Қазақстан Республикасының Білім және ғылым министрлігі

С. Торайғыров атындағы Павлодар мемлекеттік университеті

Гуманитарлық-педагогикалық факультеті

Шетел тілдері практикалық курсы кафедрасы

АҒЫЛШЫН ТІЛІ

«Энергетика» мамандығы бойынша оқитын студенттерге арналған
оқу-әдістемелік құралы

Павлодар
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Павлодар

ӘОЖ 81.111: 621.31
КБЖ 81. 2 Англ - 923
А 23

С. Торайғыров атындағы Павлодар мемлекеттік университетінің гуманитарлық-педагогикалық факультетінің оқу-әдістемелік кеңесімен басуға ұсынылды

Пікірсарапшылар:
Ж. М. Байгожина – педагогика ғылымдарының кандидаты, Павлодар мемлекеттік педагогикалық институтың шетел тілдер кафедрасының доценті.
М. С. Кулахметова – филология ғылымдарының кандидаты, С. Торайғыров атындағы Павлодар мемлекеттік университетінің шетел тілдер практикалық курсы кафедрасының доценті;

Құрастырушылар: Л. Е. Асылханова, Г. А. Кабжанова

А23 Ағылшын тілі : «Энергетика» мамандығы бойынша оқитын студенттерге арналған оқу-әдістемелік құралы / құраст.: Л. Е. Асылханова, Г. А. Кабжанова – Павлодар : Кереку, 2012. – 58 б.

Оқу-әдістемелік құралында «Ағылшын тілі» пәнінен энергетика мамандығының студенттеріне арналған аутенттік мәтіндер, пікірлер, тақырыптың нұсқаулары, жалпы-ғылыми және техникалық сипаттағы бастапқы мәтіндік материал берілген.

ӘОЖ 81.111: 621.31
КБЖ 81. 2 Англ-923

Мазмұны

БЕКІТЕМІН
С. Торайғыров атындағы
ПМУ-дың оқу ісі
жөніндегі проректоры
_________Н. Э. Пфейфер
2012 ж.«____» _________

Құрастырушы: Л. Е. Асылханова, Г. А. Кабжанова

Шетел тілдер практикалық курс кафедрасы

Ағылшын тілі: «Энергетика» мамандығы бойынша оқитын студенттерге арналған оқу-әдістемелік құралы

Кафедра мәжілісінде бекітілді 2011 ж. «_____» _____№____ хаттама

Кафедра меңгерушісі __________________ Б. К. Жумабекова

Гуманитарлық-педагогикалық факультетінің оқу-әдістемелік кеңесінде мақұлданған
2012 ж. «_______» _____ №_____ хаттама

ОӘК төрайымы ________________ Е. Н. Жуманкулова

КЕЛІСІЛДІ
ГПФ деканы _______________ Ж. Т. Сарбалаев
2012 ж. «____»_______

Аудармаға жауапты ____________Л. Е. Асылханова

Нормабақылаушы
СжМБ бастығы _______________ Г. С. Баяхметова
2012 ж. «___»________

МАҚҰЛДАНДЫ
ОҮЖжӘҚБ бастығы ______________ А. А. Варакута
2012 ж. «____»________

Алғы сөз

«Энергетика» мамандығы студенттеріне арналған практикалық сабақтардың мақсаты – бұрынғы тілдік білімдердің негізінде өз ойын жеткізуге, естігені мен оқығанын түсінуге қажетті сөйлеу шеберліктері мен дағдыларын дамыту. Бұл мақсатты компоненттер практикалық сабақтардың мазмұнын, мамандық бойынша мәтіндердің бағытын, мәтіндік тапсырмалардан соң терминологиялық сөздікті құрастыруды белгілейді. Құралға енген мәтіндердің күрделілік дәрежесі студенттерде қарым-қатынас компетентінің қалыптасқандығының бастапқы білімдік дәрежесі бар екендігін білдіреді, бұл өз кезегінде оқудың алуан түрін қолдануға жол ашады: яғни, ақпараттық – ізденушіліктен бастап ұсынылған тапсырмаларға сай тереңдетілгенге дейін.

Тапсырмаға енетіні:

- тілдік тапсырмалардың ұтымды көлемі мен үйлесімі;
- мәтіндік материалдың жоғары актуальдылығы, ақпараттылығы және танымдылығы;
- мамандық пен елтанымдық аспект бойынша коммуникативтік бағыты, оңтайлы таныстырылды.

Мамандығы мен елтанымдық тақырып бойынша мәтіндермен жеке жұмыс дағдыларын дамытуға, студенттердің кәсіби және жалпы білімдік дүниетанымын кеңейтуге ықпал етеді.

Мәтіннен кейінгі коммуникативтік тапсырмалар, сөзжасамдық, грамматикалық және сөйлеу жаттығулары мамандық бойынша лексиканы енгізуге, тілдік материалға жаттығуға және бекітуге қызмет етеді. Сонымен қатар тілдік материал мен тапсырмалар өткен материал білімдерін және тиісінше тілдік дағдылар мен шеберліктердің қалыптасу деңгейін тексеріп, жинақтауға қажет. Практикалық жұмыстың бірінші кезеңінде лексикалық тапсырмалар орындалады. Тапсырмада көзделген мақсат-терминологиялық лексикалық материалға жаттығып, бекіту. Лексикалық материалдардың жекелей, қосарланып немесе шағын топтарда орындалуы мүмкін. Одан соң студенттер үйренген лексикасы мен мәтіннің соңында сөздік қорын байыту және оқу бағдарына сәйкес кәсіби біліктілігін дамытуға алғы шарт болатын терминологиялық сөздікке сүйене отырып, арнайы мәтінді оқып, аударады. Бұдан кейін мамандық бойынша зерделік-танымдық қабілет пен грамматикалық практикалық дағдыларын дамытуға бағытталған мәтіннен соңғы тілдік және грамматикалық тапсырмалар жазбаша және ауызша түрде орындалады.

1. Machine tools

The machine-tool is the original source of every object of our industrialized world. Automobiles, airplanes diesel locomotives, washing machines, electric stoves and radio sets made by machine-tools. But without the engineer the machine-tool couldn't function.

One engineer seldom deals with every phase of development of a complex mechanism, e.g. a steam turbine. Various specialists take part in its development: a mechanical engineering skilled in the application of thermodynamics, a chemical engineer utilizing all the by-products of the fuel used, an electric engineer converting the mechanical energy into a conventional form of power, an engineer skilled in the calculation of stresses when designing the turbine blades, aproduction engineer planning the smooth flow of material into the finished product, as well as the research engineer who conceived the idea in the first place.

After all the components of the turbine have been developed into a complicated mechanism and detailed drawings have been made of all component parts, materials are ordered and routing of the materials is planned. Finally, when the planning engineer has ordered the material, the tool engineer has designed the tools and the design engineer has given specifications on the drawings, production begins. The finished components are assembled, inspected and moved from the factory to the consumer through a department directed by a sales engineer.

1.1 Vocabulary:

original source – түпкі деректеме, түпнегіз, түпдерек
to utilize the by-products of the fuel used – жанған отынды жонама қолдану
to convert … into a conventional form of – жай формаға аудару, айналдыру
stresses – кернеу
turbine blades – турбина қалағы
to conceive the idea – көзқарас ұсыну
drawings – сызбалар
inorder – тапсырыс беру
toolengineer – инженер-технолог
sales engineer – өткізу бойынша инженер

1.2 Answer the questions:

1. What is the machine-tool?
2. What are made by machine tools?

3. What is the part of mechanical engineer?
4. What is the part of chemical engineer?
5. What is this text about?

1.3 Retell the text in English.

2. Engineering work

The public has become much more aware, especially in the last decade, of the social and environmental consequences of engineering projects. For much of the nineteenth and twentieth centuries, the publicattitude could be summed up in the phrase "Science is good", and the part of science that was most visible was the engineering work that made scientific knowledge useful. Countless cars and other mechanical devices are part of our engineered invironment.

Today, however, people are more conscious of the hidden hazards in products and processes. The automobile is a typical example. No one disputs its convenience but many are also aware of the air pollution it causes and the amount of energy it consumes. Engineers are working to solve these problems by designing devices that reduce pollution and improve fuel efficiency.

The engineer, then, does not work in a scientific wacuum but must take into account the social consequences of his or her work.

2.1 Vocabulary:
social and environmental consequences – қоғамға тигізетін салдар
to be aware of to be conscious – түсіну, білу
attitude to – қатынас жасау
visible – анық, көрінетін
hidden hazards – жасырын қоқан-ноққы
to take into account – назар аудару, көңіл қою, іликке алу

2.2 Answer the questions:
1. What is this text about?
2. What are part of our engineered environment?
3. How engineers solve problems?
4. What is the automobile?

2.3 Retell the text in English.

3. Machines and work

Defined in the simplest terms a machine is a device that uses force to accomplish something. More technically, it is a device that transmits and changes force of motion into work. This definition implies that a machine must have moving parts. A machine can be very simple, like a block and tackle to raise a heavy weight, or very complex, like a railroad locomotive or the mechanical systems used for industrial processes.

A machine receives input from an energy source and transforms it into output in the form of mechanical or electrical energy. Machines whose input is a natural source of energy are called prime movers. Natural sources of energy include wind, water, steam, and petroleum. Windmills and waterwheels are prime movers; so are the great turbines driven by water or steam that turn the generators that produce electricity; and so are internal combustion engines that use petroleum products as fuel. Electric motors are not prime movers, since an alternating current of electricity which supplies most electrical energy does not exist in nature.

Terms like work, force, and power are frequently used in mechanical engineering, so it is necessary to define them precisely. Force is an effort that results in motion or physical change. If you use your muscles to lift a box you are exerting force on that box. The water which strikes the blades of a turbine is exerting force on those blades, thereby setting them in motion. In a technical sense work is the combination of the force and the distance through which it is exerted. To produce work, a force must act through a distance. If you stand and hold a twenty-pound weight for any length of time, you may get very tired, but you are not doing work in an engineering sense because the force you are exerted to hold up the weight was not acting through a distance. However, if you raised the weight, you would be doing work.

Power is another term used in a special technical sense in speaking of machines. It is the rate at which work is performed. The rate of doing work is sometimes given in terms of horsepower, often abbreviated hp. This expression resulted from the desire of the inventor James Watt to describe the work his steam engines performed in terms that his customers could easily understand. After much experimentation, he settled on a rate of 33,000 foot-pounds per minute as one horsepower. In the metric system power is measured in terms of watts and kilowatts. The kilowatt, a more widely used term, equals a thousand watts or approximately $1^1/_3$horsepower in the English system.

3.1 Vocabulary:

to accomplish – атқару
definition – анықтама
tackle – жабдықтар, бұйымдар, саймандар
transforms – алмастыру, ауыстыру, өзгерту
combustion – жану
precisely – нақты

3.2 Answer the questions:

1. What is a simple definition of a machine?
2. What is a more technical definition?
3. What does this definition imply?
4. What do we call machines whose input is a natural source of energy?
5. What natural sources of energy do you know and what machines use them?

3.3 Retell the text in English.

4. Trends in the modern machine-building industry

The scientific and technological progress will continue in engineering along two main headlines. Firstly, it is automation, including the creation of “unmanned" industries. Secondly, raising the reliability and extending the service life of machines.

This certainly requires new technology. The machine modules on a large scale are well suited for “unmanned" industries. Intense work is being carried out on new robots. What we need is not merely manipulators which can take up a work piece and pass it on, but robots which can identify objects, their position in space, etc.

We also need machines that would trace the entire process of machining. Some have been designed and are manufactured. Modern engineering thinking has created new automated coal-digging complexes and machine systems, installations for the continuous casting of steel, machine-tools for electro physical and electrochemical treatment of metals, unique welding equipment, and automatic rotor transfer lines and machine-tool modules for flexible industries.

New technologies and equipment have been designed for most branches of engineering.

In the shortest time possible the engineers are to start producing new generations of machines and equipment which would allow manufacturers to increase productivity several times and to find a way for the application of advanced technologies.

Large reserves in extending service life for machines can be found in the process of designing. At present, advanced methods have been evolved for designing machines proceeding from a number of criteria. Automatic design systems allow for an optimizing of the solutions in design and technology when new machines are still in the blueprint stage.

4.1 Vocabulary:

intense – қызу, ауыр, қиын
manipulators – көз алдаушы (әрекеттер)
coal-digging – көмір кен орны
casting – құйып алу, құю
evolved – өрістеу
to allow – рұқсат ету

4.2 Answer the questions:

1. What does automation include?
2. Name the main trends in modern machine-building?
3. In what way can automation be achieved?
4. What is the role of new technologies?
5. How can the process of designing be improved?

4.3 Retell the text in English.

5. Metal cutting

Cutting is one of the oldest arts practiced in the stone age, but the cutting of metals was not found possible until the 18^{th} century, and its detailed study started about a hundred years ago.

Now in every machine-shop you may find many machines for working metal parts, these cutting machines are generally called machine-tools and are extensively used in many branches of engineering. Fundamentally all machine-tools remove metal and can be devided into the following categories:

1. Turning machines (lathes)
2. Drilling machines
3. Boring machines
4. Milling machines
5. Grinding

Machining of large volume production parts is best accomplished by screw machines. These machines can do turning, threading, facing, boring and many ather operations. Machining can produce symmetrical shapes with smooth surfaces and dimensional accuracies not generally attainable by most fabrication methods.

Screw-machined parts are made from bar stock or tubing fed intermittently and automatically through rapidly rotating hollow spindles. The cutting tools are held on turrets and tool slides covenient to the cutting locations. Operations are controlled by cams or linkages that position the work, feed the tools, hold them in position for the proper time, and then retract the tools. Finished pieces are automatically separated from the raw stock and dropped into a container.

Bushings, bearings, nuts, bolts, studs, shafts and many other simple and complex shapes are among the thousands of products produced on screw machines. Screw machining is also used to finish shapes produced by other forming and shaping processes.

5.1 Vocabulary:

cutting – кесу
extensively – көлемді, жан-жақты
lathe – токарь станогы
grinding – ажарлау станогы
attainable – қол жетілу
spindle – шпиндель

5.2 Answer the questions:

1. When did the study of metal cutting start?
2. What is the purpose of metal cutting?
3. What machines are called "machine-tools"?
4. Where are cutting tools held?
5. What is the function of the spindle?

5.3 Retell the text in English.

6. Industrial engineering

A major in twentieth century manufacturing was the development of mass production techniques. Mass production refers to manufacturing processes in which an assembly line, usually a conveyer belt, moves the product to stations where each worker performs a limited number of operations until the product is assembled. In the automobile assembly plant such systems have reached a highly-developed form. A complex system of conveyer belts and chain drives moves car parts to workers who perform the thousands of necessary assembling tasks.

Mass production increases efficiency and productivity to a point beyond which the monotony of repeating an operation over and over slows down the workers. Many ways have been tried to increase productivity on assembly lines: some of them are as superficial as piping music into the plant or painting the industrial apparatus in bright colors; others entail giving workers more variety in their tasks and more responsibility for the product. These human factors are important considerations for industrial engineers who must try to balance an efficient system of manufacturing with the complex needs of workers.

Another factor for the industrial engineer to consider is whether each manufacturing process can be automated in whole or in part. Automation is a word coined in the 1940s to describe processes by which machines do tasks previously performed by people. We know of the advance in the development of stem engines that produced automatic valves.

Automation was first applied to industry in continuous-process manufacturing such as refining petroleum, making petromechanicals, and refining steel. A later development was computer-controlled automation of assembly line manufacturing, especially those in which quality control was an important factor.

6.1 Vocabulary:

massproduction – бұқаралық өндіріс, көлемді өндіріс
previous – бұдан бұрынғы, өткен, осыдан ілгергі
valve – қақпақша
continuous-process manufacturing – үздіксіз өндіріс
petrochemical – мұнай-химиялық
refine – тазарту
quality – сапа
especially – өзгеше, тым

6.2 Answer the questions:

1. What is a major development in manufacturing in the twentieth century?
2. How is mass production often exemplified by the assembly of automobiles?
4. To what kinds of industries was automation first applied?
5. What was a later development in industrial automation?

6.3 Retell the text in English.

7. Automation

We now use the term automation for specific techniques combined to operate automatically in a complete system. These techniques are possible because of electronic devices, most of which have come into use in the last thirty years. They include program, action, sensing of feedback, decision, and control elements as components of a complete system.

The program elements determine what the system does and the step-by-step manner in which it works to produce the desired result. A program is a step-by-step sequence that breaks a task into its individual parts.

The action elements are those which do the actual work. They may carry or convey materials to specific places at specific times or they may perform operations on the materials. The term mechanical handling device is also used for the action elements.

Perhaps the most important part of an automated system is sensing or feedback. Sensing devices automatically check on parts of the manufacturing process such as the thickness of a sheet of steel or paper. This is called feedback because the instruments return or feed back this information to the central system control.

The decision element is used to compare what is going on in the system with what should be going on, it receives information from the sensing devices and makes decisions necessary to maintain the system correctly.

The control element consists of devices to carry out the commands of the decision element. There may be many kinds of devices: valves that open or close, switches that control the flow of electricity, or regulators that change the voltage in various machines: they make the necessary corrections adjustments to keep the system in conformity with its program.

An industrial engineer working with automated systems is part of a team. Many components of the system, such as computers, are electronic devices so electronic devices so electronic engineers and technicians are also involved. Many of the industries in which automation has proved particularly suitable – chemicals, papermaking, metals processing – involve chemical processes, so there may be chemical engineers at work too. An industrial engineer with expertise in all these fields may become a systems engineer for automation projects thereby coordinating the activities of all the members of the team.

7.1 Vocabulary:

sensing – сезімтал элемент
feedback – кері байланыс
sequence – реттілік, бірізділік, жүйелілік
handling device – қолдан жасалған бұйым
manufacturing – өндірістік жүйе
adjustment – жөндеу, түзету, орнату
conformity – сәйкестік

7.2 Answer the questions:

1. What some elements of an automated system?
2. What is a program?
3. Name two terms used to describe the elements which do the actual work. What are some jobs these elements may do?
4. What are some of the things devices do?
5. How do sensing devices act on the information they receive?

7.3 Retell the text in English.

8. Factors affecting machinability

Machinability is generally assumed to be a function of tool edge life:

The main factors which influence the behaviour and thus the life of the edge of cutting tools are:

- the mechanical characteristics of the material being machined such as its strength, hardness and metallurgical structure:
- the state of the casting, involving the skin finish, critical demensions, machining allowances, slag inclusions, the presence of scabs,rust, dirt, etc.
- the nature of the machining techniques being used:
- the characteristics of the machine-tool being used, such as machine efficiency, available power, and the rigidity of the setup.

Other factors aside, it is primarily the structure of the metal which determines its resistance to the cutting action of the tool, i.e. the potential rate of metalremoval, and the resulting abrasion on the tool, i.e. the life of the cutting edge.

Structure, strength and machinability are interrelated to some extent- in general, increased strength implies reduced machinability. This basic relationship must be understood, otherwise difficulties may be experienced in the machine shop if the designer has specified a material with a higher strength than is necessary. Nevertheless, care shouldbe taken in rating machinability on the basis of strength. For example, nodular irons are normally considerably stronger than flake-graphite types, but are likely to be easier to machine. It is therefore recommended that structure, rather than strength be adopted as the basis for machining practice. Hardness provides a more reliable guide to machinability than does strength for hardnessdepends mainly on the matrix structure of the casting.

8. 1 Vocabulary:

behaviour – мінез
aside – алшақтап тұру
allowances – жіберу рұқсаты
machinability – өңделіп шығу, өңделу
scab – шапқын, бұлтық
rust – төж басу, төж
strength – күш
removal – қашықтау, алыстау, аулақтану

8.2 Answer the questions:

1. What are the main factors influencing the tool edge life?
2. Does the structure of the material influence machinability? In what way?
3. What does increased strength result in?
4. What is this text about?

8.3 Retell the text in English.

9. Welding

Welding is a process when metal parts are joined together by the application of heat, pressure, or a combination of both. The process of welding can be divided into two main groups:

. pressure welding, when the weld is achieved by pressure and

. heat welding, when the weld is achieved by heat. Heat welding is the most common welding process used today.

Nowadays welding is used instead of bolting and riverting in the construction of many types of structures, including bridges, buildings, and ships. It is also a basic process in the manufacture of machinery and in the motor and aircraft industries. It is necessary almost in all productions where metals are used. The welding process depends greatly on the properties of the metals, the purpose of their application and the available equipment.

Welding processes are classified according to the sources of heat and pressure used and resistance welding. Other joining processes are laser welding, and electron – beam welding.

Gas welding is a non-pressure process using heat from a gas flame. The flame is applied directly to the metal edges to be joined and simultaneously to a filler metal in the form of wire or rod, called the welding rod, which is melted to the joint. Gas welding has the advantage of using equipment that is portable and does not require an electric power source. The surfaces to be welded and the welding rod are coated with flux, a fusible material that shields the material from air, which would result in a defective weld.

9.1 Vocabulary:

to join – қосу
pressure welding – қысыммен пісіру
heatwelding – жылумен пісіру
instead – орнына
bolting – болттармен бекіту
riverting – кеспек, тақташа
gas welding – газбен жіберу

9.2 Answer the questions:

1. How can a process of welding be defined?
2. What are the two main groups of processes of welding?
3. How can we join metal parts together?
4. What is welding used for nowadays?
5. Where is welding necessary?

9.3 Retell the text in English.

10. Arc Welding

Arc Welding is the most important welding process for joining steels. It requires a continuous supply of either direct or alternating electrical current. This current is used to create an electrical arc, which generates enough heat melt metal and create a weld. Arc welding has several advantages over other welding methods. Arc welding is faster because the concentration of heat is high. Also, fluxes are not necessary in certain methods of arc welding. The most widely used arc-welding processes are shielded metal arc, gas-tungsten arc, gas-metal arc and submerged arc.

In shielded metal-arc welding, a metallic electrode, which conducts electricity, is coated with flux and connected to a source of electric current. The metal to be welded is connected to the other end of the same source of current. An electric arc is formed by touching the tip of the electrode to the metal and then drawing it away.

The intense heat of the arc melts both parts to be welded and the point of the metal electrode, which supplies tiller metal for the weld. This process is used mainly for welding steels.

10.1 Vocabulary:

arc welding – электр доғасымен дәнекерлеу
resistance welding – түйісу сваркасы (пісіру)
laser welding – лазерлік сварка
electron-beam welding – электронды-сәулелі сварка
edge – шек, өлке, жер
filler – толықтырғыш, толтырма
wire – сым, сым темір
rod – темір шыбық
to melt – балқу, еру

10.2 Answer the questions:

1. What do the welding processes of today include?
2. What are the principles of gas welding?
3. What kinds of welding can be used for joining steels?
4. What does arc welding require?
5. What is the difference between the arc welding and shielded-metal welding?

10.3 Retell the text in English.

11. Other types of welding

Non – consumable Electrode Arc welding.

As non-consumable electrodes tungsten or carbon electrodes can be used. In gas-tungsten arc welding a tungsten electrode is used in place of the metal electrode used in shielded metal-arc welding. A chemically inert gas, such as argon, helium, or carbon dioxide is used to shield the metal from oxidation.

The heat from the arc formed between the electrode and the metal melts the edges of the metal. Metal for the weld may be added by placing a bare wire in the arc or the point of the weld. This process can be used with nearly all metals and produces a high-quality weld. However, the rate of welding is considerably slower than in other processes.

Submerged-arc welding is similar to gas-metal arc welding, but in this process no gas is used to shield the weld. Instead of that, the arc and the tip of the wire are submerged beneath a layer of granular, fusible material that covers the weld seam. This process is also called electroslag welding. It is very efficient but can be used only with steels.

Resistance Welding.

In resistance welding, heat is obtained from the resistance of metal to the flow of an electric current. Electrodes are clamped on each side of the parts to be welded, the parts are subjected to great pressure, and a heavy current is applied for a short period of time. The point where the two metals touch creates resistance to the flow of current. This resistance causes heat, which melts the metals and creates the weld. Resistance welding is widely employed in many fields of sheet metal or wire manufacturing and is often used for welds made by automatic or semi-automatic machines especially in automobile industry.

11.1 Vocabulary:

gas tungsten – оқшау газды ортадағы вольфрам электродының балқытуымен дәнекерлеу

inert – оқшау

gas-metal arc – аргонды-доғалы дәнекерлеу

carbon dioxide – көмір қышқыл газы

droplet – тамшы

liquid – сұйықтық, сұйық

layer – қабат

weld seam – пісіру жігі

resistance – қарсылық

clamp – қысым, қысу

to submerge – тиеу, арту, бату

11.2 Answer the questions:

1. What the difference between the arc-welding and non-consumable electrode arc welding?

2. What are the disadvantages of the non-consumable electrode arc welding?

3. What is submerged arc welding?

4. What is the principle of resistance welding?

5. Where is semi-automatic welding employed?

11.3 Retell the text in English.

12. Highly automated systems

Automation is the system of the manufacture performing certain tasks, previously done by people, by machines only. The sequences of operations are controlled automatically. The most familiar example of a highly automated system is an assembly plant for automobiles or other complex products.

The term automation is also used to describe non-manufacturing systems in which automatic devices can operate independently of human control. Such devices as automatic pilots, automatic telephone equipment and automated control systems are used to perform various operations much faster and better than could be done by people.

Automated manufacturing had several steps, in its development. Mechanization was the first step necessary in the development of automation. The simplification of work made it possible to design and build machines that resembled the motions of the worker. These specialized machines were motorized and they had better production efficiency.

Industrial robots, originally designed only to perform simple tasks in environments dangerous to human workers, are now widely used to transfer, manipulate, and position both light and heavy work pieces performing all the functions of a transfer machine.

In the 1920s the automobile industry for the first time used an integrated system of production. This method of production was adopted by most car manufacturers and became known as Detroit automation. The feedback principle is used in all automatic-controls mechanisms when machines have ability to correct themselves. The feedback principle has been used for centuries. An outstanding early example is the fly ball governor, invented in 1788 by James Watt to control the speed of the steam engine. The common household thermostat is another example of a feedback device.

Using feedback devices, machines can start, stop, speed up, slow down, count, inspect, test, compare, and measure. These operations are commonly applied to a wide variety of production operations.

12.1 Vocabulary:

automation – автоматизация
previously – бұрын
sequence – реттілік, жүйелік
assembly plant – құрастыратын зауыт
non-manufacturing – өндірістік емес
device – аспап, құрал
resemble – ұқсау
efficiency – тиімділік
fly ball governor – центрден тепкіш реттеуіш
steam engine – паровоз

12.2 Answer the questions:

1. How is the term automation defined in the text?
2. What is the most “familiar example” of automation given in the text?
3. What was the first step in the development of automation?
4. What were the first robots originally designed for?
5. What is feedback principle?

12.3 Retell the text in English.

13. Automation in industry

Computers have greatly facilitated the use of feedback in manufacturing processes. Computers gave rise to the development of numerically controlled machines. The motions of these machines are controlled by punched paper or magnetic tapes. In numerically controlled machining centre machine tools can perform several different machining operations.

More recently, the introduction of microprocessors and computers have made possible the development of computer-aided design and computer-aided manufacture (CAD and CAM) technologies. When using these systems a designer draws a part and indicates its dimensions with the help of a mouse, light pen, or other input device. After the drawing has been completed the computer automatically gives the instructions that direct a machining centre to machine the part.

Another development using automation are the flexible manufacturing systems (FMS). A computer in FMS can be used to monitor and control the operation of the whole factory.

Automation has also had an influence of the areas of the economy other than manufacturing. Small computers are used in systems called word processors, which are rapidly becoming a standard part of the modern office. They are used to edit texts, to type letters and so on. Automation in Industry

Many industries are highly automated or use automation technology in some part of their operation. In communications and especially in the telephone industry dialing and transmission are all done automatically. Railways are also controlled by automatic signaling devices, which have sensors that detect carriages passing a particular point. In this way the movement and location of trains can be monitored.

Not all industries require the same degree of automation. Sales, agriculture, and some service industries are difficult to automate, though agriculture industry may become more mechanized, especially in the processing and packaging of foods.

The automation technology in manufacturing and assembly is widely used in car and other consumer product industries.

Nevertheless, each industry has its own concept of automation that answers its particular production needs.

13.1 Vocabulary:

household thermostat – тұрмыстық термостат
facilitate – мүмкіндік туғызу
punched – тесілген
aid – көмек
dimension – өлшем, өлшемдер

13.2 Answer the questions:

1. What was the first industry to adopt the new integrated system of production?
2. What do the abbreviations CAM and CAD stand for?
3. What is FMS?
4. What industries use automation technologies?

13.3 Retell the text in English.

14. Types of automation

Applications of Automations and Robotics in Industry

Manufacturing is one of the most important application areas for automation technology. There are several types of automation in manufacturing. The example of automated systems used in manufacturing are described below.

1. Fixed automation, sometimes called "hard automation" refers to automated machines in which the equipment configuration allows fixed sequence of processing operations. The machines are processed by their design to make only certain processing operations. They are not easily changed over from one product style to another. This form of automation needs high initial investments and high production rates. That is why it is suitable for products that are made in large volumes. Examples of fixes automation are machining transfer lines found in the automobile industry, automatic assembly machines and certain chemical processes.

2. Programmable automation is a form of automation for producing products in large quantities, ranging from several dozen to several thousand units at a time. For each new product the production equipment must be reprogrammed and changed over. This reprogramming and changeover take a period of non-productive time. Production rates in programmable automation re generally lower than in fixed automation, because the equipment is designed to facilitate product changeover rather than for product specialization. A numerical-control machine-tool is a good example of programmable automation. The program is coded in computer memory for each different product style and the machine-tool is controlled by the computer program.

3. Flexible automation is a kind of programmable automation. Programmable automation requires time to re-program and change over the production equipment for each series of new product. This is lost production time, which is expensive. In flexible automation the number of products is limited so that the changeover of the equipment can be done very quickly and automatically. The reprogramming of the equipment in flexible automation is done at a computer terminal without using the production equipment itself. Flexible automation allows a mixture of different products to be produced one right after another.

14.1 Vocabulary:

initial – бастапқы, бастапқысы
investment – қаржы салу

to facilitate – мүмкіндік туғызу, себепті болу
rate – шапшандық, екпін, қарқын
assembly machines – құрастыратын машина
non-productive – өнімсіз
changeover – өту, ауысу

14.2 Answer the questions:
1. What is the most important application of automation?
2. What are the types of automation used in manufacturing?
3. What is fixed automation?
4. What are the limitations of hard automations?
5. What is the best example of programmable automation?

14.3 Retell the text in English.

15. Robots in manufacturing

Today most robots are used in manufacturing operations. The applications of robots can be divided into three categories:
1. material handling
2. processing operations
3. assembly and inspection

Material-handling is the transfer of material and loading and unloading of machines. Material-transfer applications require the robot to move materials of work parts from one to another. Many of these tasks are relatively simple: robots pick up parts from one conveyor and place them on another. Other transfer operations are more complex, such as placing parts in an arrangement that can be calculated by the robot. Machine loading and unloading operations utilize a robot to a load and unload parts. This requires the robot to be equipped with a grip-per that can grasp parts. Usually the gripper must be designed specifically for the particular part geometry.

The application area of industrial robots is assembly and inspection. The use of robots in assembly is expected to increase because of the high cost of **manual labour.** But the design of the product is an important aspect of robotic assembly. Assembly methods that are satisfactory for human are not always suitable for robots. Screws and nuts are widely used for fastening in manual assembly, but the same operations are extremely difficult for a one-armed robot.

Inspection is another area of factory operations in which the utilization of robots is growing. In a typical inspection job, the robot positions a sensor with respect to the work part and determines whether the part answers the quality specifications. In nearly all industrial robotic applications, the robot provides a substitute for human labour. There are certain characteristics of industrial jobs performed by humans that can be done by robots:

1. The operation is repetitive, involving the same basic work motions every cycle.
2. The operation is **hazardous** or uncomfortable for the human worker (for example: spray painting, spot welding, arc welding, and certain machine loading and unloading tasks).
3. The work piece or tool are too heavy and difficult to handle.
4. The operation allows the robot to be used on two o three **shifts**.

15.1 Vocabulary:

gripper – қармау
to grasp – ұстау, ұстап қалу
spot welding – таңбалы, жүктелі дәнекерлеу
spray painting – бүркіп шашу
frame – кесек
spray-painting gun – бояуды тозаңдатқыш
grinding – тегістеу
polishing – жылтырауық
spindle – шпиндель
manual – қолы
shift – ауысым

15.2 Answer the questions:

1. How are robots used in manufacturing?
2. What is “material handling”?
3. What is the most common application of robots in automobile manufacturing?
4. What operations could be done by robot in car manufacturing industry?
5. What are the main reasons to use robot in production?

15.3 Retell the text in English.

16. What is an Electric Current?

The question is often asked: "What is an electric current?" No one has ever seen it. We only know of the existence of a current owing to its effects. A current can heat a conductor, it can have a chemical action when passing through a solution, or it can produce a magnetic effect. We can measure currents by observing their heating, chemical or magnetic effects. The practical unit of current is called the **Ampere.**

Two things are necessary to cause an electric current to flow: first – a complete circuit, and second – a driving force called the **electromotive force (e. m. f.).**

If you put free electrons on an insulated copper ball, what would they do? In this case they would try to repel each other. In case you connected this charged ball to another **ball** of equal size by a copper wire, what would be the result? The electrons would move along the copper wire until the number of electrons on each **ball** were the same. This is an example of electromotive force causing **a** current to flow.

A battery has a surplus of electrons on one of its two plates; so you say **that** a battery furnishes an e. m. f. If a copper wire is run from one plate to the other, a current flows in the complete circuit thus made. If a small bulb is placed in the circuit, it will light up, giving evidence to a current flow. If the battery were disconnected and a generator substituted for it, we should have a typical lighting system. Both batteries and generators are the most common sources of electromotive force. The practical unit of e. m. f. is the **Volt.**

Currents will flow more readily in some substances than in others, that is, various substances offer lesser or greater resistance to the flow of current. Such substances as porcelain, ebonite, rubber, glass and the like having extremely high resistance are known as insulators. The practical unit of resistance is the **Ohm.**

Substances whose properties lie between those of conductors and insulators are called semiconductors. Let us name but a few most widely used at present, they are germanium, silicon, selenium and copper oxide. The importance of semiconductors in our life cannot be overestimated. But for these tiny "workhorses" electronic industry would not have achieved such a great progress.

16.1 Vocabulary:

driving force *(here)* = electromotive force (e. m. f.) – электроқозғаушы күш

and the like – тағы басқалар (заттар) ұқсас

16.2 Answer the questions:

1. What is the unit of current?
2. What can an electric current do?
3. What is necessary to cause an electric current to flow?
4. What are the most common sources of electromotive force?
5. How does current flow in various substances?
6. What is the unit of resistance?
7. What substances do we call insulators?
8. What semiconductors do you know?

16.3 Words to Be Learnt

charge – қуаттау
circuit – тізбек
common – жалпы, таралған
readily – оңай, тез, жылдам
complete – *мұнда* тұйық
current – тоқ, ағыс
evidence – айғақ, дәлел
insulate – оқшаулау
insulator – айырғыш
like – ұқсас, сол сияқты, сонымен үйлес
owing to – арқасында, себепті
plate – тілім, тілімше
semiconductor – жартылай өткізгаш
silicon – кремний
substitute (for) – ауыстыру
thus – сайып келгенде
tiny – кіп кішкен

17. Charging by Induction

We have seen bodies become charged by friction. The object of the present article is to examine charging by induction.

To charge an object by induction means to charge it by the influence of an electrified body at a distance. Hence, to charge an object by induction, one should hold a charged body at some distance near the object to be charged. The charged body brought near the uncharged one is found to produce an induced charge in that object.

For our experiment we shall use again a rod and a ball hung by a silk thread. Figure ***a*** represents the ball suspended from the stand. Notice that the charges on the ball show it to be neutral.

If the rubber rod is strongly charged by rubbing it with a piece of flannel and is brought near the suspended ball, we observe our ball to be attracted, at first (see fig. 3-4, c). There must be a positive charge on the ball since attraction takes place only between unlike charges. Indeed, when the negatively charged rod is brought near the ball, some of the electrons are displaced to the far side of that ball, away from the rod. This will leave a positive charge on its side which is nearest the rod (see fig. *b)*. When the rod and the ball come into contact, electrons pass into the positive side of the ball until it becomes negatively charged (see fig. *d)*. Then the ball is repelled, of course, because it has a charge of the same sign as that of the rod. It follows that an induced charge is always the opposite of the inducing one. The charge produced by contact is the same as that on the object to make the contact.

Charging by induction was discovered by Epinus. Having been invited to work at the Petersburg Academy of Sciences, Epinus came to Russia when he was quite young.

He is reported to have spent here the remainder of his life.

In his work on electricity and magnetism published in 1759 he was among the first to note the affinity existing between electric and magnetic phenomena. Epinus was also the first to apply mathematics to the study of electricity and magnetism. But what interests us most at the moment is that he first investigated the phenomenon known at present as that of electrostatic induction. He introduced the idea of electric attraction by influence of a charged body at some distance.

The great French scientist, Coulomb, may rightly be considered to be the founder of the exact science of electrostatics. Coulomb established the law of inverse squares and put the study of electrical and magnetic phenomena on a firm quantitative basis. He proved the following: the distribution of electricity over the surface of two bodies brought into contact, or merely within each other's influence, depends upon the shape and dimensions of these bodies and not upon their material of mass. In 1785 Coulomb published the results of experiments with his torsion balance with which he made direct measurements of the attractive and repulsive forces between two electrified bodies.

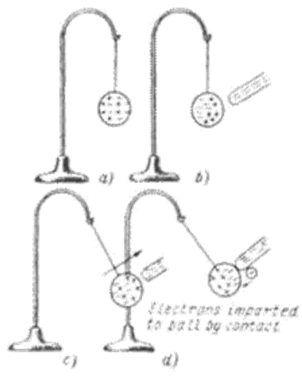


Figure. Theoretical movement of charges on a metal ball.

17.1 Answer the following questions:

1. What does this article deal with?
2. What is the object of the present article?
3. What must one do to charge an object by induction?
4. What does fig. *a* illustrate?
5. Does attraction take place between like charges?
6. What happens when a negatively charged rod is brought near the ball?
7. What happens when the rod and the ball come into contact?
8. Why is the ball repelled?
9. Is the induced charge always the opposite of the inducing one?
10. What phenomenon did Epinus investigate?
11. What law did Coulomb establish?
12. What did Coulomb prove?

17.2 Translate the following sentences and define the functions of the infinitive:

1. It is possible to detect charges which are at rest.
2. Russian scientist Petroff was the first to prove that metals can be charged by friction.
3. To prove charging by induction is not difficult at all.
4. To prove charging by induction one has to make a number of experiments.
5. Two rubbed substances happened to show similar properties.
6. We know Coulomb to have made direct measurements of the attractive and repulsive forces between two electrified objects.
7. The rubber rod is expected to attract the ball.
8. We know the induced charge to be the opposite of the inducing one.

17.3 Find the infinitives in the article and define their functions.

18. Electric Shielding and the Electric Field

Speaking of induction, we discussed a simple experiment with the ball on the silk thread and the charged rod. We saw that they affected each other at a distance. A similar effect is produced by magnets.

We call the region of influence of magnetic forces surrounding a magnet a magnetic field. Similarly, we call the space around an electric charge in which electrical forces are acting an "electric field", or an electrostatic field. That space is usually filled either by air or by some other substance. Just as we find no insulator for the magnetic field of force, so we find no insulator for the electric field of force. Electrical insulators prevent or restrict the flow of electric charges but do not prevent the affects of the electric field. The electric shielding serves these purposes. The shielding is a conducting shell surrounding the wires or electrical devices, which shell being connected to the "ground" every few meters and sometimes every few centimeters, depending upon its purpose

The explanation of the purpose of the electric (or electrostatic) shielding is quite simple. Let us picture that every electric charge is radiating electric lines of force, these electric lines of force representing the electric field, just as the magnetic lines of force represent the magnetic field.

We assume that an electric line of force begins at a + (plus) charge and ends at a — (minus) charge.

Suppose that a + charge is near a shielded wire (see fig.). The + charge attracts a — charge from the "ground" into the shield. Hence, the electric lines of force of the plus charge end at the minus charges that are outside the shielded space. Similarly a — charge that is nearby will cause a + charge on the shield.

Obviously, the shield must be a good conductor, so that the charges could flow freely. The wire inside the shield being insulated, there is no flow of electricity between the wire and the grounded shield.

One should remember the following requirement for shielding materials. The materials used for the magnetic shield must be of high magnetic permeability, the electrostatic shield requiring a material of high electrical conductivity.

Electric shielding is extremely important in radio installations.

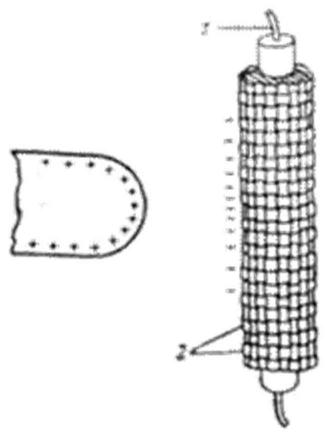


Fig. Electrostatic shielding. The positively charged rod which stimulates the effect of stray electric force induces a charge in the metal braid. But the insulated wire inside is not affected, for the lines of electric force end at the charge on the surface of the shield.
1 — insulated wire; 2 — metal shield.

18.1 Answer the following questions:

1. What did we discuss speaking of induction?
2. What do we call a magnetic field?
3. What is an electrostatic field?
4. What are the electrical insulators used for?
5. Do the electrical insulators prevent the affects of the electric field?
6. What purposes does the electric shielding serve?
7. What do the magnetic lines of force represent?
8. Where does an electric line of force begin?
9. What do you see in fig.?
10. What are the requirements for shielding materials?
11. Why must the shield be a good conductor?
12. Where is an electric shielding extremely important?

18.2 Translate the following sentences and define the functions of the participle:

1. Metals are the best conductors of electricity, minerals being rather poor conductors.
2. A charged body brought near an uncharged one will produce an induced charge in that body.
3. It must be noted that an induced charge is always the opposite of the inducing charge.
4. Speaking of the lines of force, one must remember that they do not exist in reality.

5. Some of the effects produced by the lines of force are discussed in the following article.

6. There are two figures on this page, one of them showing the electrostatic shielding.

7. The ball touching the rod surface, some of the static electricity passed to it.

18.3 State if the following sentences are true to the fact or false. Correct the false sentences:

1. We can easily find an insulator for the magnetic field of force.
2. Electrical insulators prevent the effects of the electric field.
3. The magnetic lines of force represent the magnetic field.
4. An electric line of force begins at a plus charge and ends at a minus charge.
5. A minus charge will cause a minus charge on the shield.
6. The shield must be a good insulator, so that the charges could flow freely.

19. Potential Difference and Resistance

If we were asked: "How can electric charges be made to flow and what factors influence their flow?" The analogy to the flow of water in a pipe would certainly help to make some of the principles clear.

If one considers the conditions necessary for the water flow through a pipe, it will not be difficult to understand that there must be a pump somewhere in the pipeline, or else a difference in level must evidently exist between the two ends of the pipe.

In case we are dealing with electricity, the requirements necessary for current flow are similar in that there must be in the circuit an electromotive force (a battery or a generator), or else a difference of potential should exist between the two ends of the conductor.

Let us picture what would happen provided there was a conducting wire between two points of unequal potential. It is clear that in such a case there must be a flow of electrons from one of the points to the other. Since the electrons in the wire constitute the current flow, they will certainly tend to flow from the point of lower potential towards that of higher potential.

Imagine that an electric current flows from point *A* to point *B*through the conductor in fig. In electrical terms this means that there is a potential difference between *A* and *B,* the potential at *A* being greater than that at *B.*

unless there were a flow of current between *A* and *B* in any direction, *A* and *B* would doubtless be at the same potential.

Let us return to our analogy, to the flow of water in a pipe (see fig. *a)*. There is a difference in level (or potential energy) between the water at the ends *A* and *B* of the given pipe *AB*. This difference in level is supported by a pump which raises the level (or potential energy) of the water at *B* to that at *A*.

The flow of water per second through the pipe *AB* depends first on the difference in level between points *A* and *B,* just as in the electrical case the current in the conductor *AB* depends on the potential difference between point *A* and point *B*. The other factor that is to be considered before one is able to say how much water does flow through the pipe is the resistance offered by the pipe to the flow of water. In the same way, an electrical conductor, say a wire, offers some resistance to the flow of charges passing through it.

In the case we have just considered, where a conductor is connected between two points of unequal potential, we have a momentary motion of charges. The charges move until they come to a static equilibrium state, then they stop; there is no steady current, therefore. When we have such a case of static equilibrium, the surface of a conductor is equal in potential everywhere. Naturally, it does not mean that there is an equal distribution of charge over the whole surface of the conductor but it does mean that all points of the conductor are alike with respect to potential.

If we have a conductor carrying a steady current, we obviously find that the situation is different. The current flowing there must be caused by a difference of potential from one point to another along the wire. Otherwise, there would be no cause that might make charges move along the wire.

Dealing with potential and potential difference, mention should also be made of the volt, since it is the volt that is the unit used for measuring potential and potential difference.

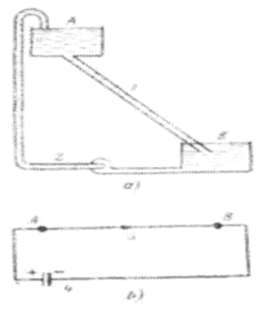


Fig. An analogy between
water flow and flow of charge.
1 – pipe; 2 – pump; 3 – conductor; 4 — battery

19.1 Answer the following questions:

1. What is this article about?
2. Does this article deal with resistance only?
3. Do electrons flow from the point of higher potential to the point of lower potential?
4. What analogy is considered in fig.?
5. What is the difference in level supported by?
6. What does the flow of water through a pipe depend on?
7. What requirements are necessary for current flow?
8. What does the current in the conductor *AB* depend on?
9. Does a conductor offer resistance to the flow of charges?
10. What factors influence the flow of charges?

19.2 Translate the following sentences, paying attention to the modality:

1. If two of the three quantities were known, the third would be found by Ohm's Law.
2. Was there a conducting wire between both points of unequal potential, the electrons would flow from one of the points to the other?
3. It was the diameter of the wire that we did change to obtain better results.
4. It was the analogy between the electron flow and the water flow that helped us to understand the principles mentioned in the article.
5. The electrons do tend to flow from the point of lower potential to that of higher potential.
6. If the pipe has a small cross-section, the water flow per second will be also small.
7. Mention should be made here that the volt is the unit used for measuring potential difference.
8. A redistribution of charges will take place, provided two charged conductors are connected by a wire.
9. Potential in a point is equal to the work that would be required to transfer the unit charge from infinity to that point.
10. Had our pipe a small cross-section, the water flow per second would be certainly small.
11. The water flow per second will be small unless the pipe has a large cross-section.

20. Lightning

Electrostatic effects are found to be usually characterized by very large potentials or voltages accompanied either by small currents or by currents that last for a very short time. A spark lasts less than one-tenth of a second and sometimes as little a time as a millionth of a second. However, two large spheres separated by a distance of one centimeter have to be charged to a potential difference of 30,000 V, at least, before the electrical intensity is sufficient to force a spark through the air resistance. If the spheres are separated by a distance of, say 40 cm, the potential difference must be nearly a million volts, only then will a spark pass.

All know at present, that lightning is a gigantic electric spark between charged clouds or between a charged cloud and the ground. However, there was a time when lightning was a subject for legends, an insoluble problem that scientists vainly tried to explain.

Benjamin Franklin, the great American scientist and progressive statesman, is acknowledged to be the pioneer of the theory of atmospheric electricity. In 1752, at Philadelphia, he flew a kite to draw down the lightning from the clouds to the earth and prove it to be electricity. In his famous kite experiment, he demonstrated that atmospheric electricity and static electricity is one and the same thing. And it was he, too, who was the first find the ingenious defense against the destructive action of lightning, – the lightning rod. Franklin was not only an outstanding scientist but also a true friend of the people. He has always been highly appreciated in Russia.

Franklin's achievements were analyzed and approved by Lomonosov who had made his own experiments independently. The idea of atmospheric electricity greatly interested both Lomonosov and his friend Professor Rihman. Both of them are reported to have made systematic observations and experiments on the subject in question. We know Rihman to have constructed for that purpose the first electrical measuring instrument in the world. However, to carry on investigations of such a kind was more than dangerous in those times. Indeed, Rihman was killed by a stroke of lightning during one of his experiments.

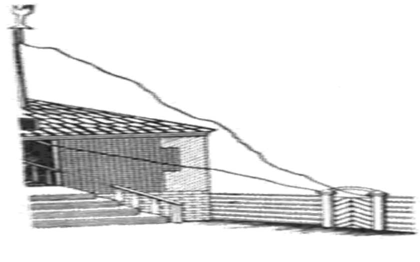


Fig. "Electric arrow" on the house where Lomonosov lived.

20.1 Answer the following questions:

1. What is this article about?
2. What are electrostatic effects characterized by?
3. How long does a spark last?
4. What is lightning?
5. What was Franklin?
6. In what field of science did he work?
7. What did Franklin demonstrate by his famous experiment?
8. What defense did Franklin find against lightning?
9. Who approved Franklin's achievements?
10. What did Rihman construct?
11. What does fig. illustrate?

20.2 Translate the following sentences and define the functions of the infinitive:

1. Coulomb is considered to be the founder of the exact science of electrostatics.
2. Lightning is known to be a great electric spark between charged clouds.
3. Franklin was one of the first scientists to prove that atmospheric electricity and static electricity is one and the same thing.
4. To prove that lightning is atmospheric electricity Franklin carried on his famous kite experiment.
5. To prove that lightning is atmospheric electricity required systematic observations and experiments.
6. We know Franklin to have invented the lightning rod.
7. It is interesting to note that Rihman constructed the first electrical measuring instrument in the world.

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

1. There was a **time** when people knew nothing about electricity.
2. One of the spheres is four **times** as large as the other one.
3. Four **times** four is sixteen.
4. At **times** a spark appeared between the two ends of the wire.
5. The experiment in question was finished in good **time**.
6. Only electrical sparks jumping between two electrodes were known before Academician Petroff's **time**.
7. In those **times** lightning was a subject for legends.
8. What **time** is it? I think it is **time** to stop the motor.

20.4 Find the infinitives in the article and define their functions.

20.5 Retell the article.

21. Like Charges Repel and Unlike Charges Attract

It is well known that electrical charges in motion constitute a current. But one might ask: "Is it possible to detect charges that are not in motion?" Yes, it is, if there is an excess of either positive or negative charges, for then they develop attractive or repulsive forces that can be detected and measured.

If you are asked to rub an ebonite rod with flannel, you will easily notice that it has acquired the property of attracting light objects such as small pieces of paper, cork, and the like. In that case it is said to be charged.

It is not difficult to make the following simple experiment. Hang a small piece of cork or any other light object by a silk thread, as shown in fig. 3-3. (The object will be referred to as a ball regardless of its shape.) It is important that the material be light in weight. If we bring the charged ebonite rod near the ball, the latter will be attracted towards it. However, if we rub the rod against the ball for some time, the ball will jump away. "How can it be", one may ask, "that the very rod that first attracted the ball, now repels it?"

The answer is simple enough. When the ball was touching the surface of the rod, some of the static electricity passed to it. It is repelled because now it has the same kind of electric charge as that on the ebonite rod. However, if a charged glass rod is brought near it, the ball is very strongly attracted. It is obvious that the electric charge passed to the ball by the ebonite rod cannot be the same kind of charge as that on the glass rod. One can simplify this statement and say:

Like charges repel each other.

Unlike charges attract each other.

Experiments have shown that there are two kinds of electric charges. A charge of the same kind as that produced on glass rubbed with silk is called a positive charge. A charge produced upon an ebonite rod when it is rubbed with flannel is known to be negative.

Under proper conditions any substance may become charged to some extent when it is rubbed against another dissimilar substance. However, they consider amber, glass, and sealing-wax as substances that are easily electrified.

Centuries ago amber was believed to be the only substance possessing that characteristic. History says that in the year 600 before our era Thales, the Greek philosopher, knew that, when amber was rubbed, it would attract small particles. William Gilbert, the English physician and physicist (1540-1603), wrote about attraction as well as repulsion in connection with his experiments on magnetism. He used the term electric force which was doubtless derived from the Greek word "electron" meaning amber.

Speaking about electricity produced by friction, it is necessary to point out that our Russian electrician Academician Petroff first made experiments and observations on the electrification of metals by friction. As a result, he was the first scientist who stated that phenomenon and proved that metals can be charged by friction.

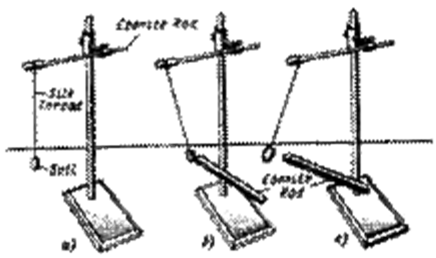


Fig. a — uncharged ball; b — uncharged ball is attracted to ebonite rod; c — ball is repelled after receiving some of the rod's charge.

21.1 Answer the following questions:

1. What will happen to an ebonite rod if you rub it with flannel?
2. What should one do in order to charge the ebonite rod?
3. What experiment does fig. illustrate?
4. What is the difference between fig. *b* and c?
5. What will happen to the ball if we bring the charged ebonite rod near it?
6. Why is the ball repelled?
7. Do unlike charges repel each other?
8. What kinds of charges do you know?
9. What substances are easily electrified?
10. What experiments and observations did Petroff make?
11. What phenomenon did Petroff state and prove?
12. What was Petroff?

21.2 Translate the following sentences:

1. It is necessary to note here that metals can be charged by friction.
2. It is known that William Gilbert made experiments in magnetism.
3. The reader is asked to describe fig.
4. One must know that like charges repel and unlike charges attract.
5. They say that glass is easily electrified.
6. Electrical charges in motion are known to constitute an electric current.

21.3 Translate the following sentences and define the functions of the words in bold type:

1. The **rubbed** ebonite rod **acquired** the property of, attracting light objects.
2. A charge **produced** on glass is a positive one.
3. Our scientists have recently **finished** their work **connected** with magnetism.
4. The phenomenon discovered by our scientists must be **studied** by the students.
5. The experiment described attracted the students' attention.
6. The rod **used repelled** the ball.
7. The reader is **asked** to retell the **above-mentioned** article.
8. The charged ball **repelled** the rod.

21.4 Retell the article.

22. Energy and its Forms

Scientifically speaking, energy is the capacity for doing work. It is well known that a falling weight striking an object exerts a force on that object and makes it move a certain distance. It means that the falling weight performs' work. The above case is typical of many other cases where first work is done on an object or system and then the object or system, in its turn, does work on something else. One must perform work in order to wind the spring of a clock. The spring returns the work when it makes the mechanism of the clock run for a number of hours. When a body is capable of performing work, it possesses energy. It is quite clear that the more work a body can do, the more energy it possesses. There are numerous forms of energy, such as: electrical, chemical, mechanical, heat energy and so on; in mechanics, they are interested in two special kinds of energy, namely, kinetic energy and potential energy which are dealt with further on.

It is quite possible to transform one form of energy into another. Take a waterfall as an example: when water falls from a height, the energy is said to change from potential to kinetic. If there is a hydroelectric plant at the waterfall, as is often the case in our country, the energy of the falling water is used to drive the turbines. The turbines are driven by the kinetic energy of the water. Since it is difficult to transfer mechanical energy over a great distance, it is used here to drive generators. These generators, in their turn, change mechanical energy into electric energy.

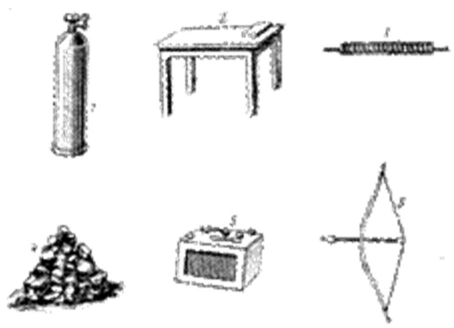
They say that "fire is man's best friend and worst enemy". If fire is controlled, the heat given off can be made to do many useful and important things. Coal or any other fuel is burned to provide the heat which will be required for driving our engines and turbines. These, in their turn, are expected to produce the mechanical work used in numberless ways.

We shall see later on how heat in an electric wire was first used to produce our electric lamp. This is a conversion of electric energy into heat, the heat being so intense in the wire that it becomes white-hot and produces light.

Kinetic and Potential Energy. Kinetic energy is the energy of motion, while potential energy is that of position. One cannot but add here that the kinetic energy of an object is the energy that it possesses because of its speed. Any moving object is expected to perform work simply because it is moving,, the quantity of energy depending on its mass and velocity. It has been found that the greater the mass and the velocity, the greater is the kinetic energy.

As stated above, the energy possessed by an object owing to its position is called potential energy. Compressing or stretching a spring, we do work that is stored up in the spring as potential energy. It is necessary to release the spring in order to get almost the same amount of work.

One cannot say that in the above case all the work expended has really been utilized. In spite of our expending a certain amount of work it is impossible to utilize it in full. Due to friction we always get less useful work out of a machine than we put into it. Part of the energy which is developed by mechanical devices is lost in the form of useless heat.



Examples of potential energy: 1 – tank of compressed air; 2 – book on table; 3 – stretched spring; 4 – pile of coal; 5 – storage battery; 6 – taut bow.

22.1 Answer the following questions:

1. What subject is dealt with in the present article?
2. What do we call energy?
3. Does the falling weight perform work?
4. When does a body possess energy?
5. What forms of energy do you know?
6. Is it difficult to transfer mechanical energy over a great distance?
7. What do we call kinetic energy?
8. What do we call potential energy?
9. Why do we get less useful work out of a machine than we put into it?
10. Can one form of energy be transformed into another?

22.2 Translate the following sentences:

1. Энергияның әр түрлі формаларының бар болатыны жақсы белгілі.
2. Жүкті көтеру үшін жұмысты орындау керек.
3. Жылу алу үшін көмірді өртейді.

23. The Scientific Meaning of the Words "Work", "Energy", and "Power"

As previously mentioned, many words that we use in our everyday speech assume a more precise and often restricted meaning in the language of science. The words "work", "energy", and "power" considered in this text are quite familiar to everyone; nevertheless, their use in scientific terminology presents certain difficulties. Discussing these three terms in some detail is the subject of our present article for we know of their being often misused.

The word "work" may serve as an example. Besides its being an English word in common usage, it is also a scientific term which has a special meaning when used in mechanics.

When we are standing and holding a heavy weight, when we are studying or teaching at the institute – we say that we are working. Studying may be very hard. We know that it will make you tired at times; nevertheless, no physicist will ever call it work. The scientific term "work" is much more restricted. Mechanical work is performed only when a force moves some object through a distance.

One can perform work by lifting a box from the floor. Pushing the box along the floor against friction also means doing work. According to physical laws you cannot perform any work, scientifically speaking, by pushing an automobile which is standing on the road, unless it starts moving. Thus, in order to do mechanical work two conditions are necessary, namely, there must be a force and it must act through a distance. Generally speaking, the greater the force and the distance moved, the greater the work performed.

Work and energy are very closely related. Indeed, one may say that the energy of a body or system is the capacity of that system or body for doing work. Power is related to both work and energy. It is the rate of performing the work in a unit of time.

While energy is the capacity for work, power is the quantity of work done in a unit of time. When a kilogram is lifted to a height of one meter, we say that a kilogram-meter of work is accomplished. The amount of the accomplished work does not depend on the time spent on lifting this weight.

Considering power requires considering the rate of performing the work. For example, if a weight is lifted to a height of one meter in one second, twice as much power will be required than in case that very weight were lifted to a height of one meter in two seconds.

If someone carried a 15-kg box up the stairs in 10 sec, the staircase being 6 m high, he would work at the average rate of 90 kgm divided by 10 sec, or 9 kgm per second.

Measuring power, we generally use such units as watts, kilowatts, and kilogram-meters per second. Seventy five kg. m. s. (kilogram-meters per second) or 736 W (watts) form a horse-power. A horse-power is a unit for measuring the amount of work performed per second.

Discussing the term "energy", we shall follow the transformation of one form of energy into another.

23.1 Answer the following questions:

1. What is the subject of the present article?
2. What terms are discussed in this article?
3. Is the term "pressure", dealt with here?
4. When is mechanical work performed?
5. Do you perform any work while lifting a box from the floor?
6. When is mechanical work performed?
7. What conditions are necessary in order to do mechanical work?
8. Are work and energy closely related?
9. What do we call power?
10. What is necessary for considering power?
11. What units are used for measuring power?

23.2 Translate the following sentences and define the functions of the gerund:

1. Work can be performed by lifting a weight.
2. Watts, kilowatts and kilogram-meters per second are used for measuring power.
3. No physicist will say that pushing an automobile means performing work unless that automobile is stationary.
4. We know of work and energy being closely related.
5. Pushing an object along the floor means performing work.
6. Could you understand this article without consulting a dictionary?
7. Can you say that teaching is performing work?
8. In physics energy is defined as capacity for doing work.
9. Lifting this heavy weight is impossible without using necessary appliances.
10. The automobile was standing without moving along the road in spite of our pushing it so hard.

23.3 State if the following sentences are true to the fact or false. Correct the false sentences.

1. When you are studying you can say that you are working.
2. To do mechanical work there must be a force.
3. The greater the force and the distance moved, the greater the work that has been performed.
4. Power is related to both work and energy.
5. For measuring work we use such units as watts and kilowatts.

6. The word "work" is a scientific term which is never used in our everyday life.

23.4 Find the gerunds in the article and define their functions.

23.5 Retell the article.

24. Lines of Force

Faraday first represented the electric field around an electrically charged body by means of lines which he called lines of force or lines of electric intensity. These lines are so drawn that at every point in the field the direction of the line tangent to the line of force in this point coincides with the direction of the intensity vector at that point. Thus, a positive unit of electric charge will tend to move along a line of force in the direction of the electric intensity, and a negative unit of charge tends moving in the opposite direction.

The number of lines of force that are radiating from a unit charge may be found by placing the unit charge at the centre of a sphere of one centimeter radius placed in a uniform isotropic dielectric. By the way, do you know what this term means? An isotropic medium is one whose properties are the same in all directions.

It is obvious that two lines of force can never meet, for then we should have the intensity at the point of meeting acting in two directions at once. In addition to that, we know of their being continuous at long as there a dielectric medium exists.

At any rate, one should always remember that lines of force do not really exist and that they by no means indicate the structure of the medium. We use these lines of force, as did Faraday, in order to picture the electric field more clearly. Representing the electric field by means of these lines helps us in picturing the forces existing between the charged bodies.

Magnetic Lines of Force. Magnetism manifests itself as if it existed in lines emanating from the magnetic materials or current-carrying conductors, these lines being called magnetic lines of force. The stronger the magnet, the more of magnetic lines of force passes through a given space. The magnetic lines taken as a whole constitute a magnetic flux.

Just like the lines of force in an electric circuit, magnetic lines of force do not exist in reality. One can imagine magnetic lines as emitted from the north pole and passing through the air to the south pole. However, they do not end on magnetic poles but continue passing from the south to the north pole. The magnetic lines of force are more than merely a means of showing the presence and direction of the magnetic field. They may serve as a unit of measurement since the magnetic field strength is measured by the number of lines of force running through a square centimeter.

Fig. shows how the lines of force are distributed between the like poles and between the unlike poles of two magnets.

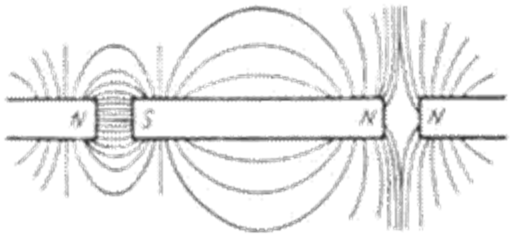


Fig. Lines of force.

24.1 Answer the following questions:

1. Does this article deal with magnetism?
2. What does the present article deal with?
3. Who first used the term "lines of electric intensity"?
4. What did Faraday first represent?
5. What is an isotropic medium?
6. Can the lines of force meet?
7. What do we use the lines of force for?
8. How can we represent an electric field?
9. What do the magnetic lines of force constitute?
10. What pole are the magnetic lines emitted from?
11. What do the magnetic lines of force show?
12. How is the magnetic field strength measured?

13 What does fig. show?

24.2 Translate the following sentences and define the functions of the gerund:

1. Charging by induction was discovered by Epinus.
2. On charging an object by induction, we charge it by the influence of an electrified body at a distance.
3. The lines of force are used for picturing the electric field.
4. In spite of our using the term "lines of force", we remember that they do not really exist.
5. The scientists go on studying the properties of the magnetic flux.
6. There are different ways of producing an electric current.

7. Considering the dielectric medium is the purpose of our work.

8. We could not achieve good results without comparing the two figures.

9. We know of the magnetic lines being emitted from the North Pole.

10. On emitting from the North pole, the magnetic lines pass through the air to the South pole.

24.3 Find the gerunds in the article and define their functions.

25. Steam Turbine and its Types

What is a blade? The blade being repeatedly mentioned in the articles on steam turbines, we shall define that term below.

The words "blade" and "vane" are known to be synonyms. Blades or vanes are curved metallic parts of the turbine whose function is to deflect or change the direction of a steam jet. There are both moving blades on which the work of the steam is done and guide blades which reverse the direction of the steam jet so that more work might be derived from it.

Types of Turbines. The three fundamental types of steam turbines are: 1) impulse, 2) reaction, 3) impulse-and-reaction. The terms "impulse" and "reaction" have specific meanings in turbine engineering practice, these specific meanings greatly differing from those of the same words as they are used both in physics and in everyday life.

An impulsive force or "impulse" is the force produced on an object when a fluid jet strikes the object. That is how a turbine specialist would define the above-mentioned term.

A well-known characteristic of an impulsive force is that the fluid jet which strikes an object and thereby produces the force leaves the object at the same or at a less velocity than that with which it strikes the object. When the fluid stream strikes an object which is so shaped that it reverses the direction of the stream, a much greater impulsive force is produced than when the direction of the stream is not reversed. This occurs in spite of the fact that the stream may leave the object with the same velocity as that with which it approached the object.

An impulse turbine (see fig.) is such a turbine whose operation almost entirely depends on the impulsive force of a steam jet or jets striking the buckets of the turbine rotor. Hence, an impulse turbine is so designed that the expansion of the steam that passes through it and makes it work occurs almost entirely in its stationary nozzles.

Practically no expansion of steam occurs in its moving blades. The steam jet from the stationary nozzles or blades strikes the rotor vanes and thus, causes the rotor to revolve by virtue of the "push" produced.

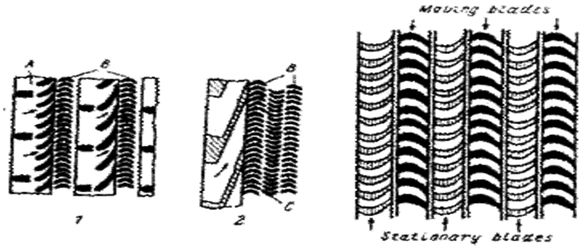
A reactive force or "reaction" is the force to be produced on an object when a fluid jet leaves the object at a greater velocity than that with which the object is approached. The above is a specific turbine engineering definition.

A reaction turbine (see fig.) is the one to depend principally on the reaction force of the steam jets as they leave the turbine's moving blades at greater velocities than those at which they approached the blades. Hence, a reaction turbine is so designed that about half of the steam passing through it and causing it to do work occurs in the moving blades and about half of it in the stationary guide vanes. The guide vanes and moving blades of a reaction turbine are designed in such a manner that the steam flows into the blades without striking them. That is possible provided the circumferential speed of the moving blades is the same as the velocity of the steam stream to enter them. The moving blades are so designed that the steam leaves them at a higher velocity than that at which it enters. Thus, the rotation of the rotor is produced by reaction.

The difference between an impulse and a reaction turbine is, therefore, that there is no appreciable expansion of steam in the moving blades of the first and considerable steam expansion in the moving blades of the second. Furthermore, it follows that in impulse turbines there is practically no difference between the pressure of the steam entering the moving blades and that of the steam leaving them. In reaction turbines there is a difference between these entering and leaving pressures.

An impulse-and-reaction turbine is the one that has some of its blading designed and arranged as in an impulse turbine and some as in a reaction turbine.

A number of the largest turbines, now in use, are of this type.



Impulse-turbine blading. Reaction-turbine blading. 1 – pressure staging;2 – velocity staging. A – nozzle; B – moving blades; C – stationary blades.

25.1 Answer the following questions:

1. What is a vane?
2. What types of blades are mentioned in the present article?
3. Do stationary blades reverse the direction of the steam?
4. What types of turbines do you know?
5. What is an impulsive force?
6. What is a well-known characteristic of an impulsive force?
7. What does the operation of an impulse turbine depend upon?
8. In what manner are the guide vanes and the moving blades of a reaction turbine designed?
9. What is the difference between an impulse and a reaction turbine?
10. What types of turbines are in use at present?
11. What does the present article deal with?

25.2 Translate the following sentences and define the functions of the word "that":

1. It is a well known fact that electrons tend to flow from the point of lower potential toward that of higher potential.
2. In any process where heat is transferred the body that is at a lower temperature is the one that gains heat.
3. The workers know that that invention will help them in the work that they decided to finish ahead of time.
4. Experiments show that all gases expand on heating.
5. In impulse turbines we find no difference in the pressure of the steam entering the blades and that of the steam that is leaving them.
6. The velocity is derived from heat that the steam turbine liberates as it issues through the opening.
7. That the steam is directed first against the blades of the first disc and gives up part of its energy to that disc is a well known fact.
8. The steam is deflected by the blades and then by means of stationary blades it is turned so that it will strike the blades of the next disc.
9. This turbine is more powerful than that one.
10. That the temperature of an object depends on the average kinetic energy of its molecules is certainly known to you.

25.3 Describe a) an impulse turbine b) a reaction turbine.

26. Steam Nozzles

We assume the steam nozzle to be a passage of varying cross-section by means of which the energy of steam is converted into kinetic energy. The nozzle is so shaped that it will perform this conversion of energy with minimum loss. One may also define a nozzle as an opening through which steam is passed from a region of high pressure to one of lower pressure so as to derive additional velocity. It is chiefly used for producing a large velocity steam jet. In other words, its chief use is to produce a jet of steam for the purpose of driving steam turbines. The function of a nozzle in an impulse turbine is to admit steam to the active or moving parts of the turbine. In a reaction turbine the stationary nozzles admit steam to the moving parts which are also of nozzle shape and guide the steam from them. The steam expanding, its velocity and specific volume will both increase; there will be condensation which will vary the degree of steam dryness. All these changes are found to affect the design of the nozzle. The weight of steam per second passing any nozzle section must be constant; hence, the nozzle cross-section varies according to the velocity and the specific volume.

At first the nozzle cross-section tapers to a smaller section to allow for these changes. On reaching this small diameter, it will diverge to a larger one. We know the throat to be the smallest section of the nozzle.

A nozzle which first converges to a throat and then diverges is known to be a converging-diverging nozzle; in this type the greatest diameter is at the exit end.

Some forms of nozzles end at the throat, and no diverging portion are fitted; this type is known as a converging nozzle and has its exit at the throat.

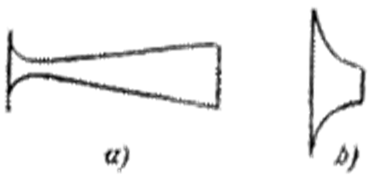
The flow of steam through a nozzle may be regarded, in its simplest form, as being an adiabatic flow. The steam enters the nozzle with a relatively small velocity and a high initial pressure, the initial velocity being so small compared with the final velocity that it may be neglected. As the steam expands, the velocity will increase, the heat energy of the steam being converted to kinetic energy. During the expansion of the steam through the nozzle no heat is supplied or rejected and, although no external work is done on a piston, work is done by increasing the kinetic energy of steam.

As the steam loses its pressure in passing through the nozzle, it is also losing its total heat; the change of total heat of the steam must, therefore, equal the increase in kinetic energy. Hence, the work done is equivalent to the heat drop.

It should be noticed that the expansion of steam through a nozzle is not a free expansion, and the steam is not throttled because of its having a large velocity at the end of the expansion. Work is done by the expanding steam in producing this kinetic energy.

In practice, there is friction produced between the steam and the sides of the nozzle; this friction causes a resistance to the flow which is converted into heat. The heat formed tends drying the steam. The effect of this friction in resisting the flow and in drying the steam must be taken into account in the design of the nozzle, as it makes a great difference to the results obtained.

A longitudinal sectional view of a converging-diverging steam nozzle is shown in the figure, *a* and that of a converging nozzle in the figure, *b*.



Steam nozzles:
a – converging-diverging nozzle; b – converging nozzle.

26.1 Answer the following questions:

1. What is a nozzle?
2. What is the chief use of a nozzle?
3. Does condensation vary the degree of steam dry-ness?
4. How does the cross-section of the nozzle vary?
5. What is the smallest section of the nozzle?
6. What nozzles do you see in the figure?
7. What is the difference between the nozzles shown in the figure?
8. With what velocity does the steam enter the nozzle?
9. Why may the initial velocity be neglected?
10. What does the steam lose in passing through the nozzle?
11. What does friction produced between the steam and the sides of the nozzle cause?

26.2 Translate the following sentences and define the functions of the non-finite forms of the verb:

1. Turbines drive about 95% of all generators producing electrical power.

2. No expansion of steam takes place in the moving blades of the turbine.

3. The steam expansion passing through the turbine and making it work is found to occur almost entirely in its stationary nozzles or in its fixed blades.

4. Nozzles in an impulse turbine are used for admitting steam to the active or moving parts of the turbine.

5. The greatest diameter in a converging-diverging nozzle is known to be at the exit end.

6. In addition to its often causing a rise in temperature, the heat supplied may also change the state of a substance without changing its temperature.

7. When liquids are heated, we expect them to expand more than solids do.

8. The attractive force of gas molecules being very small, a given body of a gas has neither a definite shape, nor a definite size.

26.3 Find the non-finite forms of the verb in the article and define them.

27. Atomic Theory and its Development

Among the scientists who studied the properties of radium was Ernest Rutherford, one of England's greatest physicists, honorary member of the U.S.S.R. Academy of Sciences and a number of other Academies.

He discovered that radium gave off three different types of rays and denoted them by the first letters of the Greek alphabet. (Following his example, we still call them alpha, beta and gamma rays). The first of them, i.e., the alpha rays, also called alpha particles, turned out to be changed electrically with a positive charge. The beta rays were found to consist of negative electrons, while the gamma rays proved to be just waves like X-rays but of much shorter wave-length.

Rutherford performed a series of experiments first with the rays of radium and later with uranium. As a result, he established the nuclear theory of atomic structure and proved that the atom consisted of electrons revolving around a very small but very heavy nucleus. He performed the first successful atom-smashing experiment in 1919.

The discovery of the neutron in 1932 was another important step leading to the understanding of nuclear structure. It made it clear that the nucleus is composed of protons and neutrons, the protons being tiny particles with a positive electric charge and the neutrons — particles without any charge.

Then the year 1934 brought a new scientific event which attracted general attention not to speak of its being of tremendous importance for world science. Irene Curie, daughter of Pierre and Marie Curie, the discoverers of radium, and her husband Frederic Joliot Curie discovered a new phenomenon-artificial radioactivity (also called "induced radioactivity"). They proved that radioactivity could be produced artificially in the laboratory in elements which were not naturally radioactive. By studying the artificial activity of uranium generated by neutrons, they furthered the discovery of nuclear fission which, in its turn, is the foundation of atomic physics.

In the course of the next five years, the most outstanding nuclear physicists both in Europe and America worked on the problem of nuclear fission. The turning point in the search for atomic energy came in 1939. In that year, it was discovered that under proper circumstances, the neutron was capable of breaking up the nucleus of a uranium atom into two parts which fly apart with high relative velocity. Besides its releasing tremendous amounts of energy the phenomenon termed fission produced 2 or 3 fresh neutrons. Two things became apparent. First: if one of these 2 or 3 neutrons could be made to produce another fission, the process would be self-sustaining (i.e., result in chain reaction). Second: ordinary uranium neither underwent fission nor could serve as a source of atomic energy. It is Uranium 235, a particular isotope of uranium, which undergoes fission and is capable of releasing an enormous amount of power.

The first atomic-power station in the world with a capacity of 5,000 kw was put into operation in the Soviet Union in June 1954. Nuclear power generation has made tremendous progress since then and scores of similar power plants are now operating in the world. In this country the total capacity of such plants has reached a million kilowatts. In this connection one can't but mention the "Romashka". The world's first atomic power plant, the Romashka, with direct conversion of atomic energy into electric energy without any rotating machinery, i.e., without going through mechanical energy was developed in the USSR and has been in operation for some years.

27.1 Translate the following questions and answer them:

1. Кім радидың қасиетін зерттеді?
2. Эрнест Резерфорд кім болды?
3. Резерфорд нені ашты?
4. Альфа бөлшектерде қандай заряд бар?
5. Бета сәулелер неден тұрады?
6. Гамма-сәуле және рентген сәулелерінің арасындағы айырмашылығы неде?
7. Резерфорд қандай тәжірибелер жүргізді?
8. Резерфорд нені орнатты?
9. Нейтрон қашан ашылды?
10. Радийді кім ашты?
11. Ирен Кюри және Фредерик Жолио Кюри нені дәлелдеді?
12. 1939 ж. не ашылды?

27.2 Translate the following sentences, paying attention to the word "as".

1. As the temperature of a liquid drops below the boiling point, its atoms continue to lose kinetic energy which appears as sensible heat.
2. As a gas is cooled, it loses heat as well as the energy which that heat represents.
3. As heat can be produced by the expenditure of work, so work can be produced by the expenditure of heat.
4. The molecule remains electrically neutral, as long as it keeps all its electrons.
5. As is well known, it is quite possible to operate most powerful engines by means of atomic energy.
6. As the results of the experiment depend on the temperature of the liquid, the liquid observed should be as hot as possible.
7. As to deuterium its name is derived from a Greek word meaning "secondary".
8. As a result of evaporation a liquid is cooled.
9. As the warm air rises, cooler air takes its place.
10. Radioactivity is recognized as a property of the atom nucleus.

27.3 Retell the article.

28. On the Development of Atomic Theory

Man has always wondered what made up matter. The answer to this question can be traced back to the scholars of ancient Greece and even to the Hindu philosophers of a still earlier period.

Democritus a Greek philosopher-materialist of the fifth century B.C was the very scholar who gave us both the concept of the atom and its name. So far as we know, he was the first scientist to state that all matter is made up ultimately of minute indestructible and indivisible particles which, according to him, are not capable of further division. Democritus called them atoms, the term being derived from two Greek words, namely: "A" in Greek means "not" and "temnein" means "to cut" so that the whole signifies "uncuttable", i.e., indivisible.

Of course, the atoms of Democritus greatly differ from the atoms of elements as we know them now; nevertheless he was far ahead of his time. One cannot but add here that the first really scientific progress beyond some of his ideas was made almost 2,000 years later. Indeed, for a continuous space of time very little more was heard about atoms. It was not until the year 1808 that John Dalton, a well-known English chemist and physicist, stated his atomic theory. Dalton had a clearer idea of the composition of matter than had been expressed before. He showed that the elements behaved as if they were composed of minute particles, atoms, as he called them, of definite weight.

Under some conditions, the atoms of one chemical element might combine with the atoms of another. Remarkable as were his scientific achievements, he was unable to realize the fundamental difference existing between the atoms of an element and the molecules of a compound.

One of the greatest contributions towards the development of the atomic theory was made by Mendeleev, our scientist of world renown, who stated his famous Periodic Law of chemical elements in 1869. Mendeleev proved that when all the chemical elements were arranged in the order of increasing atomic weights, there were periodic recurrences of elements which resembled each other.

There being a number of blank spaces in his periodic table, Mendeleev rightly predicted the existence of missing elements to be filled in. Wonderful as this prediction was, he made another one which was even more remarkable, namely, he predicted the atomic weights and other properties of the missing elements. Within a few years, the elements he had predicted from his table were really discovered. In this, as in most of his predictions, he proved to be quite right.

As the 19-th century drew near its close, the atomic theory was further developed thanks to three discoveries other. X-rays were discovered by Roentgen, the far-famed German scientist, in 1895. In 1896 but one year later, Henry Bacquerel an outstanding French physicist made his discovery of radioactivity. And in 1898, Marie and Pierre Curie, whose names are widely known throughout the world, obtained a new substance. They named it "radium". The discovery of radium and the study of its rays during the next few years greatly contributed to the further development of the atomic theory.

28.1 Answer the following questions:

1. Who gave the concept of the atom?
2. What is all matter made up of?
3. Are the atoms divisible?
4. When did John Dalton state his atomic theory?
5. What did Dalton show?
6. Is John Dalton a Russian scientist?
7. Who made one of the greatest contributions towards the development of the atomic theory?
8. What did Mendeleev prove?
9. What did he predict?
10. When were X-rays discovered?
11. Who was the first to discover radioactivity?
12. What did Marie and Pierre Curie obtain?

28.2 Retell the text.

29. Reactors. Accelerators

Reactors. In the course of the atomic energy investigation, the common word "pile" which already had so many different uses in the English language took on a new and specialized meaning. A pile is a kind of nuclear installation maintaining a continuous, controllable chain reaction with the view of getting atomic energy. No fewer signals are its turning out radioactive isotopes, to say nothing of the tremendous amounts of heat accompanying the chain reaction.

Instead of the term "pile", scientists nowadays often use a more accurately descriptive one of "nuclear reactor". If a reactor is to operate at a steady preselected fission rate, each fission must produce only one other fission. However, each fission is expected to produce

2 or 3 fresh neutrons that may cause other fissions. The first question to be asked about any reactor is just how these surplus neutrons are disposed of, the object of every reactor designer being to make them die usefully.

Most of nuclear reactors, roughly speaking, are installations usually consisting of the following elementary parts: a moderator used to slow down fission neutrons, fuel elements containing fissionable material, heat removing means, and a geometric structure in which a chain reaction can be maintained.

The installation is referred to as a thermal reactor provided most of the fissions result from the capture of neutrons which have been slowed down to thermal energies by collisions with the moderator, the so-called thermal neutrons.

When most of the fission processes are caused by the absorption of neutrons of higher energy, the system is said to be an intermediate reactor. We find the usual range of neutron energies in such a kind of reactor to be from thermal energy up to about 1,000 ev.

In case the main source of fissions is the capture of fast neutrons directly by the fuel without the neutrons having suffered any energy losses the unit under consideration is known as a fast reactor.

Variations of all main characteristics suggest, however, the possibility of variations in these fundamental types of reactors.

One can't but add in this connection that reactors of different types have been put into operation at the Beloyarskaya and the Novovoronezhskaya atomic electric stations.

Accelerators. A truly scientific investigation of the forces acting inside the atomic nucleus, of its structure and properties has been made possible owing to accelerators. These are special installations destined to accelerate "elementary" particles of matter and impart them enormous energy. In other words, accelerators are destined to create conditions under which the above particles can best be studied. Strange as it may seem but to investigate the tiniest particles of matter, invisible even through the most powerful microscope, scientists need weighty, complex installations occupying much space and requiring great amounts of electric power.

It is of interest to note here that a 10 Bev (billion electron volts) synchrotron is located near Moscow. In April, 1957, the proton synchrotron was put into operation in the laboratory of high energy physics of the international nuclear centre in Dubna. This enormous machine is capable of accelerating electrons up to 10 Bev.

Wonderful as the synchrotron in question is, it is by no means he limit. Such unique installations have been built in this country as the Erevan electronic accelerator and the world's most powerful seventy-milliard electron-volt proton accelerator located near Serpukhov.

29.1 Answer the following questions:

1. What do we call a pile?
2. For what purpose is the pile used?
3. What are the elementary parts of a nuclear reactor?
4. What is a moderator used for?
5. What is an intermediate reactor?
6. What unit is known as a fast reactor?
7. What atomic electric stations were put into operation in this country?
8. What is an accelerator used for?
9. When was the proton synchrotron put into operation in Dubna?
10. What institute is situated in Dubna?
11. What can you tell us about the world's most powerful proton accelerator?

29.2 Translate the following sentences, paying attention to the passive constructions:

1. The superheating of steam may be followed by decomposition.
2. The machine referred to was constructed in the laboratory of high energy physics.
3. Great amounts of electric power are required to investigate small particles of matter.
4. The proton synchrotron is made use of in the international nuclear centre in Dubna.
5. The achievements of Soviet physicists were preceded by scientific investigations.
6. Accelerators may be looked upon as special installations destined to accelerate elementary particles of matter.

29.3 Translate the following sentences:

1. It was Rutherford who first proposed a general theory of radioactive transformation.

2. It is an increase in temperature that increases the speed of molecules.

3. It is an accelerator that accelerates elementary particles of matter and imparts to them enormous energy.

4. It was not until April 1957 that a most powerful accelerator was put into operation in Dubna.

5. A nuclear reactor does maintain a continuous controllable chain reaction.

6. The word "pile" did take on a new meaning in the course of the atomic energy investigation.

7. When in a solid state, water has a temperature of 0°C.

8. As mentioned above, heat produced by friction is usually considered as lost heat.

9. The speed of the automobile can be increased, if necessary.

10. Although capable of being reduced to a liquid form by special means as by cold and pressure, under ordinary conditions air is invisible gas.

11. While investigating the tiniest particles of matter, scientists need complex installations occupying much space.

30. Peaceful Uses of Atomic Energy

Atomic energy can be used for good or ill. Its first use was as a bomb with its terrific destructiveness. It goes without saying that the prohibition of atomic and hydrogen weapons would create favorable conditions for peaceful use of atomic energy. In the long run, it is in its peacetime uses that it will mean most to man. Indeed, the fact that atoms should serve peace alone does not need any proof. It is prompted by the vital interests of mankind. The widespread utilization of atomic energy for peaceful purposes opens up great possibilities for economic and cultural development as well as the improvement of the living standards of the peoples. In fact, one could hardly find at present any sphere of science or engineering where the latest achievements of nuclear physics are not utilized. New advances in industry, in agriculture, in medicine and science in general are on the horizon.

The application of nuclear energy to electricity is increasingly developing. This is a vital necessity as it is the only known potential capable of meeting mankind's various power requirements. These requirements are growing and natural fuels like coal, oil, and gas are being rapidly exhausted. Thus, it is to atomic power that man turns to solve the above problem. In effect, nuclear fuel greatly exceeds in its power equivalent all the world's reserves of coal and oil taken together.

The first atomic power station in France was put into operation at the end of September, 1956. Britain's first atomic power plant went into operation in October, 1956. It is in the Soviet Union that the world's first nuclear power plant generated the first commercial current in June, 1954. Nuclear power generation has made tremendous progress since then and scores of similar power plants are now operating in the world.

The country has built and is building powerful atomic stations as well as reactors of a new type. Nuclear energy being developed in a reactor in the form of heat, its use supplies us with both cheap heat and power available in large quantities wherever needed.

The total capacity of atomic power stations reached a million kilowatts. That is far from being the limit. As a matter of fact, it is expected that by 1980 the total power capacity of Soviet nuclear power plants will have reached tens of millions kw.

Apart from its being a source of cheap heat and power, nuclear energy can also serve as a source of useful new products resulting from transmutation. What may be termed the by-products of atomic energy: radioactive isotopes and fission products (not to speak of radiation chemistry) may well prove to be of greatest importance to mankind along with atomic power itself.

We know of chemical processes where the energy of the atom accelerates a number of reactions, the latter developing under conditions which can do without complicated equipment. Atomic energy in these cases makes needless ultra high temperatures and pressures.

Ionizing radiation helps obtaining materials with new physical and chemical properties in the desirable direction. Glass, for instance, becomes stronger besides its withstanding high temperatures. As for wood, it is found to obtain a number of properties similar to those of metal.

Great possibilities are opening up in the atomic energy use for transport purposes since its advantages arise not only from the limitless power but also from the small quantity of nuclear fuel required.

Nuclear instruments used in metallurgy control the operation and the state of certain processes in blast furnaces. Isotope instruments measure the thickness of hot rolled sheet metals; find out faults in metals besides their doing many other things.

It is the atom that has accelerated the testing of minerals and the study of the earth's surface structure.

Medicine represents another promising example of nuclear energy utilization. Here, this mighty force has found a wide application.

All that has been done so far in the use of nuclear energy for peaceful purposes is but a beginning. It is obvious that in due course other possibilities will come to light. At any rate, the reader can think of ways and means that have not been mentioned here.

30.1 Put 10 questions to the text.

30.2 Translate the following sentences:

1. It is nuclear fuel that is used in atomic power plants.
2. The atom is considered to be a mighty force that can be used for the good of mankind.
3. It is necessary to insist on the prohibition of atomic and hydrogen weapons.
4. We know isotopes to possess the property of radiation.
5. Isotope instruments have the property of finding out faults in metals.
6. Were it possible to prohibit the atomic and hydrogen weapons, the living standards of the people would be greatly improved.
7. Nuclear instruments are used in metallurgy for controlling some processes in blast furnaces.
8. We know of the first nuclear power plant having been put into operation in 1954.
9. Nuclear energy can supply transport with limitless power, one of its advantages being the small amount of nuclear fuel to be consumed.

30.3 Retell the text.

Әдебиеттер

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