an hour.

In the first decade of the present century it was thought that the limit of desirable speed had been reached. But the substitution of diesel and electric engines for steam engines and numerous other improvements have shown that much higher speeds may be easily achieved. Modern transportation uses electricity in many ways. Without it transportation, as is known today, could not exist.

On the other hand, life today would be unthinkable without modern means of transportation. To reach any part of the world is a matter of hours or days, while a century or two ago it took weeks, sometimes even months or years.

## THE ELECTRICAL PROPERTIES OF MATERIALS

The electrical conductivity of material was first demonstrated in 1792 by the English experimenter Gray. His demonstrating this phenomenon made his name well-known at that time.

It was he who touched a charged glass rod to the end of a moistened cord and discovered that the cord transmitted the electricity to a distance of about 1,000 feet.

Today the exploration of the electrical properties of solids is disclosing much more interesting phenomena. We know of many new experiments having been carried out in this field.

All these have turned out to be of fundamental significance in the understanding of matter, as well as of great technological importance.

To begin with, the wide range of electrical conductivities exhibited by materials is itself a striking fact. The difference in electrical conductivity between the most conductive substances (for example, copper and silver) and the most resistive (polystyrene) amounts, to 23 orders of magnitude.

If we want to understand the extent of this spread, we should compare it with extremes in the scales of distance. One might note, for instance, that the ruler needed to measure the size of the universe is only some 23 orders of magnitude larger than the mile ruler that measures distance on the earth.

Evidently then, the electrical conductivity (or rather its inverse resistivity, the quantity used in statements of Ohm's Law) is one of the most widely varying of all physical quantities.

The individual materials begin showing great variability in resistivity according to the conditions of temperature, pressure and the mixture of component substances.

If a minute trace of gallium or arsenic (one part per billion) were added to pure germanium, its conductivity would be increased by two orders of magnitude (nearly l, 000 fold) and would rather make it suitable for using in transistors.

A tiny further addition of the impurity could increase the conductivity 100,000 fold, converting germanium to a conductor.

Similarly silicon and metal oxides such as nickel and titanium dioxide are lowered in resistivity by introducing of appropriate impurities. Indeed nickel oxide, which is an insulator in the pure state, is reduced in resistivity by 13 orders of magnitude by adding only one per cent of helium.

We know of great changes being produced by changes in temperature.

Thus a semiconductor can be made a conductor by heating it to a high temperature or it can be made an insulator by cooling it to a low temperature.

In contrast, the resistivity of a pure metal is much less increased by heating and reduced by cooling.

In some cases the change is very abrupt. For example above 150 Kelvin vanadium is a semiconductor, when it is cooled its resistivity suddenly jumps and it becomes a good insulator. Some semiconductors and insulators are extremely sensitive to light. Thus upon illuminating, their conductivity may be several orders of magnitude higher than it is in the dark. This phenomenon is called photoconductivity.

**Active Words and Expressions**

**to disclose** – виявляти
**dark** – темний
**inverse** – зворотній
**to touch** – торкатися
**to transmit** – передавати
**tiny** – малюсінький
**trace** – риса, простежувати
**magnitude** – величина
**striking** – вражаючий
**insulator** – ізолятор
**appropriate** – відповідний
**convert** – перетворювати
**evidently** – очевидно
**to reduce** – скорочувати
**rather** – досить
**resistivity** – опірність
**to spread** – поширювати
**suddenly** – раптом
**sensitive** – чутливий
**exploration** – дослідження

## Answer the following questions

1. When was the electrical conductivity of material first demonstrated?
2. What experiment did Gray carry out?
3. What is the most resistive substance?
4. What do the individual materials show?
5. What happens if a minute trace of gallium or arsenic is added to pure germanium?
6. When are nickel oxide and titanium dioxide lowered in resistivity?
7. What changes are produced by changes in temperature?
8. When does vanadium become good insulator?
9. What phenomenon is called photoconductivity?

## Exercises

**1. Read and translate the following word combinations:**

electrical conductivity, fundamental significance, technological importance, on the earth, the individual materials, inverse resistivity, minute traces, suitable for using, extremely sensitive.

**2. Make the sentences using the words:**

conduct, improve, resist, increase, exist, reduce, effect, semiconductor, illumination, resistivity, individual, variability, fundamental, experimental, technological.

**3. Translate the words in the brackets into English:**

1. The electrical ***(провідність)*** of different materials was investigated by many scientists. 2. Today ***(дослідження)*** of the electrical properties of solids has revealed many interesting phenomena. 3. To understand ***(значення)*** of this investigation we must compare it with the previous one. 4. If a ***(найдрібніший)*** trace of arsenic were added to pure germanium, the conductivity of the latter would increase. 5. Great

***(зміни)*** can be produced by increasing temperature. 6. In some ***(випадках)*** the change is very abrupt. 7. Some ***(напівпровідники та ізолятори)*** are extremely sensitive to light. 8. Can you say what principles ***(пояснюють)*** the great differences in conductivity between metals and insulators? 9. The resistivity of a pure metal is known to be increased by heating and ***(знижена)*** by cooling.

**4. Translate the sentences into Ukrainian:**

1. In a crystal of copper, in which the atoms are packed together, the electrons spread themselves over the wide range. In contrast to copper, the atoms of the semiconductor germanium turned out to be together, by forming covalent bonds. 3. It is advisable to use a solution whose resistance will be of about the same order of magnitude as the resistances in the previous solution. 4. On account of the resistance of tin to the action of air and water, it is used to coat other metals 5. Having finished measuring, you should turn off the light. 6. How can this phenomenon be accounted for? This is a question which in its turn can be solved only by very experienced chemists. 7. In order to understand this process one should read some papers before starting his work. 8. In either of these cases the solubility of lead will be lowered practically to zero. 9. On account to its resistance to corrosion, copper is widely used. 10. Trace soft aluminium which dissolve in solid copper greatly reduce the electrical conductivity. 11. If this substance is heated and turned red, cupric oxide is formed. 12. Because of uniform expansion over a wide range of temperature, mercury is used in thermometers. 13. As a rule, if the length of a conductor is doubled, the resistance is doubled too.

**5. Fill in the blanks with prepositions:**

1.When you leave the laboratory don't forget to turn . . . the light and gas. 2. Mercury is a good conductor . . . heat and electricity. 3. This can be accounted . . . the increase of temperature and pressure. 4. The resistances in ohms of these and other frequently used conductors turned out to have been carefully measured. 5. When we turn . . . the light and our electric lamp is burning, the tungsten of the lamp has about 30 times the resistance that it had. 6. The impact of light has an effect . . . electrical resistivity. 7. The resistance . . . some conductors was much greater when they carried a large current.

**6. Translate the text using a dictionary.**

**Conductivity**

It will be interesting to note that an iron wire of the same length as a copper one has a greater resistance. Under the same conditions the copper wire allows more current flowing than the iron wire. Copper has a greater conductivity. Conductivity means the ability of carrying the current. The unit of conductivity is the Siemens or the mho. The unit of resistance is the Ohm.

In 1826 Ohm found a simple correlation between resistance, current and voltage. He also observed that if the voltage remains the same, the greater the resistance, the smaller the current is. So, it can be stated: the current that flows in a circuit is directly proportioned to the voltage and inversely proportioned to the resistance.

**7. Write the translation of the following text:**

## The Metallic Elements

About seventy-nine of the one hundred substances are metals. A metal may be defined as a substance which has large conductivity of electricity and of heat, has a characteristic luster, called metallic luster, and some other properties. In addition, the electric conductivity increases with decrease in temperature.

The metals themselves and their alloys are of great usefulness to man. The importance of some alloys is due primarily to their hardness and strength. These properties are a consequence of the presence in the metals of very strong bonds between the atoms.

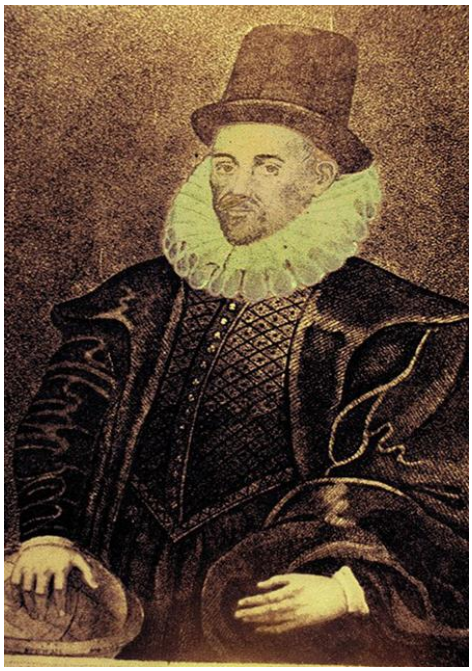
For this reason it is of great interest to us to understand the nature of the forces holding the metal atoms together in these metals and alloys.

First we should consider an alloy; it is a metallic material containing two or more elements. It may be homogeneous, consisting of a single phase, or heterogeneous, being a mixture of phases.

## MAGNETISM

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

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



the stories that they had heard from their fathers who, in their turn, heard them from their own fathers and so on.

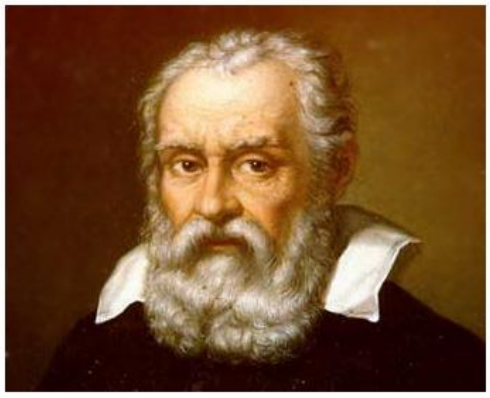
One story tells us of a man called Magnus whose iron staff was pulled to a stone and held there. He had great difficulty in pulling his staff away. Magnus carried the stone away with him in order to demonstrate its attracting ability among his friends. This unfamiliar substance was called Magnus after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

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

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

A great step forward in the scientific study of magnetism was made by Gilbert, the well-known English 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. One of his magnets, for example, could lift objects weighing 25 times its own weight.

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.

**Active Words and Expressions**

**ability –** здатність
**to attract–**притягувати
**to carry out –** виконувати
**to consist of –** складатися з
**force –** сила
**iron** – залізо
**magnetism** – магнетизм
**to make reference to** – робити нотатки з
**to possess**–володіти
**to prove** –доводити
**physicist** –фізик
**relation** – відношення
**single** – єдиний, одиничний
**steel** – сталь
**weight** –вага

## Exercises

**1. Translate the following sentences and define the non-finite forms of the verb:**

1. Protecting buildings from strokes of lightning was a great achievement in the field of electricity. 2. Speaking of the magnet, the inventor made reference to its property of attracting iron and steel. 3. Experiments showing the changes in

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

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

1.Чи існує зв'язок між електрикою та магнетизмом? 2. Чи знаєте ви, хто винайшов магнетизм? 3. Що ви знаєте про атмосферну електрику? 4. Хто довів, що наша земля є величезним магнітом? 5. Що ви знаєте про магнетизм? 6.Хто цікавився досягненнями Гілберта? 7. Які досліди проводив Франклін?

**3. Translate the following sentences paying attention to the words in bold type:**

1. These electrical devices are very large. Who can help me to **carry** them to another laboratory? 2. After the experiment had been **carried out** the students **carried** the devices **away**.3. What were the students doing when the teacher came **into** the classroom? They were **doing** the exercises. 4.Why **can't** you **do without** the thermometer? The temperature of **this** metal is known. 5. **He** could not **go** to the cinema **yes**terday. 6.Do not

**turn** the light **off, I** shall **go on** working.7. **I see** nothing, **turn** the light **on,** please. 8.On heating, ice **turns into** water. 9. Water, **in its turn, turns into** ice on freezing.

## LASER LIGHT

How does laser light differ from ordinary light? In brief, it is much more intense, directional, monochromatic and coherent.

We know the light emitted by an ordinary source such as candle or an incandescent lamp to consist of uncoordinated waves of many different lengths, that is, it is incoherent and more or less white. The scientists found the waves of laser light to be coordinated in space and time and to have nearly the same length. This coherence and chromatic purity and also intensity of laser light result from the fact that in a laser excited atoms are stimulated to radiate light before they have had time to do so spontaneously and independently.

The directionality of laser light arises from the geometry of the laser.

These properties of laser light suggest many uses for it both in technology and in physics. The scientists consider laser light to be different from ordinary light even when it merely illuminates a surface. The surface looks grainy and sparkles.

By means of some instruments it has become possible to examine materials and physical phenomena in new ways. Among the most interesting applications of the laser the probing of materials by the study of their scattering of light should be mentioned.

The laser is being applied to probe the internal structure and behavior of molecules by examining the light-scattering phenomena. Many investigators are working at the development of coherent light sources, those ones whose wave-length can be changed.

Many amplifiers and oscillators have been constructed for this purpose lately.

Laser light is applied in many fields such as medicine, biology, industry and so on. We can say scientists made laser light serve man.

The scientists found the energy density of the image formed by a lense in a laser beam to be used to heat, melt or even vaporize small areas of any material. Laser is also used to pierce holes in diamond.

Soon laser is to be used to cut a wide range of materials including wood and paper.

The scientists work hard to use laser in all fields of science and life. They expect laser to be widely used almost everywhere. It will be used for the well-being of people.

**Notes on the Text**

1. in brief – коротко
2. more or less – більш чи менш
3. result from the fact – відбуваються з-за того, що
4. light-scattering phenomena –явище розсіювання світла

**Active Words and Expressions**

**laser**– лазер
**intense**– інтенсивний
**coherent**– зв’язність
**illuminate**–освітлювати
**surface**–поверхня
**directionality** – спрямованість

**incandescent** – розжарений
**diamond** – діамант
**amplifier** –посилювач
**monochromatic** – однокольоровий
**merely**– тільки
**spontaneously** – спонтанно
**chromatic** –кольоровий
**image** –відображення
**uncoordinated** – нескоординований

## Answer the following questions

1. What is the difference between laser light and ordinary light?
2. What did the scientists find out about the waves of laser light?
3. What do the properties of laser light suggest?
4. Why did it become possible to examine some materials in a new way?
5. Which is the most interesting application of laser light well-known to everybody?
6. Where else can laser be applied?
7. Why the discovery of laser light is so important?
8. What are many scientists working at?

## Exercises

**1. Open the brackets translating the Ukrainian words into English:**

1. The light emitted by an ***(звичайним)*** source consists of uncoordinated waves. 2. The scientists found the waves of laser ***(світла)*** to be coordinated in ***(просторі)*** and time. 3. Laser light is different from ordinary light even when it ***(просто)*** illuminates a surface. 4. ***(За допомогою)*** some instruments it is possible to examine materials and physical phenomena in new ways. 5. ***(Внутрішня)*** structure should be examined much better.

**2. Fill in necessary word:**

1. Laser light differs . . . ordinary light. 2. This difference results . . . the fact that this light is more intense. 2. …means . . . some microscopes we can observe the movement of these particles. 4. This material was examined . . . new ways. 5. He is working . . . the problem of using the source of light in industry. 6. Many new instruments and devices have been built… this purpose lately. 7. This work consists . . . two parts, the first one having already been done.

**3. Translate the texts in written form using a dictionary:**

**Energy and Temperature**

The concept of energy is as difficult to define as that of matter. Energy is involved in doing work, or in heating an object.

A boulder at the top of a mountain has potential energy. As it rolls down the mountain side, its potential energy is changed into the kinetic energy of its motion. If it were to fail into a lake, and be slowed down by the friction of its motion through water, part of its kinetic energy would be changed by friction into heat, which then would raise the temperature of the boulder and of the water.

In addition, part of its kinetic energy would be transferred to the water.

Another kind of energy is radiant energy, visible light, infrared radiation, X-rays, for example, being radiant energy. They are all closely similar in nature.

When a mixture of gasoline vapor and air is exploded, energy is liberated. This energy is said to be chemical energy.

**4. Analyze and translate the following sentences:**

1. The products of an exothermic reaction contain less energy

than the reactants at the same temperature, this energy being lost to the surroundings. 2. The heat of combustion is known to be the energy lost on complete combustion of one mole of the substance. 3. Energy is known to be changed from one form to another, but it cannot be created or destroyed. 4. The energy is considered to be heat energy which is transferred to the surroundings. 5. An atomic reactor getting its energy from a loss in mass during the nuclear reaction, we consider mass to be a form of energy. 6. There are many forms of energy, kinetic energy being the energy of motion. 7. A ball rolling along a smooth surface can be expected to continue rolling along uniformly unless acted upon by an outside force.

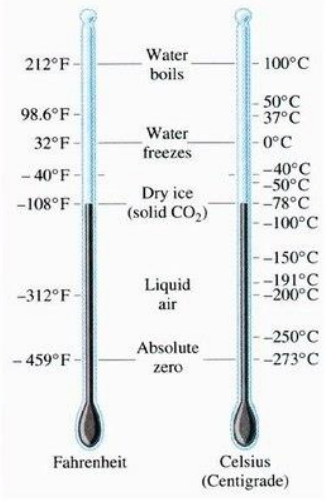
## HISTORY OF THE THERMOMETERS

Placing a kettle full of cold water on the fire is quite an ordinary thing. This time we shall do it to carry out a simple experiment. Placing a finger into the kettle from time to time, we find, of course, 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 the use of our finger. In effect, the finger can give us neither exact information, nor numerical data.

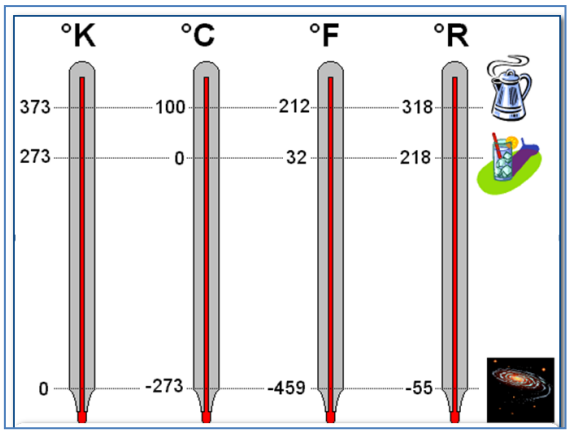
As a matter of fact, the very first step in the development of heat engineering made it necessary to find a device for indicating temperature and for measuring its changes. As is well known, the thermometer is the very instrument that serves this purpose.

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 colored 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 the same number of 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°.




Sometime 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 marked 0° and the boiling point is marked 100°C, the letter C indicating this scale. This temperature scale is employed in Ukraine as well as in most other countries of the world.

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

**Active Words and Expressions**

**body**– тіло
**to boil** – кип'ятити
**boiling point** – точка кипіння
**data** – дані
**difference** – відмінність
**means** – засоби
**mercury** – ртуть
**pressure**– тиск
**freezing point** – точка замерзання
**thermometer**– термометр
**to invent** – винаходити
**instrument**– інструмент
**the latter**– останній
**to rise** – піднімати
**to put into use** – ввести в дію
**liquid** – рідина
**purpose** – мета

## Answer the following questions:

1. What is this text about?
2. What do you do if you want to boil water?
3. What is the temperature of boiling water?

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

## Exercises

**1. Translate the following sentences:**

1. For heating a body, we place it in contact with another body at a higher temperature. 2. There are two diagrams in this figure, one of them showing the temperature difference. 3. Comparing the data obtained by our tests is the only means of solving the problem in question. 4. The instrument for measürlng the temperature of hot flowing metals is similar to that widely used in our laboratory. 5. The engineers carried out the experiment, looking at the scale of the thermometer from time to time. 6. Thermometers are employed for measuring temperature differences. 7. On the Centigrade scale the freezing point of water is marked 0°, the boiling point being marked 100°C. 8. On being rubbed amber obtained the ability of attracting objects.

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

| |
|---|
| *colored, Centigrade, amber, measuring, English-speaking countries, air thermometer, indicating, changes of atmospheric pressure, scientific.* |

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. ... looks like a yellow stone. 6. The Fahrenheit scale is mainly used in ... . Galileo's air thermometer was not sensitive to ... 7. The scientists worked out the plan of their … research.

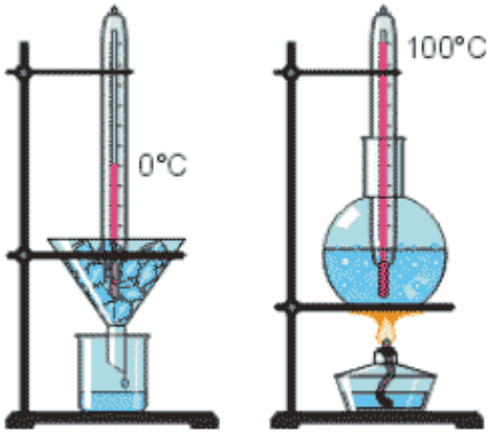
**3. Translate the following sentences paying attention to the words in bold type:**

1. You are the **only** engineer who speaks both English and German. 2. This is the **only** book by Turgenev that **I haven't** read. 3. All countries should use nuclear power for peaceful purposes **only. 4.** This phenomenon was studied first **by** Sokolov and **then** by Novikov. 5. Novikov's result was certainly better **than** that of his comrade. 6. Galileo constructed **an** air thermometer, some years **later** a French scientist constructed another one, in which water was used instead of air. 7. Both Lomonosov and Rihman studied atmospheric electricity, the **latter** being Lomonosov's friend. 8. Lenin's **letter to** American workers was translated into many languages. 9. The last **letter** of the English alphabet is "z". 10. **Some** students work and study at the same time. 11. This engineer carried on **some** experiments on the properties of semiconductors.

**4. Read and translate the text**

**Boiling**

If we heat some water in an open glass container, we can see that evaporation goes on from the top surface. This evaporation is indicated by the clouds forming where the vapour mixes with the colder air and condenses. We find that the temperature of water gradually rises until the thermometer registers 100°C. A




little before this point is reached, bubbles appear on the sides of the container. They consist partly of gases driven from liquid and partly of water-vapour, for evaporation is directed into the bubbles. Water is said to boil when vapour is formed both at the bottom of the container and at the top of it. The motion of the boiling water is caused by the bubbles of vapour rising through the water. The temperature of the boiling water is constant. This temperature is known as the boiling point of the liquid.

The boiling point of a liquid is the temperature at which it boils under some given pressure. When this point has been reached, further heating does not increase the temperature of the liquid but only changes it into steam.

When water boils in a container, we say that we see steam coming out of it. In fact, what we see is not steam at all but fine water particles. Steam itself is invisible. It is the condensed steam in the form of fine particles of water that we see.

As liquids always increase in volume when passing into the vapour state, an increase in pressure always produces an increase in the boiling point.

Just as solids may under certain conditions be cooled below their melting points without freezing so liquids may be heated above their boiling points without boiling.

## WHAT IS HEAT?

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

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

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

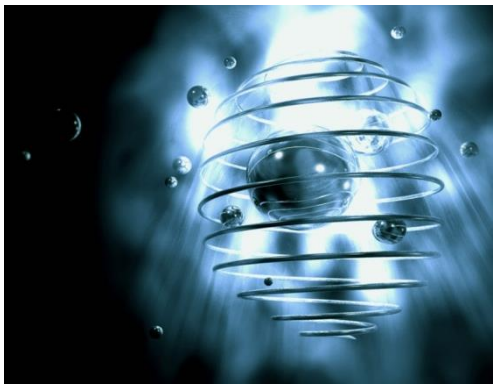
At present, we know heat to be a form of energy. Besides, we are quite familiar with the fact that all substances are made up of little particles called molecules. These are so minute that a single drop of water, for example, is assumed to have millions of them. Although a drop of water left on the table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

What process takes place when we place a kettle full of cold water on the fire, in other words, when we want to heat water? The molecules begin to move much faster then, so that every time there is a collision, they jump away from each other much

farther than they did before. As a result, the drop of water becomes larger, that is to say, it expands. In scientific language this property is called expansion.

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

Although heat and temperature arc certainly connected it is necessary to understand the difference between them. To show that similar quantities of heat may produce different effects in different substances is not difficult at all. Placing a needle on the fire at the same time as a kettle of cold water, we find that the needle is red-hot before there is any marked difference in the water temperature.



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

As for expansion caused by heating, it is useless and even dangerous in some cases while in others one cannot do without

it. For example, to measure temperature we employ a thermometer that is the instrument based on the expansion of bodies when heated.

**Active Words and Expressions**

**to cause** – спричиняти
**certain** – визначений
**collision** – зіткнення
**compression** – стискання
**conduction** – провідність
**expansion** – розширення
**to expect** – очікувати
**not at all** – ніскільки, аж ніяк
**to explain** – пояснювати
**friction** – тертя
**molecule** – молекула
**on the contrary** – навпаки
**quantity** – кількість
**to take place** – мати місце
**to place** – розміщувати, класти
**term** – термін

## Exercises

### 1. Translate the following questions and answer them

1. Що таке тепло?
2. Чому припускали, що тепло - це невагома речовина?
3. Чи могли люди спостерігати деякі теплові явища?
4. Що відбувається завдяки тертю та стисненню?
5. Які теплові явища (phenomena) встановив Ломоносов?
6. З чого складається речовина?
7. Як називаються найдрібніші частки речовини?
8. Що відбувається, коли тіло нагрівається?
9. Чи існує суттєва різниця температур між холодним та гарячим тілом?
10. Який прилад використовується для вимірювання температури?

### 2. Translate the following sentences:

1.Ми знаємо, що теплова енергія – це енергія молекулярного руху. 2. Відомо, що молекули рухаються в різних напрямках. 3. Тривалий час вважали, що тепло - це

невагома речовина. 4. Кажуть, що молекули води рухаються швидше, коли її нагрівають. 5.Вважають, що молекули холодної речовини рухаються повільніше. 6. Відомо, що при нагріванні тіла розширюються. 7. Студенти, мабуть, розуміють різницю між постійним та змінним струмом.

**3. (a) Form verbs from the following nouns:**

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

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

**4. Translate the following sentences, paying attention to the words in bold type.**

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

## ELECTRIC CIRCUIT

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 or no electric power can be supplied from the source to the load.

Thus we close the circuit when we switch on our electric lamp.

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

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

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

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

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

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

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

**Active Words and Expressions**

**cable** – кабель
**to carry** – доставляти
**closed** – тісний,закритий
**circuit** – ланцюг
**complete** – доповнювати
**conductor** – провідник
**short circuit** – коротке замикання
**to deal with** – мати справу з
**fault** – пошкодження
**generally speaking**– загалом
**fuse** – плавкий запобіжник
**to supply** – постачати
**switch** – вимикач
**transmission line** – лінія передач
**load** – навантаження
**open circuit** – розімкнутий ланцюг

## Answer the following questions

1. What is discussed in the text?
2. What do we call an electric circuit?
3. What kinds of circuits do you know?
4. When is a “short” produced?
5. What does a short circuit often result in?
6. What safety device is used in the circuit when the current is too great?

## Exercises

**1. Translate the following sentences and define the function of the infinitive**

1. The current is known to flow when the circuit is closed. 2. To stop the current flow is to break the circuit in some point. 3. To stop the current flow you must open the circuit. 4. A fuse is expected to melt and break the circuit. 5. Various switches are used to open or to close a circuit. 6. A switch is a device to break or to close the circuit. 7. We know the circuit to be a path of an electric current. 8. We may expect a short circuit to result from wire fault. 9. The overloading of the line is likely to produce a short circuit. 10. Ampere supposed the current to flow from the positive pole of the source to the negative pole.

**2. Fill in the blanks with prepositions, translate the text:**

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

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

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

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

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

## ELECTRIC LAMP

An incandescent electric lamp does not seem to have much resemblance to a heater but the two devices are similar in many respects. A lamp is a white-hot wire inside a glass bulb and a heater is a wire that is only red-hot. The lamp's filament is heated by the passage of electric current. It glows because it is so hot.

Lamps using glowing wires were made as early as 1845 but they did not work well because all known wires burned or melted before they got white-hot. Edison wanted to find a wire that would not burn or melt at high temperatures. It was easy enough to avoid burning. He simply surrounded the wire by a glass bulb from which

the air had been pumped out. Now the wire could not burn because there was no oxygen in the bulb.

But the problem of melting was harder to solve. The carbon-filament lamp which he produced as a result of thousands of experiments with different kinds of filaments could operate at a temperature of about 1900°C. Today instead of carbon filaments we use tungsten wires which usually operate at 2800°C. Tungsten is a metal with one of the highest melting points known. Because of their higher operating temperature tungsten-filament bulbs give almost 6 times as much light as carbon-filament bulbs for the same amount of electrical energy.

Lodygin, the well-known Russian scientist and inventor, was the first to discover the advantages of the metal wire filaments in comparison with other filaments. It is he who introduced tungsten filaments in a vacuum. He produced the first incandescent lamp and demonstrated his invention in 1873, lighting several Petersburg streets with his lamps. It was the world's first practical application of the incandescent lamp for lighting purposes.

Another Russian inventor, Yablochkov, invented the arc lamp in 1876. He was working in Paris at that time. His electric candle, as he called it, consisted of two carbon rods placed in parallel and separated by an insulating material. The first alternating current generator was designed and used with the Yablochkov candle. The electric candle appeared in Paris streets in 1878. Compared with the existing gas lamps they were so brilliant that the system was used by many European cities. Yablochkov's invention together with the alternating current generator was a new and simple means of arc lighting.

## Active Words and Expressions

**incandescent lamp** – лампочка розжарювання
**advantage** – перевага
**candle** – свічка
**melt** – плавитися
**carbon rod** – вуглецевий стрижень
**filament** – нитка розжарювання
**lighting** – освітлення

## Answer the following questions

1. What is incandescent electric lamp?
2. Why they did not work well?
3. What do you know about the carbon-filament lamp?
4. Where tungsten was used?
5. What discovery was made by Lodygin?
6. What do you know about Russian inventor Yablochkov and his invention?

## Exercises

**1. Finish the sentences according to the text:**

1. A lamp is a white-hot wire inside a…
2. …were made as early as 1845 but they did not work well…
3. The carbon-filament lamp which he…
4. …which usually operate at 2800°C.
5. Lodygin, the well-known Russian scientist and inventor…
6. Yablochkov invented…
7. The first alternating current generator was designed and used…
8. …Paris streets in 1878.

**2. Translate the following sentences into Ukrainian:**

1. Such conditions can and do occur due to a shortage of generating plants in this area. 2. It was in our laboratory that the device in question was first tested. 3. If this system is to serve as a voltmeter, a resistor has to be added in series. 4. In 1870

Mendeleyev arranged the elements in the form of a table and of the periodic law. 5. Provided the magnetic field is produced by a coil of several turns, its intensity is much greater than if only one turn were used. 6. Naturally, this circuit can be modified, if necessary. 7. Evidently, the frequency could be varied to meet different conditions. 8. It is impossible to say whether future improvements may not depend on the results of researches. 9. The decision had to be made as to whether the uranium should be in the form of long rods.10.It was the diameter of the wire that we did change to obtain the above results.

**3. Put *much, many, little or few.***

1. My brother is a young teacher. Every day he spends…timepreparing for his lessons. 2. I know very …about this writer. It is the first book I am reading. 3. The students of our group ask …questions at the lecture. They want to know everything. 4. You do not make … mistakes in your spelling. 5. Does your sister read ..? - Yes, she does. And your brother? - Oh, he doesn't. He has so … books, but he reads very… 6.Walk quicker, please. We have very … time. 7. I am sorry to say, I have read very … books by Jack London.

## CONDUCTORS AND INSULATORS

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

What do the terms "conductors" and "insulators" mean? Substances through which electricity is easily transmitted are

called conductors. Any material that strongly resists the electric current flow is known as an insulator.

Let us first turn our attention to conductance that is the conductor's ability of passing electric charges. The 4 factors conductance depends on are. The size of the wire used its length and temperature as well as the kind of material to be employed. It is not difficult to understand that a large water pipe can pass more water than a small one. In the same manner, a large conductor will carry the current more readily than a thinner one.

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

As mentioned above, there is a great difference in the conducting ability of various substances. For example, almost all metals are good electric current conductors. Nevertheless, copper carries the current more freely than iron; and silver, in its turn, is a better conductor than copper. Generally speaking, copper is the most widely used conductor. That is why the electrically operated devices in your home are connected to the wall socket by copper wires. The electricity has not been turned off but it has no path to travel from the socket to your electric lamp. The flowing electrons cannot travel through space and get into an electrically operated device when the circuit is broken. If we use a piece of string instead of a metal wire, we shall also find that the current stops flowing. A material like string which resists the flow of the electric current is called an insulator. There are many kinds of insulations used to cover the wires. The kind used expends upon the purposes the wire or cord is

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

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

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

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

**Active Words and Expressions**

**bare wire** – оголений дріт
**to cover** – покривати
**electrical engineering** – електротехніка
**factor** – фактор
**feature** – риса
**insulator** – ізолятор
**in the same manner** – таким же чином
**opposition** – опір
**path** – шлях
**to resist** – чинити опір, опиратися
**rubber** – гума
**similar** – подібний
**to transmit** – передавати
**socket** – електричний патрон

## Answer the following questions

1. What is discussed in the text?
2. Do all substances conduct the electric current easily?
3. What is a conductor?
4. What does conductance depend upon?
5. What materials are the best conductors of electricity?
6. Does temperature influence the conductor’s resistance?
7. What is the difference between a conductor and insulator?

8. What insulators do you know?
9. Why are power transmission line wires bare?
10. Can we do without insulators?

## Exercises

**1. Translate the following sentences**

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

**2. Translate the following groups of words:**

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

**3. Translate the following text**

### Insulator surface treatment

When the insulator is covered with a thin film of conducting electrolyte, leakage current flows to ground over the insulator surface and this gives rise to heating. The heat so generated causes the moisture to evaporate until a dry non-conducting band is formed around the insulator across which the line to

ground voltage is impressed. A visible discharge occurs across this dry band, the roots of which generates considerable heat and evaporates more moisture causing the dry band to widen. However the current in the discharge is limited by the resistance on either side. In the majority of cases, therefore the band widens to such an extent that the voltage across it is insufficient to maintain a discharge and extinction occurs.

## HEATING EFFECT OF AN ELECTRIC CURRENT

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

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

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

Let us suppose now that a small current is flowing along a thick metal conductor. Under such conditions the only way to discover whether heat has been developed is to make use of a

sensitive thermometer because the heating is too negligible to be detected by other means. If, however, our conductor were very thin while the current were large, the amount of generated heat would be much greater than that produced in the thick wire. In fact, one could easily feel it. Thus, we see that the thinner the wire, the greater the developed heat. On the contrary, the larger the wire, the more negligible is the heat produced.

Needless to say, such heat is greatly desirable at times but at other times we must remove or, at least, decrease it as it represents a waste of useful energy. In case heat is developed in a transmission line, a generator or a motor, it is but a waste of electric energy and overheating is most undesirable and even dangerous. It is this Waste that is generally called “heat loss” for it serves no useful purposes and does decrease efficiency. Nevertheless, one should not forget that the heat developed in the electric circuit is of great practical importance for heating, lighting and other purposes. Owing to it we are provided with a large number of appliances, such as: electric lamps that light our homes, streets and factories, electrical heaters that are widely used to meet industrial requirements, and a hundred and one other necessary and irreplaceable things which have been serving mankind for so many years. In short, many of the invaluable electrical appliances without which life would seem strange and impossible at present can be utilized only because they transform electric energy into heat.

The production of heat by an electric current is called heating effect. One might also name it light effect provided the heat in the conductor is great enough to make it white-hot, so that it gives off light as well as heat. Take the filament of an electric

lamp as an example. We know it to glow because of heat. By the way, were we able to look inside a hot electric iron, we should see that its wires were glowing too. A similar statement could be applied as well to almost any electric heating device. All of them give off a little light and a lot of heat.

### Active Words and Expressions

**a number of** – кількість чогось
**appliance** – пристрій, прилад
**to convert** – перетворювати
**to detect** – виявляти, знаходити
**desirable** – бажаний
**waste** – відходи
**loss** – втрата
**negligible** – незначний
**principal** – головний
**to remove** – усувати
**to send** – відправляти
**white-hot** – розпечений до біла

### Answer the following questions

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

### Exercises

**1. Translate the following sentences and change them according to 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.

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. The heating effect of the current** is the subject **of** this article. 5. Overheating **in transmission lines** is most undesirable. 6. **Work** produces heat directly or indirectly. 7. **The heat engine** turns heat into work.

**2. Translate the following word combinations**

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

з-за променистої енергії; за допомогою теплового двигуна; завдяки хімічній реакції; у випадку зменшення кпд; стосовно теплової втрати; по крайній мірі всередині лампочки; іноді це бажано; в усьому світі; замість механічної енергії.

**3. Read and translate the following text.**

IF THERE WERE NO ELECTRICITY

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

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

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

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

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

## MAGNETICEFFECT OF AN ELECTRIC CURRENT

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

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 behavior of the electric current in a single straight conductor and in a conductor that is formed into a coil, i.e. (that is) a solenoid.

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

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

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 behavior 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.

**Active Words and Expressions**

**to add** – додавати
**angle** – кут
**to adjust** – регулювати
**as soon as** – як тільки
**coil** – котушка
**core** – серцевина
**constant** – постійний, незмінний
**deflection** – відхилення
**electromagnet** – електромагніт
**to establish** – засновувати
**to find out** – з'ясовувати
**needle** – голка
**to repel** – відштовхувати
**rule** – правило
**straight** – рівний, прямий
**turn** – виток

## Answer the following questions

1. When was the voltaic cell invented?
2. What did Oersted decide to establish?
3. What did he find out?
4. When did the needle deflect?
5. Who repeated Oersted's experiments?

6. Do you know Ampere's rule?
7. What did Ampere establish and prove?
8. When magnetism is greatly increased?
9. Is the magnetic effect produced when the charges are at rest?
10. What is an electromagnet?

## Exercises

### 1. Translate the following sentences

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

### 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.

**3. Translate the following sentences:**

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.

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

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. Next summer I shall have a rest in the **country.** 6. The **rest** of the story should be translated at home. 7. Electricity at **rest** or in a static condition does not work. 8. Heat **causes** many chemical reactions. 9. What **causes** the electrons to flow along the wire? 10. A short circuit may be the **cause** of fire.

**5. Fill in the blanks with suitable prepositions:**

to equip ...; to depend ...; to compare ...; to consist ...; to

contribute ...; to be interested ...; to be familiar ...; to point ...; to look ...

**6. Form nouns from the following verbs and translate them:**
to invent, to connect, to discover, to achieve, to observe, to state, to contribute, to conduct, to produce, to operate, to deflect.

**7. Translate the following sentences, paying attention to the words in bold type.**

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. 7. In order to produce electricity more economically the generators must be **as** large **as possible.** 8. **As** a gas is cooled, it loses heat **as well as** energy. 9. The magnetic effect of an electric current is the subject of the present article, **as for** the heating effect it was dealt with before.

## GENERATORS

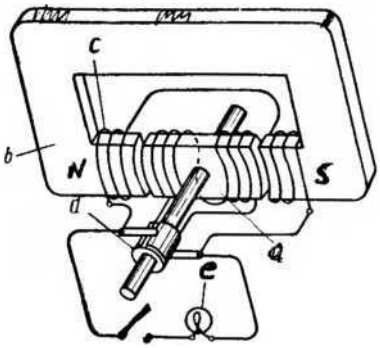
The dynamo was invented by Faraday in 1831 is certainly a primitive apparatus compared with the powerful, highly efficient generators and alternators that are in use today.

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 % of the entire 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.

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. 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 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.

**Active Words and Expressions**

**armature** – якір
**to calculate** – підраховувати
**compared with** – порівняно з
**construction** – будова
**to equip** – обладнувати
**to be likely** – бути схожим
**machine** – пристрій
**to rotate** – обертатися
**scale** – шкала приладу
**speed** – швидкість
**stator** – статор
**turbine** – турбіна
**winding** – обмотка
**to operate** – приводити в дію

## Answer the following questions

1. When did Faraday invent the dynamo?
2. Was Faraday an American scientist?
3. Can batteries supply power on a large scale?
4. What do we need electricity for?
5. What are dynamo electric machines used for?
6. What types of dynamos do you know?
7. What are the principal parts of a generator?
8. In what condition is the stator of an electromagnet?

## Exercises

**1. Translate the following sentences:**

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.

**2. Finish the sentences according to the text:**

1. The dynamo was invented by Faraday in…
2. These machines operate on the same principle as…
3.Dynamo-electric machines are used for…
4.…the generator and the alternator.
5. To generate electricity both of them…
6. The electromagnet of a d.c. generator is usually called…
7. Alternators may be divided into two types…
8. In order to produce electricity under the most economical conditions…

**3. Translate the text using a dictionary**

**Plasma generator**

As it is well known, electric current can be generated if a metal conductor continually crosses the lines of force of a magnetic field. This is the principal feature of all designs of modern electric generators and electrical engines.

However, a generator can be constructed with nothing moving inside, thus eliminating the need for a steam turbine. A copper wire acts as a conductor in ordinary dynamos. However, the metal could be successfully replaced by a jet of gas heated to a plasma state. Plasma is a rather new term in science and engineering. This term denoted another state of matter – the fourth state besides the solid, liquid and gaseous.

It is caused by heating the matter to a temperature of 4000-5000°C and higher. In this case the so-called ionized gas is produced with a tremendous mass of free electrons forced away

from the atoms. In this state a substance becomes an excellent conductor of current.

If a jet of plasma is directed between the poles of a powerful magnet, an electric current would result which could be carried elsewhere by special electrodes. Thus, the rotor with the conductors, unlike the dynamo, is replaced here by a gaseous conductor continually crossing the magnetic field.

The efficiency of transforming the energy of fuel heat into electric current in a plasma generator can be brought to 55-56%, and even to 70% some day.

## 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 are 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 quantify of power. It is important to point out that 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 distances and then in stepping these voltages down. At the consumer's end of the line,

in some distant locality, three step-down transformers are made use of to reduce that value (i.e., 275,000 volts) to 2,300 volts. Local transformers, in their turn, are expected to decrease the 2,300 volts to lower voltages, suitable for use with small motors and lamps. One could have some other transformers in the systems 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.

**Active Words and Expressions**

**to damage** – шкодити
**induction coil** – індукційна котушка
**input** – потужність, споживання
**local** – місцевий
**to point out** – вказувати
**maintenance** – підтримка, збереження
**primary** – первинний
**process** – процес

**negligible** – незначний
**output** – вироблення
**secondary** – вторинний
**whole** – цілий, увесь

## Answer the following questions

1. What is a transformer?
2. What is a transformer used for?
3. Are there any moving parts in a transformer?
4. Can a transformer be damaged by lightning?
5. What are the principal parts of a transformer?
6. How many windings are there in a transformer?
7. What winding is connected to a load?
8. What is the purpose of a step-up transformer?
9. What is known as a step-down transformer?
10. Does a transformer work on d.c.?
11. In what circuits is the transformer used?
12. For what purpose are step-down transformers used?

## Exercises

**1. Translate the following sentences.**

1. The students were asked to carry on the experiment. 2. You will be given two new magazines. 3. I was told to translate the instructions. 4. The questions were answered at once. 5. The new discovery was much spoken about. 6. This house is lived in. 7. This apparatus is often made use of. 8. The lecture will be followed by a film. 9. This substance was supposed to have some important properties. 10. This device is assumed to be the best for converting heat into work. 11. The new power plant is known to have been put into operation. 12. This invention was considered to be of great practical importance. 13. A magnetic flux is assumed to consist of magnetic lines of force taken as a whole.

**2. Translate the following sentences.**

1. Кажуть, що про цей прилад мова йде у попередньому розділі. 2. Вважали, що струм тече від позитивного потенціала до негативного. 3. Кажуть, що мій товариш хороший математик. 4. Відомо, що Ломоносов заснував Московський університет. 5. Здається, що ця речовина має деякі інші властивості. 6. Відомо, що змінний струм змінює свій напрям.

**3. Form nouns from the following words using suitable suffixes:**

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

**4. Translate the following word-combinations:**

На основі (чогось), з цієї причини, збільшувати напругу, збільшити струм, зменшити струм, чинити супротив, електротехніка, в цілому, в результаті, насправді

**5. Put 4 types of the questions to the sentences.**

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

**6. Translate the following text:**

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 electro-magnetic 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 terminal 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 current 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.

## ELECTRIC MOTOR

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

We have already seen the generator convert mechanical energy into electric energy. Now, the process is reversed. It is electricity that is supplied to the machine and it is motion that we obtain. From all that has been said in the previous articles about our getting magnetism from electricity and about the generation of electric current by using magnetism, it is obvious that generators and motors are similar in certain respects. There is certainly some difference in detail but in both of them we find an armature with windings, a commutator and brushes combined with an electromagnet for producing the magnetic field. However, in an electric motor one shunt binding is not sufficient and a second one called a series winding should be added. “Why

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

No appliance ever created by man has probably such a wide range of size and such a variety of application as a motor. In fact, on the one hand, there are all kinds of mighty giants in the motor world. These giants are known to perform innumerable operations wherever required. On the other hand, there exist all kinds of small-sized and even minute motors which are able to power various complex machines and operate equally well under any conditions. Much of our farm equipment is also driven by means of electric motors.

So far nothing was said of what a motor does in our homes. In a modern home there are many different electric motors in machines and devices utilized to meet our daily requirements: to tell the time, to wash clothes, to cool the refrigerator, to clean or brush various things, to shave, to emulate air in a warm room on a hot summer day, and so on. In effect, vacuum cleaners, washing machines, and modern refrigerators do work thanks to electric motors. It follows that in the electric motor we have a valuable and powerful appliance capable of fulfilling the required operations exactly and with just the desirable power

and rate of motion. It is readily switched on, at will, and it continues running until we switch it off. There are often cases when it is simply impossible to replace it by any other means. In short, the motor finds application in industry and engineering, in agriculture and transport, in our homes.

**Active Words and Expressions**

**brush** – щітка
**commutator** – перетворювач струму
**to exist** – існувати
**it follows** – відповідно
**to fulfill** – виконувати
**to perform** – виконувати
**rate** – ступінь, розряд
**to replace**– заміщувати
**so-called** – так званий
**field winding** – обмотка збудження
**sufficient** – достатній
**torque** – обертати, скручувати
**mighty** – могутній, величезний
**variety**– різноманітність
**shunt**– шунт, маневрувати

## Answer the following questions

1. What device is discussed in this text?
2. What is a motor employed for?
3. What kind of motors do you know?
4. What does the generator do?
5. What parts of a motor do you know?
6. What is a very strong magnetic field needed for?
7. What does the shunt field winding provide?
8. What does a motor do in our homes?
9. Do motors serve you every day?
10. Where does a motor find its wide application?

## Exercises

**1. Complete the following sentences:**

1. A transformer is a device which ...
2. A dynamo is a machine which ...
3. A battery is a device which ...

4. A switch is a device which ...
5. An engine is a machine which ...
6. A thermometer is a device, which ...
7. A motor is a device which ...
8. A generator is a machine which ...

**2. Translate the following sentences:**

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

**3. Translate the following sentences using the Passive Voice.**

1.Завтра будуть отримані нові прилади. 2. Студентам були надані нові інструкції. 3. Про досягнення цього вченого багато говорять. 4. Мене попросили провести цей дослід. 5.Приклад був продемонстрований після правила. 6. Нам показали нові матеріали. 7. Їх навчають іноземним мовам. 8. Вчора вони відповіли на ці листи. 9. Його стаття була перекладена англійською. 10.Сучасна лабораторія буде відкрита восени.

## FAULTS OF MOTORS AND WAYS OF THEIR REPAIR

Motors may have different faults. A faulty motor does not start, or, when it is started, it operates at an excessive speed. Its brushes may spark and its windings and the commutator maybe overheated and burnt. Besides, a motor may produce an abnormal noise, etc. All these and other faults should be detected and repaired.

In case the motor does not start it may have different faults.

| Possible causes of faults | Ways of repair |
|---|---|
| 1. Fuses are faulty. | 1. Replace the fuses. |
| 2. Motor is overloaded. | 2. Reduce motor load. |
| 3. Circuit in armature winding has an open. | 3. Repair the armature winding. |

In case the motor, when started, stops:

| | |
|---|---|
| 1. Rheostat is shorted. | 1. Check the rheostat and repair it. |
| 2. Rheostat switches from one position to another. | 2. Slow down operation of rheostat handle. |

Brushes may spark in case:

| | |
|---|---|
| 1. Motor is overloaded. | 1. Reduce the load and remove overload. |
| 2. Brushes are in poor condition. | 2. Replace the brushes. |
| 3. Pressure is low. | 3. Adjust the pressure. |
| 4. Pressure is excessive. | 4. Adjust the pressure. |

In case the armature winding is overheated:

| | |
|---|---|
| 1. Motor is overloaded. | 1. Remove the overload. |
| 2. Ventilation fails to operate properly. | 2. Check for slowing down the speed ofthe motor. |

In case of abnormal motor speed:

| | |
|---|---|
| 1. Motor is overloaded. | 1. Reduce the load. |
| 2. Rotor circuit has poor | 2. Repair the shorting |

| | |
|---|---|
| contact. | mechanism. |

In case rotor brushes agaist stator:

| | |
|---|---|
| Rotor brushes against stator. | Adjust air gap. |

**Active words and expressions**

**to repair** – ремонтувати
**gap** – зазор
**spark** – іскра
**speed**– швидкість
**noise** – шум
**slow** – повільний
**excessive** – надлишковий
**check** – перевірка
**to adjust** – регулювати
**brush** – щітка

## Answer the following questions

1. When does a motor operate poorly?
2. What should be done in case the motor is overloaded?
3. What should be done in case the fuses are faulty?
4. What should be done in case the rheostat is shorted?
S. What should be done in case the brushes spark?
6. What should be done in case the pressure is low?
7. What should be done in case the ventilation does not operate?
8. What should be done in case the rotor brushes against stator?

## Exercises

**1. Translate the words and word-combinations:**

air gap; commutator; stator; to contact; contact; brush sparks; slow speed; rotor; excessive speed; safety devices; process.

**2. Are the words: *spark, short, slow, brush, fault, load, test* nouns? Are they verbs? Translate the sentences into Ukrainian.**

1. New motors are given a no-load and under a load tests.
2. When the motor is tested it should produce no abnormal noise.
3. In case this noise appears the motor must be disconnected.
4. This generator must be checked; one should give it a test.

5. The motor’s brushes seem to be sparking. Can you see the sparks?
6. The windings of the coil are shorted. I have detected a short in the windings.
7. The armature rotates slowly; let’s check it up!
8. The speed of rotation is too excessive; it must be slowed down.
9. In case the rotor brushes against the stator, the motor operates slowly. The faulty brushes should be replaced.

**3. Translate the following sentences:**

1. It was in our laboratory that the device in question was first tested. 2. If this system is to serve as a voltmeter, a resistor has to be added in series. 3. In 1870 Mendeleyev arranged the elements in the form of a table and of the periodic law. 4. Provided the magnetic field is produced by a coil of several turns, its intensity is much greater than if only one turn were used. 5. Naturally, this circuit can be modified, if necessary. 6. Evidently, the frequency could be varied to meet different conditions. 7. It is impossible to say whether future improvements may not depend on the results of researches. 8. The decision had to be made as to whether the uranium should be in the form of long rods. 9. Unless they apply new devices, it will be necessary to proceed as follows. 10. It was the diameter of the wire that we did change to obtain the above results.

## METERS

Among the most common meters used there are the ohmmeter, the ammeter and the voltmeter. The ohmmeter is used to measure the value of resistance. It consists of a milliammeter calibrated to read in ohms, a battery and resistors.

The meter is connected in parallel and the circuit is not opened when its resistance is measured. The readings on the scale show the measured value. The ammeter is used to measure the value of current. When the ammeter is used the circuit should be opened at one point and the terminals of the meter should be connected to it. One should take into consideration that the positive terminal of the meter is connected to the positive terminal of the source; the negative terminal to the negative terminal of the source. The ammeter should be connected in series. The readings on the scale show the measured value.

A wattmeter is used to measure the value of power. It is connected to the circuit directly. A wattmeter consists of coils: two fixed coils and a coil which moves in the magnetic field produced by the fixed coils.

Wire used for the coils must have a high resistance; the fixed coils are in series with the load, the moving coil is connected across the line in series with a resistance. When a wattmeter is used, the readings on its scale show the value of power being used.

**Active Words and Expressions**

**meter** –вимірювальний пристрій
**battery** – батарея
**readings** – показники приладу
**to measure** – вимірювати
**to take into consideration** – брати до уваги
**scale** – шкала
**terminal** – клема
**in this way** – таким чином

## Answer the following questions

1. What is the ammeter used for?
2. What is the voltmeter used for?
3. What is the ohmmeter used for?
4. What terminals does a meter have?

5. Should the measured circuit be opened when the voltmeter is used?
6. Should the measured circuit be opened when the ammeter is used?
7. In what way should the voltmeter be connected to the circuit?
8. In what way should the ammeter beconnected to the circuit?
9. What is the difference between a voltmeter and an ammeter?10.What is the wattmeter used for? What does it consist of?
11. What common meters are used to measure the values in a circuit?

## Exercises

**1. Complete the sentences using the correct variant:**

**1. The ammeter is…**

a) a common meter.
b) an uncommon meter.

**2.In order to measure the value of current…**

a) the ohmmeter is used.
b) the voltmeter is used.
c) the ammeter is used.

**3. A meter has…**

a) positive terminals only.
b) negative terminals only.
c) positive and negative terminals.

**4. When the ammeter is used…**

a) the circuit should be opened.
b) the circuit should not be opened.

**5. The ammeter should be connected…**

a) in series.
b) in parallel.

**6. One should take into consideration that…**

a) the positive terminal should be connected to the negative terminal.

b) the positive terminal should be connected to the positive terminal of the source.

**2. Translate the following sentences into Ukrainian:**

1. The amount of heat energy added as the result of agitation was found to be negligible, no rise in temperature being observed. 2. On leaving the oil separator, the exhaust steam is diverted into two parts, part of it entering the feed water heater and the remainder flowing to the heating system. 3. These materials being unsuitable for many reasons, some others must be found to replace them. 4. Maxwell's equation led to Hertz discovering radio waves which, in turn, resulted in Popov's inventing wireless telegraphy and all the subsequent brilliant developments in radio engineering. 5. To observe is the primary rule of any experiment. 6. To prevent rust the exposed parts of the mechanism under consideration should be covered with a thick coat of paint.

**3. Insert *is, are, was, were* in the story.**

George Washington … born in Virginia. He…the first president of the United States.Before that, he…the commander-in-chief of the Continental Army during the American Revolution. Washington stayed with his soldiers when conditions … very bad. He…a man with a strong sense of duty. Today, Washington's Birthday…a holiday. Most schools… closed on that day. However, stores…open on Washington's Birthday, and there … lots of Washington's birthday sales.

# TRANSMISSION LINES

A power system is an interconnection of electric power stations by high voltage power transmission lines. Nowadays the electricity is transmitted over long distances and the length of transmitting power lines varies from area to area.

A wire system is termed a power line in case it has no parallel branches and a power network in case it has parallel branches.

According to their functions, power lines and networks are subdivided into transmission and distribution lines.

Transmission lines serve to deliver power from a station to distribution centers. Distribution lines deliver power from distribution centers to the loads.

Lines are also classed into: overhead; indoor; cable (underground).

Overhead lines include line conductors, insulators, and supports. The conductors are connected to the insulators, and these are connected to the supports. The greater the resistance, the higher are the heating losses in the conducting wires. In order to reduce the losses, a step-down transformer can be used.

Indoor lines include conductors, cords, and buses. The conductor may include one wire or a combination of wires not insulated from one another. They deliver electric current to the consumers.

As to underground lines, they are used in city areas. Accordingly, they are used in cities and towns, and in the areas of industrial enterprises.

## Active Words and Expressions

**area** – площа, область
**to distribute** – розподіляти
**distance** – відстань
**to support** – підтримувати
**network** – електрична мережа
**to term** – називати
**distribution centre** – розподільчий центр
**to divide** – ділити
**cord** – провід
**as to** – що до
**bus** – шина
**accordingly** – відповідно
**long distance** – значна відстань
**enterprise** – підприємство
**power consumption** – споживання електроенергії
**support** – щогла,опора

## Answer the following questions

1. By what means is electric power system transmitted?
2. Which system has no parallel branches?
3. Into what groups are all the transmitting lines classed?
4. What components does an overhead line have?
5. What elements do conductors consist of?
6. In what areas are overhead (underground) lines used?

## Exercises

**1. Translate the following word- combinations:**

interdependent city areas, interacting underground lines, interconnected overhead lines, transmitting power lines, transmission and distribution lines, overhead lines, step-down transformer, indoor lines, underground lines.

**2. Finish the sentences according to the text:**

1. …voltage power transmission lines.
2. A wire system is termed a power line in case…
3. …subdivided into transmission and distribution lines.
4. Lines are also classed into…
5. The greater the resistance, the higher are…
6. Indoor lines include…
7. The conductor may include one wire…

8. …and in the areas of industrial enterprises.

**3. Translate the text in writing:**

## Dynamo

Dynamo is a common device for converting mechanical energy into electric energy. This process depends on the fact that if an electrical conductor moves across a magnetic field, an electric current flows in the conductor.

Usually a dynamo includes an electromagnet, called the field magnet, between the poles of which a suitable conductor, usually in the form of a coil, called the armature, is rotated. The mechanical energy of the rotation, in the form of a current in the armature, is thus converted into electric energy.

**4. Correct the following sentences.**

1. I did went to the movies last night. 2. She didn't ate at the Chinese restaurant. 3. When they visited San Francisco? 4. Who you did call? 5. Who call you last night? 6. Why she called her mother this morning? He had not any money. 8. Where fell you? 9. Did she drank a glass of milk? 10. Where was she findthe ring? 11. You didn't finished your dinner.

## CAPACITORS

A capacitor is one of the main elements of a circuit. It is used to store electric energy. A capacitor stores electric energy provided that a voltage source is applied to it.The main parts of a capacitor are metal plates and insulators. The function of insulators is to isolate the metal plates and in this way to prevent a short.

Two common types of capacitors in use nowadays: a fixed capacitor and a variable one. The plates of a fixedcapacitor cannot be moved; for this reason its capacity does not change.

The plates of a variable capacitor move; its capacity changes. The greater the distance between the plates, the less is the capacity of a capacitor. Variable capacitors are commonly used by radiomen; their function is to vary the frequency in the circuit. Fixed capacitors are used in telephone and radio work.
Fixed capacitors have insulators produced of paper, ceramics and other materials; variable capacitors have air insulators. Paper capacitors are commonly used in radio and electronics; their advantage is their high capacity: it may be higher than 1,000 picofarad.

Besides, electrolyte capacitors are highly in use. They also have a very high capacity: it varies from 0.5 to 2,000 microfarad. Theirdisadvantage is that they change their capacity when the temperature changes. They can operate without a change only at temperatures not lower than 40°C. Common troubles in capacitors are an open and a short. A capacitor stops operating and does not store energy in case it has a trouble. A capacitor with a trouble should be substituted by a new one.

**Active Words and Expressions**

**capacitor** – конденсатор
**insulator** –ізолятор
**frequency** – частота
**distance** – відстань
**advantage** – перевага
**disadvantage** – недолік
**plate** – анод
**to apply** – застосовувати
**to move** – рухати (ся)
**to prevent** – запобігати
**reason** – причина
**for this reason**– з цієї причини
**besides** – окрім того
**provided that** – за умови що
**part** – частина

## Answer the following questions

1. What is a capacitor used for?
2. What are the main parts of a capacitor?
3. What is the function of insulators?

4. What does the capacity of a capacitor depend on?
5. What is the difference between a fixed capacitor and a variable one?
6. What should be done in order to change a capacitor?
7. What is the relation between the value of capacity and the distance of plates?
8. What type of insulators have variable capacitors?
9. What should be done in case a capacitor has a trouble?

## Exercises

**1. Translate the following word-combinations:**

paper insulators, air insulators, electrolyte capacitors, advantages of electrolyte capacitors, disadvantages of air insulators, cells under test, a radioman, radio work, radio parts, telephone and radio work, capacitors in common use nowadays.

**2. Finish the sentences according to the text:**

1. Capacitor is used to…
2. The main parts of a capacitor are…
3. …in this way to prevent a short.
4. Two common types of capacitors in use nowadays…
5. Variable capacitors are commonly used…
6. Fixed capacitors have insulators produced…
7. …it may be higher than 1,000 picofarad.
8. Electrolyte capacitors also have a very high…
9. …when the temperature changes.
10. Common troubles in capacitors are…

**3. Complete these sentences using the correct variant:**

**1. A capacitor is used…**

a) to supply voltage.
b) to increase the voltage output.
c) to store energy.

**2. The main parts of a capacitor are…**

a) insulators only.

b) metal plates only.

c) metal plates and insulators between them.

**3. The function of insulators is…**

a) to store energy.

b) to isolate the metal plates.

c) to prevent a short between the metal plates.

**4. The capacity of a capacitor depends on…**

a) the size of the plates.

b) the distance between the plates.

c) the material of the insulators.

**5. The capacity of a fixed capacitor…**

a) is constant.

b) is varied.

**6. The plates of a variable capacitor…**

a) can be moved.

b) cannot be moved.

**7. In order to charge a capacitor a voltage source is applied…**

a) to the metal plates.

b) to the insulators.

**8. The greater the distance between the plates,**

a) the greater is the capacity of a capacitor.

b) the less is the capacity.

**9. Variable capacitors have…**

a) air insulators.

b) paper insulators.

c) ceramic insulators.

**10. Electrolyte capacitors have…**

a) a very low capacity.
b) a very high capacity.

**4. Make the sentences negative and interrogative.**

1. He opened the windows before classes. 2. Ann translated a lot of foreign letters at the office last week. 3. I finished work at five o'clock the day before yesterday. 4. He lived in Kyiv five years ago. 5. They returned home in the evening.

## ELECTROMAGNETIC RELAY

Electromagnetic devices called relays are widely used in various branches of industry.

The main parts of a relay are an electromagnet, a spring and an armature. When a current starts flowing in the electromagnet winding, the armature moves and the spring closes the contacts. The primary circuit of a relay is its electromagnet circuit and the secondary circuit is the one closed by the contacts. When there is no current in the relay's primary circuit, the spring pulls the armature and the contacts open. The relay is placed close to the motor which is connected to its secondary circuit. The armature closes the contacts of the secondary circuit, and the motor starts operating; it will stop when the relay opens.

Without a relay, conductors with a large cross-section would have to be brought to the motor. This would be very uneconomical. The current in a relay is tens and even thousands of times smaller than that used to power the motor. Therefore, the connecting wires can have small cross sections.

In many systems the relay primary circuit operates automatically. Every evening and morning street lights are switched on and off from the main control panel by means of a great number of relays.

## Active Words and Expressions

**spring** – пружина
**cross-section** – поперечний перетин
**to move** – рухати
**various** –різноманітний
**to close** – замикати
**close to** – близько від
**to switch on** – вмикати
**to start** – заводити
**to switch off** – вимикати

## Answer the following questions

1. What are the main parts of a relay?
2. How is a relay put into operation?
3. When does the spring pull the armature?
4. What wires connect the panel with the relay?
5. By what means are street lights switched on and off?

## Exercises

**1. Translate the following words and word-combinations:**

relay, electromagnet, armature, system, automatic, panel, contact, to start flowing, to start moving, to start operating, to start powering the motor, various branches of industry, small cross-section, relay's primary circuit.

**2.Complete the sentences using the correct variant:**

**1. The main parts of a relay are…**

a) an electromagnet, a capacitor, and a spring.
b) an electromagnet, an armature, and a spring.

**2. When current starts flowing…**

a) the spring opens the contacts.
b) the spring closes the contacts.

**3. The spring pulls the armature…**

a) when there is current in the primary circuit.
b) when there is no current in the primary circuit.

**4. The wires connecting the panel with the relay…**

a) have a large cross-section.
b) have a small cross-section.

**5. Street lights are switched on and off…**

a) by means of relays.

b) by means of electric motors.

**3. Use the required tense form.**

1. The experiment ***(repeat)*** many times.

2. The power which ***(radiate)*** as light is almost three times as great as that radiated as heat.

3. It ***(know)*** that iron molecules are magnets at all times.

4. Under ordinary room lightning the resistance of transistors ***(decrease)*** millions of times.

5. Ruby crystals about ten centimeters long can ***(intensify)*** light ten times.

6. The density of a semiconductor laser radiation ***(be)*** hundreds of times as great as that of the ruby laser.

7. The power which ***(transmit)*** along a wire is the product of the voltage times the amperage.

**4.Translate the following sentences.**

1. Such difficulties are often met with. 2. Three scales of 50, 100 and 250 volts have been decided upon. 3. It is necessary to point out that only a brief description will be given here. 4. These capacitances are known to be inter-electrode capacitances. 5. The above possibility was not given due consideration at first. 6. It is evident that the best shielding is obtained at 0.65 wave length. 7. One could not obtain a good knowledge of the results without repeating the test. 8. It has been established that this voltage was sufficient. 9. One should keep in mind all the above-mentioned disadvantages. 10. The device is said to have been described in some earlier papers.

# FUSES

Fuses are widely used nowadays as protection devices. They are utilized in various circuits, electrical equipment and installations. Fuses serve to protect them against overcurrents and short-circuit.

There are different types of fuses in use nowadays. Of them, quartz sand fuses serve for voltages up to 500 volts; fuses of this kind are produced with current ratings of 15 to 60 amp. and of 100 to 350 amp.

Fuses are commonly used in low voltage industrial installations rated up to 1,000 V. Fuse protection is based on a very simple principle: in case of a short-circuit or overcurrent, when the maximum value of current has been exceeded, the fusible link of a fuse is heated to its melting point.

This opens the circuit and disconnects the circuit from the power source. In case of a fault, one should replace the faulty fusible element by a new one.

Fuses are used both in direct current (d.c.) and altenating current (a.c.) circuits.

## Active Words and Expressions

**fuse** – запобіжник
**link** –зв'язок
**fault** – дефект
**faulty** – несправність
**equipment** – обладнання
**installation** – пристрій
**to protect** – захищати
**to utilize**– використовувати
**to equip** – обладнувати
**to serve** – служити
**to melt** – плавитися
**up to** –аж до

## Answer the following questions

1. What does a fuse serve for?
2. For what type of current are fuses used?
3. What should be done in case of a faulty fuse?
4. What principle is fuse protection based on?

## Exercises

**1. Form the words according to the model and translate them.**

*Model:* charge – overcharge – перевантаження

connect– disconnect – роз'єднати

pressure, beat, stress, current, load, organize, place, stress, use.

**2. Distribute the words below into the three columns:**

***action*** ***process*** ***doer***

utilizer, utilize, installation, displace, overheater, displacement, overproduction, starter, equip, protection, disorganize.

**3. Finish the sentences according to the text:**

1. Fuses are widely used in…
2. …against overcurrents and short-circuit.
3. Fuses are commonly used in low…
4. …in case of a short-circuit or overcurrent, when the maximum value of current has been exceeded…
5. In case of a fault, one should…
6. …direct current (d.c.) and altenating current (a.c.) circuits.

**4. Put in *am, is, are, was,* and *were.***

1. Last year she … 22, so she … 23 now. 2. Today the weather … nice, but yesterday it … cold. 3. I … hungry. Can I have something to eat? 4. I … hungry last night, so I had something to eat. 5. Where … you at 11 o'clock last Friday morning? 6. Don't buy those shoes. They …too expensive. 7. Why … you so angry yesterday? 8. We must go now. It …very late. 9. This time last year I … in Paris. 10. We … tired when we arrived home, so we went to bed. 11. Charlie Chaplin died in 1978. He …a famous American film star.

# SUBSTATIONS

A substation is designed to receive energy from a power system, convert it and distribute it to the feeders.

Thus, a substation serves as a distribution centre. Substations feed (supply) various consumers provided that their basic load characteristics are similar.

Therefore the energy is distributed without transformation of the voltage - supplied.

Common substations comprise isolators, switchgear buses, oil circuit breakers, fuses, power and instrument transformers and reactors. Substations are classed into step up and step down ones.

The step up substation includes transformers that increase the voltage. Connected to the bus bars of the substation are the power transmission lines of power plants of the system. As to step down substations, they reduce the voltage to 10 or 6 kV.

At this voltage the power is supplied to the distribution centers and to the transformer substations of power consumers.

A transformer substation serves for transmitting and distributing electric power. It comprises a storage battery, control devices and auxiliary structures.

Transformer substations are classed into indoor and outdoor; both types are used for feeding industrial enterprises. Compared to other types of substations, transformer substations have certain advantages. They have flexible construction and easy and reliable operation.

In case of a fault in the left hand section, the main circuit breaker opens while the normally open section circuit breaker closes and puts the voltage of the section to normal. Power from a substation is delivered to distribution centers.

## Active Words and Expressions

**auxiliary** – допоміжний
**breaker** – вимикач
**busbar** – збиральна шина
**feeder** – фідер
**flexible** – гнучкий
**to comprise** – включати в себе
**to distribute** – розподіляти
**as ... to** – стосовно

## Answer the following questions

1. What does a substation serve for?
2. What type of consumers does a substation feed?
3. What parts are the power transmission lines connected to?
4. What components does a substation comprise?
5. What types are substations classed into?
6. What are advantages of a transformer substation?

## Exercises

**1. Translate the following word-combinations:**

circuit breaker, auxiliary units, distribution centre, flexible construction,reliable operation, switch gear bus, hydraulic as well as solar sources of energy, as to phase-word motors.

**2. Finish the sentences according to the text:**

1. A substation is designed to receive energy…
2. Common substations comprise…
3. The step up substation includes…
4. …they reduce the voltage to 10 or 6 kV.
5. A transformer substation serves for…
6. …are used for feeding industrial enterprises.
7. In case of a fault…
8. …is delivered to distribution centers.

**3. Insert commas where necessary and translate the sentences:**

1. Wattmeter is an instrument for the direct measurement of the power in watts of a circuit.

2. If two conductors are placed in contact or joined by a conductor of much lower resistance than the rest of the circuit most of the current will flow direct between these conductors which are then said to be short-circuited or shorted.
3. Alternating current is a flow of electricity which after reaching a maximum in one direction decreases, finally reversing and reaching a maximum in the opposite direction.
4. A few pounds of uranium can supply a medium-sized town with power it needs for a year.
5. Since the energy sources of the world are decreasing it is necessary to turn to atomic energy.
6. The engine cannot be restarted until its oil level is brought up to the correct level.
7. Pierre Curie examined properties of crystals which led him to the discovery of piezoelectric properties.
8. The capacity of the generating units has been increased which made it possible to build super-high-capacity power stations.

**4. Complete the sentences with suitable tense forms.**

Karen, Emily and Anne all (go) … to college together 20 years ago. They(have) … a wonderful time and (learn) … a lot. Now, the three of them(work) … at the same insurance company. They (eat) … lunch together every day and sometimes (tell) … stories about their school days. Yesterday, they (remember) … a funny accident at a special banquet during their sophomore year. At this dinner, they (sit) …at the same table as the president of the university. Everything (go) … along fine, but then disaster(strike) … To make a long story short, Karen (spill) … a serving dish full of spaghetti onto the president. Karen (be)…terribly embarrassed. She (apologize) … profusely and (leave) … the banquet room in tears.

## CAN SUN POWER BE USED?

Hold out your hand towards a sunbeam. It feels warm, does it not? No wonder, for only a little more than eight minutes ago it left the sun's surface whose temperature is about 6000°C. In that short period of time it has travelled about 93 million miles on its way to the earth in order to light your room, to cause the trees to grow, to produce wind energy and to create a lot of irreplaceable and wonderful things.

The energy the earth constantly receives from solar radiation is about 35,000 times the annual energy consumption of mankind. However, only a minute part of it is being utilized so far. As a matter of fact, the conversion of solar radiation directly into electric power by some efficient means has been the aim of Ukrainian and foreign scientists, inventors, and engineers for at least one hundred years.

Sun energy can be employed on the one hand directly as heat for space heating, water heating and certain other purposes and on the other hand it might be utilized for the production of electricity. In the latter case, the electric current can be obtained as follows: 1) by using fuel for thermal power plants since the sun is known to be the primary source of all energy stored in fuel; 2) by heating boilers or air heaters in thermal power plants with sunbeams concentrated by collectors; 3) by converting radiation into electric voltage by means of thermocouples or photovoltaic cells.

Generally speaking, sun energy can be utilized in the form of falling or running water. The heat of the sun annually

evaporates millions of tons of water from the oceans, seas, and rivers, lifting it high into the air. The water vapour is then carried away to various parts of the earth where some of it falls as rain, the latter (now, water again) in its turn flowing into rivers and back into oceans. Provided we construct a dam across the river, we create a reservoir, a so-called man-made sea. From the reservoir or the water-fall water may be directed to the hydroelectric station which houses the turbines, the generators as well as other suitable and necessary equipment. The force of the falling water rotates the blades of the turbine, the latter driving the electric generator. In this manner, the mechanical energy of running water, sometimes called white coal, is turned into electrical energy. However, we have just observed it to receive its power from the sun. For want of space it is impossible to mention here all our achievements in this important field of science.

Of course, scientists all over the world will continue to look for ways and means of making more efficient semiconductors. At the same time, they will do their best to find new methods of converting sun energy directly into electricity. Who knows, you or a friend of yours will perhaps be the one to come out with the best possible answer to the problem under consideration.

**Active Words and Expressions**

**blade** – турбінна лопать
**boiler**– обігрівач
**consumption**– споживання
**to feel** – відчувати
**for want of** – з-за нестачі
**radiation –** радіація
**receive –** одержувати
**sunbeam –** сонячне проміння
**space**– космос
**thermal power station** – ТЕС

**to grow** – вирощувати
**to hold out**– утримувати
**in this manner**– таким чином
**wonderful**– чудовий
**man-made** – штучний
**a lot of**– багато

## Answer the following questions

1. Where is used the coal from the mines?
2. Where is used the energy of the waterfalls?
3. Where is used the energy of the wind?
4. Where is used the energy of the tides of the sea?
5. Where is used the energy of the sun?

## Exercises

**1.Translate the following sentences:**

1. It is not difficult to distinguish the properties of a solid from those of a gas. *2.* It takes more heat to warm a large container than it is required to warm a small one. 3. When a vapour becomes completely evaporated it is said to be dry. 4. If vapour is superheated, it behaves as a gas. 5. The flow of current interested scientists for a long time; at first they thought it to be a liquid. 6. It is the sun that is an unlimited source of energy. 7. A wind-driven rotor is constructed in such a way that the wind blowing upon it makes it rotate.

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

1. Яка температура поверхні сонця? 2. Скільки сонячної енергії отримує людство? 3. Чи можна безпосередньо використовувати сонячну енергію? 4. Як можна отримати електрику від сонця? 5. Як можна створити штучне море? 6. Де встановлюють сонячні батареї? 7. Над якою проблемою працюють науковці всього світу?

**3.Continue the sentences according to the text:**

1. The energy the earth constantly receives from …
2. The conversion of solar radiation directly …

3. Sun energy can be employed on …
4. … and rivers, lifting it high into the air.
5. The water vapour is then carried away …
6. The force of the falling water rotates …
7. … is turned into electrical energy.
8. Scientists all over the world …

**4. Put *some, any, no* or their derivatives into each gap.**

1. Have you …relations? — No, I haven't .., I have …relations. 2. Has she…nephews or nieces? — She has … nephews. 3. She has …sisters, she has only brothers. 4. Do you know…about Chinese art? 5. They have …cousins in Kyiv. 6. Have you … brothers? - No, I haven't .., I have …brothers. 7. I have …good friends. 8. We didn't know…about his problems: he told us … 9. Have you got …interesting books? 10. Have you …friends in Britain? 11. He has…English books in his bookcase. 12. Did you meet …on your way to school? 13. Have you got …pencils in your bag? 14. Do we have…chalk on the blackboard?

## SOLAR POWER

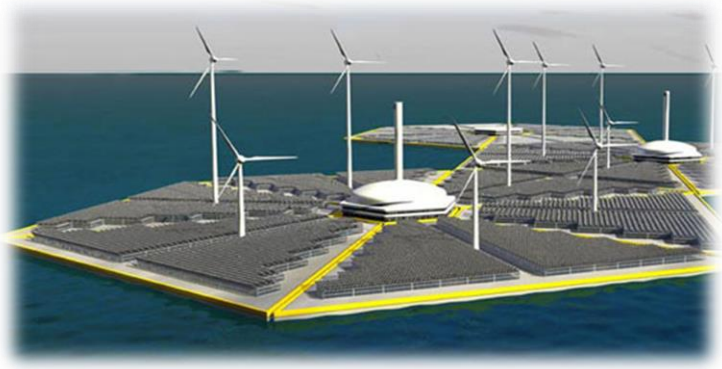
The sun is our most important source of energy, by far. It warms the earth's atmosphere, vaporizes water from the oceans, and drives the resulting clouds by means of winds to the continents, where they cause rains and livers. These drench the thirst of people, animals and of plants, which draw their energy directly from the sun and pass it on to us when we eat them. That has been going on since prehistoric times. Now it can do a little more, it could provide all the energy

needed by a modem industrial society worldwide for the indefinite future; which no “conventional” energy source could do. It could do it easily, without the pollution and hazards associated with those exhaustible sources. Most people still would like that, especially if they knew that it can be done profitably.

They are not supposed to be aware of that, and a major effort is expended to make them believe that it would require economic sacrifices rather than benefits.

In the 1970s, there was widespread enthusiasm, and a genuine grassroots movement emerged in the U. S. in anticipation of an imminent transition to an economy based on the solar sources of energy that came in the wake of the first “oil shock” and boycott (1973). There are some, who fear a transition to solar power, and they are very powerful and determined. Instead of being confined to a few small “niche markets”, new solar technologies could easily have supplied a double-digit percentage of energy used by now. All that we maintained at the time was that it could be very substantial starting profitably almost immediately. It is the prime example of confluence, rather than conflict, of environmental and economic wellness. It is essential for sustainable development worldwide, i. e. also in industrial countries. The main key to serious direct solar energy is that the sunlight first be focused, concentrated.

Inexpensive, high-grade focusing devices could have been available by easy mass-production in the 70s.



There have been problems associated with solar progress. Of those generally cited, some are real, some phony. The former can induce easy rejection or a search for solutions or ways to bypass the problems. An example for direct solar energy (SE) is that the sun does not always shine even in California. There are various ways to tackle that problem. A claim made that SE is more dangerous than nuclear fission power, because installers fall of ladders, is a good example of the phony kind. That is not to say that working for SE cannot be dangerous.

Some aspects of SE constitute a problem for some but a boon to others. Probably the main example cited as problem is its "diffuse" nature. To the extent that means that the sun shines on every field and roof, rather than concentrating its blessings onto where only giant regional utilities and polluting energy companies tied to them have access to it, it can be an advantage for many more people than associated with those companies.

Without first concentrating the sunlight, however, it would really be too diffuse for important uses such as solar (absorption) cooling, thermal electricity generation or substantial cost-effective photovoltaic power. That explains the special hostility to availability of inexpensive concentrators by those in control. It could have led to major solar proliferation long ago.

**Active Words and Expressions**

**deliberate** - добре обміркований
**obstruction** - перешкода
**drench** - зрошувати
**pollution**- забруднення
**profitably** - прибутково
**sacrifice** -жертва
**genuine**- істинний
**anticipation** - очікування
**imminent** -неухильний
**grassroots** - база, початок
**to confine** - обмежувати
**niche markets** – ринкові ніші
**phony**- фальшивий
**boon** - благо
**diffuse** - неуважний

## Answer the following questions

1.What is the sun for our life?
2.What could the sun provide for the mankind nowadays?
3.When and why was a widespread enthusiasm concerning solar energy?
4.What is the main key to serious direct solar energy?
5.What are the problems associated with solar progress?

## Exercises

**1.Translate the following word combinations into Ukrainian:**
powerful obstruction; to drive; the thirst; prehistoric times; associated with; especially; to be aware of; widespread; to fear; immediately; confluence; worldwide; inexpensive; to induce; to bypass the problem; dangerous; to constitute a problem; to have access to it; special hostility; availability.

**2. Translate the following word combinations into English:**
в усьому світі; усвідомлювати; мати доступ до; велика перешкода; особлива ворожість; спонукати; наявність; спрага; приводити в рух; боятися; обходити проблеми; складати проблему; особливо;доісторичні часи; небезпечний; пов'язаний з; недорогий; перетин поглядів; поширений; негайно.

**3.Read the text and say whether the statements are true or false.**

1. The sun is our most important source of energy.
2. It could provide all the energy needed by a modern industrial society worldwide for the indefinite future; which “conventional” energy source could do.
3. In the 1970s, there was widespread enthusiasm, and a genuine grassroots movement emerged in the U. S. in anticipation of an

imminent transition to an economy based on the nuclear energy.
4. New solar technologies could easily have supplied a double-digit percentage of energy used by now.
5. It was/is the prime example of confluence, rather than conflict, of environmental and economic wellness.
6. Expensive, high-grade focusing devices could have been available by easy mass-production in the 70s.
7. That is not to say that working for SE can be dangerous.

**4. Finish the sentences according to the text:**

1. The sun is …
2. Now it can do a little more …
3. … a major effort is expended to make them believe that it would require economic sacrifices rather than benefits.
4. In the 1970s, there was widespread enthusiasm …
5. All that we maintained at the time was …
6. The main key to serious direct solar energy …
7. An example for direct solar energy …
8…. as solar (absorption) cooling, thermal electricity generation or substantial cost-effective photovoltaic power.

## TIDAL ENERGY

Over the past three decades the feasibility of using ocean tides to generate electric power has been investigated at many sites.

Results suggest that the potential for economic development is small. Of the approximately 22,000 TWh per year dissipated by the tides, 200 TWh is row considered economically recoverable and less than 0.6 TWh is produced by existing plants.

Six areas account for well over half of the potentially developable energy:
the headwaters of the Bay of Fundy (Canada);
the Severn estuary (United Kingdom);
the Gulf of St. Malo (France);
the south-east coast of China and Russian coasts bordering the White Sea and Sea of Okhotsk.

Other potentially feasible sites include the Mersey estuary and smaller sites bordering the Irish Sea and Bristol Channel (United Kingdom), the Gulf of Kachch (India), the west coast of Korea, the north-west coast of Australia, Cook Inlet (Alaska) and the Gulf of San José (Argentina).

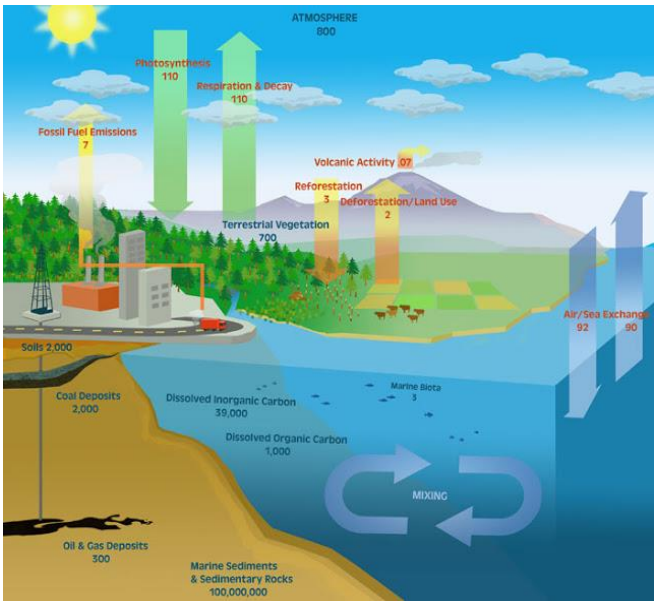
Most designs, existing or proposed, have opted for a single tidal basin to create hydraulic heads and propeller turbines to extract energy therefore. Linked and paired basins have also been considered. Innovative approaches have included extraction of energy directly from tide races using a variety of prime movers.

The main obstacle to development is economic. Capital costs are high in relation to output: a consequence of the low and variable heads available at even the best sites. Heads available at the turbine vary throughout each tidal cycle, averaging less than 70% of the maximum. As a result, installed capacity is underutilized, typical capacity factors tending to fall in the range 0.23 to 0.37. Low heads imply that civil as well as mechanical engineering components must be logic in comparison to output. For such reasons, tidal plants are likely to be practicable only where energy is concentrated by large tides and where physical features permit construction of tidal basins at low cost.

Significant capital-cost reductions through improved design and construction techniques have been achieved over the past three decades. In China a somewhat different approach has been taken: tidal plants have been built as part of broader schemes of resource utilization - typically land reclamation or aquaculture.

In a world increasingly sensitive to environmental factors, tidal plants must avoid unacceptable impacts. Tidal power is non-polluting and in this respect superior to thermal generation. Beyond that, it is difficult to generalize.

In recent years, commercial acceptance of combined-cycle generation based on combustion turbines has reduced the potential economic and environmental costs of meeting future capacity and energy demands through thermal plants wherever natural gas is available at competitive prices. This has tended to increase the economic bias against tidal power.




Another development with adverse implications for tidal power is the trend in many countries to adopt market pricing of electric energy and dispense with regulatory pricing. This in almost every case entails competition in the generation function. Under such conditions, competitors will be under strong compulsion to choose plant types having the shortest construction times and the lowest unit capital costs.

Such factors render construction of new tidal generation capacity unlikely during the near future, unless strong incentives such as emission caps or carbon taxes are imposed.

**Active Words and Expressions**

**tide** – приплив
**feasibility** – здійснюваність
**investigate** – досліджувати
**estuary** – дельта річки
**exceed** – перевищувати
**there from** – звідти
**to extract** – витягати,здобувати
**innovative approach** – новаторський підхід
**to entail** – викликати
**to render** – змінити стан чогось
**combined cycle** – комбінований цикл
**obstacle** – перепона
**imply** – мати на увазі
**to predict** – передбачати
**perturb** – порушувати
**head** – напір
**bias** – нахил
**to dispense** – розподіляти
**reclamation** – вторинне використання
**combustion** – згоряння
**capital cost** – капітальні витрати

## Exercises

**1. Give the Ukrainian equivalents to the following English word-combinations:**

ocean tides; the largest tidal plant; annual output; a single tidal basin; innovative approaches; tide races; mechanical engineering components; design and construction techniques; tidal basins; combined-cycle generation combustion turbines; energy demands; new tidal generation capacity.

**2.Find in the text the English equivalents to the following word-combinations:**

економічно-відшкодовуваний; потенціально можливі майданчики станцій; швидка течія; малий та змінний напори; капітальні витрати; вдосконалені засоби

проектування та будівництва; вироблення з комбінованим циклом.

**3.Translate the following sentences:**

1. Of the approximately 22,000 TWh per year dissipated by the tides, 200 TWh is now considered economically recoverable and less than 0.6 TWh is produced by existing plants.
2. Most designs, existing or proposed, have opted for a single tidal basin to create hydraulic heads and propeller turbines to extract energy therefore.
3. Linked and paired basins have also been considered.
4. As a result, installed capacity is underutilized, typical capacity factors tending to fall in the range 0.23 to 0.37.
5. In recent years, commercial acceptance of combined-cycle generation based on combustion turbines has reduced the potential economic and environmental costs of meeting future capacity and energy demands.
6. Under such conditions, competitors will be under strong compulsion to choose plant types having the shortest construction times and the lowest unit capital costs.

**4. Read the text and say whether the statements are true or false.**

1. Results suggest that the potential for economic development is large.
2. Five areas account for well over half of the potentially developable energy.
3. By far the largest tidal plant in service is Rance (France), with a capacity of 240 MW and an annual output exceeding 500 GWh.
4. Linked and paired basins have not been considered.

5. The main obstacle to development is economic.
6. Heads available at the turbine vary throughout each tidal cycle, averaging less than 70% of the maximum.
7. Tidal power is polluting and in this respect not superior to thermal generation.

## WIND ENERGY

Estimates of the electricity that could potentially be generated by wind power and of the land area available for wind energy have been calculated for the United States. The potential electric power from wind energy is surprisingly large. Good wind areas, which cover 6% of the U.S. land area, have the potential to supply more than one and a half times the current electricity consumption of the United States. Technology under development today will be capable of producing electricity economically from good wind sites in many regions of the country. The price of the electricity produced from wind by these advanced turbines is estimated to be competitive with conventional sources of power, including fossil fuels. Because of the increasing competitiveness of wind energy, wind resource assessment will become essential in incorporating wind energy into the nation's energy mix.

Wind turbines are now a relatively common sight across Europe, with countries such as Denmark, the Netherlands, Germany, UK, Spain and latterly France, all investing in wind farms. Offshore wind development, although far less advanced, is the greatest prize in

this field. However, relative costs of offshore compared to onshore are higher.

This project is aimed to demonstrate the economic as well as technical viability of offshore wind energy. The former was achieved through the innovative use of a floating jack-up barge which reduced the time and costs of installation. The latter was achieved mainly through the incorporation of new electronic control systems which improved the compatibility with the grid network, and reduced the need for expensive grid strengthening measures.

Five turbines were installed, about 4 km off the coast of Gotland. Each turbine is rated at 500 kW. The average annual output is some 8 GWh/y, from mean wind speeds of 8 m/s. Rock-socketed steel monopole foundations, to water depths of 5 to 6.5 m were used to secure the turbines. Total construction time was only 35 days. Monitoring of impacts on local flora and fauna, such as the seal population, is also being carried out.

**Active Words and Expressions**

**onshore** – береговий
**Gotland** – о-в Готланд (Швеція)
**estimates** – підрахунки
**to disperse** – розсіювати
**range** – класифікувати
**range** – діапазон, сфера
**mean** – середній
**expose** – піддавати дії
**to assume** – передбачати
**to cause** – викликати
**competitiveness** – конкуренція
**compatibility** – сумісність
**viable** – життєдієвий
**to restrict** – обмежувати
**to prohibit** – забороняти
**floating jack-up** – той, що сам перекидається

## Answer the following questions

1. Why is wind energy available in the USA?
2.In what countries are wind turbines a relatively common sight?

3. What is the aim of the project?
4. How many turbines were installed?
5. What was total construction time?

## Exercises

**1.Translate the following word combinations into Ukrainian:**
wind power; current electricity consumption; wing energy applications; mean wind power density; advanced wind turbine technology; wind power classification; turbine hub height; wind resource assessment.

**2. Translate the following word combinations into English:**
використання енергії вітру; сьогоднішнє споживання електрики; енергія вітру; оцінка ресурсів енергії вітру; висота корпусу турбіни; середня щільність енергії вітру; передова технологія розробки вітряків; застосування енергії вітру.

**3. Translate the following sentences:**
1. Areas designated class 4 or greater are suitable with advanced wind turbine technology under development today. The important factors include the percentage of land exposed to the wind resource and land-use and environmental restrictions.
2. The land area exposed to the wind for each grid cell was estimated based on a landform classification and ranged from 90% for relatively flat terrain down to 5% for mountainous terrain.
3. The amount of potential electricity that can be generated is dependent on several factors, including the spacing between wind turbines, the assumed efficiency of the machines, the turbine hub height, and the estimated energy losses (caused by wind turbine wakes, blade soiling, etc.).
4. The assumptions used for calculating the wind energy

potential per unit of windy land area is given in this article.

**4. Translate the text using a dictionary.**

## Wind Turbines in Low Speed Areas

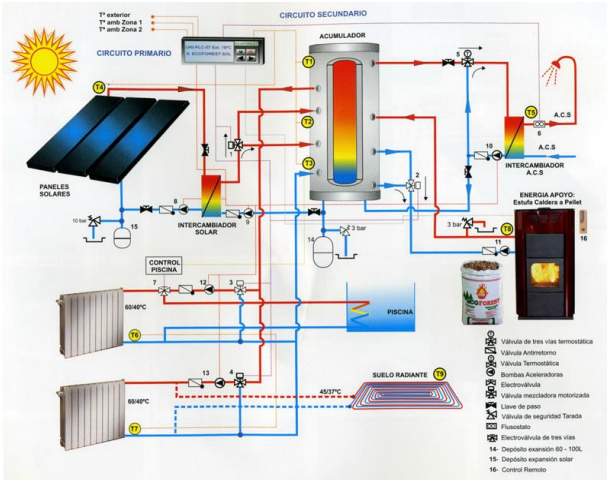
Wind energy developments have, in the past, been concentrated in areas of the world which offer higher than average wind speeds. Often, this means that developments take place in remote and/or sensitive areas. A technology which can increase the economic attractiveness of utilizing sites with lower wind speeds would be invaluable. This project will design, manufacture, install, test and measure the impact of two 1 MW turbines which have been specially adapted for use in low wind speed areas. The aim is to increase power production by up to 22%, compared to a standard turbine, mainly through the technological adaptations which allow for an enhanced rotor diameter, with a swept area of 2,830 $m^2$, and an increase in tower height from 50 to 70 m. The new turbine is installed at a site in Central Sweden.

## WAVE ENERGY

Wave energy can be considered as a concentrated form of solar energy. Winds are generated by the differential heating of the earth and, as they pass over open bodies of water, they transfer some of their energy to form waves. Energy is stored in waves as both potential energy (in the mass of water displaced from the mean sea level) and kinetic energy (in the motion of the water particles). The amount of energy transferred and hence the size of the resulting waves depends on the wind speed, the length of time for which the wind blows and the distance over which it blows. Power is concentrated at each stage in the transformation process, so that the original solar

power levels of typically ~ 100 W/m$^2$ can be transformed into waves with power levels of over 1000 kW per meter of wave crest length.

Wave energy converters extract energy from the sea and convert it to a more useful form, usually as fluid pressure or mechanical motion. This requires an interface where the force (or torque or pressure) of a wave causes relative motion between an absorber and a reaction point. There are over 1000 patents for very varied designs of wave energy converters. However, several comprehensive reviews of wave energy show that wave energy is mainly at the R&D stage, with only a small range of devices having been tested or deployed in the oceans.




In comparison with the most other renewable energy technologies, even these deployed devices are at a relatively early stage in their development. This work is leading to more reliable and efficient devices, with corresponding improvements in the economics of wave power generation. It appears that this is a transition time for several technologies as they move from theoretical assessment and small-scale tests to large-scale demonstration and commercial schemes. Many energy and engineering companies are starting to show a growing interest in these technologies. As a result, it is envisaged that within the next five years in wave energy will start to play an increasingly important role complementing other renewable and conventional energy technologies. In addition,

some wave energy devices will see growing use in providing potable water through reverse osmosis.

### Active Words and Expressions

**mean** – середній
**hence** – відповідно
**to require** – вимагати
**to cause** – викликати
**to comprise** – включати
**relative motion** – відносний рух
**deploy** – розміщувати
**shoreline** – берегова лінія
**in height** – по висоті
**to swing** – качатися
**to submerge** – занурювати
**incident wave** – падаюча хвиля
**to draw** – тягнути
**comprehensive review** – всебічний огляд
**to hinge** – прикріплювати
**to envisage** – розглядати
**to complement** – доповнити
**potable water** – питна вода

## Answer the following questions

1. What is the process of wave forming?
2. What does the size of the resulting waves depend on?
3. What is the role of energy converters?
4. How many patents are there for very varied designs of wave energy converter?
5. What stage is wave energy mainly at?
6. What can you say about tapered channel?
7. What is the difference between OWC and pivoting flap devices?
8. When will wave energy start to play an increasingly important role complementing other renewable and conventional energy technologies?

## Exercises

**1.Translate the following word-combinations:**

wave energy wind speed; original solar power levels; wave energy converters; mean sea level; conventional low-head; self-rectifying air turbine; axial-flow turbine; steel pendulum flap; wave power generation.

**2. Find in the text the synonyms of the words:**

to transmit; quantity; space of time; decrease; detailed; include; use; anticipate.

**3. Find in Ukrainian equivalents to the English words and word combinations:**

water particles; wind speed; the length of time; transformation process; crest length; to extract; fluid pressure; interface; absorber; small height; submerged structure; air chamber; axial-flow turbine; rectifying air valves; rectangular concrete box; device; in comparison with.

Невелика висота; поверхня; тиск рідини; поглинач; частки води; порівняно з; швидкість вітру; прямокутний бетонний ящик; виймати; прилад; проміжок часу; повітряна камера; процес перетворення; поглинаюча структура; довжина по гребню хвилі; осьова гідротурбіна; ректифікаційні повітряні клапани.

**4. Translate the text using a dictionary.**

**Titanic Power Needed for a Massive Movie Set**

The production of «Titanic», the Golden Globe Award winning blockbuster. It took seven months to film the movie, which is the largest budget film to date with more than $ 200 million spent. For the most part, the electrical power was used for the major lighting requirements of the evening shots (зйомки) of the ship as it sat in the seven-acre, 17 million gallon (галон = 4,54 л) exterior seawater tank. The task of lighting the 770 foot long replica, only 10 % smaller than the actual ship, took more than about 2 MW. Special effects such as the final stages of disaster, when the ship is separated into two pieces with the front half sinking in 40 feet of water, took for 1 million pound

hydraulic lifts, power by generators, to lift the steel and wood replica to a vertical position.

## GEOTHERMAL ENERGY

One is tempted to talk of the seven ages of geothermal development. From prehistory, natural hot springs have been used by man for bathing and cooking, and there is some evidence of piped systems as early as the 14$^{th}$ century, but the second age - the managed exploitation of heat from the Earth - really began about one hundred years ago with the first piped heating systems in Europe and USA. These were followed closely by the first steps in commercial power generation (as early as 1904 in Italy), which developed quietly but unspectacularly up to the time of World War II. The third age (1950-1970) was a period of slow consolidation, with systems developing slowly but - above all with far greater detailed knowledge of the underground and its exploration emerging, primarily through the oil industry.

The fourth age (1973-1980) was the golden age of geothermal energy. Spurred by the first oil shock and with a solid foundation of geological knowledge, geothermal power stations began to appear in more than 30 countries. During this period, the growth rate of worldwide installed capacity touched 14% per year, and averaged 8.5%. Similar though less spectacular development occurred also in direct geothermal heating applications.

Part of the reason for this enthusiastic development was the reliability of geothermal resources. Unlike the other sustainable energy sources such as wind or solar, geothermal resources provide firm power, 24 hours per day, 365 days per year It is not

unusual to find geothermal plant with annual availability factors in excess of 98%, so load factors can be high, the energy supplied by geothermal is some 3.5 times greater than for wind plant. This firmness in itself can be a considerable asset to the utilities.

There is evidence that this situation is now changing, and that we may be entering into the sixth age of geothermal development - one in which the environmental and other advantages of geothermal development (by comparison with other energy sources, be they fossil or renewable) begin to be recognized by a wider public. If this is true, we can expect this sixth age to merge imperceptibly into a seventh age early in the next century when new technologies - for which the research started in the 1970's - will extend the opportunities for geothermal usage to geographically and technically wider areas.

Recently, several large-scale arrays have been installed to feed larger systems where suitable supplies of deep geothermal water are not available. In the largest development to date, 4000 units - each with its own borehole - have been established on a US Army base in Louisiana to provide heating and cooling. While the main activity is currently in the USA, there are a growing number of installations in Canada, Sweden, Switzerland, Austria and Germany Smaller numbers are being installed in other European countries, and in Australia. The Geothermal Heat Pump Consortium currently has over 750 institutional, corporate and commercial members and 40 international members from countries including Australia, Canada, China,

Croatia, Finland, Germany, India, Japan, the Netherlands, Poland, Russia, Sweden, Turkey, and the UK.

The concept was developed independently in the US and Europe and, although Sweden and Switzerland have installed many thousands of units to provide winter heating in houses, the pace of installation in the USA and Canada during the last fifteen years has overtaken the European rate. There are now believed to be well over a quarter of a million installations in place in North America.

Not only are the better geothermal zones increasingly well understood, but techniques of exploration and interpretation are becoming increasingly sophisticated - thanks, again, to the hydrocarbons industry which relies on essentially the same range of technologies. Geothermal really strong point, however, is its potential to be environmentally friendly.

By operating geothermal systems as a closed loop, and reinjection the contaminants along with the cooled water, the environmental impact can be reduced almost to zero.

**Active Words and Expressions**

**evidence** – очевидність
**to emerge** – з'являтися
**to spur** – підганяти
**to appear** – з'являтися
**to occur** – відбуватися
**advantage** – перевага
**recognize** – визнавати
**asset** – цінний внесок
**inject** – вводити
**sophisticated** – складний
**to reduce** – скорочувати
**a close loop** – замкнений контур

## Answer the following questions

1. What do you know about prehistory of natural hot springs?
2. When was the golden age of geothermal energy? What do you know about it?
3. What are the positive sides of geothermal energy?
4. How many units have been established in Louisiana?

5. What countries are the members of the Geothermal Heat Pump Consortium?
6. What are the benefits of geothermal technology?

## Exercises

**1.Translate the following word combinations into Ukrainian:**
geothermal development; natural hot springs; commercial power generation; the growth rate; worldwide installed capacity; sustainable energy sources; annual availability factors; load factors; fossil fuel supplies; high initial capital investment; high interest rates; the environmental impact.

**2. Translate the following word combinations into English:**
обґрунтовані джерела енергії; потужність, встановлена в усьому світі; темп зростання; високі відсоткові ставки; розвиток геотермальної енергетики; природні гарячі джерела; щорічні коефіцієнти готовності; вплив на довкілля; коефіцієнти навантаження; запаси викопного пального; високе початкове вкладення капіталу; рентабельне виробництво електрики.

**3. Find suitable attributes for the nouns:**
development; generation; power; plant; impact; environmental; wind; hot; power; firm; springs; rate; factors; risk; water; cooled; geothermal; geological; growth; load.

**4. Translate the following sentences:**
1.From prehistory, natural hot springs have been used by man for bathing and cooking.
2. For a technology that required a high initial capital investment and achieved its returns in terms of saving on fossil fuels, that was bad news.
3. By operating geothermal systems as a closed loop, and

reinjection the contaminants along with the cooled water, the environmental impact can be reduced almost to zero.

4.There are now believed to be well over a quarter of a million installations in place in North America.

5.The Geothermal Heat Pump Consortium currently has over 750 institutional, corporate and commercial members and 40 international members from countries including Australia, Canada, China, Croatia, Finland, Germany, India, Japan, the Netherlands, Poland, Russia, Sweden, Turkey, and the UK.

## ATOMIC ENERGY

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

At present, coal is the most important fuel and our basic source of energy. It is quite possible that some day coal and other fuel may be replaced by atomic energy. Atomic energy replacing the present sources of energy the latter will probably find various new applications. As for coal, it is not only a fuel and it will therefore never lose its importance. We cannot do without it and it may find some other important applications. For example, coal will be used to get various products.

The nuclear reactor will possibly be one of the reliable furnaces producing atomic energy. Being used to produce energy, the reactor produces it in the form of heat. In other words, atoms splitting in the reactor, heat are developed. Gas, water, melted metals, and some other liquids circulating through the reactor carry that heat away. The heat may be carried to pipes of the steam generator containing water.

The resulting steam drives a turbine, the turbine in its turn driving an electric generator. So, we see that a nuclear power station is like any other power station but the familiar coal-burning furnace is replaced by a nuclear one. However, a ton of uranium (nuclear fuel) can give us as much energy as 2.5 to 3 million tons of coal.

The first industrial nuclear power station in the world was constructed in Obninsk, Kaluga region 26 June 1954. It was equipped with uranium – graphite channel reactor water coolant AM-1 (abbreviated AM originally meant “atom of the sea”) because the reactor was designed for the transport apparatus, but its dimensions were too large and it was decided to use this reactor for civil energy. The idea of core design of the station was offered by I. Kurchatov with Professor S. Feinberg, chief designer was Academician N. Dollezhal. It has already been working for many years. One may mention here that the station in question was put into operation two years earlier than the British one and three and a half years earlier than the American nuclear power stations.

The reactor of Obninsk atomic power plant in addition to producing energy served as the basis for experimental research and to produce isotopes for medical needs. Operating experience of the first, in fact the experimental nuclear power plant fully confirmed engineering solutions proposed by the experts of the nuclear industry, which allowed embarking on an ambitious program to build new nuclear power plants.

Currently Obninsk nuclear power plant is decommissioned. Its reactor was drowned April 29, 2002, successfully worked almost 48 years. Reactor shutdown was caused by scientific and technical inconvenience of its further exploitation. On the basis of Obninsk nuclear power plant was created the museum of nuclear energy.

The first nuclear installation where thermal energy generated in the reactor is transformed directly into electric energy.

**Active Words and Expressions**

**achievement**– досягнення
**installation**– обладнання
**atomic**– атомний
**power station** – електростанція
**coal** – вугілля
**to construct** – зводити
**to contain** – містити у собі
**contribution** – внесок
**reliable** – надійний
**reactor** – реактор
**steam** – пара
**in question** – про який йде мова
**to put into operation** – вводити в експлуатацію

## Answer the following questions

1.What is the difference between potential and kinetic energy?
2. What sources of energy do you know?
3. What form of energy can be changed into another form?
4. What are the industrial uses of electricity?
5. Can you name the device which changes chemical energy into electrical energy?

6. What is the difference between a battery and a generator?
7. What may coal be replaced by in future?
8. When was the first industrial nuclear power station put into operation?

## Exercises

**1. Translate the following sentences and define the functions of the participle:**

1. Working at his new device, the inventor made numerous experiments. 2. We have been speaking about the peaceful uses of atomic energy. 3. In future the nuclear reactor must be one of the most reliable furnaces producing atomic energy. 4. Atomic energy being developed in a reactor in the form of heat, we can get both heat and power. 5. The construction of power stations operating on atomic fuel and generating electric current is quite necessary. 6. Being a source of heat and power, atomic energy can also serve as a source of useful products. 7. The energy sources of the world decreasing, it is necessary to turn to atomic energy. 8. Water falling from its raised position changes potential energy into kinetic energy.

**2. Find a pairs of antonyms:**

a) possible, useful, to construct, present, largest, unlimited, to increase, to lose;

b) past, impossible, to find, useless, limited, smallest, to destroy, to decrease.

**3.Fill in the blanks with prepositions:**

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

is used directly... present. 7. Our scientists made a great contribution ... nuclear engineering.

**4. Translate the following sentences paying attention to the words in bold type:**

1. Modern civilization ***needs*** more and more electricity. 2. You ***needn't*** go to the laboratory today. 3. The energy ***needs*** in industry are increasing day by day. 4. People ***needn't*** use kerosene lamps today. 5. ***What*** do we ***need*** electric energy for? 6. Cold ***turns*** water into ice. 7. The sun, ***in its turn, turns*** ice into water. 8 The turbines are ***turned*** by steam, gas and water. 9. ***In their turn***, turbines ***turn*** generators. The teacher says: "It is your ***turn*** to read." 11. When you enter a dark room, ***turn*** the light ***on, and*** leaving it ***turn*** the light ***off.***12. It is possible ***to turn*** solar energy ***into*** electric energy owing to semiconductors.

## SOLID FUELS

In this field, technical improvements in terms of thermal efficiency play a vital role in fostering market penetration of new systems. In the solid fuel sector much attention has been paid to the so-called "clean coal technologies". This is due to recognition of the continuing importance of this fuel, especially in developing countries, but coupled with the need to improve the environmental and thermal performance of the combustion process.

Most large scale conventional power plants have net thermal efficiencies in the order of 38% for hard coal and 35% for brown coal. New systems are being developed which are aimed at increasing this, over the medium-term, to at least 50%. This will result in a reduction of 0.21 kg of $C0_2$ per kWh generated

per hard coal, and 0.34 kg/kWh generated for brown coal. In the EU countries alone, this equates to a $C0_2$ reduction of 180 million tons per year; in line with targets set in the context of the climate change debate. This increased efficiency leads to lower fuel costs per unit of output, thought to equate to a reduction of some 2.5 EU/MWh in generating costs. For a 1 such plant operating for 7,000 hours a year, this means a theoretical annual cost cutting potential of about ECU 18 million for consumers.

## OIL AND GAS

The key priorities in this sector are to improve the efficiency of exploration and production of hydrocarbons and to reduce the environmental impact of the same. Some of the most important new technologies that have contributed to the objectives are related to: new drilling and completion techniques, new seismic methods such as multi-component and multi-dimension seismic, offshore production structures and facilities. New techniques for deep water storage and new technologies for natural gas exploration and production. Demonstration and market deployment of such technology will allow not only a better exploitation of European indigenous resources but also an increased competitiveness of European service and supply companies.

### Gate 2020 - Gas Advanced Technology for Europe 2020

This project will assess existing and emerging technologies for the supply and utilization of natural gas in Europe. A research and development strategy will be identified which, if implemented, could accelerate the trend of increasing use of natural gas. Increased use of gas would result in reductions in emissions of $C0_2$; this project will assess the possible benefits of

such a scenario to the economy, the environment and industry. The technology areas that will be studied include: gas production and processing, gas transportation, LNG (liquefied natural gas), vehicles powered by natural gas, gas liquids and underground storage. Dissemination of the results of the research will encourage cooperation among European companies and organizations to develop natural gas technologies and take part in industrial initiatives.

**Active Words and Expressions**

**vital role** – життєва роль
**foster** – заохочувати
**to aim** – націлювати
**multi-dimension** – багатомірний
**equate** – урівнювати
**exploration** – дослідження
**dissemination** – поширення
**implement** – виконувати
**liquefy** – перетворювати на рідину
**deployment** – розгортання

## Answer the following questions

1. Why has much attention been paid to the so-called “clean coal technologies”?
2. What thermal efficiencies do most large scale conventional power plants have?
3. What does increased efficiency lead to?
4. What are the most important new technologies in oil and gas sector?
5. What will the project Gate 2020 assesses existing and emerging technologies for?

## Exercises

**1.Translate the following word combinations into Ukrainian:**
technical improvement; thermal efficiency; a vital role in; recognition; continuing importance; thermal performance; combustion process; conventional power plant; net efficiency;

lower fuel costs; are related to; indigenous resources; research and development strategy; would result in; gas production and processing; to encourage.

**2. Translate the following word combinations into English:**

визнання; процес згоряння; тепловиробність; важлива роль; заохочувати; зростаюча важливість; добуток та переробка газу; призведе до; практичний ККД; природні ресурси; більш низькі ціни на паливо; стратегія дослідження та розробки; пов'язані з; електростанція на традиційних джерелах енергії; дуже важливо; технічні вдосконалення.

**3. Give Ukrainian equivalents of the following word combinations:**

market penetration; solid fuel sector; environmental and thermal performance; large scale conventional power plants; net thermal efficiencies; climate change debate; theoretical annual cost cutting potential; offshore production structures; deep water storage; natural gas exploration; natural gas technologies.

**4.Finish the sentences according to the text:**

1. In the solid fuel sector much attention …
2. Most large scale conventional power plants …
3. …production of hydrocarbons and to reduce the environmental impact of the same.
4. New techniques for deep water storage and …
5. … utilization of natural gas in Europe.
6. Increased use of gas would result …
7. The technology areas that will be studied include …
8. … to develop natural gas technologies and take part in industrial initiatives.

# ELECTRIC POWER PLANTS

The two main types of power plants traditionally have been the fossil-fuel steam-electric plant and the hydroelectric plant. Other types, including internal-combustion-engine plants and nuclear plants also have been built. The selection of a particular type of generating plant and its location involves consideration of a number of factors such as plant, fuel, and transmission line costs; availability of cooling water; and environmental considerations.

For several reasons, the relative importance of the various types of power plants has been shifting. Good sites for new hydroelectric plants have become scarce in many countries. Distribution networks have been extended so that less expensive power from large steam-electric stations has been replacing power from smaller diesel-generator units. Nuclear-electric power plants have been built instead of fossil-fuel steam-electric plants because the cost of coal and oil has been increasing.

For example, in the United States in 1970, fossil-fuel steam-electric plants accounted for 76% of the power generated, hydroelectric plants for 16%, and nuclear plants for 2%.

In 2000 45% of the electric power in the United States is generated from fossil-fuel steam-electric plants, 45% from nuclear plants, and 10% from hydroelectric plants.

## Answer the following questions

1. What kinds of power plants are in use nowadays?
2. What does the selection of a type of generating plant depend

on?

3. For what reason are nuclear-electric power plants being built instead of fossil-fuel steam-electric plants?
4. What can you say about situation in the USA?

## Exercises

**1. Finish the sentences according to the text:**

1. …steam-electric plant and the hydroelectric plant.
2. For several reasons, the relative importance…
3. Distribution networks have been extended so…
4. …the cost of coal and oil has been increasing.
5. For example, in the United States in…

**2. Complete the sentences using the required prepositions:**

*according to, because of, through, of, at, for, by, during, in, in case of, into.*

1. The power transmitted ... a wire is the product... the voltage times the amperage. ... resistive losses, it is desirable to transmit power ... low amperage and high voltage.
2. ... doubling the voltage, the capability ... a given circuit can be quadrupled.
3. Devices are classed ... the operation they are intended....
4. This type ... aerial is useful and popular ... its small size.
5. ... a faulty device its readings are not to be relied ...
6. Coal and oil contain sulfur ... concentrations ... a few percent.
7. As these fuels are burned, the sulfur is converted ... sulfur-dioxide gas.
8. ... the operation ... a plant, the sulfur-dioxide and other products are discharged ... the air stacks, some ... which are about 305 meters high.

**3. Translate the following sentences:**

1. The ammeter is the very instrument to measure the electric current. 2. To heat a body we place it in contact with another body at a higher temperature. 3. We expect most bodies to expand when heated. 4. Under such conditions laboratory testing is assumed to expand rapidly. 5. Having been used for a long time, the instrument partly lost its former efficiency. 6. The pressure range being beyond the limits of the existing diagram, data have been calculated by other means. 7. Drawing curves gives us a means of showing the relation existing between the two constants. 8. Wishing to find out the cause of the fault, they examined the device in all its details. 9. The charge due to the presence of these electrons is called space charge.10.We know of copper having been used as a conductor owing to its suitable characteristics.

## WIND – POWER SYSTEMS

The Earth is unevenly heated by the sun resulting in the poles receiving less energy from the sun than the equator does. Also, the dry land heats up (and cools down) more quickly than the seas do. The differential heating drives a global atmospheric convection system reaching from the Earth's surface to the stratosphere which acts as a virtual ceiling. Most of the energy stored in these wind movements can be found at high altitudes where continuous wind speeds of over 160km/h (100 mph) occur. Eventually, the wind energy is converted through friction into diffuse heat throughout the Earth's surface and the atmosphere.The total amount of economically extractable power available from the wind is considerably more than present human power use from all sources.

## Distribution of wind speed

The strength of wind varies, and an average value for a given location does not alone indicate the amount of energy a wind turbine could produce there. To assess the frequency of wind speeds at a particular location, a probability distribution function is often fit to the observed data. Different locations will have different wind speed distributions.

Because so much power is generated by higher wind speed, much of the energy comes in short bursts. The consequence is that wind energy from a particular turbine or wind farm does not have as consistent an output as fuel-fired power plants; utilities that use wind power provide power from starting existing generation for times when the wind is weak thus wind power is primarily a fuel saver rather than a capacity saver. Making wind power more consistent requires that various existing technologies and methods be extended in particular the use of stronger inter regional transmission to link widely distributed wind farms since the average variability is much less; the use of hydro storage and demand-side energy management.

## Electricity Generation

Electricity generated by a wind farm is normally fed into the national electric power transmission network. Individual turbines are interconnected with a medium voltage (usually 34.5 kV) power collection system and communications network. At a

substation, this medium-voltage electrical current is increased in voltage with a transformer for connection to the high voltage transmission system. The surplus power produced by domestic micro generators can, in some jurisdictions, be fed back into the network and sold back to the utility company, producing a retail credit for the consumer to offset their energy costs.

Induction generators, often used for wind power projects, require reactive power for excitation so substations used in wind-power collection systems include substantial capacitor banks for power factor correction. Different types of wind turbine generators behave differently during transmission grid disturbances, so extensive modeling of the dynamic electromechanical characteristics of a new wind farm is required by transmission system operators to ensure predictable stable behavior during system faults. In particular, induction generators cannot support the system voltage during faults, unlike steam or hydro turbine-driven synchronous generators (however properly matched power factor correction capacitors along with electronic control of resonance can support induction generation without grid). Doubly-fed machines, or wind turbines with solid-state converters between the turbine generator and the collector system, have generally more desirable properties for grid interconnection. Transmission systems operators will supply a wind farm developer with a grid code to specify the requirements for interconnection to the transmission grid. This

will include power factor, constancy of frequency and dynamic behavior of the wind farm turbines during a system fault.

## Capacity

Electricity generated from wind power can be highly variable at several different timescales: from hour to hour, daily, and seasonally. Annual variation also exists, but is not as significant. Because instantaneous electrical generation and consumption must remain in balance to maintain grid stability, this variability can present substantial challenges to incorporating large amounts of wind power into a grid system. Intermittency and the non-dispatchable nature of wind energy production can raise costs for regulation, incremental operating reserve, and (at high penetration levels) could require an increase in the already existing energy demand management, load shedding, or storage solutions or system interconnection with HVDC (high-voltage direct current – line) cables. At low levels of wind penetration, a fluctuation in load and allowance for failure of large generating units requires reserve capacity that can also regulate for variability of wind generation.

In particular geographic regions, peak wind speeds may not coincide with peak demand for electrical power. In California and Texas, for example, hot days in summer may have low wind speed and high electrical demand due to air conditioning. Some utilities subsidize the purchase of geothermal heat pumps by their customers, to reduce electricity demand during the summer months by making air conditioning up to 70 % more efficient; widespread adoption of this technology would better match electricity demand to wind availability in areas with hot summers and low summer winds. Geothermal heat pumps also allow renewable electricity from wind to displace natural gas

and heating oil for central heating during winter, when winds tend to be stronger in many areas.

### Active Words and Expressions

**wind power** – енергія вітру
**electricity consumption** – споживання електрики
**wind resources** – ресурси вітру
**grid** – енергетична система
**wind turbine** – вітряк
**install** – встановлювати
**turbine weight** – вага турбіни
**wind farm** – вітряна електростанція
**turbine hub** – корпус турбіни
**power density** – щільність розсіюваної потужності
**turbine wake** – наслідки аварії турбіни
**blade soiling**– пошкодження лопаті

## Answer the following questions

1. In what countries are wind turbines a relatively common sight?
2. What generators are often used for wind power projects? What do they require?
3. What is grid management system?
4. What are the essential timescales?
5. What points and aspects should be taken into consideration before installation of the project?
6. What ecological impact is noticeable?

## Exercises

**1. Translate the following word-combinations:**

wind areas; current electricity consumption; wind energy recourses; wind energy applications; mean wind power density; advanced wind turbine technology; future generation technology; wind energy development; wind electric potential; turbine hug height; energy losses; wind resource assessment.

**2. Finish the sentences according to the text:**

1. Most of the energy stored in these wind movements can be…
2. The strength of wind varies, and an average value…
3. Making wind power more consistent requires that various existing…
4. Individual turbines are interconnected with…
5. …capacitor banks for power factor correction.
6. Electricity generated from wind power can be…
7. …of wind power into a grid system.
8. In particular geographic regions…
9. …by making air conditioning up to 70 % more efficient.
10. Geothermal heat pumps also allow renewable electricity from wind to…

**3.Translate the text using a dictionary:**

**Water-pumping windmill**

Humans have been using wind power for at least 5,500 years to propel sailboats and sailing ships, and architects have used wind-driven natural ventilation in buildings since similarly ancient times. The use of wind to provide mechanical power came somewhat later in antiquity.

In the United States, the development of the «water-pumping windmill» was the major factor in allowing the farming and ranching of vast areas of North America, which were otherwise devoid of readily accessible water. They contributed to the expansion of rail transport systems throughout the world, by pumping water from wells to supply the needs of the steam locomotives of those early times. The multi-bladed wind turbine atop a lattice tower made of wood or steel was, for many years, a fixture of the landscape throughout rural America.

**4.Write sentences about the past.**

1. He always goes to work by car. Yesterday … 2. They always get up early. This morning they … 3. Bill often loses his keys. He … last Saturday. 4. I write a letter to Jane every week. Last week … 5. She meets her friends every evening. She … yesterday evening. 6. I usually read two newspapers everyday. … yesterday. 7. They come to my house everyday. … last week. 8. We usually go to the cinema on Sunday. … last Sunday. 9. Tom always has a shower in the morning. … last morning. 10. They buy a new car every year. Last year … 11. I eat an orange every day. Yesterday … 12. We usually do our shopping on Monday. … last week.

## HYDROELECTRIC POWER PLANTS. HYDROELECTRICITY

Hydroelectric power plants are built on rivers. Large-capacity hydroelectric power plants are commonly located at considerable distances from the consumers of electric power.

The production process at these plants is rather simple: the water flows into the hydroturbine runner, acts upon the runner blades and rotates the runner and the turbine shaft.

The generator shaft is connected to the turbine runner shaft. The difference in the water level influences the power capacity of a plant, i.e. the magnitude of the water head and the daily inflow of water fluctuate considerably according to the season.

The production process is different at power plants of different constructions and of different kinds. In atomic power plants, for example, it is not so

simple as in hydroelectric plants.

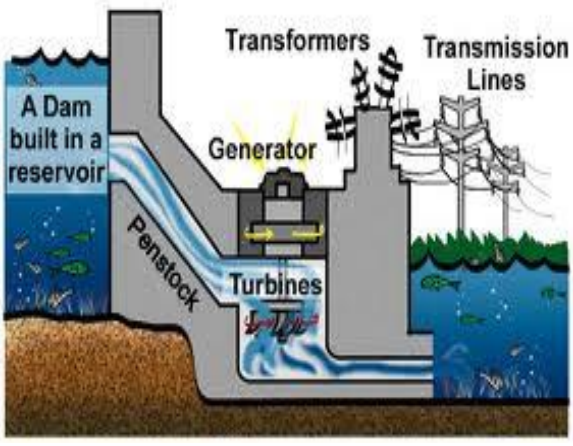
Hydroelectric power now supplies about 19% of world electricity. Large dams are still being designed. Apart from a few countries with an abundance of hydro power, this energy source is normally applied to peak load demand, because it is readily stopped and started. It also provides a high-capacity, low-cost means of energy storage, known as «pumped storage».

Hydropower produces essentially no carbon dioxide or other harmful emissions, in contrast to burning fossil fuels, and is not a significant contributor to global warming through $CO_2$.

Hydroelectric power can be far less expensive than electricity generated from fossil fuels or nuclear energy. Areas with abundant hydroelectric power attract industry.

The chief advantage of hydroelectric dams is their ability to handle seasonal (as well as daily) high peak loads. When the electricity demands drop, the dam simply stores more water (which provides more flow when it releases). Some electricity generators use water dams to store excess energy (often during the night), by using the electricity to pump water up into a basin. Electricity can be generated when demand increases. In practice the utilization of stored water in river dams is sometimes complicated by demands for irrigation which may occur out of phase with peak electrical demands.

Not all hydroelectric power requires a dam; a run-of-river project only uses part of the stream flow and is a characteristic of small hydropower projects.




There are some considerations

in a micro-hydro system installation. The amount of water flow available on a consistent basis, since lack of rain can affect plant operation. The more head, the more power that can be generated. There can be legal and regulatory issues, since most countries, cities, and states have regulations about water rights and easements.

Over the last few years, the U.S. Government has increased support for alternative power generation. Many resources such as grants, loans, and tax benefits are available for small scale hydro systems.

In poor areas, many remote communities have no electricity. Micro hydro power, with a capacity of 100 kW or less, allows communities to generate electricity. This form of power is supported by various organizations such as the UK's Practical Action.

Micro-hydro power can be used directly as «shaft power» for many industrial applications. Alternatively, the preferred option for domestic energy supply is to generate electricity with a generator or a reversed electric motor which, while less efficient, is likely to be available locally and cheaply.

**Active Words and Expressions**

**blade** – лопать
**level** – рівень
**magnitude** – величина
**head** – верхівка
**plant** – станція
**runner** – ротор
**shaft** – привод, вал
**rotate** – обертатися
**to influence** – впливати
**fluctuate** – коливатися
**hydropower** – гідроенергетика
**evaporate** – випаровуватися
**runoff** – об'єм
**deposit** – осаджувати
**to account for** – нараховувати
**a great deal of** – велика кількість

**residential customer** – побутовий споживач

**abundant** – у величезній кількості

## Answer the following questions

1. On what sites are hydroelectric power plants built?
2. Are large-capacity plants located far from consumers of power?
3. Is the production process at the plants simple or is it complex?
4. What influences the power capacity of a plant?
5. According to what factors does the daily inflow of water fluctuate?
6. Does the production process at the plant depend on its construction?

## Exercises

**1. Say whether the following statements are true or false:**

1. Hydropower provides a high-capacity, low-cost means of energy storage, known as «pumped storage».
2. Hydropower produces essentially carbon dioxide or other harmful emissions.
3. All hydroelectric power requires a dam.
4. There are some considerations in a micro-hydro system installation.
5. Governments of different countries have increased support for alternative power generation.
6. Micro-hydro power can be used for many industrial applications.
7. Hydroelectric power can be far more expensive than electricity generated from fossil fuels.

8. The chief advantage of hydroelectric dams is their ability to handle seasonal high peak loads.

**2.Match the English phrases corresponding to their Ukrainian equivalents:**

| | |
|---|---|
| 1. falling water | 1. велика кількість |
| 2. ultimately | 2. потреби в електроенергії |
| 3. differences | 3. падаюча вода |
| 4. land elevation | 4. обсяг опадів |
| 5. rainfall runoff | 5. повністю |
| 6. energy supply | 6. у великій кількості |
| 7. abundant | 7. відмінність |
| 8. electrical needs | 8. підняття землі |
| 9. a great deal of | 9. енергоресурси |
| 10. consumers | 10. споживачі |

**3.Translate the following sentences with the Gerund:**

1.Hydropower was a clean and environmentally safe method of producing electricity.

2. In this respect, hydropower is better than burning coal, oil or natural gas.

3. Decaying vegetation, submerged by flooding, may give off quantities of greenhouse gases equivalent to those from other sources of electricity.

4. Reservoirs can be used for ensuring adequate water supplies, providing irrigation and recreation.

5. Damming a river can alter the amount and quality of water in the river downstream of the dam, as well as preventing fish from migrating upstream to spawn.

6. These impacts can be reduced by requiring minimum flows downstream of a dam, and by creating fish ladders.

7. Harnessing this resource would require billions of dollars.

**4.Choose the correct word.**

1. Whenever we met, Jack avoided *(to look, looking)* at me. 2. Most people enjoy (*to travel, travelling)*to different parts of the world. 3. Maggie needs *(to find, finding)* another job. Her present company is going out of business. 4. May I change the TV channel, or do you want *(to watch, watching)* more of this program? 5. Lily is considering *(to change, changing)*her major from pre-med studies to psychology. 6. Although Joe slammed on his brakes, he couldn't avoid *(to hit, hitting)* the small dog that suddenly darted out in front of his car. 7. I hope *(to write, writing)* my autobiography before I die. Do you think anyone would read it? 8. Joyce thanked us for *(to invite, inviting)* them to dinner and said that they wanted to have us over for dinner next week. 9. If you delay *(to pay, paying)* your bills, you will only incur more and more interest charges. 10. My lawyer advised me not*(to say, saying)*anything further about the accident.

## NUCLEAR POWER

The EU is producing not only more electricity than ever, but also more favorable consideration as a viable part of the nation's energy mix. Consider that, for the first time, political leaders are proposing nuclear power as an important, long-term energy solution. Even the mainstream media – known for its harsh treatment of the industry – has begun talking in terms of a nuclear industry «renaissance».

The near-term impetus for this turn-around stems from recent events – regional power shortages, increased natural gas costs, and premium market prices for electricity. However, the fact that nuclear power is in the position to be favorable considered

is a result of the substantial performance improvements achieved at US plants during the past decade.

Most important, these performance gains came with equally impressive improvements in safety indicators. The challenge for individual nuclear stations is to continue this idea by solidifying competitive gains already achieved and squeezing further improvements from each unit.

US nuclear plants have done an excellent job of maintaining and improving plant design margins and operating reliability. Extensive monitoring and surveillance testing of plant systems, structures and components such as containment building, reactor vessel, reactor cooling system pressure boundary, steam generators, pressurizer, piping, pump casings and valve bodies are performed yearly to verify the plant is maintained in excellent condition. Few if any nuclear plant components will require replacement specifically to achieve extended operations for an additional 20 years.

Nuclear power is a very clean source of energy and none of our other energy sources are at present time as clean and efficient. But there is always the risk of leaks, explosions and so forth.

It seems that the horror story of Chernobyl still haunts our minds whenever this topic is brought up. And it was a terribly tragic accident that destroyed the life of not only the people near it but the lives of the whole world’s population generations ahead. This must not happen again. But if we take precautions, build the power plants in a place without risk of earthquakes and

most importantly make sure it is properly funded we can narrow the risk down to almost nothing.

No source of energy is without problems and we have to ask ourselves – do we want to choose nuclear power or do we want oil and coal, that isn't instantly as harmful as nuclear power, but which can't be solved at all.

### Active Words and Expressions

**favorable consideration** – сприятливе судження
**harsh treatment** – жорстке ставлення
**renaissance** – відродження
**impetus** – поштовх
**unusual events** – надзвичайні події
**pressurizer** – компенсатор тиску
**piping** – трубопровід
**energy mix** – структура енергетики
**in the wake of** – під впливом чого-небудь
**performance improvements** – покращення робочих характеристик
**steam generator** – парогенератор
**reactor vessel** – бак ядерного реактора
**pump casing** – корпус насосу
**valve bodies** – корпус вентиля
**containment building** – захисна оболонка ядерного реактора

## Answer the following questions

1. How is nuclear power considered in the US in last decade?
2. What does the near-term impetus for this turn-around stem from?
3. What are extensive monitoring and surveillance testing of plant systems performed for?
4. Will nuclear power prosper in our Ukraine?
5. What can you say about an accident in Chernobyl?

## Exercises

**1. Finish the sentences according to the text:**

1. Political leaders are proposing nuclear power…
2. However, the fact that nuclear power is…

3. US nuclear plants have done…
4. …as clean and efficient.
5. …horror story of Chernobyl…
6. But if we take precautions…
7. No source of energy is without…
8. Chernobyl accident had happened…

**2. Find Ukrainian and English equivalents:**

| | |
|---|---|
| 1. Energy mix | 1.помилка |
| 2. long-term | 2. поступатися |
| 3. to cancel | 3.основні ЗМІ |
| 4. mainstream media | 4.структура енергетики |
| 5. to stem from | 5.походити від |
| 6. premium | 6.падати |
| 7. gains | 7.у гарному стані |
| 8. safety indicators | 8.скасовувати |
| 9.to drop | 9.більш висока ціна |
| 10.to solidify | 10.твердішати |
| 11. to squeeze | 11.змушувати |
| 12. design mergins | 12.крайнє значення |
| 13. in excellent conditions | 13.показники безпеки |
| 14. to rank second | 14.прибуток |

**3.Translate the sentences:**

1. The filament heated, the electrons leave its surface and travel to the plate. 2. Multiplying the mass of a moving body by its velocity, we shall get its momentum. 3. In many instances an apparatus designed for quite a different purpose was adopted, certain changes being made when required. 4. The problem having excited a great deal of discussion, a series of tests had to be carried out. 5. The oil having been exhausted, the engine stopped. 6. There are two diagrams in this figure, one of them

showing the relation between volume and temperature. 7. Working at his new device, the inventor made numerous improvements, the latter resulting from his own experiments. 8. They went on studying the nature of the new phenomenon. 9. There are different means of producing an electric current. 10. We heard of that experiment having been started last week.

**4.Use Present Simple or Present Continuous tense.**

1. I can't afford that ring. It (cost) … too much. 2. Look. It (begin) … to rain. Unfortunately, I (have, not) … my umbrella with me. Tom is lucky. He(wear) … a raincoat. 3. I (own, not) … an umbrella. I (wear) … a waterproof hat on rainy days. 4. Right now I (look) … around the classroom. Ann (write) … in her book. Carlos (bite) … his pencil. Peter (scratch)…his head. Ahmed (stare)…out of the window. He (seem) … to be daydreaming, but perhaps he (think) … hard about verb tenses. What you (think) … Ahmed (do)? 5. There's a book on my desk, but it (belong, not) … to me. 6. Dennis (fix) … the roof of his house today, and he (need) … some help. Can you help him? 7. Barbara often (tutor) … other students in her math class. This afternoon she(help) … Steve with his math assignment because he (understand, not) … the material they (work) … on in the class this week. 8. Right now I (look) … at Janet. She (look) … angry. I wonder what's the matter. She (have) … a frown on her face. She certainly (have, not) … any fun right now.

## ATOMIC POWER PLANT

Atomic power plants are modem installations. They consist of several main units and a great number of auxiliary ones.

In a nuclear reactor uranium is utilized as a fuel. During

operation process powerful heat and radioactive radiation are produced. The nuclear reactor is cooled by water circulation. Cooling water circulates through a system of tubes, in which the water is heated to a temperature of 250-300°C. In order to prevent boiling of water, it passes into the reactor at a pressure up to 150 atmospheres.

A steam generator includes a series of heat exchangers comprising tubes. The water heated in the reactor is delivered into the heat exchanger tubes. The water to be converted into steam flows outside these tubes. The steam produced is fed into the turbogenerator.

Besides, an atomic power plant comprises a common turbogenerator, a steam condenser with circulating water and a switchboard.

Atomic power plants have their advantages as well as disadvantages. The reactors and steam generators operate in them noiselessly; the atmosphere is not polluted by dust and smoke. As to the fuel consumption, it is of no special importance and there is no problem of fuel transportation. The disadvantage of power plants utilizing nuclear fuel is their radiation. Radioactive radiation produced in the reactors is dangerous for attending personnel. Therefore, the reactors and steam generators are installed underground. They are also shielded by thick (up to 1.5 m) concrete walls. All their controls are operated by means of automatic devices. These measures serve to protect people from radioactive

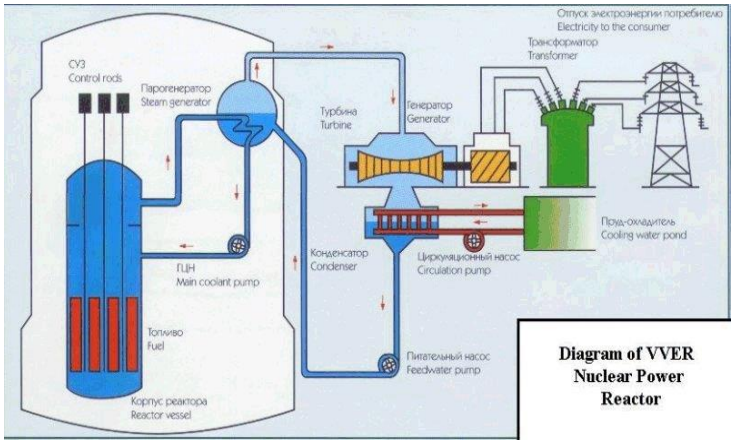



**Diagram of VVER Nuclear Power Reactor**

radiation.

Any operating nuclear power plant releases fission products into the environment, which causes environmental pollution.

To prevent the harmful effects of nuclear power release, the nuclear power plants are supplied with protective installations that serve as barriers to the pollution. First, the nuclear fuel and the fission products are confined within sealed tubes made of stainless steel or zirconium. Then the assembly of tubes is placed in a steel reactor vessel. And finally the steel reactor vessel is placed in a large steel and concrete housing.

As to the hot radioactive waste products they are disposed in heavily shielded cylinders. The cylinders are buried 305 to 610 meters underground.

**Active Words and Expressions**

**exchanger** – теплообмінник
**steam** – пара
**tube** – труба, лампа
**dust** – пил
**to deliver** – постачати
**to pollute** – забруднювати
**attending personnel** – обслуговуючий персонал
**dispose**– усувати
**to shield** – захищати
**concrete** – бетон
**fission** – розщеплення
**stainless** – нержавіюча сталь
**steel vessel** – посудина
**waste** – відходи
**to confine** – уміщувати
**to release** – вивільняти
**withstand** – протистояти

## Answer the following questions

1. What are the main units of an atomic power plant?
2. By what means is the nuclear reactor cooled?
3. At what pressure does the water pass into the reactor?
4. What types of power plants pollute the air with dust and smoke?
5. Why is it necessary to protect attending personnel?
6. What kind of products does the operating nuclear power

plant release?

7. What installations are used to prevent the harmful effects of a nuclear power plant operation?
8. What material are the tubes made of?
9. Where are the fission products confined?
10. In what part of the installation is the reactor vessel placed?
11. In what way are the hot radioactive waste products disposed?

## Exercises

**1. Translate the following words and word-combinations:**

auxiliary units; heat exchanger; the polluted atmosphere; utilized nuclear fuel; shielded concrete walls; fuel consumption; steam generator; nuclear fuel; nuclear fission; steel vessel; reactor vessel; fission release; sealed tubes; concrete housing; waste products; nuclear waste; shielded cylinders.

**2. Finish the sentences:**

1. A nuclear reactor is used in…
2. A nuclear reactor is cooled by…
3. Water is passed into the reactor…
4. High pressure…
5. Atomic power plants…
6. Attending personnel is shielded by…
7. A nuclear power plant releases…
8. The protective power plant installations…
9. The fission products are confined…
10. The waste products are disposed…

**3. Give the English equivalents of the prepositions:**

1. The energy ***(для)*** a nuclear power plant comes ***(з)*** the heat released ***(під час)*** fissioning of uranium ***(в)*** a nuclear reactor.
2. There are two main differences ***(між)*** a nuclear power plant

and a steam-electric power plant. 3.The nuclear power plant uses a nuclear fuel ***(замість)*** a fossil fuel, and it uses a reactor ***(замість)*** a boiler.4***.(З-за)*** their high fuel consumption gas turbines are more expensive to operate than steam turbines.5.The radioactive pollution produced ***(в)*** a reactor has all three forms: gaseous, liquid and solid.6.The beta particles are dangerous for man ***(тому, що)*** they penetrate deep ***(в)*** the matter.

**4**. **Translate the following sentences:**

1. Radium is said to be one and a half million times more radioactive than uranium. 2. Tests have shown the thermometer to be very sensitive. 3. The oscillator referred to above seems to deliver only a small amount of power. 4. The instrument to be described here was designed several years ago. 5. To analyze this effect is to take into consideration all the elements of the circuit. 6. To analyze this effect we shall consider all the circuit elements. 7. We expected the discovery to produce great changes. 8. To explain that the formula given here are correct, it is necessary to study them first. 9. To explain why the formulas given here are correct would require considerable time.10. The apparatus to be designed is to be used at the power station.11. This type of engine is said to have some advantages.12. To find out the state of a mass of a gas is quite possible.

## THERMAL POWER STATION

A modern thermal power station is known to consist of four principal components, namely, coal handling and storage, boiler house, turbine house, switchgear. Besides the principal components mentioned above there are many additional parts of

the plant. The most important of them is the turbo-generator in which the current is actually generated.

A steam turbine requires boilers to provide steam. Boilers need a coal-handling plant on the one hand and an ash-disposal plant on the other. Large fans are quite necessary to provide air for the furnaces. Water for the boilers requires feed pumps. Steam must be condensed after it has passed through the turbines, and this requires large quantities of cooling water. The flue gases carry dust which must be removed by cleaning the gases before they go into the open air.

A modern thermal power-station is equipped with one or more turbine generator units which convert heat energy into electric energy. The steam to drive the turbine which, in its turn, turns the rotor or revolving part of the generator is generated in boilers heated by furnaces in which one of three fuels may be used – coal, oil, or natural gas. Coal continues to be the most important and most economical of these fuels.

**Active Words and Expressions**

**coal handling** – подача вугілля,топка
**boiler house** – бойлерна
**furnace** – піч
**fuels** – паливо
**switchgear**– розподільче обладнання
**storage** – база, склад
**turbine house** – турбінний зал
**pump** – насос

## Answer the following questions

1. What are the main components of the thermal power station?
2. What is the most important fuel for these stations?
3. What can you say about environmental impact of these stations?
4. Name thermal power stations in your region and explain the great use of them.

## Exercises

**1. Complete the sentences according to the text:**

1. A modern thermal power station consists of …
2. The most important part is …
3. A steam turbine requires …
4. Boilers need two kinds of plants, they are …
5. The flue gases carry dust which …
6. The modern thermal power station is equipped with …
7. ...one of three fuels may be...
8. ...most economical of these fuels.

**2. Form nouns by adding the suffixes *-er, -or.***

to work, to invent, to compose, to calculate, to operate, to act, to react, to emit, to transmit, to use, to combine.

**3. Form adverbs from adjectives by adding the suffix *-ly:***

easy, reasonable, usual, special, physical, functional, real, regular, magnetical, different, logical, mathematical, subsequent, consequent.

**4. Look up the meanings of these words in a dictionary, if necessary. Translate them. Mind the word order.**

***place, iron, lift, house, light, heat, use, form, change, wire***

1. The conductor wires are placed high up.
2. Electromagnets lift iron weights.
3. The plastic box houses the conducting and the insulating elements of the apparatus.
4. The house is lighted and heated by solar energy.
5. The light went out. Light the candle, please.
6. After the metal was heated it changed its color to a red heat.
7. Numerous changes are taking place in the uses of atomic energy.

8. Electric power is used universally.
9. The newly made invention has a great number of uses.
10. The wire and the source form a circuit.

## THERMAL STEAM-TURBINE POWER PLANTS

Large steam-turbine plants have two forms: condensing plants or electric power plants.

The great masses of hot steam, having accomplished the mechanical work in the turbines of condensing steam-turbine plants, are condensed, i.e. are cooled down and turned back into distilled water, and returned to the boiler for production of steam to activate the turbine.

Condensation of steam takes place in condensers where the hot steam is cooled when it comes in contact with tubes through which cold water, supplied from a water reservoir (river or lake), is circulated. This cooling water, after it takes the heat from the spent steam, is returned to the water source carrying along with it the unutilized heat energy. This water is called the circulating water. The importance of the distilled water for feeding steam boilers is extremely great since chemically clean water decreases the formation of scale in the boiler tubes, and, thus, makes their service life longer.

Condensing plants of large generating capacity are built close to sources of fuel, in order not to transport large quantities of fuel over considerable distances. The electric power generated in such plants is transmitted over long distances for the supply of large industrial regions. So these plants are called regional thermal power plants. Heat and electric power plants, in addition to electric power generation, also supply heat to closely

located consumers (within a radius of 50 km), i.e. serve as district heat plants. To such heat consumers belong to all kinds of industrial enterprises that require heat for production purposes, and also municipal consumers such as baths, laundries and the heating systems of dwelling houses and other buildings.

The electric power developed by the generators is fed to the switchboard of the plant, whence it is delivered by overhead transmission and cable lines to the consumers.

## Answer the following questions

1. In what part of the power plant does condensation of steam take place?
2. Why is distilled water used for feeding steam boilers?
3. How closely does an electric power station located to consumers?
4. What kinds of industrial enterprises that require heat for production purposes do you know?

## Exercises

**1. Complete the sentences according to the text:**

1. …condensing plants or electric power plants.
2. …in the turbines of condensing steam-turbine plants.
3. Condensation of steam takes place in…
4. The importance of the distilled water for…
5. …are built close to sources of fuel…
6. The electric power generated in…
7. …closely located consumers (within a radius of 50 km).
8. The electric power developed by the generators is fed to…

**2.Translate the negative sentences into Ukrainian:**

1. No charges can move in an open circuit. 2. Nothing less than a map of the Universe is planned by the research. 3. No special

equipment is necessary to carry out the experiment.4. A current which does not change its polarity is called a direct current. 5. A dry battery is a type of a small battery containing no free liquid. 6. The efficiency of a machine can never be greater than unity; it is often given as a percentage.7. Electrically safe locations are those where conditions causing extremely high danger of electric shock do not exist.8.No electric device has only advantages. All of them have also disadvantages.

**3. Choose the correct form:**

1. The aluminium plant is a **(*consumer, consumption)*** of the ***(local, locally)*** generated electric power. 2. The ***(new, newly)*** built shops are ***(importance, important)*** for the future of the power plant. 3. Nuclear energy is energy released during a nuclear ***(reactor, reaction)*** as a result of ***(convertible, conversion)*** of mass into energy. 4.Uranium is a ***(comparison, comparable, comparatively)*** rare element. 5. The most ***(importance, important)*** problems in ***(atom, atomic)*** power ***(generator, generation)*** are connected with the reactor. Reactor ***(technologist, technology)*** is still in ***(progressive, progress). 6.*** The light-water reactor types seem most ***(usefulness, usefully, useful)***.

**4. Look up the meanings of these words in a dictionary, if necessary. Translate them. Mind the word order.**

| |
|---|
| *balance, amount, cause, increase* |
| *water, fuel, control, measure,* |

1. The fuel-and-energy balance is important for industry.
2. Conductivity increases with heating.
3. The machine should be re-fuelled.
4. The amount of power used in the world in a year amounts to 12,000 million tons of equivalent fuel.

5. Water barriers are crossed by submarine cables.
6. The instrument is foot-controlled by a pedal.
7. Force and motion go together; one is a cause, the other, a result.
8. An electromotive force causes the electrons to move.
9. Control of the apparatus is placed on the panel.
10. The volt is a measure of electromotive force.

## THE ROLE OF ELECTRICITY AND ITS FUTURE APPLICATION

At a time when communication technologies are becoming ever more essential for uniting knowledge and making fast decisions, one third of the earth's inhabitants – nearly 2 billion people – still have no access to a modern energy source. The implications of energy over the coming twenty years are wide and varied and will include issues as crucial as economic development and political stability in numerous countries, safeguarding our local and global environment, controlling global warming, social equity, achieving a balance between rural and urban development policies and so on. Briefly, sustainable human development.

Whether we are in charge of policy or the economy, it is our joint responsibility to place the issue of access to clean and cost-effective electricity for all at the centre of the much-needed debate to determine nor only what type of progress, democracy and humanism, but also

what type of development, our generation will bequeath to the generations yet to come. We should consider the conditions for access to electricity, not in terms of sustainable economic, social and political development for all the inhabitants of this planet.

Wide disparities in access to affordable commercial energy threat to social stability and counter to the concept of human development. Air pollution and emissions of gases threaten our health, degrade our environment and alter the global climate system. The current consumption of primary energy increases at a rate of 2 % every year, but this growth is very unequal around the world:

– Europe 0, 2 % year;

– USA – Canada 1,4 % year;

– Developing countries 4,5 % year.

If the global growth rate continues, it will mean a doubling of energy consumption by 2035 relative to 1998, and a tripling by 2055. Energy consumption is bound to increase.

Physical resources and technical opportunities are available to meet the challenge of sustainable development, but it requires policy changes, such as:

– more effective use of energy (buildings, electric appliances, vehicles, production processes);

– increased reliance on renewable energy sources;

– accelerate development and deployment of new energy technologies;

–as well as taking into account the costs of the various solutions.

**Active Words and Expressions**

**to make fast decisions** – приймати швидкі рішення

**access** – доступ

**unite knowledge** – об’єднувати знання

**issue** – проблема

**essential**– важливий, суттєвий
**implication** – залучення
**varied** – різноманітний
**safeguard** – гарантувати
**treat** – загрожувати
**to take into account** –брати до уваги
**renewable** – той, що поновлюється
**social equity** – соціальна рівність
**sustainable** – стійкий
**to be in charge of** – опікуватися
**determine** – визначати
**responsibility** – відповідальність
**to meet the challenge** – прийняти виклик
**bequeath** – заповідати

## Answer the following questions

1. What issues will the implications of energy include?
2. What is our joint responsibility?
3. What can alter the global climate system?
4. What policy changes are required forphysical resources and technical opportunities?

## Exercises

**1. Complete the sentences according to the text:**

1. At a time when communication technologies are becoming ever more essential...
2. ...to clean and cost-effective electricity for all...
3. We should consider the...
4. ...to the concept of human development.
5. The current consumption of primary energy increases...
6. Physical resources and technical opportunities are available to...

**2. Distribute the words into four columns.**

***Model:*** **what?(use)** **what to do?(to use)**
**what kind of ? (useful)** **how?(usefully)**

insulator, failure, fail, addition, additional, overestimate, equal, equalize, equality, equally, different, differ, difference, resist, resistance, resistivity, resistant, commonly, consumer, faulty,

impossibility, carelessly, number, numerous, possible, clockwise

**3. State the voice and the tense form of the following verbs.**

*Model:* was removed - Past Indefinite Passive

| | |
|---|---|
| is discharged | extends |
| was being discharged | does not maintain |
| has discharged | is not maintained |
| had not been attached | will be linked |
| is circulating | will release |
| will not be heated | will have been removed |

**4. Change the sentences into questions:**

1. There are various types of nuclear reactors.
2. The use of underground transmission lines must be increased.
3. The fuel can be enriched uranium.
4. The fission heat is used to generate steam, which drives a turbine generator.

## INTERNATIONAL COOPERATION

Since the oil crises of the 1970's international cooperation has become an increasingly important factor in energy policy for most countries of the industrial world. It arose from the need to cope effectively with the disruptive impact of oil-price increases on the economy.

International cooperation has contributed substantially to the formulation and application of concerted actions to reduce dependency on oil and respond collectively to emergency situations.

Despite progress, it was soon realized however that energy issues couldn't be solved by industrial countries alone, working in isolation. Nor was it a matter of redistributing energy

resources and proceeds from oil-trade between oil producing and consuming countries. Energy policy can no longer be applied without due attention to the realities of an increasingly interdependent world economy, in which long-term issues, like the environment, population growth and the advancement of less developed countries raise serious concerns.

Consequently, international energy cooperation has been included as an integral part of the energy policy of the European Union. The need to strengthen cooperation is further underlined by recent events and developments taking place within as well as outside the Union. In the first place, policy objectives and priorities have concentrated on the establishment of a Single Market to include the energy sector, as a means towards increasing availability and reducing the cost of energy supplies throughout the Union. Given the energy situation prevailing in most of the Member States, attaining this objective depends heavily on the extent to which energy relations with other countries can be promoted and secured. The specific European Union Programme concentrates on the transfer of energy policy know-how and strategies to Third Countries with the following approach:

– the global objective of securing energy supplies at reasonable prices;

– facilitating collaboration between European companies and major energy producing and consuming industries in third countries;

– protection of the environment from industrial pollution.

Despite recent economic setbacks, many of the newly emerging world economies are being fuelled by massive increases in energy use and this will have significant repercussions on the environment.

The energy environment interrelation is subsequently very important and has been reflected in many cooperation activities, particularly in the area of clean coal technologies or renewable energy sources such as wind, small hydro, solar, photovoltaic, solar thermal and biogas.

Energy cooperation should function in close collaboration with both national administrations and regional organisations. Such cooperation not only contributes to economic development but also to peace and stability for the countries.

### Active Words and Expressions

**to cope with** – справлятися з чимось
**disruptive impact** – руйнівний вплив
**interdependent** –взаємозалежний
**a matter of** – справа
**reasonable prices** –розумні ціни
**economic setback** – економічний спад
**interrelation** – взаємозв'язок
**to have repercussions on** –мати вплив на
**reduce dependency** – скоротити залежність
**to facilitate collaboration** – сприяти співробітництву
**industrial pollution** – промислове забруднення
**emerge** – з'являтися
**contribute to economic development** – робити внесок в економічний розвиток

### Answer the following questions

1. Why has the international cooperation become an increasingly important factor in energy policy for most countries of the industrial world?

2. What is the need to strengthen cooperation further underlined by?
3. Why couldn’t energy issues be solved by industrial countries alone?
4. What does the specific EU Programme concentrate on?
5. What’s the core problem?

## Exercises

**1. Complete the sentences according to the text:**

1. International cooperation has...
2. Energy issues couldn’t be solved...
3. Energy policy can no longer be...
4. ...policy of the European Union.
5. The specific European Union Programme concentrates on...
6. Despite recent economic setbacks, many of...
7. ...such as wind, small hydro, solar, photovoltaic, solar thermal and biogas.
8. Energy cooperation should function in close...

**2. Find in the text the English phrases:**

ефективно справлятися з; деструктивний вплив на; зменшувати залежність від; реагувати на екстрені ситуації; забезпечення енергопостачання; викликати серйозну стурбованість; за розумними цінами; тісно співпрацювати з; робити внесок в економічний розвиток; організація із захисту енергоресурсів.

**3. Put three questions to the each of the sentences.**

1. Electric charges are acted upon by forces when they move in the magnetic field.
2. Copper has been used as a conductor since the beginning of the industry.

3. Nuclear reactors decrease air and land pollution but they increase thermal and radiation pollution.

**4. Use the required tense form and translate the sentences.**

1. The experiment ***(repeat)*** many times. 2. The power which ***(radiate)*** as light is almost three times as great as that radiated as heat. 3. It ***(know)*** that iron molecules are magnets at all times. 4. Under ordinary room lightning the resistance of transistors ***(decrease)*** millions of times. 5. Ruby crystals about ten centimeters long can ***(intensify)*** light ten times. 6. The density of a semiconductor laser radiation ***(be)*** hundreds of times as great as that of the ruby laser. 7. The power which ***(transmit)*** along a wire is the product of the voltage times the amperage.

## UNION'S EUROPEAN PROGRAMME

EUP supports the progression of improved non-nuclear energy technologies through demonstration and market penetration. The focus of the Programme component is on the demonstration and promotion of clean and efficient energy technologies in three board areas:

– renewable energy sources;
– rational use of energy in buildings, industry and transport;
– cleaner and more efficient use of fossil fuels and more effective exploration, distribution and transportation of hydrocarbons.

At the core of the aims of the European Union as a whole, are three central objectives. First, to help promote economic growth and create employment. Second, to improve the competitiveness of our industries. Third, to protect our environment and contribute towards sustainable development. New energy


technologies can make an important contribution towards achievement of these objectives. A more efficient use of resources, such as fuels and electricity, helps to improve the relative cost-effectiveness of our industries and hence the goods and services they make and sell. As the recent economic crisis in the Far East has shown, the world is truly a global village. Likewise, our industries across the EU are intrinsically connected to the ebbs and flows of international markets. The technologies supported under programme like THERMIE have contributed to a more efficient use of resources, thus reducing costs and making the companies more competitive. The indicator commonly used to measure the efficiency of energy use in the industrial sector is that of energy consumption per unit of output, known as energy intensity.

Investment in new technologies can also have an impact in another area, namely that of employment creation. Many of the technologies supported by initiatives such as THERMIE are more labor intensive than their conventional competitors, either in manufacturing and installation, or in operation and maintenance. Thus, investing in these applications, and the firms that produce them, allows for a contribution towards employment creation. Moreover, many of the jobs created are highly skilled or are located in priority areas.

Investing in technology to stimulate economic growth is not sufficient, in itself, to meet our objectives. We must also work towards promoting sustainable development and protection of our environments. The emphasis on clean and efficient

technologies can make a substantial contribution towards achievement of these aims. All of the technologies and applications supported under THERMIE offer access to zero or low emissions of gases such as $CO_2$, the main greenhouse gas.

In the Solid Fuel sector, for example, the advanced coal technologies supported within THERMIE offer access to substantial reductions in emissions of greenhouse gases and those responsible for acid deposition. A recent analysis by the European Commission sought to quantify these savings.

As a consequence of the investments made in new technologies, and changing patterns of energy supply, the Member States of EU, and the EU itself, are contributing to lowering the emissions of greenhouse gases. The investments made from EU funds can help a project partner in many different ways. Firstly, the mechanism allows for the creation of a vehicle to support the exchange of information and experience between companies and organizations across the EU and beyond. Second, the impact of the European funding is to stimulate projects, which wouldn't otherwise have gone ahead, or to the same extent.

Technical performance is another key area where the Programme's initiatives have been focused. In this case, the impact of THERMIE has been improved the reliability and efficiency of the technologies and applications, so as to encourage their market deployment.

**Active Words and Expressions**

**to support** – підтримувати
**penetration** – проникнення
**at the core** – у центрі
**objective** – ціль
**employment** – зайнятість, робочі
**creation** – створення
**substantial** – важливий, значний
**to promote** – сприяти
**deployment** – розгортання
**ebbs and flows** – припливи та

місця
**impact** – вплив
**exchange** – обмін
**cost-effectiveness** – витрати-ефективність (економічний показник)
відливи
**to sight** – побачити, роздивитися
**vehicle** – засіб
**experience** – досвід
**intrinsically** – в дійсності

## Answer the following questions

1. What is the focus of the programme?
2. What are three central objectives at the core of the aims of the European Union as a whole?
3. What impact can investment in new technologies also have?
4. What can the emphasis on clean and efficient technologies make?
5. How can the investments made from EU funds help a project partner?

## Exercises

**1. Translate the following word combinations:**

improved non-nuclear energy technologies; clean and efficient energy technologies;renewable energy sources; energy intensity; employment creation; acid deposition; market deployment.

**2. Complete the sentences according to the text:**

1. The focus of the Programme…
2. At the core of the aims of the European Union…
3. New energy technologies can…
4. As the recent economic crisis in…
5. …technologies supported under programme like THERMIE…
6. …of employment creation.
7. The emphasis on clean and efficient technologies can make…
8. …as $CO_2$, the main greenhouse gas.
9. Member States of EU, and the EU itself, are contributing to…

10. Technical performance is another key…

**3.Underline the infinitives in the sentences. Translate them.**

1. To magnetize a body requires some energy.
2. In order to build the power plant near Northfield (USA), three miles of tunnels were drilled.
3. The distance to be covered was equal to ten miles.
4. To reduce the power losses, thick wires should be used.
5. No additional components were used since they were not needed to actuate the relay.
6. Various installations were used in order to transform electric power into mechanical, heat, and chemical power.
7. At least 90 per cent of electric energy to be generated at present is a.c.
8. A.c. can be increased, or decreased to meet industrial requirements.
9. Gas turbines can be started within minutes, while steam plants may require hours to be put into operation.
10. The most important problems in atomic power generation are known to be concerned with the reactor. The light-water reactor types seem to be most promising.

**4. Use Participle I, Participle II or the Gerund of the verb in brackets and translate the sentences.**

1. **(*Cool)*** an electric conductor results in its reduced resistance to electric current.
2. What is the name of an **(*insulate)*** material ***(use)*** to prevent an electric shock?
3. The ***(apply)*** technique brought about quite unexpected results.
4. Mica is used as a dielectric due to ***(have)*** high voltage strength.
5. The world's first tidal power station, a plant on the Rene

River in France, began ***(operate)*** in 1966.

6. Solar energy has been converted to electricity by ***(use)*** solar cells, which are semiconductor devices ***(produce)*** from thin slices of silicon.

## ENVIRONMENT SHOULD BE OUR COMMON CONCERN

Society which turns its back on nature is doomed. Many people today believe that the dominant forces of global society are, in fact, ignoring Nature's needs.

Everywhere the natural environment is being overexploited, weakened and soiled. Man uses atmosphere as both a resource and a place for depositing wastes. He takes from atmosphere oxygen as a necessary ingredient for his industrial activities and for his own biological processes. He returns to it a mixture of gases and solids, the by-products of combustion, respiration.

The historical development of urbanization and industrialization has produced geographical regions where the natural balance is disturbed. Evidence abound that the dangers of uncontrolled industrialization are leading to the pollution of lakes and rivers and human tragedies like those which occurred in Bhopal (India), where thousands of people died as a result of a deadly gas leak from a chemical plant in 1984, or at Chernobyl atomic power plant in 1986. Just as obvious are the large - scale loss of tree cover, soils and biological diversity as a result of uncontrolled economic development, and the

horrors of chemical warfare and nuclear power testing. We have all experienced the result: air pollution, a shortage of drinking water, the ruin of forests, soil degradation and etc. As a result people are affected directly or indirectly.

Some effects are direct and evoke physiological response (eye irradiation, respiratory diseases), other effects are indirect, but nonetheless disturbing. Women, for instance, have learned that their breast milk is contaminated with dioxin, that pesticides and herbicides are present in ground water. They are told that the life-giving sun is becoming dangerous due to a weakened ozone layer, that children everywhere are vulnerable to genetic disorders caused by contaminated environments.

As the planet's natural resources diminish, and a growing world population increases demands on those resources, competition for access to them will escalate. This struggle for limited resources will result in a new resource wars.

The major environmental threat to life on Earth is the weakening of ozone layer. The Earth's ozone shield – the vital layer of the atmosphere - protects all living creatures from the damaging effects of the Sun's rays. Recent scientific research proved data that the protective layer of ozone around our planet is under severe attack. The major cause of weakening of the ozone layer is believed to be increasing amount of harmful chemicals that are being released into the atmosphere by mankind. Many scientists warn that the chemicals in spray cans also add to the destroying of the Earth's ozone shield. Scientists stress that a further one per cent drop in the overall ozone layer can cause an increase of skin cancer.

The air contamination due to man's economic activity is bringing mankind to the greenhouse effect. It appears when CO

and certain other gases in the atmosphere allow the sun's ultra-violet rays to penetrate and warm the earth but then absorb the infrared energy the earth radiates back into space forming a kind of thermal blanket around the Earth.

Acid rains and forest fires play their role in the destruction of forests. As a consequence the ruin of forests brings about ecological disaster. Machine tillage of the soil affects its natural fertility, while the ever-growing application of fertilizers and pesticides damages nature by changing the ecological conditions of human habitation.

Environmental protection is a task requiring the joint efforts of the entire world population, of government agencies, and public organizations of the world over.

**Vocabulary notes**

1. to turn one's back on – повернутися спиною до…
2. evidence abounds that – є багато доказів того, що…
3. deadly gas leak – витік смертельного газу
4. the large-scale loss of tree cover – широкомасштабна втрата лісового покриття
5. chemical warfare and nuclear power testing – хімічна війна і ядерні випробування
6. is under severe attack – перебуває під суворою руйнівною дією
7. one per cent drop in the overall ozone layer – падіння на 1% усього озонового шару

**Active Words and Expressions**

**oxygen** – кисень
**combustion** – згоряння
**by-product** – побічний продукт
**to be doomed** – бути приреченим
**global society** – світове суспільство

**respiration** – дихання
**response** – реакція
**diversity** – різноманітність
**spray cans** – аерозолі
**disease** – хвороба
**vulnerable** – уразливий
**acid rain** – кислотний дощ
**severe** – суворий
**ultra-violet** – ультрафіолетовий
**aggravate** – погіршувати
**necessary ingredient** – необхідна складова
**natural balance** – природна рівновага
**skin cancer** – рак шкіри
**human habitation** – житло людини
**thermal blanket** – теплова ковдра
**tillage** – обробіток землі

## Answer the following questions

1. Does ignoring nature cause positive consequences?
2. What does man use atmosphere?
3. How do urbanization and industrialization affect nature?
4. Can you name facts of negative consequences of economic activity?
5. What can air pollution cause?
6. What are the major environmental threats to life on earth at present?
7. What is the major cause of the ozone layer weakening?
8. When does the greenhouse effect appear?
9. How do acid rains affect our environment?
10. What can make environmental protection more effective?

## Exercises

**1. Translate the following word-combinations:**

natural environment, industrial activity, biological process, natural balance, uncontrolled industrialization, atomic power plant, chemical warfare, nuclear power testing, air pollution, life-giving sun, ozone shield, protective layer, harmful chemicals, air contamination, greenhouse effect, acid rains, environmental protection.

**2. Finish the sentences according to the text:**

1. Man uses atmosphere as both a…
2. The historical development of urbanization…
3. …in Bhopal (India), where thousands of people died as a result of…
4. …air pollution, a shortage of drinking water, the ruin of forests, soil degradation and etc.
5. As the planet's natural resources diminish, and a growing…
6. The major environmental threat to life on Earth…
7. …is believed to be increasing amount of harmful…
8. The air contamination due to man's economic activity is…
9. Acid rains and forest fires play…
10. …by changing the ecological conditions of human habitation.

**3. Write the translation of the following text:**

**Lead**

Lead is naturally present, in small amounts, in soil, rocks, surface waters, and the atmosphere. Due to its unique properties it has been an element widely useful to human. This utility has resulted in greatly elevated lead concentrations in certain ecosystems. Locations where lead is being mined, smelted, and refined, where industries are consuming lead, and in urban-suburban complexes the environmental lead level is greatly elevated. It is widely agreed that a primary source of these latter sites in the combustion of gasoline containing lead additives. Other important sources include coal combustion, burning or attrition of lead-painted surfaces, and industrial processes.

The atmospheric lead particles are found to be widely distributed over all parts of the earth. The input of lead, it's

cycling within forest ecosystems, its transfer in food chains, and its residence in soil received considerable research attention.

**4. Put 4 types of the questions to the sentences:**

1. The major environmental threat to life on Earth is the weakening of ozone layer.
2. Many people were affected by Chernobyl catastrophe.
3. Plants and animals fail to live without oxygen.
4. Industrial enterprises must use filters for exhaust gases to be purified.

## CHERNOBYL ACCIDENT

The accident, which was of global concern, was the accident in Ukraine in the Chernobyl power plant located in Polesye on the River Pripyat. It is considered the worst nuclear power plant accident in history and is the only level 7 event on the International Nuclear Event Scale.

On 26 April, 1986, Unit 4 of the Chernobyl nuclear plant suffered a major accident. The Chernobyl 4 reactor was a graphite-moderated, light-water-cooled system. The installed electrical generating capacity was 1 GW. The accident followed some engineering tests of a generator.

During the tests, basic operating safety rules were being violated. Most control rods were withdrawn from the core and the safety systems were switched off. Two explosions and a fire that followed them damaged the reactor and the containment building. The graphite started to bum. Explosive energy was released, which resulted in the 1000 ton cover plate of the

reactor being lifted up.

The fire inside Reactor 4 continued to burn until 10th of May; it is possible that well over half of the graphite burned out. The fire was extinguished by a combined effort of helicopters dropping over 5,000 metric tons of materials like sand, lead, clay, and boron onto the burning reactor and injection of liquid nitrogen. Ukrainian filmmaker Vladimir Shevchenko captured film footage of a Mi-8 helicopter as it collided with a nearby construction crane, causing the helicopter to fall near the damaged reactor building and kill its four-man crew.

A prolonged release of large quantities of radioactive products transported by the cloud from Chernobyl was detected not only in northern and southern Europe but also in Canada, Japan, and the USA.

The major part of the release took place over the period of about ten days. There were two peaks in release rate (26th April and 5th May). Later on, the release continued for many weeks at a lower rate before the destroyed reactor was finally sealed, which took place some five months later.

Initially the cloud of radioactive material was carried over the Baltic Sea into Scandinavia. After a few days the wind direction rotated clockwise and the cloud travelled eastwards across the USSR and southwards to Turkey.

The total mass of the radioactive particles released in the accident was about 6000-8000 Kg. More than half of it was deposited near the plant but the rest travelled thousands of kilometers. Great damage was done to their economy, nature and people’s health. The problem of

Chernobyl has not been solved yet because of the economic difficulties that Ukraine is having now. The power plant was closed on December 15, 2000.

There is no doubt that the nuclear plant accidents offer a number of lessons to be learnt.

At present, over 200 nuclear power reactors for commercial electricity production operate in Europe.

The accident at the Chernobyl nuclear plant has shown that large-scale accidents in nuclear power plants can lead to contamination of the entire continent.

## Answer the following questions

1. What was the cause of the Chernobyl accident?
2. What was the path of the radioactive material released in the accident?
3. What can accidents at the nuclear plants lead to?
4. What Vladimir Shevchenko was doing near the atomic power station?

## Exercises

**1. Finish the sentences according to the text:**

1. The Chernobyl 4 reactor was a…
2. During the tests, basic operating…the graphite started to bum.
3. …until 10$^{th}$ of May; it is possible that well over half of the graphite burned out.
4. …over 5,000 metric tons of materials like sand, lead, clay, and boron onto the…
5. Ukrainian filmmaker Vladimir Shevchenko captured film footage of a Mi-8 helicopter as…
6. …but also in Canada, Japan, and the USA.
7. Initially the cloud of radioactive material…

8. …was about 6000-8000 Kg.
9. …on December 15, 2000.
10. …can lead to contamination of the entire continent.

**2. Translate the following sentences into Ukrainian:**

1. For many centuries the problem of air pollution was not paid attention to. 2. We ought to protect the environment for it is in danger of human activity. 3. Industrial enterprises must use filters for exhaust gases to be purified. 4. The ecosystem has a definite role to play for an overall balance has to be maintained. 5. Plants and animals fail to live without oxygen. 6. Many countries on the globe fail to fight man-made pollution. 7. The experiment was very tedious but they failed to get the desirable results. Transportation devices all over the world fail to prevent air from exhaust gases pollution. 8. Their attempt to make this experiment failed.9. The problem of environmental protection is very important, a special committee having been set up under the UNO. 10. The development of modern industry is likely to be accompanied by the development of wasteless production. 11. Concentration of CO happens to be rather high in air. 12. Primitive man appeared to disturb the balance of nature by farming and cattle breeding.

**3. Match the English words with their definition:**

| | |
|---|---|
| 1. Environment | a) an area set aside for preserving nature |
| 2. Fauna | b) organism’s physical and biological surroundings |
| 3. Flora | c) warming of temperatures around the world |
| 4. Garbage can | d) layer of gases that surrounds the earth |
| 5. Global warming | e) animals or animal life |

| | |
|---|---|
| 6. Climate | f) plants or plant life |
| 7. Atmosphere | g) aspects of the weather (rainfall, light, air movement) |
| 8. Biosphere | h)you can even kill with this dangerous thing |
| 9. Litter | i)to continue to be alive after coming close to death |
| 10.Pollution | j) to make dirty air, water, everything around us |
| 11.Smog | k) rain polluted by chemicals |
| 12. Species | l) it may be nuclear, industrial, dangerous |
| 13. Acid rain | m) a result of people's bad actions in nature |
| 14. To pollute | n) mixture of smoke and fog |
| 15. Waste | o) a group of similar types of animals or plants |
| 16. To poison | p) garbage like food, paper and cans |
| 17. To survive | q) waste bin |

**4. Give the synonyms of the following words:**

| | |
|---|---|
| disaster | rule, law |
| to occur | to throw away |
| contaminated | radioactive |
| core | to turn off, to scram |
| shut down | to exaggerate |
| to require | sick, dirty |
| regulation | to take place |
| to eject | catastrophe |

# CHERNOBYL NUCLEAR POWER STATION

On April 26, 1986 one of the history's worst nuclear accident occurred at the Chernobyl Nuclear Power station in Ukraine. At 1:23 AM, technicians at the plant allowed the power in the 4th reactor to fall to low levels as part of a controlled experiment, which went terribly wrong. The reactor overheated and caused a meltdown of the core. This resulted in an explosive force of steam, which blew off the lid of the reactor. Large amounts of the radioactive materials were released into the atmosphere. The reactor-4 explosions released more radioactivities that the atomic bombs dropped on Hiroshima and Nagasaki during World War II. Most of the discharged material was deposited close by as dust and debris, but wind carries the lighter radioactive material over the Ukraine, Belarus, Russia and parts of Europe.

The operator's over-confident decision-making, a flaw in the design of the reactor and inadequate safety systems are believed to be the major factors that caused the Chernobyl disaster. Many people were affected by this catastrophe. The accident caused 31 immediate deaths that were mainly the result of exposure the radiation. The main casualties were among those who fought the fires caused by the explosion. Once the fires were extinguished, a liquidating crew of around 200,000 people was initially employed to clean up the site. Later the number swelled to 600,000. This crew was exposed to high doses of radiation, which might affect their health in the long run.


Many children in the surrounding areas are developed thyroid cancer due to the radiation emitted. Many Ukrainians, Russians and Belarusians were evacuated and later given new homes in a different area.

Today reactor-4 is buried in cement tomb which was quickly built in order to allow the other reactors at the power station to continue working. However, this shelter is not strong and will not last and there are plants to replace it. Many people have suffered in some way as a result of the Chernobyl disaster and millions of dollars are still being spent today to contain reactor-4 and assure that no further radiation leakage occurs.

**Active Words and Expressions**

**core** – ядро, серцевина
**casualty**– жертва
**lid** – покриття
**crew** – команда
**to release, deposit** – випускати
**to clean up** – прибирати
**to leak** – витікати
**dust and debris** – пил, уламки
**to enclose** – огороджувати
**lack** – недолік
**flaw** – тріщина
**explosion** – вибух

## Exercises

**1. Choose the right variant.**

**1. The Chernobyl disaster is thought to be …**

a) as serious as Hiroshima and Nagasaki bombings;
b) a minor accident with no future consequences;
c) one of many similar accidents;
d) Europe’s greatest catastrophe.

**2. When the Chernobyl-4 reactor overheated …**

a) technicians turned it down;
b) it melted the core;

c) the power plants was filled with steam;
d) it sealed the lid of the reactor shut.

**3. One of the causes of the accident was …**

a) the raising of the power in 4th reactor to high levels;
b) a design faults;
c) the installation of proper safety back-up systems;
d) the technicians lack of confidence.

**4. The 4th reactor explosion resulted in the …**

a) spread of the heavier radioactive material by the wind;
b) immediate death of 200,000 people;
c) release of dust and debris into the atmosphere;
d) release of the 4th reactor's cover.

**5. Most of the people who died as a result of the explosion were…**

a) firefighters;
b) members of clean- up crew;
c) operators of the reactor;
d) children.

**6. The members of clean-up crew…**

a) developed thyroid cancer;
b) put out the fires;
c) were subject to high levels of radiation;
d) were unharmed by the radiation.

**7. Reactor-4…**

a) is steel leaking radiation;
b) is enclosed in cement;
c) will be replaced in future;
d) cost millions of dollars.

**2. Finish the sentences according to the text:**

1. …Chernobyl Nuclear Power station in Ukraine.
2. The reactor overheated and…
3. The reactor-4 explosions released more radioactivities that…
4.…radioactive material over the Ukraine, Belarus, Russia and parts of Europe.
5. The accident caused 31 immediate deaths…
6. Many children in the surrounding areas…
7.Today reactor-4 is buried in cement tomb which…
8. …that no further radiation leakage occurs.

**3. Translate the following sentences:**

1.Сьогодні проблеми навколишнього середовища найбільш важливі для сучасного суспільства.
2.Забруднення води, грунту та радіоактивне забруднення шкодять природі.
3.Учені вважають, що людська діяльність змінює клімат нашої планети та руйнує його.
4.Тільки зараз ми зрозуміли, що наша планета знаходиться під загрозою і це - наша провина.

**4. Put 4 types of the questions to the sentences:**

1. After the Chernobyl tragedy thousands of people greatly suffered from radiation.
2. Lake Baikal is the deepest freshwater lake on the Earth.
3. Modern plants and factories send a lot of smoke into air.

## LOMONOSOV

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

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

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

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

studied.

Lomonosov possessed an unusual capacity for work. His scientific activity lasted but 25 years but in these 25 years he carried out an extraordinary amount of useful, educational work in various fields of scientific and cultural life. He carried on scientific research in natural sciences 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 Russia?» One more question «Who built the first glass-making factory in Russia?» It was Lomonosov, of course!

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

**Active Words and Expressions**

**amount** – кількість
**as a result**– в результаті
**matter** – речовина
**momentum** – рушійна сила

**to experience** – випробовувати
**heat** – тепло
**in addition to** – окрім того
**to last** – тривати
**law** – закон
**light** – світло
**natural** – природній
**nevertheless** – тим не менш
**numerous** – багаточисельний
**on the basis of** – на основі
**theory** – теорія

## Exercises

**1. Form questions for the following answers:**

1. In the village of Denisovka.
2. On November 19, 1711.
3. At the age of 19.
4. Yes, I do.
5. No, he did not.
6. At the age of 35.
7. On the basis of molecular and atomic theory.
8. For Russian science and the enlightenment.

**2.Give suitable adjectives to the following nouns:**

*Model:* chemical laboratory

sciences, scientist, current, time, way, winter, want, language, application, activity, theory, cloud, furnace, flash, installation, inventor.

**3. Form nouns from the following verbs:**

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

**4. Translate the following sentences paying attention to the words in bold type:**

1. I like to read **but** I have very little time for reading. 2. My friend speaks of nothing else **but** his examinations. 3. As for the power spent in producing lightning flashes it is but 1/10,000 of the power got by mankind from the sun. 4. The Fahrenheit scale

is used in England, **but** it is not used in Ukraine. 5. We know that a thermometer is used **for** measuring temperature differences. 6.Iwas **sent** for the doctor. 6. These students studied English **for** 2 years.8.Ukrainian scientists and inventors work **for** this country.9.Our professor left **for** Leningrad **for** he is going to work there **for** 3 weeks. 10. It is necessary **for** me to be at home at 6 o'clock. 11. The scientist was observing a new phenomenon for a long time. 12. We need much electricity **for** it is used both in our homes and industry.

**5. Translate the following sentences using the infinitive:**

1.Щоб бути інженером, необхідно багато читати і добре вчитися. 2. Пірометр використовується для вимірювання температури гарячих металів. 3.Людина навчилася розщеплювати атоми для того, щоб отримати велику кількість енергії. 4. Вчені намагаються вирішити проблему, яка пов'язана з новими явищами в електриці. 5. Громовідвід – це металічний пристрій для захисту будівель від блискавки. 6. У ті часи, проводити досліди з атмосферною електрикою, було дуже небезпечно. 7. Намагнітити річ – це означає, розмістити її в полі дії магніту.

## FARADAY'S DISCOVERY

Although for certain purposes we still employ batteries to a limited extent to generate electric current, the usual procedure today is by electromagnetic induction. Great generators in our power stations, driven by powerful turbines, operate through the relative movement of conductors and magnets on a principle discovered by that remarkable man, Michael Faraday in 1831.

Michael Faraday, English experimental physicist, was born in 1791 in a poor family. A bookbinder's apprentice in London, Faraday was a clever boy. In the early part of 1812 he was given tickets to hear a course of lectures by Humphry Davy at the Royal Institution. At the end of the course he bound his notes on the lectures and posted them to the lecturer with a request that he should be appointed to the post of assistant. A few months later, at the age of twenty-two Michael Faraday was appointed to a post at the Royal Institution at 25 shillings a week. Thus, he started on that remarkable career which lasted for nearly half a century, during which he laid the foundation for the electrical age. He became a skilful experimenter and an enthusiastic lecturer. Faraday had many important discoveries. Among them the concept of the magnetic field and the magnetic lines of force, production of new kinds of optical glass, and research on electrolysis.

During the ten years or so before his great discovery, many investigators took a great interest in the connection between electricity and magnetism. It had been definitely established by Oersted's experiment that magnetism could be produced from the electric current. Why, then, could not the process be reversed and the electric current produced from magnetism?

The fulfillment of Faraday's hopes came in the year 1831 as a result of his experiments in the laboratory at the Royal Institution. We can read in his «Laboratory Notes» how, day by day, he carried on different

experiments with wire and coils, permanent bar magnets and magnetic needles with varying results.

On October 17, 1831, he discovered that if he connected a coil of wire to a galvanometer and inserted a magnet into the coil, he obtained a deflection on the galvanometer. The coil consisted of eight windings of copper wire each 27 feet long, the windings being connected in parallel. When he was inserting one end of the magnet into the coil, he noticed that the deflection of the galvanometer continued only for a short time and stopped as soon as the magnet was completely inserted. No current was generated while the magnet remained stationary. When it was taken away, there was a second galvanometer deflection but this time in the reverse direction. In both cases, however, there was a current only during the time when the magnet was moving. Faraday was very modest and he loved his work more than honors. He refused to become President of the Royal Society and also refused to be knighted.

**Active Words and Expressions**

**apprentice** – помічник
**bookbinder** – майстерня з переплетення
**coil** – котушка
**direction** – напрям
**deflection** – відхилення
**induction** – індукція
**knight** – лицар
**refuse** – відмовлятися
**skilful** – досвідчений
**windings** – обмотка

## Answer the following questions

1. What principle was discovered in 1831?
2. When and where was born Michael Faraday?
3. What had happened to him in 1812?
4. At the age of 22 Michael Faraday was appointed to a post at the Royal Institution, wasn’t he?
5. Which important discoveries did he make?

6. What do you know about “Laboratory Notes”?
7. What did he discover on October 17, 1831?
8. Did he become President of the Royal Society?

## Exercises

**1. Translate the following words and word combinations:**

помічник; майстерня з переплетення книжок;стаття про електрику; квиток на лекцію; робити нотатки; важливе відкриття; оптичне скло; електроліз; механічний рух; відмовлятися; досвідчений експериментатор; мідна проволока; королівське товариство.

**2. Finish the sentences according to the text:**

1. …discovered by that remarkable man, Michael Faraday in 1831.
2. …in 1791 in a poor family.
3. In the early part of 1812 he was ….
4. …be appointed to the post of assistant.
5. He became a skilful experimenter ….
6. During the ten years or so before his great discovery ….
7. We can read in his “Laboratory Notes” how ….
8. He discovered that if he connected a coil….
9. …he noticed that the deflection of the galvanometer continued only for….
10. Faraday was very modest and he ….

**3. Translate the following sentences into Ukrainian:**

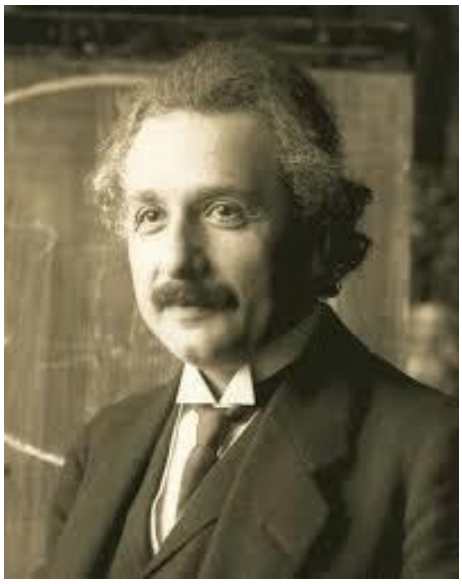
1. Further tests have shown the receiver to be very sensitive. 2. The instrument to be used for testing purposes is similar to that widely applied in the research laboratories. 3. We know of copper having been used as a conductor owing to its suitable characteristics. 4. Copper being a good conductor, we were recommended to use it when carrying on our research work. 5.

In spite of all difficulties encountered the research laboratory succeeded in mastering the method under consideration.

6. At the end of the last century Popov transmitted and received electromagnetic energy over a considerable distance without using any conductors.7.On studying the nature of the new phenomenon, they were not satisfied with the results obtained and started testing various engines.

## EINSTEIN'S TRIUMPH AND TRAGEDY

Albert Einstein was a famous scientist who completely changed the way that people saw our world and the universe. Einstein created many theories which proved that things like gravity, light, energy and matter were connected with each other. At first, very few scientists could understand Einstein's theories but as time passed other scientists showed that he was correct.



Albert Einstein was born in Ulm, Germany in 1879 and grew up in Munich. He wasn't a good student at school and only did things he was interested in, like science and mathematics. At a very early age young Albert started wondering about the mysteries of the universe.

After school Einstein went to Switzerland and tried to become a teacher there, but he couldn't find a job. He went to work at the Swiss patent office in Bern where he studied what other people had invented.

After divorce from his first wife, a classmate of his, Albert went to Berlin where he married his cousin Elsa. He lived in

Berlin for a long time and there he developed many of his scientific theories. Einstein became so well-known that he was invited to universities around the world to talk about his discoveries. In 1921 he received the Nobel Prize for Physics.

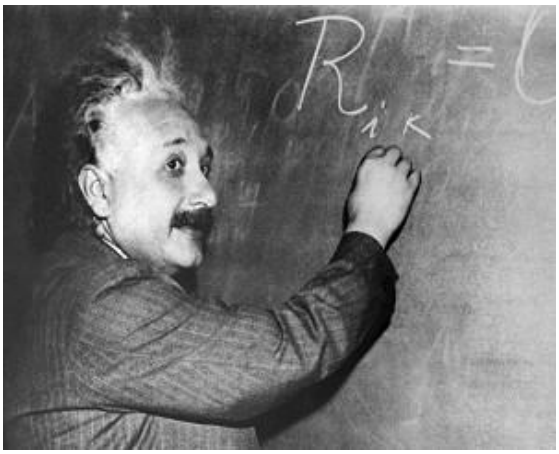
In the meantime things were starting to change in Germany. Einstein was against the Nazis and their ideas of controlling the world and killing Jews. The Nazis, in return, hated him and his theories and they burned most of his books.

Einstein decided to leave Germany and go to the United States. When World War II broke out in 1939 Einstein discovered that German scientists were working on a bomb that could kill thousands of people. He wrote a letter to the American president to warn him and suggested that the Americans start building one too.

In 1941 the American government started the Manhattan project which led to the construction of the atomic bomb. Two of these bombs were dropped over Hiroshima and Nagasaki to end the war against Japan. Einstein was horrified when he heard the news. He wanted the world to use atomic energy for peaceful purposes.

For the last twenty years of his life, Einstein lived in Princeton where he continued his scientific work. He died on April 18, 1955.

Einstein, as everyone knows, did something remarkable, but what exactly did he do? Even among educated men and women, few can answer. We are resigned to the importance of his theory, but we don’t comprehend it. It is this circumstance which is largely responsible for the isolation of modern science. This is bad for us and bad for science; therefore more than curiosity is at stake in the desire to understand Einstein.



Step by step Einstein came to his fateful mass-energy equation. “The mass of a body is a measure of its energy content”, he wrote in 1905, and gave his now-famous formula, $E = mc^2$, where $E$ is energy content, $m$ is mass (which varies according to speed) and $c$ is the velocity of light.

When Einstein was 26, he put forward an idea which changed the world. His idea revolutionized our conception of the physical universe; its consequences have shaken human society.

Einstein’s achievement is one of the glories of man. Unfortunately, the scientist’s great idea first was used not for the benefit of man, but for his destruction. When he realized the ominous consequences of his fatal equation and the responsibility he bore and vehemently protested against the military use of his discovery. But in vain. Besides, it became clear that the benefits of the so-called peaceful use of nuclear energy become also highly questionable. Some great ideas may lead to still greater disasters. This was the triumph and tragedy of the genius.

**Active Words and Expressions**

**benefit** – приносити користь
**comprehend** – осягати
**consequence** – висновки, наслідки
**discovery** – відкриття
**glory** – слава
**meantime** – тим часом
**ominous** – зловісний
**prove** – доводити
**responsible** – відповідальний
**remarkable** – визначний
**velocity** – швидкість
**in vain** – дарма
**vehemently** – стрімко
**universe** – всесвіт

## Answer the following questions

1. When and where was Einstein born?
2. What sciences he was interested in?
3. Where did he study?
4. When did he receive the Nobel Prize?
5. Einstein was against the Nazis, wasn't he?
6. What was happened in 1939?
7. Can you name Einstein's famous equation?
8. Did Einstein's great idea change the world?
9. What facts produced a strong impact on Einstein's moral outlook?
10. Could Einstein have foreseen the tragical consequences of his discovery?

## Exercises

**1.Translate the following word combinations into Ukrainian:**
the mysteries of the universe; to be interested in; divorce; around the world; Nazis; fatal equation; peaceful purposes; benefit of man; velocity of light; human society; ominous consequences; military use; nuclear energy.

**2. Finish the sentences according to the text:**

1. …who completely changed the way that people saw our world and the universe.
2. He wasn't a good student …
3. He went to work at the Swiss …
4. Einstein became so well-known that he …
5. …and they burned most of his books.
6. When World War II broke out …
7. In 1941 the American government …
8. The mass of a body is a measure …
9. Einstein's achievement is one …

10. …against the military use of his discovery.

**3.Translate the following sentences:**

1. It is called fusion because it is based on fusing light nuclei such as hydrogen isotopes to release energy.
2. One way to achieve these conditions is to use magnetic confinement.
3. The Russians by bringing their leading fusion expert Academician I. V. Kurchatov to give a lecture "The Possibility of Producing Thermonuclear Reactions in a Gas Discharge" revealed their own work in the field and were shared our experience with ZETA.
4. By 2020 Western European oil and gas reserves will have declined to a point at which only Norway is expected to have significant reserves of natural gas and Western Europe may well enter a phase of declining oil production and rising oil import dependency.
5. In 25 years time, Europe's dependence on the external supply of conventional fuels is likely to have increased from the current level of around 50% to around 70%.
6. Another important factor is likely to be a further tightening of international agreement regarding $C0_2$ emissions to decelerate the effects of global warming and consequent climatic changes.

**4. Fill in the blanks with the correct words. Use *is,are,some*.**

1. There … cereal in the cabinet. 2. There … eggs in the refrigerator. 3. There … cookies in the cabinet. 4. There … bananas on the counter. 5. There … rice in the refrigerator. 6. There … bread on the counter. 7. There… oranges on the counter. 8. There … apples in the basket. 9. There … peanut butter in the cabinet. 10. There … doughnuts on the counter. 11. There … coffee in the cup.

# WILHELM ROENTGEN AND HIS DISCOVERY

Wilhelm Conrad Roentgen was born on March 17, 1845 in the border region of Germany and Holland, in Lenepe. He received his college education in Zurich in the very polytechnic, which later studied Einstein. Passion for physics led him after graduation in 1866 to continue physical education. Defended his thesis in 1868 on his Ph.D., he worked as an assistant at the Department of Physics, first in Zurich, then in Giessen, and then in Strasbourg.

There was a good X-ray experimental school and became a first-class experimenter. He produced the exact measurement of the ratio CV for gases, viscosity and dielectric constant of a number of liquids, investigated the elastic properties of crystals, their piezoelectric and pyroelectric properties, and measured the magnetic field by moving charges (current X-rays).

Some important studies performed X-ray with his disciple, one of the founders of Soviet physics A. F. Ioffe. Research related to electromagnetism, crystal physics, optics, and molecular physics. In 1895 he opened a radiation with a wavelength shorter than the wavelength of ultraviolet rays (X-rays), further called X-rays, and investigated their properties: the ability to be reflected, absorbed, and ionize the air, etc. Suggested by proper design of tube obtaining X-rays - reclining platinum anode and cathode concave: the first took photographs with the help of X-rays.

His experience has demonstrated that the magnetic field is generated by moving charges, and was important to

create Lorentz electron theory.

Many papers have been devoted to the X-ray properties of liquids, gases, crystals, electromagnetic phenomena, discovered the relationship of electrical and optical phenomena in crystals. For the discovery of rays that bear his name in 1901 Roentgen first among physicists won the Nobel Prize.

From 1900 until the last days of his life (he died February 10, 1923) he worked at the University of Munich.

Of great interest are medical applications of X-rays. Since Rontgen's discovery that X-rays have been developed for their use in medical imaging. Radiology is a specialized field of medicine. Radiographers employ radiography and other techniques for diagnostic imaging. Indeed, this is probably the most common use of X-ray technology.

X-rays are especially useful in the detection of pathology of the skeletal system, but are also useful for detecting some disease processes in soft tissue. Some notable examples are the very common chest X-ray, which can be used to identify lung diseases such as pneumonia, lung cancer. In some cases, the use of X-rays is debatable, such as gallstones or kidney stones. Also, traditional plain X-rays pose very little use in the imaging of soft tissues such as the brain or muscle. Imaging alternatives for soft tissues are computed axial tomography, magnetic resonance imaging (MRI) or ultrasound. Since 2005, X-rays are listed as a carcinogen by the U.S. government.

The most notable uses of X-ray:

- X-ray crystallography in which the pattern produced by the diffraction of X-rays through the closely spaced lattice of atoms in a crystal is recorded and then analyzed to reveal the nature of that lattice.
- X-ray astronomy, which is an observational branch of astronomy, which deals with the study of X-ray emission from celestial objects.
- X-ray microscopic analysis, which uses electromagnetic radiation in the soft X-ray band to produce images of very small objects.
- X-ray fluorescence, a technique in which X-rays are generated within a specimen and detected. The outgoing energy of the X-ray can be used to identify the composition of the sample.

Among the important early researches in X-rays were Professor Ivan Puluy, Sir William Crookes, Johann Wilhelm Hittorf, Eugene Goldstein, Heinrich Hertz, Philipp Lenard, Hermann von Helmholtz, Nikola Tesla, Thomas Edison, Charles Glover Barkla, and Max von Laue. In a humorous case of hindsight, Lord Kelvin said "X-Rays are a hoax".

**Active Words and Expressions**

**experimenter** – експериментатор
**carcinogen** – канцероген
**viscosity** – в'язкість
**platinum anode** – платиновий анод
**investigate** – досліджувати
**medical imaging** – медичний знімок
**disciple** – учень, послідовник
**soft tissues** – м'які тканини
**lung diseases** – легеневі захворювання
**fluorescence** – флюоресценція
**magnetic resonance imaging (MRI)** – магнітно-резонансна томографія (МРТ)
**skeletal system** – кісткова система
**lung cancer** – рак легенів
**radiology** – радіологія

## Answer the following questions

1. What is Wilhelm Conrad Roentgen?
2. Why and where did he continue physical education?
3. Did he become a first-class experimenter?
4. Who was the disciple of Roentgen?
5. What was opened by Roentgen in 1895?
6. How many papers have been devoted to the X-ray properties?
7. What had happened in 1901?
8. What is radiology?
9. What is the medical usage of X-rays?
10. Could you name the important early researches in X-rays?

## Exercises

**1. Translate the following sentences into English**

1. Вильгельм Конрад Рентген народився 17 березня 1845 року в прикордонній області між Голландією та Німеччиною у місті Ленеп.
2. Він одержав технічну освіту в Цюриху, в тій самій технічній школі, в якій пізніше навчався Эйнштейн.
3. Він працював над точними вимірюваннями відношення об’єму для газів, в’язкості та над діелектричною проникністю деяких рідин, досліджував властивості пружності кристалів, їх п’єзоелектричні та піроелектричні властивості, вимірював магнітне поле рухомих зарядів.
4. Частину важливих досліджень Рентген виконав зі своїм учнем, з одним із засновників радянської фізики А. Ф. Йоффе.
5. Ним були зроблені наукові дослідження стосовно електромагнетизму, фізики кристалів, оптики, молекулярної фізики.

6. Його дослід наочно продемонстрував, що магнітне поле утворюється рухомими зарядами і мав важливе значення для створення Лоренцем його електронної теорії.

**2. Finish the sentences according to the text:**

1. Passion for physics led him…
2. He produced the exact measurement of…
3. …the ability to be reflected, absorbed, and ionize the air, etc.
4. His experience has demonstrated that the magnetic field…
5. …Roentgen first among physicists won the Nobel Prize.
6. Since Rontgen's discovery that X-rays have…
7. Radiographers employ radiography…
8. X-rays are especially useful in the detection…
9. …such as gallstones or kidney stones.
10. Among the important early researches in X-rays were…

**3. Translate the following sentences:**

1.Having been used for a long time, the instrument partly lost its former efficiency. 2. The pressure range being beyond the limits of the existing diagram, data have been calculated by other means. 3. Drawing curves gives us a means of showing the relation existing between the two constants. 4. Wishing to find out the cause of the fault, they examined the device in all its details. 5. The charge due to the presence of these electrons is called space charge.6. By raising the filament temperature, we increase the number of electrons emitted. 7. In order to design the contrivance in question, one should take into consideration the following factors. 8. Some 100 years ago steam engines were first introduced, the valves being hand-operated.9. The next point to be studied is the geometry of the parts to be welded. 10. The stored energy can be dissipated in various ways, these ways having been dealt with in the previous article.

**4. Write full sentences. Use *am, is, are*.**

Model: (my shoes very dirty). My shoes are very dirty.

1. My bed … very comfortable.
2. Your cigarettes … in your bag.
3. I … not very happy today.
4. This restaurant…very expensive.
5. The shops… not open today.
6. Mr. Kelly's daughter…six years old.
7. The houses in this street …very old.
8. The examination… not difficult.
9. Those flowers …very beautiful.

## IVAN PULUY – ROENTGEN'S PREDECESSOR

Among illustrious names in Ukrainian scientific research one of the least known is that of Ivan Puluy (1845-1918), whose valuable contribution to world science has not been duly appreciated up to this day. Like many other prominent scientific figures whose tragic fate had torn them away from native soil, he lived and toiled abroad, among strangers.

Thousands of scientists and researches of Ukrainian origin played an outstanding role in many branches of the world's civilization, culture, and science. In Ukraine's tragic history the brain drain of her best cultural figures and scientific minds began as early as the 17$^{th}$century. Leaving for Moscow and St. Petersburg were numerous humanitarian who made their significant contribution to Russian science – among them linguists,

philosophers, musicians, architects, painters. Their influence found its reflection in science, literature, music, art, construction, even in language and mannerisms.

Ukrainian professors contributed largely to research carried out at the Universities of the USA and Canada, Berlin and Paris, Prague and Bratislava, Warsaw and Sofia. Their scientific gains went down in history, their inventions and discoveries are appreciated and remembered nowadays by thankful humanity.

The greatest scientist of the Austro-Hungarian Empire of the second half of the 19th century, Ivan Puluy, investigated unseen X-rays, later known as Roentgen's rays. His incandescent lamps were far more perfect than those invented by T. Edison. Puluy contributed, to some extent, to the invention of miners' lamps, telephone networks, neon signs, etc. Together with P. Kulish he effected the first Ukrainian translation of the Bible, and was the first to translate into Ukrainian Prayer-book, Psalter as well as a geometry text-book.

Traditionally Roentgen's name is associated with invisible rays penetrating through wood, metals, paper, leather, etc. Professor Wilhelm Roentgen began to investigate X-rays on November 8, 1885, his discovery being to a great extent, a stroke of good luck. And on January 23, 1896 W. Roentgen made a public report in Wurzburg informing the scientific world about his invention which was then an early stage of development. Five years later Roentgen's work was awarded the Noble Prize.

To tell the truth, Puluy's investigation of the mysterious X-rays began, however, much earlier, at least a dozen years before. As far back as 1877, on his own conception, Puluy worked out cathode ray-tubes and their photographs (as well as the results of

investigation) were published in scientific papers of the Vienna Academy of Sciences. For the invention and construction of the vacuum lamp he was awarded the Silver Medal at the World Electrotechnical Exhibition in Paris in 1881. Photoprints by means of unknown rays were received in 1886, but Puluy's indecision prevented him from publishing scientific results and the pioneer ideas were unrealized through the scientist's own negligence.

Puluy's priority in the study and investigation of X-rays was undoubted though his data had not been properly recorded. By the time Roentgen made his tests, professor Puluy had published 100 pages on his own works on the subject of cathode lamps and invisible rays.

Puluy's whole life was completely devoted to science – he was physicist, mathematician, philosopher, electrotechnician, architect, pedagogue, linguist (he knew 15 foreign languages), besides being a writer, investigator, experimenter. In his youth he studied physics, mathematics, astronomy, and later on he taught these and other exact sciences. Generations of young people of his time owe a great lot to the famous scientist. Puluy's Fund which existed up to 1939 allotted stipends to poor students from Ukraine. Living in Prague since the autumn of 1884 till his death on January 31, 1918, Ivan Puluy did his best to contribute to the science of the country whose sons and daughters have given their due to the memory of the great Ukrainian scientists.

**Active Words and Expressions**

**humanitarian** – гуманіст
**illustrious** – славетний
**mannerism** – манера
**pioneer ideas** – новаторські
**exhibition** – виставка
**tear away from** – відірвати від
**a stroke of good luck** – дарунок долі

думки
**incandescent lamp** – лампочка розжарювання
**Psalter** – Псалтир
**appreciate** – поважати, оцінювати
**allotted stipends** – виділяв стипендії
**priority** – пріоритет, передування в часі

## Answer the following questions

1. Who is Roentgen's predecessor?
2. Was Ivan Puluy's contribution to world science duly appreciated?
3. When did the brain drain from Ukraine begin?
4. Where did Ukrainian humanitarian go to work to?
5. What physical phenomenon did Puluy investigate?
6. When did Puluy begin investigating X-rays?
7. What field of knowledge was Puluy competent in?
8. What did he do together with P. Kulish?
9. What are the properties of X-rays?
10. What foreign Universities did Ukrainian scientists work at?

## Exercises

**1. Name the word-building elements, translate into Ukrainian.**

Importance – important – unimportant; consider – consideration – considerable; refer – referable – reference – referential; oppose – opposite – opposition; know –knowledge; practice – practical – unpractical; rich – enrich – enrichment; add – addition – additional; frequency – frequent – frequently; person – personal – impersonal.

**2. Finish the sentences according to the text:**

1. …he lived and toiled abroad, among strangers.
2. In Ukraine's tragic history the brain drain of her best…
3. Their influence found its reflection in…

4. …the USA and Canada, Berlin and Paris, Prague and Bratislava, Warsaw and Sofia.
5. Ivan Puluy investigated…
6. …into Ukrainian Prayer-book, Psalter as well as a geometry text-book.
7. …were published in scientific papers of the Vienna Academy of Sciences.
8. Puluy's priority in the study and investigation…
9….he was physicist, mathematician, philosopher, electrotechnician…
10. Puluy's Fund which existed up to 1939…

**3. Translate the following sentences:**

1. This brief description of some methods used in our work covers only a few of the problems encountered. 2. The resistance being very high, the current in the circuit is low. 3. The test referred to above can be easily made. 4. There is always water vapour in the air, the amount depending upon various conditions. 5. Until now we have been discussing reactors from which no power is being taken. 6. The region of highest resistance is the point of contact between the pieces being welded. 7. Some of the effects produced by an electric current are discussed in the following chapter.8. The filament heated, the electrons leave its surface and travel to the plate. 9. Multiplying the mass of a moving body by its velocity, we shall get its momentum. 10. The problem having excited a great deal of discussion, a series of tests had to be carried out.

**4. Write positive or negative sentences. Use the forms to be.**

1. Paris … the capital of France. 2. I … interested in football. 3. I … hungry.4. It … warm today. 5. Rome … in Spain.6. I … afraid of dogs. 7. My hands … cold. 8. Canada … a very big

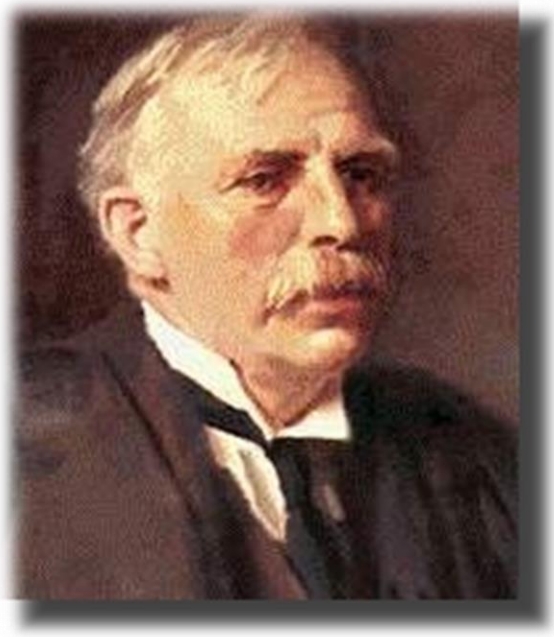
country.9. The Amazon … in Africa.10. Diamonds … cheap.11. Motor racing … a dangerous sport. 12. Cats …big animals.

## ERNEST RUTHERFORD – BRITISH PHYSICIST (1871-1937)

Rutherford's father was a wheelwright and farmer, and Ernest worked on the farm. He showed great promise at school and in his teens gained a scholarship to New Zealand University, where he finished fourth. In the university he became interested in physics and developed a magnetic detector of radio waves. He was completely interested in the practical applications of his discoveries. In 1895 came the turning point, for he received a scholarship to Cambridge University.

At Cambridge he worked under J.J. Thomson. Then, after a short period at McGill University in Montreal, Canada, and a trip to New Zealand to get married, he returned to England.

Hard on the heels of Becquerel, Rutherford began work in the exiting new field of radioactivity. He was one of those who, along with the Curies, had decided that the rays given off by radioactive substances were of several different kinds. He named the positively-charged ones alpha rays and the negatively-charged ones beta-rays. These names are still used, except that both are now known to consist of speeding particles, so one often speaks of alpha particles and beta particles instead. When in 1900 it was



discovered that some of the radiations were not affected by a magnetic field, Rutherford was able to demonstrate them to consist of electromagnetic waves and named them gamma rays.

Between 1906 and 1909 Rutherford, together with his assistant, Geiger, studied alpha particles intensively and proved conclusively that the individual particle was a helium atom with its electrons removed. The alpha particles were like the positive rays that had been discovered by Goldstein, and in 1914 Rutherford suggested that the simplest positive rays must be those obtained from hydrogen and that these must be the fundamental positively-charged particle. He called it a proton.

Rutherford's interest in alpha particles led to something greater still. In 1906, while still at McGill in Montreal, he began to study how alpha particles are scattered by thin sheets of metal. He continued these experiments in 1908, when back in England working at Manchester University.

From his experiments Rutherford evolved the theory of the nuclear atom. He maintained that the atom contains a very tiny nucleus at its center which is positively changed and which contains all the protons of the atom and therefore virtually all of its mass. In the other regions of the atom are the negatively-charged electrons which are very light and which interpose no detectable barrier to the passage of the alpha particles. This view of the atom is the one accepted today.

For working out the theory of radioactive disintegration of elements, for determining the nature of alpha particles, for devising the nuclear atom Rutherford was awarded the 1908 Nobel Prize in chemistry. In 1917 Rutherford got to work in earnest on quantitative measurements of radioactivity.

Rutherford was thus the first man ever to change one element

into another as a result of the manipulations of his own hands. He had achieved the dream of the alchemists. He had demonstrated the first man-made nuclear reaction. By 1924 he had managed to knock protons out of the nuclei of most of the lighter elements.

Rutherford accepted a professorship of physics at Cambridge in 1919, and was president of the Royal Society from 1925 to 1930. After 1933 he was violently anti-Nazi in his sympathies. Toward the end of his life he expressed himself as quite doubtful that the vast energy of the atomic nucleus, as made evident in radioactivity, could ever be controlled by man. In this he was overtly conservative (as he was in his reluctance to accept Einstein's theory of relativity). However, he died, two years before the discovery of uranium fission by Hahn and so was not to know how wrong he was in this respect.

**Active Words and Expressions**

**wheelwright** – колісний майстер
**scholarship** –стипендія
**radioactive substances** – радіоактивні речовини
**alpha particles** – альфа частки
**alchemist** – алхімік
**beta particles** – бета частки
**disintegration** – розпад
**reluctance** – неприйняття, супротив

## Answer the following questions

1. Was Rutherford good at school?
2. Which science he was interested in?
3. Where did he study and work?
4. How did he work in the field of radioactivity?
5. What do you know about the theory of the nuclear atom?
6. What event had happened in1908?
7. Ha had achieved the dream of the alchemists, hadn't he?
8. What did Rutherford do at the end of his life?

## Exercises

**1. Translate the following words and word combinations:**

son of wheelwright and farmer; magnetic detector of radio waves; positively-charged; helium atom; man-made nuclear reaction; to consist of speeding particles; the theory of radioactive disintegration of elements; president of the Royal Society; quantitative measurements; obtained from hydrogen.

**2. Finish the sentences according to the text:**

1. In the university he became interested in…
2. …practical applications of his discoveries.
3. Hard on the heels of Becquerel, Rutherford began…
4. He was one of those who, along with the Curies…
5. When in 1900 it was discovered that some of the radiations were…
6. He maintained that the atom contains…
7. …Nobel Prize in chemistry.
8. Rutherford was thus the first man ever…
9. Rutherford accepted a professorship of physics…
10. He died, two years before the discovery…

**3. Fill in the gaps with appropriate prepositions.**

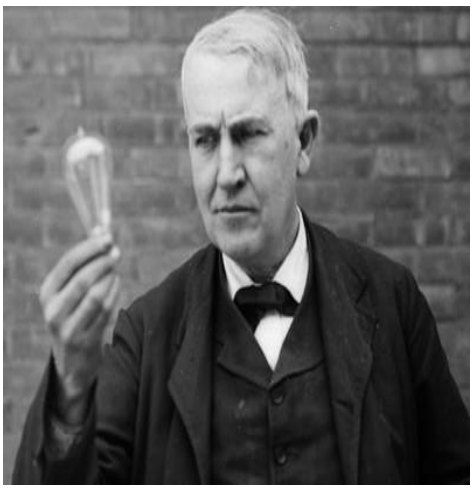
1. Everyone is talking … the explosion in the high school chemistry lab. 2. Karen was absent … the class six times last term. 3. Fruit consists mostly… water. 4. Our children are very polite … adults, but they argue … their playmates all the time. 5. Three centimeters is equal … approximately one and a half inches. 6. I'm not ready … my trip. I haven't packed yet. 7. I borrowed some clothes … my best friend. 8. Are you familiar … ancient Greek mythology? 9. I discussed my problem … my uncle. 10. Someday astronauts will travel … another solar system.

**4.Put the verbs in brackets in the Future Indefinite Tense.**

1. I (***know***) … the result in a week. 2. You (***be***) … at home tonight? 3. You(***have***) … time to help me tomorrow? 4. It (***matter***) … if I don't come hometill morning? 5. You (***be***) … able to drive after another five lessons? 6. Do youthink he (***recognize***) … me? 7. Unless he runs he (***not catch***) … the train.8. He (***lend***) … it to you if you ask him. 9. I hope I (***find***) … him. 10. If petrolpipe attendants go on strike we (***not have***) … any petrol. 11. He (***believe***) …whatever you tell him. 12. I (***remember***) … this day all my life. 13. Perhapshe (***arrive***) … in time for lunch. 14. If he works well I (***pay***) … him $ 10.15. I wonder how many of us still (***be***) … here next year.

## THOMAS EDISON (1847-1931)

In 1877, an American, Thomas Alba Edison, made a recording on a little machine which he had invented, and played it back to himself. It was a historic moment - the first talking machine in the world had been invented. Next, Edison got interested in the invention of an electric-light bulb for lighting streets and buildings instead of gas. He had to work for thirteen months but finally he succeeded and produced the incandescent lamp.



His other inventions include the phonograph or gramophone, the cinematograph, an improved system of electric transmission and numerous other things. Since his early childhood he had a difficult life. He was a very inquisitive child who always asked «Why?» and always tried out any idea

he had. When he was six, Thomas decided to help a mother goose to hatch eggs by sitting himself on the nest. On another occasion he almost drowned when he dived into the river and swam under a ship trying to examine its structure.

He went to school for only three months because his teacher said that the boy was stupid. Edison spent all his free time experimenting.

One day he read in a book that balloons could fly because they had gas in them. So he thought that if he drank enough soda water and filled his stomach with gas he would be able to fly too. His flying attempt finished with his lying on the ground sick and the world spinning around him.

Edison began to work as a newspaper boy when he was twelve. One winter night the boy didn't hear the conductor's whistle and when the train started to move, it dragged Thomas along. The boy was saved by the conductor who caught him by the ears and pulled him onto the train. After that something happened to the boy's ears and he began to grow deaf. But it didn't stop the curious child. He decided to produce his own newspaper and he set up his «publishing house» in a baggage car. The money he got for his paper he spent on books and laboratory equipment which he installed in the same baggage car. Everything finished with a fire which started when a bottle with phosphorus fell on the floor. That ended Edison's career with the railway.

One day when Edison was 15, he saved the life of a child who was playing on the; train tracks. In gratitude the father of the child, a telegraph operator, gave Edison several lessons in telegraphy and in the next five years Thomas worked as a telegrapher in different cities of the USA and Canada. But this career of his also ended with a scandal when a night inspector

found Edison sleeping and his new invention, connected to the clock, working instead of him. Thomas's mother continued his education at home, and the boy demonstrated a brilliant memory and great love of books and studies.

Even when he was an old man he never stopped working. Edison is believed to have said the following words, «Genius is ten per cent inspiration and ninety per cent perspiration».

**Active Words and Expressions**

**gramophone** – грамофон
**nest** – гніздо
**inspiration** – натхнення
**drowned** – тонути
**balloon** – повітряна куля
**baggage car** – багажний вагон
**laboratory equipment** – лабораторне обладнання
**perspiration** – наполегливість

## Answer the following questions

1. What was Thomas Alba Edison?
2. What discoveries is he famous for?
3. What had happened to him in childhood?
4. Was he good at school?
5. Where did he work?
6. What was the motto of Edison?

## Exercises

**1. Match the following English words with their Ukrainian equivalents:**

1) to discover
2) to research
3) to invent
4) to identify
5) to improve
6) to involve
7) to encourage
8) to promote

a) заохочувати
b) поліпшувати
c) відкривати
d) залучати
e) сприяти
f) досліджувати
g) винаходити
h) розпізнавати

**2. Finish the sentences according to the text:**

1. Edison got interested in the…
2. His other inventions include…
3. He went to school for only…
4. …in a baggage car.
5. …he saved the life of a child…
6. …of the USA and Canada.
7. …and great love of books and studies.
8. …«Genius is 10% inspiration and 99% perspiration».

**3. Translate the sentences:**

1. The following precautions should be observed to insure better results in our experiment. 2. To find an instrument suitable for our testing was the next problem to be solved.3. We know the strength of a current to depend upon the resistance of the circuit. 4. For a long time the atom was thought to be indivisible. 5. The oscillograph to be used for testing purposes is similar to that used in our laboratory. 6. If considered from this point of view, the problem seems to be rather complicated. 7. Radium is said to be one and a half million times more radioactive than uranium. 8. Tests have shown the thermometer to be very sensitive. 9. The oscillator referred to above seems to deliver only a small amount of power. 10. The instrument to be described here was designed several years ago.

**4. Use one of the tenses: the Present Indefinite, Past Indefinite, Present Continuous, Past Continuous.**

1. Nona (***to celebrate***) … her birthday yesterday. Her room looked beautiful, there (***to be***) many flowers in it. When I (***to come***) … in, somebody (***to play***) … the piano, two or three pairs (***to dance***) … 2. Listen! Somebody (***to play***) … the piano. 3. I (***to like***) … music very much. 4. When I (***to look***) … out of the

window, it (***to rain***) … heavily and people (***to hurry***) … along the streets. 5. What you (***to do***) … at seven o'clock yesterday? - I (***to have***) … supper. 6. When I (***to come***) … home yesterday, I (***to see***) … that all my family (***to sit***) … round the table. Father (***to read***) … a letter from my uncle who(***to live***) … in London. 7. Where you (***to be***) … yesterday? - I (***to be***) … at home the whole day. - How strange. I (***to ring***) … you up at two o'clock, but nobody (to answer) … - Oh, I (***to be***) … in the garden. I (***to read***) … your book and (***not to hear***) … the telephone. 8. What you (***to do***) … at five o'clock yesterday? — I (***to work***) … at the library. — I (***to be***) … there, too, but I (***not to see***) … you.

## YURI KONDRATYUK AND THE MOON

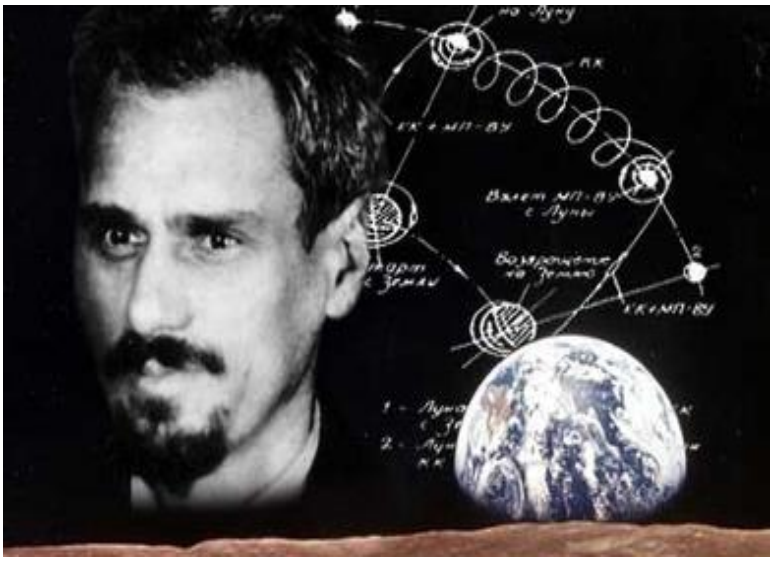
In the domain of cosmic research Ukraine's contribution is represented by many illustrious names among which one of the first belongs by right to Yuri Vasylyovich Kondratyuk (Shargey) (1897-1941). He stands in the constellation of such outstanding scientific figures as K. Tsiolkovsky, V. Vernadsky, S. Korolyov, and others.

He was born on the 21$^{th}$ of June, 1897 in Poltava. The dramatic circumstances of his life made him live under an assumed name and world fame came to him many years after this pioneer in working out rocket engineering and the theory of cosmic flights had left the Earth for ever.

After finishing the 2-nd Poltava gymnasium he entered St. Petersburg University in 1916. 1918-1925 he worked in Ukraine, in Poltava, Kiev and some smaller towns, and since 1925 in the Northern Caucasus. In 1927 he moved to Novosibirsk where his occupation was projecting elevating

gears. In the 30th he worked in Kharkiv at the Ukrainian Research Institute of Industrial Energetic. He stood at the head of the group of scientists whose task was designing and constructing a huge Crimean wind-power station. Working in Moscow before the war he devoted much time to energetic problems. It is a well-known fact that in building the Ostankino teletower, specialists used Kondratyuk's workings out of reinforced towers construction and wind-power technique. Kondratyuk is often referred to as Ukrainian Tsiolkovsky for his main scientific interests lay in solving the problems of cosmonautics, cosmic flights and constructing the interplanetary spaceships. In working at these problems as well as many others he toiled independent of K. Tsiolkovsky who knew Kondratyuk's works and approved of his ideas.

On July 21, 1969 the first flight to the Moon, the age-long dream of humanity, was realized by three American astronauts – Neil Armstrong, Michael Collins and Edwin Aldrin. The first steps on the surface of the Moon were made by Neil Armstrong who was joined 20 minutes later by Edwin Aldrin. This Apollo Moon flight and landing, as admitted by world's scientists, including Americans, would have been impossible without Y. Kondratyuk's solving a number of problems.



In Y. Kondratyuk's works a number of new solutions were found pertaining to the development of cosmonautics: rocket

dynamics, rocker building and cosmic system creation. His scientific merits were not duly appreciated during his lifetime and his untimely death at the front prevented the great scientist and engineer from realizing his gift and talent to the full. A crater on the back side on the Moon was named after Yuri Kondratyuk. Y. Kondratyuk's ideas have brought our country world fame, their influence has not been lost up to now and will serve generations to come.

**Active Words and Expressions**

**technique** – техніка
**illustrious** – славетний
**huge**– велетенський
**interplanetary space ships** – міжпланетні кораблі
**appreciate**– цінувати
**constellation**– плеяда
**reinforced towers**– залізобетонні вежі
**cosmonautics**– космонавтика

## Answer the following questions

1. Who represents Ukraine's science in cosmic research?
2. What outstanding scientists carried out research on cosmic flights?
3. Where was Kondratyuk born?
4. Where did he get his education?
5. What problems was Kondratyuk concerned with in Kharkiv?
6. What did Tsiolkovsky think of Kondratyuk's ideas of cosmonautics?
7. When were the first steps on the Moon made?
8. Were Kondratyuk's merits appreciated during his life?

## Exercises

**1. Translate the following words and word-combinations:**

world standards, world science, life standards, space exploration, scientific exploit, aerial navigation, inventor, astronomer, rocket, aviation, human knowledge.

**2. Finish the sentences according to the text:**

1. …1897 in Poltava.
2. 1918-1925 he worked in…
3. He stood at the head of the group…
4. …construction and wind-power technique.
5. Y. Kondratyuk is often referred to as Ukrainian Tsiolkovsky…
6. …Neil Armstrong, Michael Collins and Edwin Aldrin.
7. …without Y. Kondratyuk's solving a number of problems.
8. Y. Kondratyuk's ideas have brought…

**3. Look up the meanings of these words in a dictionary, if necessary. How are they translated in the sentences below? Mind the word order.**

***place, iron, lift, house, light, heat, use, form, change, wire***

1. The conductor wires are placed high up.
2. Electromagnets lift iron weights.
3. The plastic box houses the conducting and the insulating elements of the apparatus.
4. The house is lighted and heated by solar energy.
5. The light went out. Light the candle, please.
6. After the metal was heated it changed its colour to a red heat.
7. Numerous changes are taking place in the uses of atomic energy.
8. Electric power is used universally.
9. The newly made invention has a great number of uses.
10. The wire and the source form a circuit.

**4. Complete with *don't, doesn't, have to* or *must not.***

1. The soup is too hot. You … eat it yet. Wait for it to cool. 2. You … have soup for lunch. You can have a sandwich if you like. 3. Liz finally got a car, so now she usually drives to work.

She … take the bus. 4. Tommy, you … say that word. That's not a nice word. 5. Mr. Moneybags is very rich. He … work for a living. 6. If you are in a canoe, you … stand up and walk around. If you do, the canoe will probably tip over. 7. According to the rules of the game, one player … hit another player. 8. The review class before the final exam is optional. We … go unless we want to.

# IDIOMS AND PREPOSITIONAL PHRASES

| | |
|---|---|
| **According to** | згідно з |
| **along with** | поряд з |
| **all over the world** | в усьому світі |
| **a number of** | декілька |
| **a part from** | окрім |
| **as a matter of fact** | фактично |
| **as a result** | в результаті |
| **as close as possible** | як можна ближче |
| **as early as** | ще (про час) |
| **as far as ... is concerned** | стосовно |
| **as far back as** | ще (в), вже (в) |
| **as follows** | наступним чином |
| **as for** | щодо |
| **as is the case** | як у випадку з |
| **as long as** | до тих пір поки |
| **as soon as** | як тільки |
| **as to** | що стосується |
| **as well** | також |
| **as well as** | також, як і |
| **at any rate** | у будь-якому випадку |
| **at last** | нарешті |
| **at least** | щонайменше |
| **at once** | одразу ж |
| **at present** | в даний момент |
| **at the same time** | у той же час |
| **at times** | іноді |
| **at will** | за бажанням |
| **because of** | внаслідок |
| **both... and** | як… так і |
| **but for** | якщо б не |
| **by all means** | неодмінно |
| **by chance** | раптово |
| **by means of** | за допомогою |
| **by no means** | ні в якому разі |
| **by some means or other** | таким чи іншим чином |
| **by the way** | між іншим |
| **by turns** | по черзі |
| **consideration should be given to** | слід звернути увагу на |
| **can’t but** | не можна не |
| **can’t help (+gerund)** | не можливо не |
| **deal with** | мати справу з |
| **do a world of good** | робити багато гарного |
| **do without** | обходитися без |

| | |
|---|---|
| **due to** | дякуючи |
| **either ... or** | або…або |
| **ever since** | з того часу |
| **first** | перш за все, спочатку |
| **for ever** | назавжди |
| **for example, for instance** | наприклад |
| **for short** | коротше |
| **for the present** | на цей раз |
| **for the sake of** | заради |
| **for this reason** | з цього приводу |
| **for want of** | з-за нестачі чогось |
| **from time to time** | час від часу |
| **give rise to** | викликати, бути результатом |
| **give way to** | поступатися |
| **go into operation** | вступати в дію |
| **have nothing to do with** | не мати жодного відношення до |
| **in addition to** | до того ж, окрім того |
| **in case** | у випадку, якщо |
| **in certain respects** | у деякому відношенні |
| **in comparison to** | у порівнянні з |
| **in effect** | дійсно |
| **in fact** | фактично |
| **in its turn** | у свою чергу |
| **in no time** | дуже швидко, миттєво |
| **in order to** | для того, щоб |
| **in other words** | інакше кажучи |
| **in particular** | особливо |
| **in question** | про який йде мова |
| **in spite of** | не зважаючи на |
| **instead of** | замість того, щоб |
| **in this connection** | у зв’язку з цим |
| **in view of** | на увазі |
| **it goes without saying** | зрозуміло, само собою |
| **it is high time** | давно час |
| **it stands to reason** | ясно, очевидно |
| **it was not until** | лише тільки в, ще в (про час) |
| **keep in mind** | мати на увазі, пам’ятати |
| **kind of** | свого роду |
| **last but not least** | останній по порядку, але не за значенням |
| **last but one** | передостанній |
| **make use of** | використовувати |
| **meet the needs (requirements)** | відповідати потребам (вимогам) |
| **more or less** | більш чи менш |

| | |
|---|---|
| **needless to say** | нічого й казати |
| **neither ... nor** | ні…ні |
| **no longer** | більше ні |
| **no matter** | неважливо, незалежно від |
| **no sooner ... than** | як тільки |
| **not at tall** | зовсім ні, аніскільки |
| **not to speak of** | не кажучи про |
| **no wonder** | не дивно |
| **of course** | звичайно |
| **on account of** | внаслідок |
| **one and the same thing** | одне й те саме |
| **on the basis of** | на основі |
| **on the contrary** | навпаки |
| **on the part of** | з боку |
| **on the whole** | в цілому, взагалі |
| **or so** | приблизно |
| **owing to** | завдяки |
| **pay attention to** | звертати увагу на |
| **play a part in** | відігравати роль |
| **put in to operation** | увести в дію |
| **put into use** | увести в експлуатацію |
| **rather than** | скоріше ніж, а не |
| **result from** | отримати в результаті |
| **so far** | до сих пір, поки що |
| **so to say** | так сказати |
| **take advantage of** | скористатися |
| **take into account** | брати до уваги |
| **take into consideration** | брати до уваги |
| **take part in** | брати участь у |
| **take place** | відбуватися, мати місце |
| **thanks to** | завдяки |
| **that is to say** | інакше кажучи |
| **the former** | перший (зі згаданих) |
| **the latter** | останній (зі згаданих) |
| **under consideration** | той, що розглядається |
| **up to** | до |
| **with respect to** | по відношенню до |

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