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Кафедра «Белорусский и иностранные языки»

ИНОСТРАННЫЙ ЯЗЫК (АНГЛИЙСКИЙ)

УЧЕБНО-МЕТОДИЧЕСКОЕ ПОСОБИЕ
для студентов технических специальностей

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Представленные тексты и упражнения охватывают грамматический и языковой материал. Данное учебно-методическое пособие рассчитано для аудиторной и внеаудиторной работы.

Для магистрантов технических специальностей дневной и заочной форм обучения.

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ПОЯСНИТЕЛЬНАЯ ЗАПИСКА

Электронный документ (ЭД) составлен на основании типовой программы – минимума кандидатского экзамена по иностранным языкам, утвержденный ВАК РБ от 16.12.2004 г. № 164.

Он предназначен для магистрантов и соискателей дневной и заочной форм обучения, продолжающих изучение того иностранного языка, который они изучали в университете. Данный документ ориентирован на обучающихся 1-ого года обучения (в первом и втором семестрах) по специальностям магистратуры ГГТУ им. П.О. Сухого.

Электронный документ содержит профессионально ориентированный иноязычный материал межкультурной, межличностной и профессиональной тематики, необходимой для формирования предметной иноязычной компетенции во всех видах иноязычной речевой деятельности.

Важнейшими лингво-дидактическими принцами, отраженными в ЭД, являются:

- взаимосвязь и взаимозависимость видов иноязычной речевой деятельности;
- стимулирование самостоятельной иноязычной работы обучающихся по специальностям магистратуры университета;
- преобладающая роль заданий практического характера с иноязычным аутентичным материалом;
- тенденция к беспереводному использованию языка;
- тематический отбор учебно- научных материалов;
- социокультурный, лингвокультурологический и профессиональный рост магистрантов в процессе обучения.

Электронный документ реализует три основные функции:

- информационно-методическую: цели, задачи, содержание обучения, стратегии образования и воспитания средствами изучаемого предмета;
- организационно-планирующую: определение количественных и качественных характеристик учебного материала, уровень языковой подготовки обучаемых;
- контролирующую: промежуточный контроль знаний- зачет и итоговый контроль знаний магистрантов, соискателей, кандидатский экзамен.

Изучение иностранных языков в течение двух семестров в магистратуре университета является неотъемлемой частью общеобразовательной и профессиональной подготовки магистрантов, соискателей, научных и научно-педагогических кадров. Знание иностранных языков облегчает доступ к научной информации, использование ресурсов

Интернета, помогает налаживанию международных научных контактов и расширяет возможности повышения профессионального уровня научных работников и будущего ученого.

В связи с процессами глобализации усиливаются интеграционные тенденции в науке, технике, культуре и образовании, что повышает роль иностранного языка как посредника всех интеграционных процессов. Именно язык воплощает единство процессов научного общения.

Курс изучения иностранного языка носит профессионально ориентированный и коммуникативно-прагматический характер.

Целью преподавания дисциплины является овладение иностранным языком как средством межкультурного, межличностного, прагматического и профессионального общения в различных сферах научной и производственной деятельности и дальнейшее совершенствование коммуникативной компетенции и ее компонентов.

В основе учебных материалов ЭД лежат научные тексты, оригинальные аутентичные материалы и иноязычные источники.

Коммуникативные задачи включают обучение следующим практическим умениям и навыкам:

- оперирование основными лексико-грамматическими конструкциями, свойственными для научных жанров технической речи;
- свободного чтения оригинальной литературы соответствующей отрасли знаний;
- оформление извлеченной из иностранных источников информации в виде перевода, реферата, аннотации, резюме, обзора;
- письменного научного общения;
- устного общения в монологической и диалогической форме по специальности;
-способность извлекать и интерпретировать информацию научного характера;
- способность понимать и ценить чужую точку зрения;
- готовность к различным формам и видам межкультурного сотрудничества (совместный проект, гранд, конференция, конгресс, симпозиум, семинар, совещание), а также к освоению достижений науки в странах изучаемого языка.

UNIT 1

AUTOMATION AND ITS TYPES

PASSIVE VOICE

GRAMMAR

Образование страдательного залога
(“to be” + Participle II)

	Present	Past	Future	Future-in-the-Past
Indefinite	Houses **are built** every day. (Дома строятся каждый день) My works **are** often **translated.** (Мои труды часто переводят).	A new house **was built** yesterday. (Новый дом был построен вчера). My report **was translated** 2 hours ago. (Мой доклад был переведен 2 часа назад).	A new house **will be built** here next year. (В следующем году здесь будет построен новый дом). This report **will be translated** into English next month. (Этот доклад будет переведен на английский язык в следующем месяце)	***It was reported*** that a new house **would be built** the following year (*Сообщили*,что новый дом будет построен в следующем году). That report **would be translated** the next month. (Этот доклад будет переведен следующем месяце).
Continuous	The house **is being built** *now*.(Дом строится сейчас). My report **is being translated** at the moment. (Мой доклад сейчас переводят).	The house **was being built** *from 8 till 17 o’clock yesterday*. (Дом строили вчера с 8 до 17 часов). My report **was being translated** when I came in. (Когда я вошел, мой доклад переводили).	-----//--------	-----//--------

Perfect	The house **has** *already* **been built**. (Дом уже построили). This report has never been translated . (Этот доклад никогда не переводили).	The house **had been built** *by 7 o'clock yesterday*. (Дом построили вчера к 7 часам). The report **had been translated** before I came. (Доклад перевели до того, как я пришел).	The house **will have been built** *by 7 o'clock tomorrow*. (Дом будет построен завтра к 7 часам). The report **will have been translated** *by next Monday*. (Доклад переведут к следующему понедельнику)	***It was reported*** that a new house **would have been built** *by the following year*. (Сообщили, что новый дом будет построен к следующему году). They said my report would have been translated by the next week. (Они сказали, что мой доклад будет переведен к следующей неделе)
Perfect Continuous	-----//--------	-----//--------	-----//--------	-----//--------

	Present	**Past**	**Future**	**Future-in-the-Past**
Indefinite	It is written. It is not written. Is it written?	It was written. It was not written. Was it written?	It will be written. It will not be written. Will it be written?	It would be written. It would not be written. Would it be written?
Continuous	I am listened to. I am not listened to. Am I listened to?	I was listened to. I was not listened to. Was I listened to?	-----//--------	-----//--------
Perfect	It has been built. It has not been built. Has it been built?	It had been built. It had not been built. Had it been built?	It will have been built. It will not have been built. Will it have been built?	It would have been built. It would not have been built. Would it have been built?
Perfect Continuous	-----//--------	-----//--------	-----//--------	-----//--------

Перевод страдательного залога

1. Страдательный залог при переводе на русский язык может быть передан:

а) кратким страдательным причастием прошедшего времени с суффиксом –н или –т (с вспомогательным глаголом быть или без него), т.е. русским страдательным залогом:

The experiments were made last year. (Опыты (были) проведены в прошлом году).

б) глаголом на –ся в соответствующем времени, лице и числе;

The experiments were made last year. (Опыты проводились в прошлом году)

в) глаголом действительного залога в соответствующем времени, 3-м лице мн.числа, являющимся частью неопределенно-личного предложения:

2. Предложения с сочетаниями "модальный глагол + инфинитив страдательного залога" (can be solved, must be solved, may be solved, have to be solved и т.д. …) рекомендуется переводить - *можно, нужно, следует и др.*:

The problem must be solved. (Эту проблему нужно решить).

3. Страдательный залог с подлежащим ***it*** переводится неопределенно-личным предложением:

It is thought . . . – думают (полагают), что . . .
It is known . . . – известно, (что) . . .
It is said….. – говорят, (что) ….
It is reported … - сообщают..
It is believed… - думают (полагают) …

4. При переводе английских предложений с глаголом в форме страдательного залога часто используется обратный порядок слов (русское предложение начинается со сказуемого):

New technique has been developed. (Была разработана новая методика).

Трудные случаи перевода страдательного залога.

1. Можно выделить два типа глаголов, которые вызывают трудности при переводе на русский, если они используются в страдательном залоге:

а) глаголы, которые требуют после себя дополнения с предлогом и в русском переводе тоже имеют предложное дополнение, например:

to depend on (upon) smth. — зависеть от чего-либо
to deal with smth. — иметь дело с чем-либо
to refer to smth. — ссылаться на что-либо

Примечание. Запомните что перевод глагола *to refer to* в сочетании со словом *as: to refer to as* 'называться', например:

The phenomenon *is referred to as* acceleration. (Это явление *называется* акселерацией).

б) глаголы, за которыми идет беспредложное дополнение, но которые в русском переводе требуют предложного, например:

to answer smth. — отвечать *на*
to follow smth. — следовать *за* чем-либо
to affect smth. — влиять *на* что-либо

to influence smth. — влиять *на* что-либо
to approach smth. — подходить к чему-либо

The problem *was not dealt with. (С* этой проблемой *не имели дела.)* Эта проблема *не рассматривалась.*
Any questions *were answered* correctly. *На* многие вопросы *были даны* правильные *ответы.*

Grammar Practice

1. Translate the sentences into Russian drawing your attention to the verbs in the Passive Voice:

1) We were shown a new experiment that will be used in modern technology. 2) All the mechanisms should be protected from corrosion. 3) New grammar rules will be learnt by the students this year. 4) The differential equation is solved every our Maths lesson. 5) The differential equation has already been solved. 6) The differential equation was solved when the Professor entered the room. 7) Written reports are usually signed by our deen and his secretary. 8) Written reports are signed. You may take them. 9) The Professor is being listened to with great interest. 10. It is known that every problem must be solved.

2. Use the verbs in brackets in the Passive Voice:

1) The term automation (to use) to describe nonmanufacturing systems. 2) Many tasks (to perform) by industrial robots at the conference now. 3) The equipment (not to use) recently. 4) At this very moment a new lathe (to show) to us and in the nearest future (to be demonstrate) to the students. 5) The articles (to translate) by 6 o'clock last Monday. 6) An experimental model (to invent) by the engineers all the summer last year. 7) They said that robot (to utilize) by the following week. 8) This initial investment (to facilitate) the assembly machines manufacture next year.

3. Translate into English:

1) Известно, что в следующем месяце будет проводится конференция по автоматизации. 2) Центробежная сила была открыта в 1788 году. 3) Некоторые люди опасаются, что их рабочие места будут заменены роботами. 4) Мне было предложено участвовать в конференции, которая состоится через две недели. 5) Я писал доклад всю прошлую неделю.

Reading Comprehension

1. Read the Text A using a dictionary. Write out the phrases used in the Passive Voice:

1) dial	набирать номер
2) assembly plant	сборочный завод
3) nonmanufacturing	непроизводственный
4) resemble	походить
5) flyball governor	центробежный регулятор
6) steam engine	паровоз
7) facilitate	способствовать
8) punched	перфорированный
9) dimension	измерение, размеры
10) feedback	обратная связь
11) equipment	оборудование
12) sequence	последовательность
13) initial	первоначальный, начальный
14) investment	инвестиция, вклад
15) facilitate	способствовать
16) rate	скорость, темп
17) assembly machines	сборочные машины
18) changeover	переход, переналадка
19) to utilize	утилизировать, находить применение
20) gripper	захват
21) to grasp	схватывать
22) spot welding	точечная сварка
23) continuous	непрерывный
24) arc welding	электродуговая сварка
25) spray painting	окраска распылением
26) frame	рама
27) spray-painting gun	распылитель краски
28) grinding	шлифование
29) polishing	полирование
30) spindle	шпиндель
31) manual	ручной
32) hazardous	опасный
33) shift	смена

Text A AUTOMATION

Automation is the system of 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 nonmanufacturing 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 workpieces 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 control mechanisms when machines have ability to correct themselves. The feedback principle has been used for centuries. An outstanding early example is the flyball 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.

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 centres 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 on 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 dialling and transmission are all done automatically. Railways are also controlled by automatic signalling 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.

2. Find the equivalents in the text A:

1) принцип обратной связи;
2) обрабатывающие центры;
3) контролируемая обработка;
4) легкие и тяжелые заготовки;
5) автоматическое устройство сигнализации;
6) производственные потребности

3. Say if the following statements are true or false:

1) The development of automation technology depend on the use of computers and computer-related technologies.
2) Automation was the first step in the system of manufacture.
3) An early example is the flyball governor invented to control the speed of aircrafts.

4. Answer the questions to the text:

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 automaton?
4) What were the first robots originally designed for?
5) What was the first industry to adopt the new integrated system of production?
6) What is feedback principle?
7) What do the abbreviations CAM and CAD stand for?
8) What is FMS?
9) What industries use automation technologies?

1. Read the Text B and do the tasks given after the text:

Text B TYPES OF AUTOMATION

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

Fixed automation, sometimes refers to automated machines in which the equipment configuration allows fixed sequence of processing operations. These machines are programmed 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 fixed automation are machining transfer lines found in the automobile industry, automatic assembly machines and certain chemical processes.

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 are 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 programme.

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.

1. Answer the questions to the text:

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 automation?
5) What is the best example of programmable automation?
6) What are the limitations of programmable automation?
7) What are the advantages of flexible automation?

8) Is it possible to produce different products one after another using automation technology.

2. Explain in English what does the following mean:

1. automation technology
2. fixed automation
3. assembly machines
4. non-productive time
5. programmable automation
6. computer terminal numerical-control machine-tool.

1. Read the text C and do the following :
a) write 5-6 questions to the text and give the answers to them;
b) write the summary to the text:

Text C **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 or 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 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.

In robotic processing operations, the robot manipulates a tool to perform a process on the work part. Examples of such applications include spot welding, continuous arc welding and spray painting. Spot welding of automobile bodies is one of the most common applications of industrial robots. The robot positions a spot welder against the automobile panels and frames to join them. Arc welding is a continuous process in which robot moves the welding rod along the welding seam. Spray painting is the manipulation of a spray-painting gun over the surface of the object to be coated. Other operations in this category include grinding and polishing in which a rotating spindle serves as the robot's tool.

The third application area of industrial robots is as-sembly 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 humans 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 un¬ loading tasks),
3) the workpiece or tool are too heavy and difficult to handle,
4) the operation allows the robot to be used on two or three shifts.

UNIT 2

COMPUTER BASICS

THE INFINITIVE

GRAMMAR

Инфинитив – неопределенная форма глагола, отвечает на вопрос *что делать*? или *что сделать*? Показателем инфинитива является частица *to*.

Формы инфинитива:

Indefinite	Active	Passive	Выражают действия, одновременные с действием глагола-сказуемого.
	to write	to be written	
Continuous	to be writing	-------	
Perfect	to have written	to have been written	Выражают действия, предшествующие действию глагола-сказуемого, переводятся прошедшим временем.
Perfect Continuous	to have been writing	-------	

Функции инфинитива:

1) подлежащее:
переводится существительным или неопределенной формой глагола

It is sometimes possible to recover data from a corrupted disc.- Иногда можно восстановить данные с разрушенного диска.
To input data is to transfer data or information from outside a computer to its memory. – Ввести данные - значит передать данные или информацию извне компьютера в его память.

2) составное именное сказуемое:
(существительное + глагол be + инфинитив)
Подлежащее может быть выражено существительными: aim, purpose – цель; duty – долг; task – задача; method – метод; wish – желание; plan – план; function – назначение; problem – проблема, задача.
Глагол-связка to be либо совсем не переводится на русский язык, либо переводится словами *заключаться в том, что(бы), состоять в том, чтобы.*

His task is to debug the problem. – Его задача (состоит в том, чтобы) отладить программу.

3) составное глагольное сказуемое:
переводится неопределенной формой глагола

Because the computer revolution is so new, many effects are still to be discovered. – Поскольку компьютерная революция еще так нова, нам еще предстоит многое открыть.
4) дополнение
переводится неопределенной формой глагола

We want to keep the information about our clients in a database. – Мы хотим хранить информацию о наших клиентах в базе данных.

5) определение
переводится определительным придаточным предложением, сказуемое которого имеет оттенок долженствования, возможности или будущего времени.

Инфинитив после слов the first (the second, etc.), the last является определением и переводится на русский язык в том времени, в котором стоит глагол to be

As this is the robot to be driven by the general public it has on-board sensors to safeguard itself against the commands that could put it in danger.-Так как это робот, которым будут управлять не- специалисты, у него есть бортовые сенсоры для защиты от команд, представляющих опасность для него.

Charles Babbage was the first to design the programmable computer – Чарльз Бэббидж первым создал программируемый компьютер.

6) обстоятельство:

- цели

может стоять или в начале или в конце предложения, вводиться союзами in order (to) – для того чтобы; so as (to) –так чтобы

(In order) To type letters and files we use a word processing program.
Для того чтобы напечатать письма и файлы, мы используем программу «текстовый редактор»

- следствия

со словами too – слишком; enough – достаточно) часто при переводе имеет модальный оттенок This metal is too brittle to be hammered. – Этот метал слишком хрупок, чтобы ковать его.

Объектный инфинитивный оборот (Complex Object)

Объектный инфинитивный оборот – это сочетание имени существительного в общем падеже или местоимения в объектном падеже с инфинитивом глагола, выступающего как единый член предложения – сложное дополнение. Оно употребляется после глаголов с широким кругом значений, выражающих умственную деятельность; желание, требование; физическое восприятие; констатацию факта; просьбу, запрет; приказ, разрешение и др.

Subject	*Predicate*	*Complex Object*	
Noun (Pronoun)	expect, assume, think, suppose, know, believe, consider, want, wish	Noun (Pronouns): me, you, him, her, us, them	Infinitive with -to-
Noun (Pronoun)	make, see, observe, hear, watch, feel	Noun (Pronoun)	Infinitive without –to-
Engineers *Инженеры*	consider считают,	computing equipment что компьютерная техника	to make production processes more effective делает производственный процесс более эффективным
I Я	have never heard никогда не слышал, чтобы	her она	*sing* that song. *пела* эту песню

Запомните значения глаголов, вводящих сложное дополнение:

assume	считать, полагать	desire	хотеть, желать
believe	считать, полагать	require	требовать
consider	считать, полагать	wish	хотеть, желать
choose	считать	want	хотеть
expect	ожидать, надеяться	feel	чувствовать
find	находить,обнаруживать	hear	слышать
hold	считать	see	видеть
know	знать	watch	наблюдать
maintain	утверждать	observe	наблюдать
reckon	считать	cause	причинять, вызывать
suppose	полагать, предполагать	make	заставлять
take	считать	allow	позволять
think	думать, полагать	enable	давать возможность
show	показывать	force	вынуждать
prove	доказывать	ask	просить

Субъектный инфинитивный оборот (Complex subject)

Субъектный инфинитивный оборот (сложное подлежащее) состоит из существительного в общем падеже или местоимения в именительном падеже и инфинитива, стоящего после сказуемого.

Subject Noun/Pronoun	*Predicate*	*Infinitive*
	is said is known is supposed is believed	
Computing equipment is known to make production processes more effective. – Известно, что компьютерное оборудование делает производственные процессы более эффективными.		
	seems appears happens proves	
The chip appeared to *be* a crucial development in the accelerating pace of computer technology. – *Кристаллы оказались важным изобретением в ускорении развития компьютерных технологий.*		
	is likely is sure is certain	
He is certain to know the password. – *Несомненно, он знает* пароль.		

Запомните значения следующих глаголов, глагольных словосочетаний, образующих с инфинитивом субъектный инфинитивный оборот.

1. Глаголы, которые употребляются в этом обороте в страдательном залоге:

know	знать	believe	полагать; считать
consider	считать; рассматривать	find	полагать; считать
say	говорить	suppose	предполагать
state	заявлять; сообщать	assume	предполагать
report	сообщать	expect	ожидать
think	думать; считать	hear	слышать

2. В действительном залоге употребляется только несколько глаголов:

seem	казаться	happen	оказываться; случаться
appear	казаться	chance	оказываться; случаться
prove	оказываться	turn out	оказываться

3. Инфинитив в этом обороте может также стоять после словосочетаний;

be likely	вероятно; может	be sure	несомненно; конечно
be unlikely	вряд ли; не может быть, что	be certain	несомненно; конечно
be not likely	маловероятно		

Предложный инфинитивный оборот “for + существительное (местоимение) + инфинитив” (for-phrase)

выполняет роль любого члена предложения: дополнения, части сказуемого (в научной литературе чаще всего функции обстоятельства цели или следствия) и переводится в зависимости от выполняемой им функции. Может переводиться придаточным предложением, вводимым союзами *что, чтобы, для того чтобы, который,* подлежащим которого становится существительное или местоимение, стоящее перед инфинитивом, а сказуемым – инфинитив.

The only conclusion for him to make was the following. – Единственный вывод, к которому он мог прийти, заключался в следующем.

Возможен перевод этого оборота существительным или инфинитивом:

It was important for us to solve this problem as soon as possible. – Нам было важно решить эту проблему как можно скорее.

GRAMMAR PRACTICE

1. Read and translate the sentences. Find the Infinitive and characterize it:

1) Because computers have moved into society so rapidly and so completely, you need basic computer skills just to pursue your career goals and function effectively in society. 2) High-level languages were developed to make programming available to

most people. 3) To be useful, information must be relevant, timely, concise, accurate and complete. 4) The first computing device could have been as simple as a set of stones used to represent bushels of wheat or herds of animals. 5) Compared to the postal service, electronic mail has many advantages. 6) Many systems let you check to see whether the recipient has accessed your message. 7) International electronic mail systems enable you to find "pen pals" all over the world. 8) Programming languages require certain formalities, and advanced text editors help programmers stick to proper forms. 9) Processor is known to refer to the processing circuits: central processing unit, memory, interrupt unit, clock, and timing. 10) Many so-called general-purpose computers are known to have features which restrict their use to certain general problem areas. 11) It is important for the researchers to fulfil their work in time. 12) It takes more time for the reaction to complete at low t^o. 13) It is impossible for the driver to stop the at such a high speed quickly. 14) The problem I spoke to you about is too difficult for the designers to be solved in a year or so. 15) Assembly machines are considered to be examples of fixed automation. 16) The real situation is stated to be very complex. 17) The fact happened to become known to everybody. 18) These two methods turned out to be incompatible in effectiveness. 19) The conditions seem to have been poorly chosen. 20) It causes the monitor to indicate computer failure. 21) It is usually rather difficult to get nitrogen to combine with other elements.

2. Translate the sentences into Russian:

1) Утверждают, что этот метод будет работать безотказно. 2) Известно, что этот прибор работает безотказно. 3) Профессор говорил громко, чтобы все могли услышать его. 4) Мы знали, что он принял участие в международной конференции. 5) Кажется, что все поняли это правило. 6) Наверняка, выпуск этих компьютеров увеличится. 6) Известно, что компьютерное оборудование делает производственные процессы более эффективными.

Reading Comprehension

Read the text A. Translate this text with the help of a dictionary:

1) encompass	охватывать, заключать в себе
2) desktop	рабочий стол (компьютера)
3) central processing unit (CPU)	центральное процессорное устройство
4) modify	определять , видоизменять
5) handheld	портативный
6) output device	система вывода
7) flow	поток
8) silicon, chip	микросхема
9) Content-Scrambling System	система шифрования содержания
10) decryption	дешифрование
11) circuitry	схема
12) pervasiveness	проницаемость

Text A A COMPUTER

The word "computer" has been part of the English language since 1646, but if you look in a dictionary printed before 1940, you might be surprised to find a computer defined as a person who performs calculations! Prior to 1940, machines designed to perform calculations were referred to as calculators and tabulators, not computers. The modern definition and use of the term "computer" emerged in the 1940s, when the first electronic computing devices were developed.

Most people can formulate a mental picture of a computer, but computers do so many things and come in such a variety of shapes and sizes that it might seem difficult to distill their common characteristics into an all-purpose definition. At its core, a computer is a device that accepts input, processes data, stores data, and produces output, all according to a series of stored instructions.

Computer input is whatever is typed, submitted, or transmitted to a computer system. Input can be supplied by a person, the environment, or another computer. Examples of the kinds of input that a computer can accept include words and symbols in a document, numbers for a calculation, pictures, temperatures from a thermostat, audio signals from a microphone, and instructions from a computer program. An input device, such as a keyboard or mouse, gathers input and transforms it into a series of electronic signals for the computer to store and manipulate.

In the context of computing data refers to the symbols that represent facts, objects, and ideas. Computers manipulate data in many ways, and this manipulation is called processing. The series of instructions that tell a computer how to carry out processing tasks is referred to as a computer program, or simply a "program". These programs form the software that sets up a computer to do a specific task. Some of the ways that a computer can process data include performing calculations, sorting lists of words or numbers, modifying documents and pictures, keeping track of your score in a fact-action game, and drawing graphs. In a computer, most processing takes place in a component called the central processing unit (CPU), which is sometimes described as the computer's "brain".

A computer stores data so that it will be available for processing. Most computers have more than one place to put data, depending on how the data is being used. Memory is an area of a computer that temporarily holds data waiting to be processed, stored, or output. Storage is the area where data can be left on a permanent basis when it is not immediately needed for processing. Output is the result produced by a computer. Some examples of computer output include reports, documents, music, graphs, and pictures. An output device displays, prints, or transmits the results of processing.

Take a moment to think about the way you use a simple handheld calculator to balance your checkbook each month. You're forced to do the calculations in stages. Although you can store data from one stage and use it in the next stage, you cannot store the sequence of formulas – the program – required to balance your checkbook. Every month, therefore, you have to perform a similar set of calculations. The process would be much simpler if your calculator remembered the sequence of calculations and just asked you for this month's checkbook entries.

Early “computer” were really no more than calculating devices, designed to carry out a specific mathematical task. To use one of these devices for a different task, it was necessary to rewire its circuits – a job best left to an engineer. In a modern computer, the idea of a stored program means that a series of instructions for a computing task can be loaded into a computer’s memory. These instructions can easily be replaced by a different set of instructions when it is time for the computer to perform another task.

The stored program concept allows you to use your computer for one task, such as word processing, and then easily switch to a different type of computing task, such as editing a photo or sending an e-mail message. It is the single most important characteristic that distinguishes a computer from other simpler and less versatile devices, such as calculators and pocket-sized electronic dictionaries.

1. Are the following statements True or False:

1) A computer can be defined by its ability to perform different mathematical and logical operations according to a set of instructions.
2) Computers had already been used before WWII.
3) There is no any significant difference between memory and storage.
4) Computer programs and software mean the same.
5) CPU is a part of a computer that controls all other parts of the system.
6) Computers and calculators are very similar devices which are based on the stored program concept.

2. Match the words with their synonyms:

supply	unit
distinguish	appear
purpose	but
device	open
emerge	goal
available	differentiate
although	provide

3. Complete the following sentences choosing one out of the variants given:

1. If you don’t back up regularly, you can lose all your … .
a) CPU b) programs c) data d) storage
2. A computer … input, processes and stores data, produces output according to a series of instructions.
a) accepts b) submits c) emerges d) transmits
3. Reports, documents, graphs and pictures can be … to as computer output.
a) performed b) supplied c) transformed d) referred
4. A computer can perform various tasks such as word processing or sending messages that … it from any calculator.
a) set up b) distinguish c) keep track d) mean

5. Memory is the part of a computer where data and instruction are stored … .
a) permanently b) available c) temporarily d) versatile
6. Data is processed in the … according to the instructions that have been loaded into the computer memory.
a) CPU b) variety c) storage d) output

4. Fill in the gaps according to the text:

A computer is a ___ that accepts input, ___ data, stores data, and produces out put according to a series of stored instructions. Before a computer processes data, it is temporarily held in ___. This data is processed in the ___. The idea of ___ program means that a series of instructions for a computing task can be loaded into a computer's memory.

5. Discuss the following questions:

1) How old is the word "computer"?
2) What is a computer?
3) What can be called "computer input"?
4) What input devices can you name?
5) Why do we need software?
6) What is the purpose of the CPU?
7) How do memory and storage differ?
8) What computer output can we get?
9) What's so significant about a computer's ability to store instructions?
10) What does a stored program mean?

Read the Text B and do the exercises given after it:

Pre-reading. Match the terms with the appropriate definitions.

a desktop computer	a) this computer is especially suited for storing and distributing data on a network; these machines do not include features such as sound cards, DVD players, and other fun accessories; they don't require specific hardware and just about any computer can be configured to perform such work;
a notebook	b) these are powerful desktop computers designed for specialized tasks; they can tackle tasks that require a lot of processing speed, most have circuitry specially designed for creating and displaying three-dimensional and animated graphics and often dedicated to design tasks;
a tablet computer	c) it's a large and expensive computer capable of simultaneously processing data for hundreds or thousands of users; used by businesses or governments to provide centralized storage,

	processing and management for large amount of data in situations where reliability, data security and centralized control are necessary;
a handheld computer	d) it fits on a desk and runs on power from an electrical wall outlet; its keyboard is typically a separate component, connected to the main unit by a cable;
a workstation	e) it's a portable computing device featuring a touch-sensitive screen that can be used as a writing or drawing pad;
a mainframe computer	f) it's one of the fastest computers in the world; can tackle complex tasks such as breaking codes, modeling worldwide weather systems and simulating nuclear explosions;
a supercomputer	g) it features a small keyboard or touch-sensitive screen and is designed to fit into a pocket, run on batteries and be used while you are holding it; also called a PDA (personal digital assistant), it can be used as an electronic appointment book, address book, calculator and notepad;
a server	h) it's a small lightweight personal computer that incorporates screen, keyboard, storage and processing components into a single portable unit, also referred to as a "laptop".

Text B PERSONAL COMPUTER SYSTEMS

The term "computer system" usually refers to a computer and all the input, output, and storage devices that are connected to it. A personal computer system usually includes the following equipment:

• System unit. The system unit is the case that holds the main circuit boards, microprocessor, power supply, and storage devices. The system unit the notebook computer holds a built-in keyboard and speakers, too.

• Display device. Most desktop computers use a separate monitor as a display device, whereas notebook computers use a flat panel LCD screen (liquid crystal display screen) attached to the system unit.

• Keyboard. Most computers are equipped with a keyboard as the primary input device.

• Mouse. A mouse is an input device designed to manipulate on-screen graphical objects and controls.

• Hard disk drive. A hard disk drive can store billions of characters of data. It is usually mounted inside the computer's system unit. A small external light indicates when the drive reading or writing data.

• CD and DVD drives. A CD drive is a storage device that uses laser technology to work with data on computer or audio CDs. A DVD drive can work with data on computer CDs, audio CDs, computer DVDs, or DVD movie disks. Some CD and DVD drives are classified as "read only" devices that cannot be used to write data onto disks. They are typically used to access data from commercial software, music, and movie CDs or DVDs. "Writable" CD and DVD drives, however, can be used to store and access data.

• Floppy disk drive. A floppy disk drive is a storage device that reads and writes data on floppy disks.

• Sound card and speakers. Desktop computers have a rudimentary built-in speaker that's mostly limited to playing beeps. A small circuit board, called a sound card, is required for high-quality music, narration, and sound effects. A desktop computer's sound card sends signals to external speakers. A notebook's sound card sends signals to speakers that are built into the notebook system unit.

• Modem and network cards. Many personal computer systems include a built-in modem that can be used to establish an Internet connection using a standard telephone line. A network card is used to connect a computer to a network or cable Internet connection.

• Printer. A computer printer is an output device that produces computer-generated text or graphical images on paper.

The term peripheral device designates equipment that might be added to a computer system to enhance its functionality. Popular peripheral devices include printers, digital cameras, scanners, joysticks, and graphics tablets.

The word "peripheral" is a relatively old part of computer jargon that dates back to the days of mainframes when the CPU was housed in a giant box and all input, output, and storage devices were housed separately. Technically, a peripheral is any device that is not housed within the CPU.

Although a hard disk drive seems to be an integral part of a computer, by the strictest technical definition, a hard disk drive would be classified as a peripheral device. The same goes for other storage devices and the keyboard, monitor, LCD screen, sound card, speakers, and modem. In the world of personal computers, however, the use of the term "peripheral" varies and is often used to refer to any components that are not housed inside the system unit.

1. Find in the text the opposites to the given words:

internal   rough   unfasten   secondary   reduce   successively

2. Put the letters in the following words into correct order:

peroayrtylm   netmipqeu   literesav   hpelarepir   afuteer   beroadyk

3. Complete the following sentences choosing one out of the variants given:

1. Which of the following statements about hard disk is not true?
a) it stores data   b) it's not a peripheral   c) it's a magnetic device
d) it's placed inside a computer
2. This storage format is used to store digital video or computer data.
a) a floppy disk   b) CD   c) a sound card   d) DVD
3. What are the elements of a computer system?

a) disk drives b) a monitor c) a central processor d) all of the above

4. These portable computers are ideal for mobile users. They are easy to carry and can be used outdoors without the need for an electrical outlet.

a) mainframes b) notebooks c) workstations d) servers

5. Which of the following functions can a floppy disk drive perform?

a) store data b) read data c) write data d) all of the above

6. This electronic device has a special pen and acts like an electronic piece of paper transferring images to the computer screen.

a) a laptop b) PDA c) a tablet computer d) a mainframe

4. Answer the questions to the text:

1) How do notebook computers differ from desktops?
2) What is a hand held and what is it used for?
3) What's a peripheral device and can a hard disk be called so?

Read the Text C and perform one of the projects given after the text:

Text C DIGITAL RIGHTS MANEGEMENT

Suppose you purchase a music CD of your favorite recording group. Now you want to transfer the file to your computer, rip the best tracks, and transfer them to your portable audio player. But wait! That CD is copy protected and your computer CD drive won't read it. You purchased the disk. Can't you listen to the music on any device you choose? The answer is "yes" and "no". Yes, copyright law gives you the right to make copies for your personal use and transfer works into a format that works on your equipment. However, the growing pervasiveness of digital rights management may curtail your ability to exercise these rights.

It is easy to copy digital material. Before the dawn of the digital age, copies produced by analog equipment, such as photocopiers and audio tape dubbing machines, were of considerably poorer quality than the originals. Copies of digital materials, however, are indistinguishable from the originals, and that factor has encouraged an alarming increase in software, music, and movie piracy.

The battle against piracy took shape as a concept called digital rights management (DRM), vigorously supported by Microsoft and backed by a host of industry leaders.

Today, digital rights management encompasses a variety of technologies implemented by copyright holders, such as record companies and software publishers, which restrict the usage of digital material. DRM systems address piracy by using a variety of technologies for manipulating data, media, devices, and transactions.

Software copy protection techniques include reading data written to places on a disk or CD-ROM that the drive cannot normally access, using hardware that must be plugged into the computer when the software is run, requiring a serial number during the installation process, and using Internet product activation that checks the validity of an installation. Most software copy protection schemes have proved to be costly for publishers or inconvenient for consumers.

Many consumers are not aware that they pay a surcharge for every blank audio tape or CD they purchase. Collected revenues from this surcharge go to music publishers to compensate recording artists for the fact that many people duplicate works without authorization.

Most of today's music download sites encrypt music files and embed codes that limit the number of times they can be copied and the devices on which they can be played. Various formats used by different sites are not compatible with each other and require different players. Music from several different download sites cannot be compiled into a single playlist. It is becoming more common for music CDs to use play-protection technology designed to make the CD unusable in devices, such as computer CD-R drives, that can also be conveniently used for duplicating CDs. Consumers who purchase these protected CDs find that they cannot be copied to a computer hard disk, then ripped to produce an MP3 file for a portable audio player.
Commercial movie DVDs use CSS (Content-Scrambling System) encryption to make DVDs playable only on authorized DVD players equipped with decryption key circuitry. Movies purchases in the United States and Canada cannot be played on devices manufactured for the European or Asian markets.

Despite DRM technologies and the inconveniences imposed on consumers, digital piracy remains rampant. According to an article about digital rights management posted on Wikipedia, "To date, all DRM systems have failed to meet the challenge of protecting the rights of the rights holder while also allowing the use of the rights of the purchaser. None have succeeded in preventing criminal copyright infringement by organized, unlicensed, commercial pirates."

Current DRM technologies do not seem able to distinguish between pirates and legitimate consumers. As a result, DRM technologies essentially pose restrictions on consumers that go beyond the intended limitations of copyright law.

The current status of DRM seems to conflict with the original intent of copyright law to allow consumers to manipulate and copy works for their own use. Can technology eventually offer a solution that prevents piracy, but allows individuals to exercise their rights to fair use of copyrighted materials?

Topics for a project:

1. Although the Internet provides a global communications network, communication between people still depends on finding a common language. For this project, explore the Web and experiment with ways in which technology is being used to close the language gap. You might start at Google or Wikipedia and look at the selection of languages they offer. Chronicle your exploration making sure to document the sites you visited. Present your conclusions about Internet.

2. Whether you're taking this course to fulfill a graduation requirement or to improve your career options take a few minutes to evaluate what you expect to gain from this course. Look though the units of this textbook and select the section that you think will be the most useful, interesting and the section that seams to be the least relevant to you. Incorporate your thoughts in two or three paragraphs.

UNIT 3

FERROUS AND NON - FERROUS

THE PARTICIPLE

GRAMMAR

Причастие является неличной формой глагола и обладает признаками как прилагательного (иногда наречия), так и глагола. В английском языке имеются следующие формы причастия:

	Participle I	Participle II	Perfect Participle
Active	asking writing	-	having asked having written
Passive	being asked being written	Asked written	having been asked having been written

Participle I выражает действие, являющееся:

- признаком предмета

Students reading a new article – студенты, читающие статью.

- сопутствующим действием

Reading a new article, students found out much interesting – читая новую статью, студенты выявили много интересного.

Действие, выраженное Participle II, всегда носит страдательный характер, т.е. направлено на предмет или лицо, с которым связана эта форма: written-*написанный*.

Perfect Participle указывает на законченность действия по отношению к основному действию в предложении, выраженному сказуемым: having written – *написав*; having asked – *спросив*.

Participle I + Perfect Participle в страдательном залоге указывают на то, что действие, выраженное причастием, направлено на лицо или предмет с ним связанный: being written – *будучи написанным*; having been written *будучи (уже) написанным*.

Функции причастия и способы перевода.

1) определение

Participle I

Отвечают на вопрос *какой (-ая, -ое, -ие) ?*. Может переводиться:

- причастием действительного залога, оканчивающимся на – *ющий, - вший*

- причастным оборотом или определительным придаточным предложением:

The man conducting a lecture is our Professor. – Человек, читающий лекцию. (который читает), наш профессор.

Participle II может переводиться:

- причастием страдательного залога не/совершенного вида, оканчивающимся на – *ный, -мый, -тый:*

- причастным оборотом или придаточным определительным предложением:

The lecture conducted by our Professor was interesting. - Лекция , прочитанная нашим профессором, была интересной.

2) обстоятельство (очень часто в сочетании с союзами while, when, if). Отвечают на вопросы *как? когда?* Причастия в данной функции могут переводится:

- деепричастием с суффиксами *–а, -ав, -ив* или причастным оборотом

(*While) working in the lab we made experiments. –Работая в лаборатории, мы проводили эксперименты.*

- придаточным предложением или существительным с предлогом.

When tested that device showed good results. Во время испытаний этот прибор показал хорошие результаты. (Когда этот прибор проходил испытания, он показал хорошие результаты).

If used this method will help us to increase the output. Если этот способ будет применён, он поможет нам повысить выпуск продукции.

3) Часть сказуемого

Participle I образует времена группы Continuous.

The system is not working. Система не работает.

Participle II образует:

- конструкции пассивного залога;

The problem is being solved. Проблема решается.

- времена группы Perfect.

A group of engineers has designed a new device. Группа инженеров сконструировала новый прибор.

Participle I и Participle II в функции части сказуемого переводятся глаголом в личной форме. Формальным признаком причастия в функции части сказуемого является наличие перед причастием глаголов to be и to have в личной форме.

Сложные формы Participle I

К сложным формам Participle I относятся формы типа: being used, having used, having been used.

-форма типа being used (Indefinite Passive) показывает, что действие, выраженное причастием, происходит одновременно с действием, выраженным глаголом в личной форме; формы типа having used, having been used (Perfect

Active/Passive) показывают, что действие, выраженное причастием, предшествует действию, выраженному глаголом-сказуемым.

The devices being used in our work are up-to-date. Приборы, применяемые в нашей работе, современны. Having finished his experiments he compared the results. Закончив свои эксперименты, он сравнил результаты.

-перевод сложных форм причастий зависит от выполняемой ими функции. В функции определения причастие переводится причастием настоящего времени страдательного залога или определительным придаточным предложением:

The method being used by this engineer is very effective. Метод, используемый этим инженером, очень эффективен.

В функции обстоятельства причастие обычно переводится обстоятельственным придаточным предложением или деепричастием совершенного вида:

Having finished the series of experiments they published the results. Закончив серию экспериментов, они опубликовали результаты. Having been translated into many languages the book became very popular. После того, как книга была переведена на многие языки, она стала очень популярной.

Причастные обороты (Participle constructions).
Объектный причастный оборот (The Objective Participle Construction)

Объектный причастный оборот представляет собой сочетание личного местоимения в объектном падеже (или существительного в общем падеже) с последующим причастием I в неперфектной форме или причастием II. Объектный причастный оборот в предложении является сложным дополнением и употребляется:

- после глаголов, выражающих физическое восприятие: to see видеть, to hear слышать, to feel чувствовать, to notice замечать, to find находить, to watch наблюдать, to observe наблюдать.

I saw her crossing the street. Я видел, как она переходила улицу.

- после глаголов, выражающих желание: want, wish, would like.

I want the letter posted at once. Я хочу, чтобы письмо было отправлено немедленно.

- после глаголов в конструкции have smth. done. Данная конструкция означает, что действие производится не подлежащим, а каким-либо другим лицом.

I had my suit cleaned. Я почистил костюм. (Мне почистили костюм).

Объектный причастный оборот обычно переводится придаточным дополнительным предложением, которое вводится союзами *как, что, чтобы.* Местоимение в объектном падеже переводится соответствующим личным местоимением в именительном падеже.

I saw him running along the street. Я видел, как он бежал по улице.

Независимый (самостоятельный) причастный оборот (The Absolute Participle Construction)

В английском языке различают зависимые и независимые причастные обороты. Зависимый причастный оборот не имеет своего действующего лица (подлежащего) и эквивалентен русскому придаточному определительному или обстоятельственному предложению.

The engineer testing the engine is a good specialist. Инженер, испытывающий двигатель, хороший специалист.

Кроме того, существуют причастные обороты, в которых имеется собственное, не зависимое от главного предложения подлежащее, выраженное существительным в общем падеже или личным местоимением именительном падеже. Такие обороты называются самостоятельными (независимыми) причастными оборотами. В русском языке аналогичной конструкции не существует.

The engineer having tested the engine, we were sure that its performance would be perfect. После того, как инженер проверил двигатель, мы были уверены, что он будет хорошо работать.

Независимый причастный оборот, в отличие от зависимого, отделяется от главного предложения запятой.

Чтобы правильно перевести независимый причастный оборот, определите его место по отношению к главному предложению:

- если независимый причастный оборот *предшествует* главному предложению, переведите его придаточным обстоятельственным предложением с одним из подчинительных *союзов (так как; поскольку; когда; после того, как; если)*;

Steel being a very strong material, we find wide application of it in engineering. - Так как сталь является очень прочным материалом, она находит широкое применение в технике.

- если независимый причастный оборот находится *после* главного предложения, используйте при переводе союзы *(а, и, но,* или слова *причём, при этом;*

The plan was discussed in detail many workers taking part in this discussion. План подробно обсудили, причем многие рабочие принимали участие в этом обсуждении.

Независимый причастный оборот, выражающий сопутствующее обстоятельство, может начинаться с предлога *with*:

The operator was adjusting the machine, with other workers watching him. Оператор налаживал станок, а остальные рабочие наблюдали за ним.

Иногда в независимом причастном обороте опускается Participle I глагола to be:

The lesson (being) over, everybody left the classroom. Так как урок окончился, все вышли из аудитории.

It being very dark, I could see nothing. Так как было совсем темно, я ничего не мог увидеть.

Причастные обороты являются принадлежностью письменной речи. В устной речи они обычно заменяются придаточными предложениями.

Grammar Practice

1. Choose the right variant of the Participle and translate the sentences into Russian:

1) A group of researchers at Bell labs have made tiny *functioning/functioned* transistors a million times smaller than a grain of sand.
2) Each molecular transistor is 10 times smaller than any components *creating/ created* with today's most *advancing/ advanced* chip *making/ made* techniques.
3) In the media you can often find articles *telling/ told* of hackers *breaking/ broken* into computer systems and websites *stealing/ stolen* and *destroying/ destroied* information.
4) Hacker is a computer user *breaking/ broken* a system's security and *stealing/ stolen* valuable information.
5) Hackers will often write open-source code *allowing/ allowed* others to see what they have done.
6) The hacking contest was not run fairly and proved nothing about the integrity of the *proposing/ proposed* technologies.
7) Chemically *producing/ produced* components are microsopicaller, faster and more efficient then today's silicon products made *using/ used* lithography.
8) Technologies such as the Internet, PCs and wireless telephony have turned the globe into an increasingly *interconnecting/ interconnected* network of individuals, organizations and governments *communicating/ communicated* and *interacting/ interacted* with each other with through a veriaty of channels.
9*) Using/ used* effectively, information and communication technologies can help to create *training/ trained*, *educating/ educated* and healthy workforce.
10) The method *using/ used* depends on the length to be measured.
11) An intelligent network consists of *distributing/ distributed* signaling network of switches, databases and *dedicating/ dedicated* computer servers.

2. Translate the words in brackets into English using the right Participle:

1) The research work (производимая) at the laboratory is of great importance. 2) The engineer (который проводит) this research is a talented physicist. 3) The students (посещающие) these lectures are from various faculties. 4) The lecture (которую

посетили) by these students was on mathematics. 5) The substance (называемое) “water” consists of two gases: hydrogen and oxygen. 6) The students (обсуждающие) this problem will take part in the scientific conference. 7) The problems (обсуждаемые) at the conference are very complicated.

Reading Comprehension

Read the Text A and translate it using a dictionary:

1) dense	плотный
2) malleable	ковкий, податливый
3) ductile	пластичный, вязкий
4) pure	чистый, беспримесный
5) uster	блеск, глянец ценить
6) precious	драгоценный, благородный
7) coinage	чеканка монет
8) to rust	ржаветь, подвергаться коррозии
9) monetary	монетный, денежный
10) consumption	потребление
11) dentistry	стоматология
12) resistance to corrosion	устойчивость против коррозии
13) conductivity	удельная электропроводимость
14) wiring	(электрическая) проводка
15) property	свойство, качество, характеристика
16) melting point	точка (температура) кипения
17) protective coating	защитное покрытие
18) insoluble	нерастворимый
19) to dissolve	растворяться, таять

Text A GOLD

Gold is a dense, soft, shiny, malleable and ductile metal. Pure gold has a bright yellow colour and luster – the colour of the sun. It has been a valuable and highly precious metal for coinage, jewelry and other arts since long before the beginning of recorded history. It is and will always be a wonderful metal in many ways, as it doesn’t rust away and can easily be worked. Gold has been the most common basis for monetary exchange throughout human history.

People have mined about 165,000 tonnes of gold in human history. The world consumption of new gold produced is about 50% in jewelry, 40% in investments, and 10% in industry. Gold has many practical uses in dentistry, electronics and other fields. Its high malleability, ductility, resistance to corrosion, other chemical reactions and conductivity of electricity have led to many uses of gold, including electric wiring and coloured-glass production.

Gold readily creates alloys with many other metals. People produce these alloys to modify the hardness and other metallurgical properties, to control melting point or to create exotic colours. Chemically gold is unaffected by air, moisture and most corrosive reagents, and therefore it suits for use in coins and jewelry and as a protective coating on other metals. Gold is almost insoluble, but it can be dissolved in aqua regia. People have highly valued gold in many societies throughout the ages. It has often had a strongly positive symbolic meaning closely connected to the values held in societies. People have long been making wedding rings of gold, and in many societies gold symbolizes power, strength, wealth, success, happiness, love, intelligence, summer and the sun.

1. Find the equivalents in the text:

ценный металл, практическое применение, устойчивость против коррозии, электрическая проводимость, изменять прочность, защитное покрытие, высоко ценить, тесно связанный

2. Put the sentences in its tight order:

1) Chemically gold is unaffected by air, moisture and most corrosive reagents. 2) Gold has many practical uses in dentistry, electronics and other fields. 3) People have highly valued gold in many societies throughout the ages. 4) The world consumption of new gold produced is about 50% in jewelry, 40% in investments, and 10% in industry. 5) Gold is a dense, soft, shiny, malleable and ductile metal. 6) Gold has been the most common basis for monetary exchange throughout human history. 7) It is almost insoluble, but it can be dissolved in aqua regia.

3. Answer the question to the text:

1) What kind of metal is gold?
2) What is the world consumption of gold today?
3) Where is gold used?
4) What are the properties of gold?
5) What does gold symbolize?

Read Text B and define its main parts:

Text B **METALS. ALLOYS**

It is known that metals are very important in our life. Metals have the greatest importance for industry. About two thirds of all elements found in the earth are metals. It is difficult to give a simple and yet precise definition of a metal, since metals have greatly different properties, appearances and chemical actions. For simplicity metals are defined as elements possessing certain metallic properties, they are hard, heavy, lustrous, malleable, ductile, tenacious and usually good conductors of heat and electricity. Most metals are also relatively dense and heavy. All except four metals are solid at room temperature.

Some elements possess so few metallic qualities that it is uncertain whether they should be called metals or non-metals. Carbon and silicon are such elements. They are, for example, fairly good conductors of heat and electricity, and thus resemble the metals, on the other hand, they are neither strong nor ductile and thus resemble the non-metals.

Metals widely used in industry are called engineering metals. The most important engineering metals is iron (Fe) which in the form of alloys with carbon (C) and other elements finds greater use than any other metals.

Metals consisting of iron combined with some other elements are known as ferrous metals. All the other metals are called non-ferrous. The most important non-ferrous metals are copper (Cu), aluminum (Al), lead (Pb), zink (Zn), tin (Su).

Engineering metals are usually used in industry in the form of alloys, the properties of alloys being much better than those of pure metals. In industry alloys are nearly always made by melting two or more metals together and mixing them. A striking feature about alloys is that they often differ materially in their properties from the properties of the metals composing them. The occurrence of the metals in the earth's crust in unequal, some of them being plentiful, the other existing only in small quantities.

1. Find the sentences in the text used in the Participle.

2. Answer the questions to the text:

1) What is metal?
2) Where is metal used most of all?
3) What are the properties of metals?

Read Text C and write a summary to it:

Text C Grey Cast Iron

Grey cast iron is one of the most valued of cast metals. It may be made by melting pig iron and scrap in the cheapest of melting processes, the cupola, and then cast into sand molds. Besides being of low cost, grey cast iron shows properties that make it a valuable metal industrially.

Among its outstanding properties are the following:
1. Excellent machinability; 2. Excellent wear resistance; 3. Tensile strength; 4. grey cast iron has no well-defined elastic limit and may be loaded up to 89% or more of its maximum strength; 5. It is the only ferrous allow that may be varied in stiffness; 6. Included in its properties is its valuable damping capacity for vibrations and its good resistance to corrosion.

The elements in grey cast iron are the same as in steel and the structural constituents formed from these elements are the same in steel as in cast iron (ferrite, pearlite, cementite, and manganese-sulphide). However, due to the greater percentage of carbon and phosphorus, two additional constituents are found in this form of cast iron, namely, graphitic carbon and steatite, a phosphorus eutectic structure. The graphitic carbon found in grey cast iron gives to this form of iron its outstanding properties, and may be considered its most important constituent. It is the amount, size, shape and distribution of the graphitic carbon which determines the physical properties of grey cast iron. Large flakes of graphitic carbon result in a stronger casting. Carbon that does not form graphite is present in the iron as combined carbon (cementite). The amount of cementite present in grey cast iron determines its hardness. Many grey cast irons are now cast with the additions of some alloying elements, such as nickel, copper, molybdenum and chromium. The alloys are used to improve the strength and hardness of castings.

UNIT 4

ELECTRONICS

THE GERUND

GRAMMAR

Признаки герундия и его перевод

Герундий образуется так же, как и причастие: к инфинитиву без частицы *to* прибавляется окончание *– ing: to read – reading, to write – writing*.

Герундий имеет признаки существительного и глагола, и можно его переводить или **существительным**, обозначающим **процесс** (словом, оканчивающимся на *–ание*, *-ение*), или **глаголом**, чаще всего **инфинитивом**, и иногда (если есть предлог) **деепричастием**, например:

Saying is one thing and *doing* is another.	*Сказать* – это одно, а *сделать* – это другое.
By doing nothing we learn to do ill.	*Не делая* ничего, мы учимся делать зло.

Функции герундия в предложении

1. Подлежащее:

Defining problems precisely requires patience.	Точное *определение* (постановка) задач требует терпения.
Getting several viewpoints is vital.	Чрезвычайно важно *иметь* несколько точек зрения.

2. Определение:

Memory is the process of selective *forgetting*.	Память – это процесс выборочного *забывания*.

Существительные, после которых употребляется герундий в функции определения:

ability	-	способность	advantage	-	преимущество
chance	-	возможность	merit	-	достоинство
necessity	-	необходимость	possibility	-	возможность
probability	-	вероятность	reason	-	причина, основание
way	-	способ			

3. В роли обстоятельства герундий всегда имеет предлог и иногда может переводиться деепричастием, например:

In an interview a person can learn only *by listening*, not *by talking*.	Во время интервью человек может (что-то) узнать, только *слушая*, но не *говоря*.

4. Дополнение:

We thought of *starting* another series of experiments.	Мы подумывали о том, чтобы *начать* еще одну серию экспериментов.

Переходные глаголы, после которых в качестве дополнения без предлога может использоваться герундий:

to avoid	-	избегать	to deserve	-	заслуживать
to prefer	-	предпочитать	to require	-	требовать
to resist	-	сопротивляться	to try	-	пытаться

Например:

He preferred *changing* the course of actions.	Он предпочел *изменить* ход действий.

Герундий может употребляться и после глаголов, требующих дополнения с предлогом:

to account for	-	объяснять	to accuse of	-	обвинить в
to aim at	-	стремиться к	to depend on	-	зависеть от
to differ in	-	различаться	to be fond of	-	любить, нравиться
to insist on	-	настаивать на	to be interested in	-	интересоваться
to object to	-	возражать против	to prevent from	-	предотвращать
to rely on	-	полагаться на	to be responsible for	-	быть ответственным за
to result from	-	быть результатом	to result in	-	приводить к
to succeed in	-	удаваться	to think of	-	думать о

Например:

They *insisted on postponing* the discussion.	Они *настаивали на том, чтобы отложить* обсуждение.

Герундий в составе сказуемого

1. Герундий может также играть роль именной части составного сказуемого. В этом случае перед ним используется другой глагол, который берет на себя показатели времени, числа, лица, наклонения. Такими глаголами могут быть:

- глагол-связка *be*, который обычно переводится словами *являться*, *заключаться в* и др.

The main point of a transformer *is providing* the change of voltage (составное сказуемое: *be* – глагол-связка, *providing* - герундий).	Главным назначением трансформатора *является обеспе*чение изменения напряжения.

- глаголы, передающие начало, продолжение или прерывание действия типа:

to begin, to start - начинать
to continue, to go on - продолжать
to finish - кончать, заканчивать
to give up - переставать (что-л. делать), отказываться от
to keep (on) - продолжать
to stop - прекращать

- обратите внимание на перевод следующих словосочетаний, за которыми используется герундий:

cannot help – *нельзя* (*не можем*) + *не* + неопределенная форма глагола

Например:

They *could not help using* this information.	Они *не могли не использовать* эту информацию.

(it is) worth
(it is) worthwhile } *стоит* + неопределенная форма глагола или существительное

Например:

It is *worth (while)* discussing this phenomenon.	*Стоит обсудить* это явление.

no use – *нет смысла (бесполезно)* + неопределенная форма глагола

Например:

There is *no use considering* these writings.	*Нет смысла рассматривать* эти произведения.

Три *ing*-формы

1. Существуют три части речи, имеющие окончание *–ing* (три *ing*-формы) – причастие I, герундий и отглагольное существительное:

covering – Participle I	покрывающий (определение)
	покрывая (обстоятельство)
(by) covering – Gerund -	(путем) покрытия (процесс)

(a) covering – Noun - покрышка, пленка, покрытие (предмет)

2. Герундий и отглагольное существительное часто могут переводиться одинаково: существительным с окончанием *–ание*, *-ение*.

- если перед *ing*-формой есть предлог (но нет артикля) и после нее нет предлога *of*, то это **герундий**, и, значит, нас интересует **процесс**, **действие в его длительности**;
- если перед *ing*-формой стоит артикль или после нее есть дополнение с предлогом *of*, то это – **отглагольное существительное**, и, значит, нас интересует сам **факт**, **явление**, **предмет**, а не процесс. Ср.:

There are different ways of *solving* a problem (*solving* – герундий, обозначающий процесс).	Существуют разные способы *решения* одной и той же проблемы.
The solving of the problem was approved (*the solving* – существительное, обозначающие факт).	*Такой метод решения* этой проблемы был одобрен.

Образование сложных форм герундия и их перевод.

Формы герундия

	Active	**Passive**
Indefinite	planning	being planned
Perfect	having planned	having been planned

Indefinite Gerund – передает действие, **одновременное** с действием сказуемого;
Perfect Gerund – передает действие, которое происходит раньше действия сказуемого;
Active Gerund – подлежащее **само совершает** действие, выраженное герундием;
Passive Gerund – действие герундия (который стал сказуемым в придаточном предложении) переходит на подлежащее.

Например:

We *know* of the work *being carried out* in his laboratory.	Мы *знаем*, что эту работу *выполняют* в его лаборатории.
We know of the work *having been carried out* in his laboratory.	Мы *знаем*, что эту работу *выполнили* в его лаборатории.

Герундиальные обороты

Герундий с относящимися к нему словами образует **герундиальные обороты**, которые обычно начинаются с предлога, притяжательного местоимения или существительного в притяжательном (иногда общем) падеже. Герундиальные обороты можно разделить на две группы: зависимые и независимые.

1. Зависимые герундиальные обороты

Зависимые герундиальные обороты – это такие обороты, в которых перед герундием (после предлога) нет слова, обозначающего действующее лицо или предмет. При переводе таких оборотов придаточными предложениями обычно повторяется подлежащее английского предложения (используя, если нужно, соответствующее местоимение), а герундий становится сказуемым.

Предлог, вводящий герундиальный оборот в английском предложении, при переводе на русский язык должен стать союзным словом, соединяющим главное предложение с придаточным. Поэтому в русском переводе главное и придаточное предложения соединяются словами *то*, *что* в том падеже, который определяется предлогом, например:

In spite of being very complicated the problem has been solved.	*Несмотря на то, что эта проблема* очень сложная, ее (все же) решили.

Служебные слова и словосочетания, вводящие герундиальные обороты:

by	-	тем, что	in addition to	-	кроме того, что
of	-	о том, что	in spite of	-	несмотря на то, что
to	-	тому, что	besides	-	кроме того, что
in	-	в том, что; к тому, что	owing to	-	благодаря тому, что
due to	-	вследствие того, что			

2. Независимые герундиальные обороты

Независимые герундиальные обороты – это такие обороты, в которых между предлогом и герундием имеется слово, выражающее лицо (или предмет), которое совершает действие, передаваемое герундием. Такое слово может быть притяжательным местоимением или существительным в общем или притяжательном падеже.

При переводе оборота придаточным предложением это местоимение или существительное становится подлежащим, а герундий – сказуемым придаточного предложения. Перевод герундиального оборота придаточным предложением начинается с перевода предлога, стоящего перед герундием, например:

The accuracy of the definition depends *on the terms* being carefully formulated.	Точность определения зависит *от того*, насколько тщательно сформулированы (*все*) *члены*.

Примечание. Если герундиальный оборот играет роль подлежащего (перед герундием нет предлога), то перевод его придаточным предложением следует начинать со слов *то*, *что* (в именительном падеже), например:

His *having made* this experiment is a known fact.	*То, что он* уже провел этот эксперимент, является известным фактом.

При переводе независимых герундиальных оборотов, в которых перед герундием стоит притяжательное местоимение, это местоимение в русском предложении становится личным местоимением в именительном падеже, т.е. подлежащим, например:

There is no hope of *our* getting a complete analysis of the measurements within 10 days.	Нет надежды, что *мы* получим полный анализ этих измерений в течение 10 дней.

Grammar Practice

1. Translate the sentences into Russian drawing attention to the Gerunds used in the function of… :

a) подлежащего:

1) Reading science fiction is a fascinating pastime. 2) Engineering is becoming more popular. 3) There is no denying the fact.

b) части сказуемого:

1) Professor Taylor's suggestion is worth discussing. 2) These rules are worth remembering. 3) I am for discussing it at once.

c) дополнения:

1) I am very tired of arguing with you. 2) He was surprised at having been invited to the conference. 3) You must excuse my not answering you before. 5. I don't remember hearing the legend before.

d) определения:

1) There are different ways of solving this problem. 2) Young people are excited at the idea of purchasing audio-visual equipment. 3) We have a plan for modernizing the factory. 4) He was in the habit of doing things thoroughly.

e) обстоятельства:

1) It was planned to put the plant into operation 3 years after signing the contract. 2) Before reaching a final decision the market research group is to collect some information. 3) He gave a few examples instead of explaining the rule.

2. Translate into Russian:

1) Their having overheated the gas changed the results of the experiment. 2) The investigator mentioned his testing this material for strength. 3) We heard of our engineer having left for the international symposium. 4) We insisted on the experiment being

repeated. 5) In spite of the gases being compressed they return to their original volume as soon as the applied force stops acting. 6) Newton's having stated the laws of motion is very important for modern science. 7) We knew of Newton's having developed the principles of mechanics the station. 8) Franklin's having worked in the field of electricity is known all over the world. 9)They didn't know of his having been given new materials. 10) We know of Faraday's having stated the law of electromagnetic induction. 11)We heard of the new computer having been put into operation.

3. Choose the right variant

1. Is there anything in that new magazine worth _____.
a) to read
b) reading
2. Although I was in a hurry, I stopped _____ to him.
a) to talk
b) talking
3. I really must stop ______.
a) to smoke
b) smoking
4. Would you mind ______ the front door?
a) to close
b) closing
5. You should remember ______ him. He'll be at home.
a) to phone
b) phoning
6. Do you enjoy ______?
a) to teach
b)teaching
7. All parts of London seem ______ to different towns and epochs.
a) to belong
b) belonging
8. Why have you stopped? Go on ______.
a)to read
b)reading
9. The teacher asked us some questions and went on ______
a) to tell
b) telling
10. When we had finished ______we passed our papers to the Professor'stable.
a) to write
b) writing

Reading Comprehension

Read the Text A and translate it using a dictionary:

Text A ELECTRONIC CIRCUIT ELEMENTS

electronic circuits	электронные схемы
inductor	индукционная катушка
capacitor	конденсатор
resistor	сопротивление
electron tube	электронная лампа
transistor	транзистор
wire-wound ceramic type	проволочно-керамический тип
adjustable (variable) resistor	переменное сопротивление
metal collar	металлический хомут
contact band	контактное кольцо
adjustment knob	установочная ручка
screw adjustment	установочный винт
potentiometer	потенциометр
inductance coil	катушка самоиндукциицепь
choke coil	дроссельная катушка
tuned circuits	настроенные цепи
transient voltages, electrical transients	неустановившиеся напряжения
e.m.f. = electromotive force	электродвижущая сила
"slug" or movable core	подвижной сердечник
Selectivity	избирательность
filament	нить накала
metal enclosure	металлический баллон
electron-emitting material	электронно-излучающий материал
barium oxide	окись бария
rectifier	выпрямитель
h. f. a. c. carrier	высокочастотная несущая волна переменного тока
audio portion	низкочастотная часть
r. f. portion	высокочастотная часть
fine wire	тонкая проволока
crystal lattice	кристаллическая решетка
n-type germanium	*n*-германий
p-type germanium	*p*-германий
valence electron	валентный электрон
junction transistor	плоскостный транзистор
point-contact transistor	точечный полупроводниковый транзистор
rugged construction	прочная конструкция

Resistors. A resistor is a circuit element designed to insert resistance in the circuit. A resistor may be of low value or of high value.

Resistors in electronic circuits are made in a variety of sizes and shapes.

They are generally classed as fixed, adjustable or variable, depending upon their construction and use.

The resistance value of small fixed resistors is sometimes indicated by a code colour.

Resistors required to carry a comparatively high current and dissipate high power are usually of the wire-wound ceramic type.

Adjustable and variable resistors. An adjustable resistor is usually of the wire-wound type with a metal collar which may be moved along the resistance wire to vary the value of the resistance placed in the circuit. In order to change the resistance, the contact band must be loosened and moved to the desired position and then tightened so that it will not slip. In this way the resistor becomes, for all practical purposes, a fixed resistor during operation.

A variable resistor is arranged so that it may be changed in value at any time by the operator of the electronic circuit. This change is usually accompanied by rotating a small adjustment knob or by turning a screw adjustment. Variable resistors are commonly known as rheostats or potentiometers.

It must be pointed out that the use of a resistor of any type must be very carefully considered. The capacity of a fixed resistor, rheostat or potentiometer must be such that it can handle the current through the circuit without damage computing the current by means of Ohm's law.

Inductors. The purpose of an inductor, or inductance coil, is to insert inductance into a circuit. The effect of an inductance is to oppose any change[6] in the existing current flow in a circuit. The opposition to current flow in an a. c. circuit by an inductor is called inductive reactance and is measured in ohms.

Inductors are made in many shapes and designs. An inductor used in extremely high-frequency circuits may consist of only one turn or even less than one turn of wire. On the other hand, an inductor used as a choke coil in a low-frequency circuit or in a filter circuit may contain many turns of wire and also be wound on an iron core to increase the inductance.

Inductors are often used in radio in connection with capacitors to provide tuned circuits. These tuned circuits are most valuable in radio and television for filtering out unwanted frequencies[7] and passing the desired frequencies.

Inductance coils are rated as to value in henrys. One henry is a comparatively large inductance. Therefore, many of the inductors used in electronic circuits are rated in millihenrys. One millihenry (mh) is one thousandth of a henry. One henry is the inductance of a coil which will produce a back voltage of 1 volt when the current change is at the rate of lamp per second.

Capacitors. A capacitor may be defined as a device consisting of two or more conductor plates separated from one another by a dielectric and used for receiving and storing an electric charge. The effect of a capacitor in an electric circuit is to oppose any change in the existing voltage.

Capacitors are commonly used in d. c. circuits to reduce the effects of transient voltages and currents. Electrical transients are high voltages developed from time to time when the circuit is broken or reconnected, as when a switch is turned on or off. These transient voltages are usually caused by the inductance of a circuit. In an a. c. circuit the capacitor is often used to block the direct current but permit the flow of the alternating current. In effect, the alternating current appears to flow through the capacitor but is actually being stored first on one plate of the capacitor and then on the other.

Like many other electronic units, capacitors are manufactured in a wide variety of sizes and styles. Some very low-capacity capacitors are merely tiny wafers of metal separated by an insulator; large capacitors may weigh several pounds. Fixed capacitors are of two general types. One is the dry capacitor which consists of metal plates separated by a dry dielectric such as mica or waxed paper, and the other is the electrolytic capacitor, whose dielectric is a chemical paste or one electrolyte. The electrolytic capacitor is effective in only one direction. This means that it must be connected in such a manner that the positive and negative polarities are correct. If it is connected in reverse, the current will flow through the capacitor and destroy it. Fixed capacitors of both the dry and electrolytic type are manufactured in a wide variety of shapes and sizes. The electrolytic capacitors are marked to indicate the correct method of connection into a circuit.

The unit of capacitance is a farad. A capacitor which will store 1 coulomb of electricity under an e. m. f. of 1 volt has a capacitance of 1 farad. The farad is an extremely high value of capacitance; therefore capacitors used in standard electronic circuits are rated in[9] microfarads (1 mf = one millionth of a farad) or micromicrofarads (1 mf = one millionth of a microfarad).

1. Give the equivalents:

высокочастотная несущая волна переменного тока; электронные схемы; металлический хомут; контактное кольцо; установочная ручка; установочный винт.

2. Translate from Russian into English:

1) Резисторы в электронных схемах производятся различных размеров и форм. 2) Переменный резистор устроен так, что он может быть изменен в любое время оператором электронной схемы. 3) Переходные напряжения обычно вызваны индуктивностью цепи.

3. Continue the sentences according to the text:

1) A resistor is a ……. . 2) Variable resistors are commonly known as…… 3) Fixed capacitors are of two general types. One is ……which consists of…., and the other is …… .4) The purpose of an inductor is …. . 5) ………. is a farad.

4. Put 5-6 questions to the text.

Read the Text B. Write out the very main facts from it and answer the questions given after the text:

rectifier	выпрямитель
h. f. a. c. carrier	высокочастотная несущая волна переменного тока
audio portion	низкочастотная часть
r. f. portion	высокочастотная часть
fine wire	тонкая проволока
crystal lattice	кристаллическая решетка
n-type germanium	*n*-германий
p-type germanium	*p*-германий
valence electron	валентный электрон
junction transistor	плоскостный транзистор
point-contact transistor	точечный полупроводниковый транзистор
rugged construction	прочная конструкция

Text B **TRANSISTORS**

Among the most important discoveries in electronics during recent years is the invention of the transistor. The transistor is a very small device which is replacing and is doing the work of a much larger electron tube. One of its principal advantages, however, is that no current is required for a heater circuit, as the transistor works at room temperature. During operation a transistor becomes heated, and so it is necessary to make certain that the transistor circuit is not overloaded beyond its operating limits.

Semiconductors. The operation of a transistor depends upon the nature and characteristics of a crystal substance such as germanium, or silicon. Pure germanium and silicon are good insulators because there are no free electrons to carry current through the material. However, when a very small percentage of an impurity is added, their crystal lattice structure remains the same, but the extra electrons brought in by the impurity remain free in the material to act as current carriers. This makes the material a semiconductor, that is, it will carry current in one direction and block the flow of current in another direction. Germanium with an impurity which leaves an excess of electrons in the material is called *n*-type germanium because of its negative characteristic. When an impurity such as aluminium is added to germanium, *p*-type germanium is formed. This is because aluminium atoms have fewer valence electrons, and when combined with germanium, they leave vacant spots or holes where an electron should be in order to balance the charges between the atoms. A current flows in *p*-type germanium, electrons move into the holes, leaving other holes at the points from which they came. This is the hole current.

Junction transistor. There are two principal types of transistors: the point-contact transistor and the junction transistor.

A junction transistor consists of three principal sections and may be manufactured as one piece. In a *n-p-n* transistor the crystal consists of a section of *n*-type germanium, and another larger section of *n*-type germanium. One end of this transistor is called the emitter, the small *p*-type section is called the base, and the other end is called the collector. The collector is baised positive with respect to the base; hence there will normally be no current flow across the base-to-collector junction. The positive collector will draw the electrons away from the junction and the negative base will draw the holes away from the junction, and so there can be no transfer of holes or electrons at this point. Since the emitter is negative with respect to the base, the electrons will flow from the emitter to the base and the holes will move from the base to the emitter. This results in a substantial flow of electrons from the emitter to the base, and since the base is very thin, these electrons move across the base and into the positively charged collector.

The result is that a substantial collector current will flow. This collector current will vary in accordance with the changes of the current flow across the emitter-to-base junction. Generally speaking, we may consider the operation of this transistor similar to that of a triode tube with the emitter representing the cathode,[2] the base representing the control grid and the collector representing the plate.

The advantages of a transistor are its very small size and weight, the fact that no power is necessary for heating it, and its comparatively rugged construction.

1. Answer the questions to the text:

1) What is the transistor?
2) Why is silicon a good insulator?
3) How is *p*-type germanium formed?
4) What are the advantages of the transistors?

Read the Text C and answer to the key question: what if the man didn't invent the electron tube? Write a summary to the text.

Text C **THE ELECTRON TUBE**

It may be stated that the modern electronic industry was born with the invention of the electron tube. The first discoveries in electron-tube phenomena were made by Thomas Edison in 1883 during his experiments with the incandescent lamp. Edison discovered that the heated filament of an incandescent lamp gives off electrons which pass to another electrode in the bulb and thus create an actual current flow from the filament to the other electrode, or plate.

The diode tube. An electron tube, also called a vacuum valve, consists of a glass or metal enclosure in which electrodes are placed and sealed in either a gaseous or an evacuated atmosphere. The simplest of electron tubes is the diode, which has two operating electrodes. One of these is the heated cathode, which emits the electrons, and the other is the plate or anode. The cathode may be directly heated or indirectly heated. The tube with the directly heated cathode utilizes the heated filament for the cathode, in this case the filament is coated with a special material which greatly increases the number of electrons emitted. If the tube has an indirectly heated cathode, the cathode consists of a metal tube in the centre of which is a filament or heater. The heater is insulated from the metal tube. The outside of the cathode tube is covered with an electron-emitting material such as barium oxide, strontium oxide or thorium oxide.

The principal advantage of the diode tube is that it permits the flow of current in one direction only, that is, from the heated cathode to the anode. If an alternating current is applied to the cathode, the tube will conduct only during one half of each cycle, that is, while the cathode is negative and the anode or plate is positive. For this reason diode tubes are often used as rectifiers to change alternating current to direct current. Diode tubes are used in the power-supply circuits of such electronic devices as radio and television, which obtain their primary power from a. c. sources.

Another use of the diode tube is as a detector.[4] In this application the tube changes the h. f. a. c. carrier wave into a direct current which displays the modulation of the a. f. signal, separates the audio portion of a radio signal from the r. f. portion which is the carrier wave.

The triode tube. The triode tube was discovered by Dr. Lee De Forest. De Forest found that by adding a third element to the diode tube the electron flow from the cathode to the plate could be effectively controlled by changing the electrical charge on the grid placed between them.

The effect of the grid in a triode makes it possible for the tube to act as an amplifier, that is, small changes in voltage on the grid will cause very substantial changes in the current flow from the cathode to the plate.

UNIT 5

WELDING

THE SUBJUNCTIVE MOOD

THE CONDITIONAL SENTENSES

Сослагательное наклонение (The Subjunctive Mood) употребляется:

1) в придаточных предложениях подлежащих, начинающихся с союза that, после главных предложений, содержащих составное именное сказуемое с оценочным словом: ***it is possible*** *возможно,* ***it is probable*** *вероятно,* ***it is important*** *важно,* ***it is***

strange *странно,* ***it is necessary*** *необходимо,* ***it is desirable*** *желательно,* ***it is required*** *требуется****, it is a miracle*** *удивительно,* ***it is essential*** *важно.*

Сказуемое придаточного предложения имеет форму **should + *инфинитив без частицы to (или только инфинитив без частицы to)*.**

It's essential that the meeting be held at once. Очень важно, чтобы встреча была проведена немедленно.

It's strange that you should say it. Странно, что вы это говорите.

2) в придаточных дополнительных предложениях, начинающихся с союза **that** после глаголов:
to suggest - предлагать,
to insist - настаивать,
to propose - выдвигать предложение,
to order - приказывать, to command - командовать,
to request - просить,
to recommend - рекомендовать,
to demand - требовать.

Сказуемое придаточного предложения также имеет форму

should + инфинитив без частицы to (или только инфинитив без частицы to).

He suggested that I should speak to the dean. Он предложил мне поговорить с деканом.

Сослагательное наклонение после вышеуказанных глаголов употребляется только в том случае, если главное и придаточное предложения имеют разные подлежащие.

Сравните:

I insist that she should write the work herself. Я настаиваю, чтобы она писала работу сама.

I insist on doing the work myself. Я настаиваю на том, чтобы делать работу самому.

He suggests going to the lecture. Он предлагает сходить на лекцию.

3) в придаточных предложения, начинающихся с союзов
as if - как будто,
as though - как если бы,
in order that (to) - для того, чтобы,
so that - так, чтобы,
lest - чтобы не.

The Earth behaves as if it were a large magnet. Земля ведет себя так, как будто она была огромным магнитом.

He must hurry lest he should be late. Он должен торопиться, чтобы не опоздать.

THE CONDITIONAL SENTENSES (условные предложения)

Тип предложения	**Условное придаточное предложение**	**Главное предложение**
I тип. Изъявительное наклонение. Условие реальное, относящееся к будущему времени. (Переводится будущим временем).	Present Indefinite	Future Indefenite
	As soon as we *receive* the necessary data, Как только мы *получим* необходимые данные,	we *shall inform* you. мы *сообщим* вам.
II тип. Сослагательное наклонение. Условие нереальное (или маловероятное), относящееся к настоящему или будущему времени. (переводится глаголом в прошедшем времени с частицей “бы”)	Past Indefinite в значении сослагательного наклонения ______________________ If there *were* no atmosphere, Если бы не было атмосферы,	Should (would, could, might) + Indefinite Infinitive ______________________ the surface of the Earth *would become* too hot by day and too cold by night то поверхность Земли была бы слишком горячей днём и слишком холодной ночью.
III тип. Сослагательное наклонение. Нереальное условие, относящееся к прошедшему времени. (Переводится так же, как II тип).	Past Perfect в значении сослагательного наклонения	Should (would, could, might) + Perfect Infinitive
	If he *had worked* hard last term, Если бы он работал усердно в прошлом семестре, If he had had more time yesterday, Если бы у него было вчера больше времени,	he *would have passed* his exam. он бы сдал экзамен. he might have done this work. он бы выполнил эту работу.

Бессоюзные условные предложения

В научно-технической литературе встречаются бессоюзные условные предложения, в которых наблюдается обратный порядок слов (инверсия) , т.е. сказуемое или часть его (вспомогательный глагол) ставится перед подлежащим. Такая инверсия в предложении является признаком условного предложения в сослагательном наклонении.

Условное придаточное предложение	Главное предложение
I тип Should any repair be required (If any repair is required)… Если потребуется ремонт,	it will be made immediately он будет произведён немедленно
II тип Had we enough time to spare (If we had enough time…) Было бы у нас достаточно времени,	we should attend the conference. мы бы пошли на конференцию.
III тип Had we applied this method of work, (If we had applied…) Если бы мы применили этот метод работы (тогда),	we should have had the desired results. мы бы имели бы желаемые результаты.

Grammar practice

1. Translate into Russian:

1) If the distance between the two points be the same, no further experiment will be necessary. 2) It is necessary that atomic energy should be used for industrial purposes. 3) It is agreed that applied research in international management should support managers to increase the efficiency of MNCs (MultiNational Corporations). 4) In order to define quality requirements and to evaluate the product quality, each quality characteristic and subcharacteristic should be measurable. 5) The world itself behaves as if it were an enormous but weak magnet. 6) The man spoke as if he were an expert in that line. 7) He insisted that such additional functions should be grantable to any dimension. 8) In addition the downloaded code might know how to react to user inputs and how data should be stored and saved. 9. This substance might be an insulator or a conductor. 10. Atomic energy finds such wide and varied application in

our life that our age might be called the age of atom. 11. You could save a lot of trouble if you knew what were in the instruction book.

2. Translate into Russian:

1) If he had been given an opportunity, the work might have been finished. 2) They would not have put something into the box, if there were no way to get it out. 3) Users soon get bored of waiting, and the project will be much less successful than if it had delivered a near instantaneous response, even at the cost of less detailed analysis. 4) If a new network had been added to the system, the modulator system would have been retrained. 5) Only a few years ago if you had heard of sending up artificial moons to circle the earth that idea would have sounded fantastic. 6) But for this increment, the system would stay in the same position indefinitely. 7) But for the preliminary work it would have been impossible to cope with the new project. 8) Should your work meet these conditions, it will be of great service to our industry. 9) Had he informed me in time I should have sent this device. 10) Had you taken all safety measures the machine would not have been broken. 11) Had the degree of evaporation been high, the salinity of water would have been rising. 12) Had this warning been needed, the processing might have taken quite a different turn.

3. Choose the right variant:

1. He spoke as if he … the information from the Internet. a) had got b) got c) would get d) would have got
2. If she … known the facts, she could have told us what to do.
a) have b) will have c) would have d) had
3. If I … trying harder, I would have succeded when I was a student.
a) was b) am c) had been d) have been
4. Your English … , unless you study more.
a) would improve b) will improve c) wouldn't improve d) won't improve
5. If she had passed an exam, she … given a grant.
a) would be b) will be c) had d) would have
6. If the system represented a network, the signal … easily processed.
a) would be b) would have been c) were d) will be
7. If I had known the rule, I … the mistake in my test.
a) won't make b) wouldn't have made c) wouldn't make d) had made

Reading Comprehension

Read the Text A. Translate it using the dictionary.

pressure welding	сварка давлением
heat welding	сварка нагреванием
bolting	скрепление болтами
riveting	клепка

gas welding	газосварка
arc wading	электродуговая сварка
resistance welding	контактная сварка
laser welding	лазерная сварка
electron-beam welding	электронно-лучевая сварка
rod	прут, стержень
flux	флюс
fusible	плавкий
to shield	заслонять, защищать

TEXT A WELDING

Welding is a process when metal parts are joined together by the application of heat, pressure, or a combination of both. The processed 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 riveting 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.

The welding processes widely employed today include gas welding, arc welding, and resistance welding. Other joining processes are laser welding, and electron-beam welding.

Gas 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.

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 electric arc, which generates enough heat to 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. Shielded Metal 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 filler metal for the weld. This process is used mainly for welding steels.

1. If the statements are true or false?

1) Arc welding has the only advantage over other welding methods. 2) Gas welding is a pressure process using heat from a gas flame. 3) Nowadays welding is used instead of bolting and riveting in the construction of many types of structures, including bridges, buildings, and ships. 4) The welding processes is not employed today.

2. Find the following words and word combinations in the text:

1) сварка давлением
2) тепловая сварка
3) болтовое (клепаное) соединение
4) процесс сварки
5) зависеть от свойств металлов
6) имеющееся оборудование
7) сварочный электрод
8) плавкий материал
9) дефектный сварной шов10. непрерывная подача электрического тока
11) электрическая дуга
12) источник электрического тока

3. Answer the questions to the text:

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?
6. What do the welding processes of today include?
7. What are the principles of gas welding?
8. What kinds of welding can be used for joining steels?
9. What does arc welding require?
10. What is the difference between the arc welding and shielded-metal welding?

Read the text B and give the annotation to it.

Text B OTHER TYPES OF WELDING

Non-consumable Electrode Arc welding

As a 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 ['hidism], 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.

Gas-Metal Arc

In gas-metal welding, a bare electrode is shielded from the air by surrounding it with argon or carbon dioxide gas and sometimes by coating the electrode with flux. The electrode is fed into the electric arc, and melts off in droplets that enter the liquid metal of the weld seam. Most metals can be joined by this process. Submerged Arc

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 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 ['semi pits'mastik] machines especially in automobile industry.

1. Answer the questions:

1. What is 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?

2. Translate into Russian:

1. In resistance welding, heat is obtained from the resistance of metal to the flow of an electric current.
2. The heat from the arc melts the edges of the metal.
3. A bare electrode is shielded from the air by surrounding it with argon or carbon dioxide gas.
4. Submerged-arc welding is similar to gas-metal arc welding.
5. Electrodes are clamped on each side of the parts to be welded.
6. Resistance causes heat which melts the metals and creates the weld.

Read the text C and resume it.

TEXT C METALWORKING PROCESS

Metalworking is the process of working with metals to create individual parts, assemblies or large scale structures. The term covers a wide range of work from large ships and bridges to precise engine parts and delicate jewelry. Metalworking is a science, art, hobby, industry and trade. One should know that modern metalworking can be divided into the following categories: forming, casting, machining, heat treatment and joining, each of these manufacturing processes representing a particular branch of the metalworking industry. Casting may be briefly described as shaping by means of pouring molten metal into a mold and allowing it to cool with no mechanical force. Forming processes modify metal or workpiece by deforming the object, that is, without removing any material. Forming can be done with a system of mechanical forces and with heat. Forming includes rolling, forging, stamping and pressing. These are the processes involving plastic deformation of the metal that must be shaped. Machining may be applied to a group of processes that consist in removing excess metal from cast, rolled or forged parts in order to obtain a desired shape. And it can be done with the help of different machine-tools, the most important of which are the lathe, the milling, boring, turning and grinding machines. Joining includes such methods as welding, soldering, brazing and riveting which can be used for attaching one surface to another. Metals should be heat treated to alter the properties of strength, ductility, toughness, hardness or resistance to corrosion. Common heat treatment processes include annealing, precipitation strengthening, quenching, hardening, normalizing and tempering. Every processing engineer must know all the metalworking processes in order he may choose the most advantageous and economical techniques.

1. Find the following words and word combinations in the text:

расплавленный (жидкий металл), сооружения крупного масштаба, желаемая форма, удаление припуска, пластичность, станок, техническое оборудование

2. What famous discovers in metalworking and welding do you know?

UNIT 6

THE FAVOUR OF INNOVATIONS

SEQUENCE OF TENSES

DIRECT AND INDIRECT SPEECH

Правило согласования времен (Sequence of Tenses) заключается в зависимости времени придаточного дополнительного предложения от времени главного. Если сказуемое в главном предложении стоит в настоящем или будущем времени, в придаточном предложении употребляется любое время, которое требуется по смыслу, например:

I suppose he is there.
I suppose that you were present at the last conference.
I suppose that you will be present at the conference.

Если сказуемое главного предложения выражено глаголом в одной из форм прошедшего времени, то сказуемое дополнительного придаточного предложения должно быть выражено глаголом в одной из форм прошедшего времени:
- если глагол придаточного предложения выражает действие (или состояние), одновременное с действием глагола в главном предложении, то глагол придаточного предложения ставится в Past Indefinite или Past Continuous. На русский язык глагол придаточного предложения, передающий одновременность действия, переводится глаголом в настоящем времени:

He said that he worked much. Он сказал, что много работает.
He said that he was working at his experiment. Он сказал, что работает над своим экспериментом

- если глагол придаточного предложения выражает действие, которое предшествовало действию, выраженному глаголом главного предложения, то глагол придаточного предложения употребляется в форме Past Perfect или Past Perfect Continuous и переводится на русский язык глаголом в прошедшем времени:

He said that he had finished his article.
He said that he had been working for more than an hour when we arrived

Если время совершения действия придаточного предложения точно определено (год, число, день, неделя), то глагол в придаточном предложении может стоять и в Past Indefinite, например:

He said he arrived at 7.

- если глагол придаточного предложения выражает действие, будущее по отношению к глаголу главного предложения, то он употребляется в одной из форм Future-in-the-Past:

He said he would translate the article. Он сказал, что переведет эту статью.
He said he would be translating it till 5 o'clock. Он сказал, что будет переводить статью до 5.
He said he would have translated that text by the end of the lesson. Он сказал, что переведет этот текст к концу занятия.

Прямая и косвенная речь. Direct and Indirect Speech

При переводе предложения из прямой речи в косвенную соблюдаются все правила последовательности времен.

При переводе прямой речи в косвенную глагол to say, имеющий при себе дополнение с предлогом to, обычно заменяется глаголом to tell, за которым всегда следует беспредложное дополнение:

She said to me, "I have finished my work." She told me she had finished her work.

Если прямая речь представляет собой **общий вопрос**, то в косвенной речи дополнительное придаточное предложение имеет прямой порядок слови вводится союзами *whether* или *if*:

He asked me, "Do you know English?" He asked me whether (if) I knew English.

She asked him, "'Are you busy?" She asked him whether (if) he was busy.

Если прямая речь представляет собой **специальный вопрос**, то в косвенной речи дополнительное придаточное предложение имеет прямой порядок слов и присоединяется к главному при помощи вопросительных слов, которые становятся союзными словами:

He asked, "Where do you live?" He asked me where I lived.
She asked them, "What are you doing?" She asked them what they were doing

В дополнительных придаточных предложениях, вводимых союзом when, будущее время не заменяется настоящим, как в придаточных предложениях условия и времени.

Если прямая речь представляет собой **побудительное предложение**, то в косвенной речи глагол, стоявший в повелительном наклонении, употребляется в форме инфинитива, причем приказание обычно выражается глаголами to tell, to order, to offer, а просьба - глаголами to ask, to beg, to implore:

The teacher said to us, "Stop writing!" The teacher told us to stop writing.
She said to Peter, "Take my book." She offered Peter to take her book..

Кроме изменения формы глагола, в придаточном предложении при обращении прямой речи в косвенную происходит следующая замена наречий места, времени и указательных местоимений:

Прямая речь	Косвенная речь
now	then
here	there
this, these	that , those
today	that day
tomorrow	the next day, the following day
yesterday	the day before, the previous day
next week / year	the next week / year, the following week / year
last year	the previous week last year the year before

1. Translate the sentences into the Russian language:

1.Today we often say that we live in the age of science and technology. 2. They say that home shopping programmers will allow viewers to shop everything from a yacht to a loaf of bread. 3. They knew that the students were organizing a meeting. 4. Our teacher said that the term "engineering" had many Russian equivalents. 5. The teacher was glad that the students were listening to him so attentively. 6. Someone can easily find out what you bought and what you paid for it. 7. When we speak of technology today, we are looking at it in a much narrower sense. 8. They meant industrial technology that began about 200 years ago with the development of power-driven machines. 9. I wasn't sure the book was worth reading. 10. The speaker said it was a historic discovery.

2. Open the brackets:

1. I thought that you (to arrive) at some decision. 2. We didn't remember that he (to repeat) that speech from memory. 3. He believed that a fine memory (to be) absolutely

necessary for that post. 4. He promised that he (to give) a lecture in the near future. 5. The scientists believe that the life in the nearest future (to be) more exciting and comfortable. 6. We agreed that the goods (to be packed) in wooden boxes. 7. Many people support the idea that (to advance). 8. I wasn't sure I (to get through) to them at once. 9. She thought we (to wait) for her. 10. He said he always (to remember) his first day at the University. 11. He told me that we (to install) a new computer of the latest model on the following day. 12. I thought I (to achieve) good results if modern techniques were used. 13. He said the purpose of his visit (to be) to talk about cultural exchanges for the next few years. 14. They were told the experiment (to begin) if nothing changed.

3. Transform the sentences into the Reported Speech:

1. He said, "We were just discussing the terms of the agreement when the telephone call interrupted us". 2. He went on insisting, "The counterparts will agree to our new price if we send them a fax immediately". 3. The professor said to me, "You should wait until they call for you". 4. They asked me, "Could you take a message?"
5. The teacher asked the student, "Will the world become a more interesting place to live in due to modern technologies?" 6. "How many of you took part in the discussion?" she wanted to know. 8. He asked, "Why can't a definite answer be given soon?" 9. She tried to find out, "How long will it take you to make arrangements?"

4. Choose the right variant:

1. Tom said that he had been late for work that morning, and he added that he … before. a) had never been late b) was never late c) never has been late d) is never late

2. Yesterday he mentioned they … this project at the moment.
a) are supporting b) supported c) were supporting d) had supported

3. The students promised that they ... for the exam.
a) would be studying b) will study c) studied d) are studying

4. She admitted that she … the course a week before.
a) has started b) started c) would start d) had started

5. The librarian didn't think the students….their books to the library by the following week.
a) would take b) would have taken c) took d) had taken

6. George was worried if … enough time to finish his report for the conference.
a) would he have b) he would have c) will have d) had

7. Did you say….very early the following morning?

a) you would have to get up b) would you have to get up c) you will have to get up d) you have to get up

8. Before television …, people had been reading, thinking, and conversing.
a) had been appearing b) had appeared c) was appearing d) appeared

9. They said that science and technology greatly … in 5 years.
a) had advanced b) advanced c) would advance d) will advance

10. The scientists believed that the life in the future … more exciting and comfortable.
a) will be b) would be c) had been d) has been

Reading Comprehension

1. Read the Text A and translate it within a dictionary:

in favour of	в пользу, быть сторонником чего-либо
application	применение, использование
DNA-testing	ДНК-тест
to inspire	вдохновлять, стимулировать, влиять
-fold	n-кратный, n-кратно
added value	добавленная стоимость
dump truck	самосвал

Text A In Favour of Innovations

Numerous innovations have been developed by Belarusian scientists over the last years, all for application in the domestic economy. In total, the National Academy of Sciences (NAS) created over 2,600 original developments in 2010, including high-efficiency machinery and equipment, tools, devices, materials, technologies and control systems. In 2009, scientists from the NAS took part in 40 state and numerous international sci-tech programmes.

Major efforts are being concentrated on innovations with practical applications. For example, the Physics Institute developed and produced universal three-wave lasers, widely used during surgical procedures. Doctors have already developed a complex of medical technologies with the help of this laser used in Belarus and abroad. In 2009, seven new structures appeared at the NAS: in microbiology, DNA-testing and biotechnologies. These are the 5th and 6th such technological structures with industrial manufactures inspired by their scientific achievements.

In 2009, Belarus planned to create a high-tech park focusing on microelectronics, optics and laser. In 2009, the National Academy of Sciences sold $17.5m of sci-tech products and this figure should rise. Scientists assure that all their developments are 100 percent added value with no import components.

By 2015, the NAS plans to increase its exports 2.5-fold. The Belarusian industry remains the major supplier of local scientific developments. One of the scientific developments brought to life at Minsk Motor Works and at the Belarusian Automobile Works is a 320-tonne capacity heavy duty dump truck. In total, in 2009 new models accounted for almost one third of all Belarusian industrial output. One industrial enterprise in the Minsk region received a proposal from investors to organize the production of high-speed trains using technologies developed in Belarus as well as foreign innovations. Innovations are essential to the republic to manufacture competitively.

1. Find the synonims to the following:

to produce, progress, to encourage, for benefit of, suggestion, to make up, new development, to develop, company

2. Give the equivalents according to the text:

внутренняя экономика, высокоскоростной, реализовать / осуществить, с помощью, парк высоких технологий, в 2.5 раза, конкурентоспособно, насчитывать / составлять

3. Are the statements true or false :

1. In 2009, scientists from the NAS took part in 40 international scitech programmes. 2. Doctors use universal three-wave lasers in Belarus and abroad. 3. A high-tech park of Belarus will focus on microelectronics, optics and laser. 4. Scientists assure that all their developments are 100 percent added value, with import components. 5. In 2009, new models of heavy duty dump trucks accounted for almost 2/3 of all Belarusian industrial output.

5. Give the answers to the questions:

1. What is the NAS?
2. What developments did the National Academy of Sciences create in 2010?
3. What innovation do doctors use during surgical procedures in Belarus and abroad?
4. What did Belarus plan to create in 2009 and in what spheres?
5. How many sci-tech products did the National Academy of Sciences sell in 2009?
6. What is one of the scientific developments brought to life at Minsk Motor Works and at the Belarusian Automobile Works?
7. What kind of innovation are Belarusian scientists and engineers going to develop in railway movement?

Read the text B and give its main idea:

Text B Automobile Industry

In the U.S. and around the world the recession that started in 20072008 had the most dramatic impact on the automobile industry. In 2009, America's car and light truck market was much worse. This was easily the worst year in decades for the car business, with two giant manufacturers filing for bankruptcy, General Motors and Chrysler.

In 2011, sales were growing at the most rapid rates in emerging nations such as India, Brazil, Chile and Russia. Brazil, enjoying exceptional economic growth, may become one of the world's largest car markets by 2016. The biggest upward trend in auto sales has been in China. China has clearly become the world's largest car market. One of the biggest winners in today's highly competitive automobile market has been Korea where Hyundai, along with its brand Kia, have enjoyed soaring global sales. Consumers are mostly attracted to their more reasonable prices, more excellent warranties and world class manufacturing quality. Korean carmakers are competing aggressively against the world's largest firms. Inexpensive cars manufactured in China will soon be on the market in many nations. The question is not whether China will export cars and trucks, but whether consumers will be convinced that they offer safety and reliability. Higher costs, tougher labor laws and daunting government regulations are constant challenges to European manufacturers. Nonetheless, firms like Volkswagen and Mercedes Benz have found great success in the global market, often locating plants in nations where their products sell better. Volkswagen has its eye on becoming the world's largest car company.

1. Answer the questions:

1. What America's car manufacturers was 2009 the worst year for?
2. In what countries were auto sales growing at the most rapid rates in 2011?
3. What are the biggest winners in today's highly competitive automobile market? And what are they famous for?
4. What are consumers expecting from Chinese inexpensive cars?
5. What are constant challenges to European manufacturers?

Read the Text C and write a summary to it:

TEXT C MODERN TECHNOLOGY

Technology plays an important role in all aspects of our lives – the way we work, the way we live at home. The speed of technological change in the past 100 years has been incredible.

Modern technology has dramatically improved our lives. In grocery stores, cashiers used to punch keys on cash registers to enter the price of each item. These days, scanners read bar codes on products packaging, and the prices are recorded by computerized cash register. In the past we made a trip to the bank to deposit or withdraw money. Now we can use ATMs (automated teller machines). And many people do their bank transactions at home on line.

Personal computers enable us to create documents, store information, and analyze data – at work or at home. The Internet allows us to send and receive e-mail messages, connects us to the World Wide Web, and allows us to go shopping online from our homes. Miniature cameras that patients can swallow permit doctors to diagnose medical conditions without surgery. "Smart homes" operated by computers turn lights on and off as people enter or leave the rooms and enable the homeowners to turn on the heat or air conditioning.

Many people feel, however, that technology has its price. With automated supermarket checkout lines, ATMs and online banking, and Internet shopping, we can meet our daily needs without having contact with other people. Life with technology can be very lonely! Also, many people are concerned about privacy. Technology makes it possible for companies or the government to monitor our use of the Internet. Our credit card numbers, bank account information, medical information, and other personal data are all stored on computers. Protecting that information will be an important issue in the years ahead.

1. Speak about new technologies that changed our lives. Can you imagine your life without…. (you choose without what).

APPENDIX I

MY DEGREE COURSE

postgraduate student	аспирант
undergraduate student	магистрант
Professor	профессор
Full professor (Am)	профессор
Emeritus professor (Am)	почетный профессор
Vice rector / Chancellor	проректор
Vice rector / Chancellor for academic affairs	проректор по учебной работе
Vice rector / Chancellor for research	проректор по научной работе
to prepare / write a thesis	писать диссертацию
prove / maintain a thesis	защитить диссертацию
to do smth with a high level of technical skill	делать что-либо

1. Answer the questions given below. While answering them use the following phrases:

My field of research is … .

The problem I
am studying concerns …
study …
investigate …
do research on …
carry out an investigation of …
undertake a study of …

I am engaged in	studying investigating researching into	the activity the function the nature the structure the effects the action the courses the influence the properties	of

The main aim of my investigation The chief purpose of my work The primary objective of my research	is	to find out … to discover … to obtain … to assess … to demonstrate … to show …

		to test …
		to check …
		to verify …

The problem I'm trying to solve	is	…
The problem I'm studying		

The investigation I'm carrying out	is	interesting
		fascinating
		important
		of practical importance
		of fundamental value
		involves certain difficulties
		presents some difficulties

In my work I	turn for help to	my supervisor
	turn for advice to	my colleagues
	consult	my Chair Chief
	discuss things with	
	consult standard reference books	

I carry out		to determine the parameters of …		
make	experiments	to examine facts about (questions concerning …)		
perform		to measure the rate of (the amount of …)		
		to obtain data on …		
		to test the validity of …		
		to provide evidence for …		
		to reveal the causes of …		
		to find out whether …		
		to confirm	the idea	
			the theory	that
			the hypothesis	

I managed	to give	good		showing	
	to present	strong	evidence	suggesting	
	to provide	sufficient	data	indicating	
	to obtain	convincing		which show(s)	that …
		interesting		suggest(s)	
		promising		indicate(s)	

The evidence	is		certain	theoretical importance
These data	seem to be	of	some	practical value

are great experimental value

The techniques I use (apply) are as follows … .
The procedure I follow in my experiments is like this: … .
The facilities I need for my work include … .

The questions:

1 What are you? What is your occupation?
2 When and what higher educational establishment did you graduate from?
3 How long have you already been working at the Byelorussian Academy of Sciences?
4 Are you a research worker or a postgraduate?
5 What area of science are you concerned with?
6 Are there many unsolved problems in your field of knowledge?
7 What problem do you deal with?
8 How many years have you been working on this problem?
9 Have you got acquainted with the literature available?
10 How is this problem being tackled in the Soviet Union and abroad?
11 What famous scientists are engaged in this problem?
12 What is it that causes scientists to have such a great interest in this problem?
13 How do you approach the problem you work on?
14 What methods do you use in your work?
15 What is the essence of your method?
16 What theory is your research based on?
17 Is your work of theoretical or practical importance?
18 Have you already collected and arranged the necessary data?
19 Do you collaborate with anybody in your work or have you a particular topic?
20 Do you consult anybody on the problem you are interested in?
21 Who is your scientific supervisor?
22 What is his contribution to science?
23 Do you carry out any experiments?
24 What instruments do you use?
25 What measurements do you make?
26 What substances do you employ?
27 What progress have you made in your work?
28 When will you finish your work on the problem?
29 Have you obtained any promising results?
30 Are there any practical results to come out of your efforts?
31 What is the importance of your work for our notional economy?
32 What difficulties do you face in your work?
33 What conclusions have you come to in your research?
34 Are any seminars held at your lab?
35 Do you attend them?
36 How often are the seminars held?

37 What is the aim of the seminars?
38 What problems do you discuss at the seminars?
39 What questions attract your attention?
40 Have you got any scientific publication?
41 What are the subjects of your papers?
42 Have you ever participated in the work of scientific conferences, symposia?

3. Speak on your research work, using the given plan:

1 Area of science you are concerned with.
2 Subject of your research.
3 Topicality of the problem you deal with.
4 Experimental data.
5 Theories and concepts used.
6 Methods of research.
7 Material treatment.
8 Research equipment.
9 Cooperation with other researchers.
10 Research supervision.
11 Results evaluation.
12 Presentation of research results.

ENGINEERING

Let me introduce myself. My name is *Alex Mironov*. Last year I graduated from Gomel State Technical University named after Pavel Sukhoi. My major is Engineering. I specialized in industrial electronics. My university academic program included a great number of humanities, exact sciences and special courses.

Being a student I was really interested in doing research. That is why I made reports at the annual students' scientific conferences and was engaged in gathering and analyzing experimental data for my future research work.

After the graduation I chose an academic career. I think that to contribute to the improvement of training engineers is a very challenging and responsible job.

Now I am a post-graduate student and undertake a program of study and research under the supervision of a staff member who holds a senior doctorate. S/he assists me in many ways. I meet my scientific adviser at regular intervals to discuss the progress of my work. I often consult him / *her* when I encounter difficulties in my research. The theme of my research selected with my supervisor's help is very promising and may produce significant results in the appointed period of time.

I am at the very beginning of my investigation. I have been working at the chosen problem for two years. The main stages of my investigation are: problem formulation, collecting, assessment and analyzing data and relevant information. The techniques I use in my research are as follows: comparison, analysis, synthesis, analogy and simulation. My higher degree thesis should demonstrate that the research has been conducted with a high level of technical skill and that I have employed the most suitable procedures and techniques. Being rather an experimentator than a theoretician I make use of various measuring and registering devices. The facilities I need for doing my research include PC with a data base analyzing system.

I regularly prepare research publications on matters relevant to my investigation and written reports on the work carried out. I also take part in various scientific conferences and do my best to submit the major sections of my thesis in time. I hope the thesis will meet necessary requirements and will be accepted by the Academic Council which will take the decision to award me the highest degree.

APPENDIX II

PART I

Texts for translation using dictionaries.

THE NATURE OF THE ATOM

All the prime movers, natural and man-made, which, humanity has harnessed to ease its burden of labour and raise its standard of living are, in fact, attempts at utilizing the energy of the sun: it sustains organic life on earth with its light and heat, it makes the water circulate between the heavens and the sea, it creates the wind, and it has filled for us a vast storehouse of coal and oil, the mineral deposits from old ages of vegetation. What our inventors did when they built power-producing engines was to change one form of energy–such as the heat of burning coal – into another, the mechanical energy of rotating wheels or the light of an electric lamp. They could not create energy from nothing; they could only release it by some chemical process. This means that although the molecules, or combinations of atoms, may break up and form new combinations, the atoms themselves remain intact and unchanged.

There is one source of energy, however, which owes nothing to the heat and light of the sun; nor can it be harnessed by a chemical process. It is the energy of the atomic nucleus.

The term 'atom', coined by the Greek philosopher Democritus about 2,500 years ago, is rather misleading. It means 'the indivisible', and it is a relic from the times when people believed that all matter consisted of very small particles which were unchangeable and indivisible, and that each element had its own special kind of particles. Only the medieval alchemists hoped that they could, by some magic, change the particles of one element into those of another – lead, for instance, into gold.

Today we know that atoms are neither unchangeable nor indivisable. The story of research into the nature of the atom has been told many times. It may be sufficient to recall that Marie and Pierre Curie, by their discovery of radium, in 1898, made the whole theory of the indivisible atom crumble, because here was an element which disintegrated and sent out rays, consisting of particles much smaller than the atom.

Another discovery, made three years earlier, seemed to point in the same direction: that of the X-rays by Professor Wilhelm Konrad Rontgen at the University of Bavaria. Using a cathode-ray tube, he found that the radiation emanating from it was able to penetrate thin matter like wood and human flesh, but was stopped by thicker objects such as pieces of metal and bones. It was only later that the nature of these mysterious rays was discovered: particles of negative electricity, called electrons, turn into electro-magnetic waves, of the same kind as light but of shorter wave-length and therefore invisible, when they strike a material object such as a metal shield in the cathode-ray tube.

These and other phenomena and discoveries around the turn of the century were deeply disturbing for the physicists, and they saw that the whole traditional concept of the structure of matter had to be completely revised More than that: the borderline between matter and energy seemed to disappear. When, as early as 1905, Albert Einstein published his Special Theory of Relativity, in which he declared that matter could be converted into energy– very little matter into very great energy – there was a storm of protest in the scientific world. But little by little the evidence that he was right accumulated, and within a few years an entirely new picture of the atom emerged from the studies and laboratories of scientists in many countries.

From that evidence Lord Rutherford, the New Zealand-born scientist, and his young Danish assistant, Niels Bohr, developed by 1911 their revolutionary theory of what the atom was really like. That picture of the atom has since been elaborated and filled in with more details. It is not yet complete; but its essential features are known to be correct – otherwise there would be no atomic bombs, which few people would regret, or nuclear power stations.

Broadly speaking, the atom is a miniature solar system, with a 'sun', the nucleus, and a number of 'planets', the electrons, revolving around it. All the matter of the atom is concentrated in the nucleus: there are protons, particles with a positive electric charge, neutrons, particles without a charge, and some other particles whose role and nature is still being investigated. The electrons, which have next to no mass and weight, are negatively charged; in fact, they are the carriers of electricity in all our electric wires and appliances. Normally there are as many positive protons in the nucleus as there are electrons revolving around it, so that their charges cancel each other out and the atom as a whole is electrically neutral. But if for some reason an atom loses a proton or an electron or two, its electrical balance is disturbed, it becomes negatively or positively charged and is called an ion.

The atoms of all the elements contain the same kind of particles; what distinguishes them from each other is merely the number of particles – of protons in the nucleus and of electrons revolving around it. Hydrogen, for instance, being the lightest and simplest element, has only one of each; uranium, the heaviest element occurring in Nature, has 92. So all you have to do to change one element into another is either to knock some protons and a corresponding number of electrons off each atom, or add them; in fact, this process is going on in Nature all the time. Theoretically, we could change lead into gold, as the alchemists dreamed of doing, by removing three protons and electrons from a few billion lead atoms, which have 82 of each, then we would get gold atoms with 79 protons and electron each. However, the knocking-off process would be much more expensive than the gold we would get.

The neutrons, which are present in the atoms of many elements, are of particular importance in the utilization of atomic energy. Most elements are mixtures of ordinary atoms and so-called isotopes: the isotope atoms have more, or fewer, neutrons than the ordinary atoms. An isotope differs from the ordinary form of the element only in weight, but chemically it behaves in exactly the same way. Water, for instance, is a mixture of ordinary molecules of hydrogen and oxygen atoms and of 'heavy' ones. The heavy hydrogen atom has an extra neutron in its nucleus. Uranium, on the other hand, has an jsotope whose nucleus contains fewer neutrons than the ordinary element. This isotope – atomic weight: 235; atomic weight of ordinary uranium: 238 – has a very special significance in nuclear physics because it is, like many other heavy-element isotopes, 'unstable'. What does this mean? Nothing else but the phenomenon which the Curies discovered in radium. An unstable nucleus is one that is likely to break up into the nucleus of another element. Professor Otto Hahn found in Berlin in 1938 that when uranium atoms are bombarded with neutrons they split up in a process which he called 'fission' (a term used in biology for the way in which some cells divide to form new ones). The 92 protons of the uranium nucleus split up into barium, which has 56, and krypton, a gas with 26 protons. Frederic Joliot-Curie, the son-in-law of Marie Curie, proved some months later that in this fission process some neutrons from the uranium nucleus were liberated; they flew off, and some struck other nuclei, which in turn broke up, liberating still more neutrons. Enrico Fermi, an Italian who had gone to America to escape life under fascism, developed the theory of what would happen if a sufficiently large piece of unstable uranium broke up in this way – there would be a 'chain reaction': the free neutrons would be bombarding the nuclei with such intensity that in no time at all the whole lump of uranium would disintegrate. But it would nut just turn quietly into barium and krypton as in Berlin laboratory experiment. There were now two smaller nuclei, no longer held together as before but pushed apart by electric repulsion, and flying off at great speed, with neutrons shooting about in all directions. And such sudden display of energy–for movement is energy – would, according to Einstein's famous Mass-Energy equation, correspond to some loss of mass. If the two parts of a nucleus which has undergone fission could be put together again, their combined mass would be smaller than that of the original nucleus.

What has become of the missing bits? They have turned into pure energy – into movement, into heat. This was the theory that led, within the short space of four years, to the first atom bombs. On Monday, 6 August 1945, while cheerful crowds in England enjoyed their first holiday after the end of the war in Europe, one such bomb was dropped on the town of Hiroshima in Japan. It killed or injured nearly 200,000 people. Three days later another bomb was dropped on Nagasaki, with 65,000 victims. The centres of both cities were completely destroyed.

EARLY DAYS OF ELECTRICITY

There is electricity everywhere in the world. It is present in the atom, whose particles are held together by its forces; it reaches us from the most distant parts of the universe in the form of electro-magnetic waves. Yet we have no organs that could recognize it as we see light or hear sound. We have to make it visible, tangible, or audible, we have to make it perform work to become aware of its presence. There is only one natural phenomenon which demonstrates it unmistakably to our senses of seeing and hearing – thunder and lightning; but we recognize only the effects – not the force which causes them. Small wonder, then, that Man lived for ages on this earth without knowing anything about electricity. He tried to explain the phenomenon of the thunderstorm to himself by imagining that some gods or other supernatural creatures were giving vent to their heavenly anger, or were fighting battles in the sky. Thunderstorms frightened our primitive ancestors; they should have been grateful to them instead because lightning gave them their first fires, and thus opened to them the road to civilization. It is a fascinating question how differently life on earth would have developed if we had an organ for electricity. We cannot blame the ancient Greeks for failing to recognize that the force which causes a thunderstorm is the same which they observed when rubbing a piece of amber: it attracted straw, feathers, and other light materials. Thales of Miletos, the Greek philosopher who lived about 600 B. C, was the first who noticed this. The Greek word for amber is elektron, and therefore Thales called that mysterious force 'electric'. For a long time it was thought to be of the same nature as the magnetic power of the lodestone since the effect of attraction seems similar, and in fact there are many links between electricity and magnetism. There is just a chance, although a somewhat remote one, that the ancient Jews knew something of the secret of electricity. Perhaps the Israelites did know something about electricity; this theory is supported by the fact that the Temple at Jerusalem had metal rods on the roof which must have acted as lightning-conductors. In fact, during the thousand years of its existence it was never struck by lightning although thunderstorms abound in Palestine. There is no other evidence that electricity was put to any use at all in antiquity, except that the Greek women decorated their spinning-wheels with pieces of amber: as the woollen threads rubbed against the amber it first attracted and then repelled them – a pretty little spectacle which relieved the boredom of spinning. More than two thousand years passed after Thales's discovery without any research work being done in this field. It was Dr. William Gilbert, Queen Elizabeth the First's physician-in-ordinary, who set the ball rolling. He experimented with amber and lodestone and found the essential difference between electric and magnetic attraction. For substances which behaved like amber – such as glass, sulphur, sealingwax – he coined the term 'electrica', and for the phenomenon as such the word 'electricity'. In his famous work De magnete, published in 1600, he gave an account of his studies. Although some sources credit him with the invention of the first electric machine, this was a later achievement by Otto von Gue-ricke, inventor of the air pump. Von Guericke's electric machine consisted of a large disc spinning between brushes; this made sparks leap across a gap between two metal balls. It became a favourite toy in polite society but nothing more than that. In 1700, an Englishman by the name of Francis Hawksbee produced the first electric light: he exhausted a glass bulb by means of a vacuum pump and rotated it at high speed while rubbing it with his hand until it emitted a faint glow of light. A major advance was the invention of the first electrical condenser, now called the Leyden jar, by a Dutch scientist, a water-filled glass bottle coated inside and out with metallic surfaces, separated by the non-conducting glass; a metal rod with a knob at the top reached down into the water. When charged by an electric machine it stored enough electricity to give anyone who touched the knob a powerful shock. More and more scientists took up electric research. A Russian scientist Professor Richmann from St. Petersburg, was killed when he worked on the same problem. Benjamin Franklin, born in Boston, was the fifteenth child of a poor soap-boiler from England. He was well over 30 when he took up the study of natural phenomena. 'We had for some time been of opinion, that the electrical fire was not created by friction, but collected, being really an element diffused among, and attracted by other matter, particularly by water and metals,' wrote Franklin in 1747. Here was at last a plausible theory of the nature of electricity, namely, that it was some kind of 'fluid'. It dawned on him that thunderstorms were merely a discharge of electricity between two objects with different electrical potentials, such as the clouds and the earth. He saw that the discharging spark, the lightning, tended to strike high buildings and trees, which gave him the idea of trying to attract the electrical 'fluid' deliberately to the earth in a way that the discharge would do no harm. In order to work this idea out he undertook his famous kite-and-key experiment1 in the summer of 1752. It was much more dangerous than he realized. During the approach of a thunderstorm he sent up a silken kite with an iron tip; he rubbed the end of the kite string, which he had soaked in water to make it a good conductor of electricity, with a large iron key until sparks sprang from the string – which proved his theory. Had the lightning struck his kite he, and his small son whom he had taken along, might have lost their lives. In the next experiment he fixed an iron bar to the outer wall of his house, and through it charged a Leyden jar with atmospheric electricity. Soon after this he was appointed Postmaster General of Britain's American colonies, and had to interrupt his research work. Taking it up again in 1760, he put up the first effective lightning conductor on the house of a Philadelphia business man. His theory was that during a thunderstorm a continual radiation of electricity from the earth through the metal of the lightning-conductor would take place, thus equalizing the different potentials of the air and the earth so that the violent discharge of the lightning would be avoided. The modern theory, however, is that the lightningconductor simply offers to the electric tension a path of low resistance for quiet neutralization. At any rate – even if Franklin's theory was wrong – his invention worked. Yet its general introduction in America and Europe was delayed by all kinds of superstitions and objections: if God wanted to punish someone by making the lightning-strike his house, how could Man dare to interfere? By 1782, however, all the public buildings in Philadelphia, first capital of the USA, had been equipped with Franklin's lightning-conductors, except the French Embassy. In that year this house was struck by lightning and an official killed. Franklin had won the day. It was he who introduced the idea of 'positive' and 'negative' electricity, based on the attraction and repulsion of electrified objects. A French physicist, Charles Augustin de Coulomb, studied these forces between charged objects, which are proportional to the charge and the distance between the objects; he invented the torsion balance for measuring the force of electric and magnetic attraction. In his honour, the practical unit of quantity of electricity was named after him. To scientists and laymen alike, however, this phenomenon of 'action at a distance' caused by electric and magnetic forces was still rather mysterious. What was it really? In 1780, one of the greatest scientific fallacies of all times seemed to provide the answer. Aloisio Galvani, professor of medicine at Bologna, was lecturing to his students at his home while his wife was skinning frogs, the professor's favourite dish, for dinner with his scalpel in the adjoining kitchen. As she listened to the lecture the scalpel fell from her hand on to the frog's thigh, touching the zinc plate at the same time. The dead frog jerked violently as though trying to jump off the plate. The signora screamed. The professor, very indignant about this interruption of his lecture, strode into the kitchen. His wife told him what had happened, and again let the scalpel drop on the frog. Again it twitched. No doubt the professor was as much perplexed by this occurrence as his wife. But there were his students, anxious to know what it was all about. Galvani could not admit that he was unable to explain the jerking frog. So, probably on the spur of the moment1 he explained: 'I have made a great discovery – animal electricity, the primary source of life!' 'An intelligent woman had made an interesting observation, but the not-sointelligent husband drew the wrong conclusions', was the judgement of a scientific author a few years later. Galvani made numerous and unsystematic experiments with frogs' thighs, most of which failed to prove anything at all; in fact, the professor did not know what to look for except his 'animal electricity'. These experiments became all the rage in Italian society, and everybody talked about 'galvanic electricity' and 'galvanic currents' – terms which are still in use although Professor Galvani certainly did not deserve the honour.

A greater scientist than he, Alessandro Volta of Pavia, solved the mystery and found the right explanation for the jerking frogs. Far from being the 'primary source of life', they played the very modest part of electric conductors while the steel of the scalpel and the zinc of the plate were, in fact, the important things. Volta showed that an electric current begins to flow when two different metals are separated by moisture (the frog had been soaked in salt water), and the frog's muscles had merely demonstrated the presence of the current by contracting under its influence. Professor Volta went one step further – a most important step, because he invented the first electrical battery, the 'Voltaic pile'. He built it by using discs of different metals separated by layers of felt which he soaked in acid. A 'pile' of these elements produced usable electric current, and for many decades this remained the only practical source of electricity. From 1800, when Volta announced his invention, electrical research became widespread among the world's scientists in innumerable laboratories.

TERMS AND DEFINITIONS

In the following paragraphs the terms commonly used to distinguish between the various properties, or ways measuring the properties of alternating current are described.

Cycle and Period. The complete series of changes consisting of the growth and decay of the voltage or current in one direction, together with its growth and decay in the reverse direction, is called one cycle. A voltage or current that is reproduced at equal intervals is said to be periodic, and the minimum time interval elapsing before the same instantaneous value recurs is called the periodic time or the period.

Frequency. The number of complete cycles per second through which a voltage or current passes is called the frequency. It is always expressed in cycles per second, the reciprocal of this number being the periodic time. Frequencies are now standardized for power purposes in the principal countries of the world, the standard for Great Britain being 50 cycles per second, while the U.S.A. has adopted 60 cycles per second.

Wave Form. The shape of the graph of the voltage or current, when plotted against time as a base, is called the wave form or wave shape. The ideal aimed at is that of the sine wave, i.e. the graph has the same shape as the graph of a sine function in mathematics. The sine goes through 360° in a complete cycle, and so the time scale on the wave form of a voltage or current is usually represented in degrees, 360° being considered the equivalent of the time corresponding to 1 cycle, or the periodic time. Since these degrees may not always coincide with the geometrical degrees through which the rotating member of a machine has been rotated, they are called electrical degrees, in order to distinguish them from geometrical degrees. One cycle is thus regarded as the equivalent of 360°, and 180° is considered as a halfcycle, i.e. the duration of the voltage or current in one direction only.

Phase and Phase Difference. During the interval of time necessary for a current to pass through one complete cycle, it passes through many phases. In fact it has a different phase for each different interval of time. Consider the analogous case of the phases of the moon. Starting from the time of new moon the, moon passes through its various phases, measured by its age from the time of the new moon, up to full moon, and then onwards through the various stages of the waning moon. Similarly an alternating current goes through various phases, starting from zero, rising up to maximum, and dying down again to zero. In the A.C. case, however, this comprises only half a cycle, for the whole series of values are then repeated in the opposite (negative) direction. Other electrical quantities, such as voltage, power, etc., in addition to current go through various phases from 0° to 360°; indeed all quantities which vary in a periodic manner do so. When two voltages or two currents are considered together, however, or when a voltage and current are considered simultaneously, the frequency being the same, they may not pass through the same phase at the same instant of time. For example, two currents may be such that, although their frequency may be the same, their phase at a particular instant of time may be different. One may pass through its maximum value at the instant when the other has a zero value, or some other value not its maximum value; the two currents, etc., are then said to have a phase difference, this being quoted in degrees. One current has its maximum value at the same time that the other is zero, the two currents are said to be in quadrature; they have a phase difference of 90°. Phase difference, because it is constant in a circuit where steady conditions obtain, is much more important in a.c. work than the actual phase which varies from instant to instant. The phase difference is measured by the distance between the points where the two graphs cross the base line in the same direction. This distance is measured in electrical degrees, the scale being obtained by considering the distance corresponding to one complete cycle as 360°. The current that is ahead in phase is said to lead the other current, while this current is said to lag behind the first current. Similarly, when considering two voltages, one is said to lead and the other to lag. Again, a voltage may lead the current that it produces, the current lagging behind the voltage.

Maximum and Average Values. An alternating current varies in strength from instant to instant, and reaches a maximum value twice in every cycle, once in each direction. This maximum value is called the crest value. The average value, taken throughout a complete cycle, is equal to zero, since there is as much current flowing in one direction as there is flowing, in the other direction. Considering a half-cycle, however, the average value has a definite positive value. This can be evaluated by measuring the lengths of a number of equidistant ordinates and taking their average value. In the case of a sine wave, this average value is found to be equal to π 2 or 0.687 times the maximum value but is not, however, the value read on an ordinary ammeter, nor is it the value commonly used to denominate the value of an A.C.

ENERGY LEVELS AND ACCEPTORS

A way of introducing donors and acceptors into semiconductors arises from nonstoichiometry in compounds. Several possible ways this might happen can be foreseen. The nonstoichiometry can arise either by virtue of vacant lattice sites for one component of the compound, or because of an excess of one component located in interstitial sites. Anion or cation excesses or deficiencies might be involved, and we might be concerned with either donors or acceptors. To illustrate how nonstoichiometry leads to such effects, we consider only a single example here. A donor center can result from the trapping of one or more electrons in an anion vacancy. The classic examples of centers of this type are the Frmters in alkali halides, although these materials are not usually considered semiconductors. The same kind of center is believed to result from nonstoichiometry in CdS. A crystal of CdS. We may show a crystal of CdS, in which a few anion lattice sites are vacant, corresponding to a stoichiometric excess of cadmium. In order to maintain charge neutrality in the crystal, two electrons must be supplied for every ion removed. In the vicinity of the vacancy, there is a net positive charge, and there will be, a strong tendency for the extra electrons to be held to this centre, and this combination, the electrons trapped in the anion vacancy, is the donor centre. If, by some means, any of these trapped electrons can be released, they enter the conduction band of the crystal and increase the electrical conductivity. In the case of arsenic in germanium, it is apparent that the fifth electron lies in a higher energy state than the normal valence electrons, so that the localized extra level associated with the arsenic lies above the top of the filled band. At the same time, since there is some binding energy for an electron in this state to remain on the arsenic, the level lies below the lowest "free" electron state in the conduction band. The extra state must therefore lie in the forbidden y gap, as shown in Fig. The energy required to remove this electron may be estimated by noting the similarity to the removal of an electron from a hydrogen atom. The coulombic attraction between the arsenic and the electron, as compared with the hydrogen atom, is reduced by the dielectric constant of the medium, since the electron orbit in the solid encompasses several atomic distances. The reduction in ionization energy depends on the square of the dielectric constant, which is 15.8 for germanium. The ionization energy for the free hydrogen atom is 13.6 eV, so one expects the ionization energy for arsenic in germanium to be reduced by a factor $(15.8)^2$, thus $13.6/(15.8)^2 = 0.05$ eV. A further reduction is expected because the effective mass for electrons should be used, rather than the actual electronic mass, in computing the energy. This reduction leads to good agreement with the experimental values, which lie near 0.01 eV. This, then, is the energy difference between the bottom of the conduction band and the localized energy level at an arsenic. Similar considerations show that an acceptor like boron provides levels just above-the top of the filled band, as shown in Fig. Centers like these: are often called "hydrogen-like". At room temperature, the thermal excitation energy of the electrons is sufficient to ionize almost completely arsenic centers in germanium, so there is an increased concentration of electrons in the conduction band nearly equal to the arsenic concentration, and these give rise to an increase in the electrical conductivity. Such behavior is called "extrinsic", as it depends on the concentration of imperfections in the lattice. The case of boron in germanium provides an example of an extrinsic semiconductor where an excess of holes has been introduced. At room temperature the boron levels are nearly all ionized, that is to say, the holes have been removed from them and have entered the valence band, leaving an electron trapped on each acceptor center. Not all donors and acceptors in germanium have as small ionization energies as do boron and arsenic, and larger ionization energies are encountered in other materials also. When both acceptors and donors are present in material – and for practical reasons this will almost always occur to some degree – there is a "compensation" effect. The difference between donor and acceptor concentration will determine the carrier concentration.

Thus, with five arsenic and two boron atoms present, the boron levels are filled by two of the available electrons from the arsenic and only three conduction electrons are supplied.

THE DISCOVERY OF ELECTRO-MAGNETIC INDUCTION

It is at this important juncture in the history of electrical research that we see the first, shy attempts to make this force of Nature do some work. Now we are concerned with the development of electricity for the transmission of energy. One day in 1819 a Danish physicist, Hans Christian Oersted, was lecturing at the University of Kiel, which was then a Danish town. Demonstrating a galvanic battery, he held up a wire leading from it when it suddenly slipped out of his hand and fell on the table across a marine's compass that happened to be there. As he picked up the wire again he noticed to his astonishment that the needle of the compass no longer pointed north, but had swung completely out of position. He switched the current off, and the needle pointed north again. For a few months he thought over this incident, and eventually wrote a short report on it. No one could have been more surprised than Oersted at the extraordinary impact which his discovery made on physicists all over Europe and America. At last the longsought connection between electricity and magnetism had been found! Yet neither Oersted nor his colleagues could forsee the importance of this phenomenon, for it is the connection between electricity and magnetism on which the entire practical use of electricity in our time is founded.

What was it that Oersted had discovered? Nothing more than that an electrically charged conductor, such as the wire leading from a battery, is the centre of a magnetic 'field', and this has the effect of turning a magnetic needle at a right angle with the direction in which the current is flowing; not quite at a right angle, though, because the magnetism of the earth also influences the needle.

Now the physicists had a reliable means of measuring the strength of a weak electric current flowing through a conductor; the galvanoscope, or galvanometer, is such a simple instrument consisting of a few wire loops and a magnetic needle whose deflection indicates the strength of the current. Prompted by the research work of Andre-Marie Ampere, the great French physicist whose name has become a household word as the unit of the electric current, the Englishman Sturgeon experimented with ordinary, non-magnetized iron. He found that any piece of soft iron could be turned into a temporary magnet by putting it in the centre of a coil of insulated wire and making an electric current flow through the coil.

As soon and as long as the current was turned on the iron was magnetic, but it ceased to be a magnet when there was no more current. Sturgeon built the first large electro-magnet, and. with this achievement there began the development of the electrical telegraph and later the telephone. But there was yet another, and perhaps even more important, development which began with the electro-magnet.

Michael Faraday repeated the experiments of Oersted, Sturgeon, and Ampere. His brilliant mind conceived this idea: if electricity could produce magnetism, perhaps magnetism could produce electricity! But how? For a long time he searched in vain for an answer. Every time he went for a walk in one of London's parks he carried a little coil and a piece of iron in his pocket, taking them out now and then1 to look at them. It was on such a walk that he found the solution. Suddenly, one day in 1830, in the midst of Green Park (so the story goes), he knew it: the way to produce electricity by magnetism was – by motion. He hurried to his laboratory and put his theory to the test. It was correct.

A stationary magnet does not produce electricity. But when a magnet is pushed into a wire coil current begins to flow in the coil; when the magnet is pulled out again, the current flows in the opposite direction. This phenomenon, confirms the basic fact that the electric current cannot be produced out of nothing–some work must be done to produce it. Electricity is only a form of energy; it is not a 'prime mover' in itself. What Faraday had discovered was the technique of electro-magnetic induction, on which the whole edifice of electrical engineering rests. He soon found that there were various ways of transforming motion into electric current. Instead of moving the magnet in and out of the wire coil you can move the coil towards and away from the magnet; or you can generate electricity by changing the strength of stationary magnet; or you can produce a current in one of two coils by moving them towards and away from each other while a current is flowing in the second.

Faraday then substituted a magnet for the second coil and observed the same effect. Using two coils wound on separate sections of a closed iron ring, with one coil connected to a galvanometer and the other to a battery, he noticed that when the circuit of the second coil was closed the galvanometer needle pointed first in one direction and then returned to its zero position. When he interrupted the battery circuit, the galvanometer jerked into the opposite direction. Eventually, he made a 12inch-wide copper disc which he rotated between the poles of a strong horse-shoe magnet; the electric current which was generated in the copper disc could be obtained from springs or wire brushes touching the edge and axis of the disc. Thus Faraday demonstrated quite a number of ways in which motion could be translated into electricity. His fellow-scientists at the Royal Institution and in other countries were amazed and impressed – yet neither he nor they proceeded to make practical use of his discoveries, and nearly forty years went by before the first electric generator, or dynamo, was built. Meanwhile, fundamental research into the manifold problems of electricity continued.

In America, Joseph Henry, professor of mathematics and natural science, also starting from Oersted's and Sturgeon's observations, used the action of the electric current upon a magnet to build the first primitive electric motor in 1829. At about the same time, Georg Simon Ohm, a German school-teacher found the important law of electric resistance: that the amount of current in a wire circuit decreases with the length of the wire, which acts as resistance. Ohm's excellent research work remained almost unnoticed during his lifetime, and he died before his name was accepted as that of the unit of electrical resistance.

VOLTAGE TRANSFORMERS

Why Voltage Transformers are Used.

When an instrument or meter having a voltage winding is connected to a high-voltage alternating-current circuit, the use of a voltage transformer (sometimes called a potential transformer) is necessary. It is not practicable to wind the voltage coil of a meter for direct connection to, say, an 11,000-volt supply, because the space available on the voltage electromagnet is not sufficient to accommodate the number of turns of wire which would be necessary. Moreover it would be quite impossible to insulate adequately the winding and the terminals in such a manner as to render the meter safe to handle when the circuit to which it was connected was alive. Accordingly, a voltage transformer is always used when a meter is installed for use on a high-voltage system. In this connection potentials in excess of 660 volts are regarded as high voltage. A voltage transformer may be defined as an instrument transformer for the transformation of voltage from one value to another, usually a lower one. The primary winding of a voltage transformer is the winding to which is applied the voltage to be measured or controlled, as the case may be. The secondary winding is the winding the terminals of which are connected to the meter or instrument. The standard voltage at the terminals of the secondary winding is 110 volts.

Construction of Voltage Transformers.Voltage transformers are frequently fitted in switchgear cubicles, and owing to the restricted space available the dimensions of the transformer must be kept down to a minimum. Clearances between conductors or other live parts, which in power transformer design are regarded as minimum values, cannot always be provided in voltage transformers, and as reliability is the first consideration it is only by skilful design and care in manufacture that safety can be assured. A voltage transformer comprises a magnetic circuit, usually built, up with iron strips assembled together to form a core on which the primary and secondary windings are mounted. The primary winding which is connected to the high-voltage supply consists of a large number of turns of a fine-gauge wire and is usually divided into a number of separate sections. The object of dividing the primary in this manner is to limit the voltage across each section to a comparatively low value. In practice, the voltage per section does not usually exceed 1,000 volts, and frequently is much less than this figure. Each section consists of layers of wire, 3/8 in. to 3/4 in. wide, with a strip of paper or other insulating material to separate the layers. For mechanical reasons and in order to minimize the risk of breakage and open circuits, wire smaller than 36 W. G. (0.0076 in. dia.), is seldom used in the primary winding. In voltage transformers for operation at 6,600 volts or less, it is common practice for the sections of the primary to be assembled on a tube of insulating material adjacent to the core, a second tube surrounding the sections and carrying the secondary winding. This disposition of the windings is advantageous in the case of open-type transformers since the high-voltage winding is shielded from mechanical damage by the two tubes and only the more robust low-voltage winding is exposed. For voltages in excess of 6,600 volts this arrangement is undesirable, partly because the joints between sections which are increasing in number are inaccessible, and partly because of the increasing cost of the two tubes, both of which must be capable of withstanding the full working voltage continuously. The alternative disposition in which the secondary winding is adjacent to the core and is surrounded by the primary, is more usual, a heavy tube separating the windings. Only a light tube separates the secondary from the core and no mechanical protection is provided over the high-voltage windings. This, however, is unnecessary since transformers for the higher voltages are protected by a tank or other enclosure containing oil or some other insulating medium. Voltage transformers are made up in single units for connection to single-phase, twophase or three-phase systems. The magnetic circuit of a single-phase voltage transformer may be of the core type or the shell type, somewhat similar in shape to the cores of current transformers. The windings are usually disposed on both limbs of the core-type carcase and on the middle limb of the shell-type. The shell-type construction is seldom employed where the system voltage exceeds 3,300 volts. Twophase voltage transformers are required occasionally and if made up as single units, a three-limbed core is used, similar in shape to the shell-type current transformer core. The windings are disposed on the two outer limbs and as the middle limb carries the common flux for both phases It is of greater sectional area than the outer limbs. The more usual practice however is to use two separate single-phase transformers on a two-phase system. Three-phase voltage transformers are built up on three-limbed cores, all the limbs being of equal cross-sectional area. Each limb carries the primary and secondary windings for one phase of the supply, and when used for connection to a meter, the connections are usually arranged star. When a transformer is switched on to a live line, the voltage between the turns of the high-voltage winding adjacent to the line terminal may be raised momentarily to a value many times the normal. A similar condition may arise as a result of switching operations elsewhere on the system and in an extreme case the voltage between successive end turns may reach a very high value; such a condition persists only for a minute fraction of a second but it imposes an additional stress on the inter-turn insulation which in the absence of precautionary measures may result in failure. The stress on the insulation is greatest between the first and second turns counting from the end of the high-voltage winding and diminishes turn by turn until, at some distance from the end, the abnormal stress disappears entirely. In power transformer practice it is customary to reinforce the insulation between the end turns of the high-voltage winding and about ten per cent of the winding may be dealt with in this manner.

This reinforcement is graded and is heaviest on the first few turns, but progressively less and less is added until finally reinforcement ceases, in a voltage transformer of comparable voltage, the number of turns in the highvoltage winding is very much greater than in a power transformer and reinforcement of the insulation on ten per cent of the turns would be impracticable. It is customary, however, to reinforce the insulation of the whole of the turns in the first section of the winding. As an additional precaution, a reactance coil consisting of a few turns of heavily-insulated wire is sometimes connected between the high-voltage terminal and the end of the high-voltage winding. This reactance acts like a cushion between the line and the high-voltage winding and reduces the severity of the transient stresses without adding appreciably to the dimensions of the transformer or impairing its accuracy.

POWERHOUSE AUXILIARY MOTORS

A complete description of the many and varied motor applications found in a modern steam station is almost a description of the station itself. Every phase of power generation requires some closely associated auxiliary equipment, which, in a modern power plant, is driven almost exclusively by electric motors.

Indicative of the large number of motor applications in a steam station, a recent power plant comprising two 75,000-kw turbines required over 700 auxiliary motors. In a typical plant the auxiliaries consume approximately 6 percent of the total power output and have a total horsepower rating of from 12 to 15 percent of the kilowatt rating of the main turbine generators. No two generating stations are identical. It is impossible to state exactly the motor sizes and types that will be present in a steam generating station of a particular size. The requirements are governed by such factors as type of fuel, heat cycle, source of water, and anticipated station loading cycle. Approximate sizes of the major auxiliary motors are given later as percentages of the nominal rating of the turbine-generator unit. The figures are average values based on a survey of steam stations with turbine-generator units of 100 megawatts and below. Characteristics of Powerhouse Auxiliary Motors.– The primary characteristics to be considered in selecting auxiliary motors are size, speed, motor type, torque requirements, operating conditions, class of insulation, and type of enclosure. In addition, motors for central-station service must have special features that insure reliability and ease of operation, features such as special moisture-resistant insulation, adequate provision for oil-ring inspection on motors with sleeve bearings, easy accessibility of the bearings and windings for servicing and inspection, and adequate terminal boxes. The reliability, efficiency, and simplicity of installation and control of the squirrel-cage induction motor have made it the almost universal choice for powerhouse applications.

Powerhouse auxiliary motors range in size from less than one horsepower, used to open and close valves, to several thousand horsepower, used to pump water into the boiler. They usually have drip-proof enclosures with class A insulation, and are designed to have low starting current and normal starting torque. However, some auxiliaries require special torque or speed characteristics, or present unusual service conditions such as excessive dirt, moisture, abrasive flyash, or high temperature; or the plant may be an outdoor installation. Motors for such applications must have special characteristics to satisfy these requirements.

Pump Motors. Pumping is one of the major duties performed by powerhouse auxiliary equipment, and usually the largest motors in the station are those that drive the boiler-feed pumps. In a typical station the total horsepower rating of the boilerfeed-pump motors is between five and six percent of the kilowatt rating of the associated turbine. At least two and usually three boiler-feed pumps of equal rating are used. These pumps operate against a very high head of water and require 3,600rpm driving motors. The output of the boiler-feed pumps is controlled by throttling or by varying the speed of the pump. The latter method is attractive because of reduced operating cost. Variable-speed control, when used, is achieved with a variable-speed coupling or by using a wound-rotor motor and a liquid rheostat.

The torque requirements of boiler-feed pumps and most other pumps are satisfied by motors with low starting current and normal starting torque. Most boilerfeed-pump motors are rated for a temperature rise of 40 degrees C above ambient and have class A insulation. Where the ambient temperature is above 40 degrees, class B insulation is used. Although drip-proof construction is usual, special enclosures are sometimes used to reduce the noise level of the motor or to protect the motor from flyash and other unfavorable atmospheric conditions. Noise can be reduced by using pipe- or base-ventilated motors in which the inlet and exhaust for cooling air are at a remote location. In particularly dirty locations enclosed motors are used. Air for such motors is cooled by either an air-to-air or an air-to-water heat exchanger. Since outside air is never drawn into the motor, the windings are protected from contamination. In addition to boiler-feed pumps, numerous other pumps are associated directly with the water cycle of the plant or perform auxiliary functions. These include pumps for handling circulating water, condensate, drain water, raw water, water-purification chemicals, ash, flood water, water for fire protection, sump water, lubricating oil, and station water supply. Usually the largest of these are the circulating-water pumps. In a typical station, there are two circulating-water pumps per turbine with a total horsepower slightly less than one percent of the turbine rating. The remaining pumps range in size from a fraction of a horsepower for small chemical-feed pumps to 100 to 300 horsepower for some raw-water, ash, and fire pumps. The size of the driving motor in a particular application is determined by the head and capacity requirements, which are influenced by the nature of the water source. The location, and the speed and torque requirements of these pumps usually allow the use of standard drip-proof, squirrel-cage induction motors with low starting current and normal starting torque. Most pump motors have a synchronous speed of 1,200, 1,800 or 3,600 rpm; however, some motors, such as the circulating-water pumps, may require speeds as low as 277 rpm. Vertical motors are frequently used for pumping service because they require much less floor space.

THE STEAM TURBINE

It is most important to remember that electricity is only a means of distributing energy, of carrying it from the place where it is produced to the places where it is used. It is not a 'prime mover' like the steam-engine or even the water mill. A generator is no use at all unless it is rotated by a prime mover.

During the' first few years of electric power there was no other way of moving the generators than either by the force of falling water or by ordinary steam-engines. Soon, however, there came a new and very efficient prime mover, the steamturbine. The steam-turbine must be a much more efficient and powerful prime mover than the reciprocating engine because it must short-cut the complicated process of converting steam energy into rotary motion via reciprocating motion. But the problems involved in building such a machine seemed formidable, especially that of high-precision engineering. It was only towards the end of the nineteenth century that engineering methods were developed highly enough for a successful attempt.

Two men undertook it almost simultaneously. The Swedish engineer, Gustaf Patrik de Laval, built his first model in 1883. He made the steam from the boiler emerge from four stationary nozzles arranged around the rim of a wheel with a great number of small inch, de Laval's turbine wheel rotated at up to 40,000 revolutions per minute. He supported the wheel on a flexible shaft so that it would adjust itself to fluctuations of pressure– which, at such speeds, would have broken a rigid shaft in no time. De Laval geared an electric generator to his turbine after he had succeeded in reducing the speed of rotation to 3,000 r. p. m. His turbo-generator worked, but its capacity was limited, and it was found unsuitable for large-scale power stations. Although the simplest form of a machine has often proved the most efficient one in the history of technology, this was not the case with the steam-turbine.

Another inventor, and another system, proved much more successful. In 1876 Charles Parsons began to work on the idea of a steam-turbine, for which he forsaw a wide range of applications. The reciprocating steam-engine, which was unable to convert more than 12 per cent of the latent energy of coal into mechanical power, was not nearly effiuient enough for the economical generation of electricity – energy leaked out right and left from the cylinder, and the condenser. Besides, there were limits to the size in which it could be built, and therefore to the output: and Parsons saw that the time had come to build giant electric power stations. As he studied the problem he understood that the point where most would-be turbine inventors1 had been stumped was the excessive velocity of steam. Even steam at a comparatively low pressure escaping into the atmosphere may easily travel at speeds of more than twice the velocity of sound – and high-pressure steam may travel twice as fast again, at about 5,000 feet per second. Unless the wheel of a turbine could be made to rotate at least at half the speed of the steam acting upon its blades, there could be no efficient use of its energy. But the centrifugal force alone, to say nothing of the other forces which de Laval tried to counter with his flexible shaft, would have destroyed such an engine.

Parsons had the idea of reducing the steam pressure and speed, without reducing efficiency and economy, by causing the whole expansion of the steam to take place in stages so that only moderate velocities would have to be reached by the turbine wheels. This principle still forms the basis of all efficient steam-tirbines today. Parsons put it into practice for the first time in his model of 1884, a little turbine combined with an electric generator, both coupled without reducing gear and revolving at 18,000 r. p. m. The turbine consisted of a cylindrical rotor enclosed in a casing, with many rings of small blades fixed alternately to the casing and to the rotor. The steam entered the casing at one end and flowed parallel with the rotor ('axial flow'); in doing so it had to pass between the rings of blade – each acting virtually as a nozzle in which partial steam expansion could take place, and the jets thus formed gave up their energy in driving the rotor blades. It was a more complicated solution of the problem than de Laval's, but it proved to be the right one. The speed of 18,000 r. p. m. used the energy of the steam very well, and the generator developed 75 amperes output at 100 volts. The little machine, built in 1884, is now at the Science Museum. Parsons expected, and experienced, a good deal of opposition – after all, there were enormous vested interests in the manufacture of reciprocating steam-engines. He began to build some portable turbo-generators, but there were no buyers. Strangely enough, a charity event created the necessary publicity for the turbine. In the winter of 1885-1886, a pond froze over, and a local hospital decided to raise funds by getting young people to skate on the ice and charging for admission.

The Chief Constable had the idea of asking Mr. Parsons to illuminate the pond with electric lamps, powered by one of the portable 4-kW turbo-generators. The event was a great success, and the newspapers wrote about it. The next step was that the organizers of the Newcastle Exhibition of 1887 asked Parsons to supply the current for its display of electric lighting.

Parsons, who died in 1931 at the age of 76, lived long enough to see one of his turbines producing more than 200,000 kW. He also suceeded in introducing his steam-turbine as a new prime mover in ship propulsion. Until this day, the steam-turbine has held its place as the great prime mover for the generation of electricity where no water power is available. The steam which drives them in the power stations may be raised by coal, oil, natural gas, or atomic energy – but it is invariably the steam-turbine which drives the generators; Dieselengines are the exceptions, and are only used where smaller or mobile stations are required and no fuel but heavy oil is available. Today's steam-turbines, large or small, run at much lower speeds than Parson's first model, usually at 1,000–3,000 r. p. m. When, a quarter of a century after Charles Algernon Parsons's death, the first nuclear power station in the world started up, his steam-turbines were there to convert the heat from the reactor into mechanical energy for the generators. The atomic age cannot do without them – not yet.

NUCLEAR POWER PLANT

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

A nuclear reactor has several advantages over power-plants that use coal or natural gas. The latter produce considerable air pollution, releasing combusted gases into atmosphere, whereas a nuclear power plant gives off almost no air pollutants. As to nuclear fuel, it is far cleaner than any other fuel for operating a heat engine. Furthermore our reserves of coal, oil and gas are decreasing so nuclear fuel is to replace them. It means that coal and oil can be used for some other purposes. The amount of nuclear fuel which the nuclear power-plant consumes is negligible while the world's uranium and thorium resources will last for hundreds of years. The construction of the world's first nuclear power-plant in Obninsk near Moscow is a great historical event and the beginning of atomic energetics. Since then our country has achieved a great progress in this field.

It should be noted that while the unit capacity of the Obninsk nuclear power-plant was five thousand kW, that of the first unit of the Leningradskaya nuclear power-plant was one million kW. Our industry produces two main types of reactors namely vessel-type reactors and channel-type reactors. The former are installed at the Novovoronezhskaya and the Armenian nuclear power-plants, the latter operating at the Leningradskaya and Kurskaya power-plants.

It is necessary to mention here that channel-type reactors have been operating since 1954 at the world's first nuclear power-plant and in the far North-East of our country where they produce both electricity and heat.

The nuclear power-stations are mostly designed for generation of electricity. If a station generates only electric energy, it is equipped with condensing turbines and the station is known as a condensing one. At present the nuclear power-stations mainly operate as condensing plants. The nuclear power-stations designed to produce not only electrical energy but also heat are called nuclear heat-and-power plants.

A fast-neutron reactor which supplies both electricity and heat for desalting sea water was put into operation in Shevchenko on the Caspain Sea. Its capacity is partly used for generating electricity, the rest going as heat to obtain desalted water. It should be also mentioned that that area has no natural fresh water and was a lifeless desert before the nuclear power plant began operating there.

According to the program of nuclear power development, the nuclear power plants are mainly built in the European part of the USSR. This increases the power supply reliability in the most industrially developed areas of our country. Besides it reduces the transportation of fuel from the East and saves millions tons of coal and oil.

In 1979, there were 226 nuclear power-plants all over the world. It is not a very great figure compared with the thermal and hydropower stations. However, by the end of the present century half of all the world's electricity will come from nuclear power plants.

Of all the methods of energy production nuclear power engineering presents the least danger to nature. But so far it is incapable of providing the necessary amount of energy–the road It has passed is too short. Therefore, along with the accelerated construction of nuclear power-stations, much attention will be paid in the USSR to the development of coal-based thermal power-stations reliably provided with fuel resources.

In keeping with the economic and social development plan of the USSR for 1981-1985 and for the period up to 1990 electricity production will reach a great figure.

REACTOR OF THE FUTURE

Man receives nine-tenths of the energy he needs by burning valuable materials like oil, coal and gas in furnaces and engines. However, the resources of these materials are not unlimited. It is estimated that they will be exhausted in 150-200 years or so. What will happen then? Shall we leave the future generations without energy? These are the questions the scientists are mostly interested in.

Soviet scientists are intensively working at the problem of creating controlled thermonuclear reactors. Positive results of research in this field would give man a practically inexhaustible source of energy.

The tests on the Tokomak-7, the world's first large thermonuclear installation with superconducting magnetic windings have proved the possibility of creating supercon- ducting magnetic systems for retaining plasma at one million degrees Centrigrade.

The huge building in which the experiments are made looks like a big factory. The equipment and installations simulate and recreate the processes going on inside the Sun and in the remote stars. Scientists try to tame matter in a plasma state. Theoretical calculations and numerous experiments show that a controlled thermonuclear reaction would take place if we could heat a compound of 1014 nuclei of heavy isotopes of hydrogen deuterium and tritium to a temperature of- one hundred million degrees and make the tiny ball shine for, at least, one second.

An inexhaustible terrestrial sun would light up, its light dispelling the forecasts about the inevitable energy crisis. This is the reactor of the future. The nearest to it, that we have at present, are the Tokomaks constructed by the Soviet scientists.

The Institute of Atomic Energy named after Kurchatov where the Tokomaks were born made the next big steps forward on this difficult road. The Tokomak-7 proved in practice for the first time that the magnetic windings cooled to cosmic cold could become a superconductor even within 35 cm from the plasma heated to a million degrees. The Tokomak-7 is about the same size as the preceding the Tokomak-10. But unlike the latter it has superconducting coils to create the magnetic field preventing the plasma from coming, into contact with the chamber walls.

What are the advantages of the new coils? It is possible to raise the plasma temperature to 13 million degrees in the Tokomak-10. But to reproduce a thermonuclear reaction lasting half a second, the installation requires the energy produced by a 200 thousand kW power plant. The superconducting coils require thousands of times less energy than the copper ones in the Tokomak-10. Let us consider another advantage of the Tokomak-7. The experiment on the Tokomak-10 lasts less than a second. Then it has to be turned off so that the coils would N not overheat, whereas the Tokomak-7 having superconducting coils can operate as long as required.

Using superconductivity in thermonuclear installations, it is possible to make experiments without thinking about the coils overheating and at much less energy consumption. This paves the way to intense research on the Tokomak-15. The latter is an intermediate step to the thermonuclear power plant. It is twice the size of the Tokomak-7. A smaller Tokomak-11 is used for experiments on methods to heat plasma to much higher temperatures by ejecting a beam of fast neutron atoms of hydrogen and deuterium into the burning area. As for fuel the thermonuclear power plant would use sea water or a variety of hydrogen it contains in enormous amounts. In short, our scientists do their best to carry out a controllable thermonuclear reaction so as to light up the man-made sun on earth.

PART II
Texts for understanding and resuming.

ATOMIC ENERGY

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

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

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

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

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

The Belarusian nuclear power-station named after academician Kurchatov may serve as an example of the peaceful use of atomic energy in the USSR. Soviet scientists and engineers achieved a nuclear superheating of steam directly in the reactor itself before steam is carried into the turbine. It is certainly an important contribution to nuclear engineering achieved for the first time in the world. We might mention here another important achievement, that is, the first nuclear installation where thermal energy generated in the reactor is transformed directly into electrical energy. Speaking of the peaceful use of atomic energy it is also necessary to mention our nuclear ice-breakers. "Lenin" is the world's first ice-breaker with a nuclear installation. Its machine installation is of a steam turbine type, the steam being produced by three reactors and six steam generators. This ice-breaker was followed by many others.

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

EARLY HISTORY OF ELECTRICITY

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

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

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

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

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

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

ELECTRICITY

It is impossible to imagine our civilization without electricity: economic and social progress will be turned to the past and our daily lives completely transformed. Electrical power has become universal. Thousands of applications of electricity such as lighting, electrochemistry and electrometallurgy are longstanding and unquestionable.

With the appearance of the electrical motor, power cables replaced transmission shafts, gear wheels, belts and pulleys1 in the 19-th century workshops. And in the home a whole range of various time and labour saving appliances have become a part of our everyday lives. Other devices are based on specific properties of electricity: electrostatics in the case of photocopying machine and electromagnetism in the case of radar and television. These applications have made electricity most widely used. The first industrial application was in the silver workshops in Paris. The generator – a new compact source of electricity – was also developed there. The generator replaced the batteries and other devices that had been used before.

Electric lighting came into wide use at the end of the last century with the development of the electric lamp by Thomas Edison. Then the transformer was invented, the first electric lines and networks were set up, dynamos and induction motors were designed. Since the beginning of the 20th century the successful development of electricity has begun throughout the industrial world. The consumption of electricity has doubled every ten years. Today consumption of electricity per capita is an indicator of the state of development and economic health of a nation. Electricity has replaced other sources of energy as it has been realized that it offers improved service and reduced cost. One of the greatest advantages of electricity is that it is clean, easily-regulated and generates no by-products. Applications of electricity now cover all fields of human activity from house washing machines to the latest laser devices.

Electricity is the efficient source of some of the most recent technological advances such as the laser and electron beams. Truly electricity provides mankind with the energy of the future.

DIFFERENCE BETWEEN A.C. AND D.C.

A direct current (D.C.) flows continuously through a conducting circuit in one direction only, although it may not be steady so far as magnitude is concerned. It is unidirectional in character. An alternating current (A.C.), on the other hand, continually reverses in direction, as its name implies. Starting from zero, it grows in one direction, reaches a maximum, dies down to zero again, after which it rises in the opposite direction, reaches a maximum, again dying down to zero. It is thus continually changing in magnitude as well as direction, and this continual change causes certain effects of far-reaching importance.

It can be shown that high voltages are desirable for the economic transmission of a given amount of electric power. Take, for example, the transmission of 1000 kW. If the transmission voltage is 100 volts the current must be 10,000 amperes, but if the transmission voltage is 10,000 volts the current is only 100 amperes. The crossection of the cables transmitting the power is determined by the current to be carried, and so in the former case the cables would need to be very much larger than in the latter case. It is true that the high-voltage cable would need to have more insulation, but even so, it would be very much cheaper than the larger low-voltage cable. A high voltage is therefore essential for the economic transmission of electric power. Again, a.c. generators can be designed and built for much higher voltages than can d.c. generators, the voltage of the latter being limited by the problem of sparking at the commutator, a component which is absent in the a.c. generator. Then there is the most important factor that it is easy to transform a.c. power from one voltage to another by means of the transformer, an operation that is denied to the d.c. system. The transformer also enables the voltage to be stepped down at the receiving end of the transmission line to values which can readily be used by the various consumers. If necessary, it can be converted to the d.c. form for actual use, although this is not often necessary. There are certain processes for which D.C. is either essential or at any rate desirable but the utilization of electric power in the a.c. form is growing steadily. At the present day, by far the greater part* of the generation, transmission, and utilization of electric power is carried out by means of A.C.

DIRECT-CURRENT METERS

Functions of a Direct Current Meter.A direct current meter is an instrument intended for the measurement of electrical quantity in a direct current circuit. There are two main classes of direct current meters, (1) ampere-hour meters and (11) watthour meters. An ampere-hour meter measures the product of the current in amperes flowing in a circuit and the time in hours during which the flow is maintained. A watt-hour meter measures the product of the power in watts and the time in hours during which the flow of power is maintained.

Direct Current Ampere-hour Meters. Ampere-hour meters are used by electrical undertakings for measuring the supply of electricity to domestic and industrial, consumers. These undertakings are under a statutary obligation to maintain the voltage at consumers' terminals at a declared value within close limits; assuming that the supply voltage is maintained at the declared value, an ampere-hour meter can be calibrated to register in terms of kilowatt-hours at this voltage. This principle is accepted as satisfactory in most countries where the voltage at consumers' terminals is maintained within narrow limits of the declared voltage, and since direct current ampere-hour meters are, in general, more reliable and less costly than direct current watt-hour meters the practice has much in its favour.

In addition to the foregoing, ampere-hour meters are used for measuring the current consumption in battery charging, electro-deposition and other electrolytic or industrial processes and in some instances they exercise a controlling function over these operations. Many types of ampere-hour meter have been manufactured in the past, the most important being electrolytic meters and motor meters. Theoretically the former are capable of very accurate registration but in practice the working results are not so good as with motor meters, and the latter are preferred by most supply authorities.

GENERATING AN ELECTRIC CURRENT

The first method used in producing an electric current was chemical in nature. Credit for its discovery is given to an Italian physician named Aloisio Galvanl (17.47–1798). One day while engaged in dissecting a frog, Galvanl noticed the leg muscles contract whenever a nearby electric machine was in operation. Further investigation showed the same twitching effect to be obtained by simply connecting the nerve and muscle of the leg to dissimilar metals. But no such result was obtained if only one metal was used or if non-conductors were employed. There were obviously two possible sources of the phenomenon. Either the current was set up at the junction of the two metals or it was a property of the animal tissues. Galvani favoured the latter view and in 1791 announced his discovery, attributing the current to what he called "animal electricity" or as it came to be known, "galvanism". Galvani is an excellent example of a scientist who behaved most unscientifically with regard to a hypothesis which he himself had advanced. He became so prejudiced in favour of his animal magnetism theory that it was quite impossible for him to view objectively later evidence which definitely contradicted it and finally caused it to be discarded.

Another Italian, Alessandro Volta (1745–1827), a professor of physics in the University of Pavia, established the true source of the electric current. He demonstrated that it could be produced by the action of dissimilar metals without the presence of animal tissue of any sort.

In the course of his experiments in 1800 he developed the first electric battery, a device known as a voltaic pile. Although he tried a number of different materials he found that the best results were obtained when he used silver and zink as the two metals. The pile consisted of a Befits Of small discs of these and of cardboard, the latter having been soaked in a salt solution-Then he piled the discs up one on another in the order silver, zink, cardboard, and so forth, ending with zinc. By connecting wires to the top and bottom discs he was able to get continuous electric currents which were of substantial size.

All the essentials of a modern electric cell or battery were present in the voltaic pile. Developments since that time have been largely directed toward making cells more convenient to use and toward eliminating various undesirable chemical reactions.

SEMICONDUCTOR PRINCIPLE

The term "semiconductor" implies a definition, namely, that it is a material having an electrical conductivity inter mediate between that of metals and insulators. For many purposes this is a satisfactory definition. We recognize, how ever, that an enormous range of conductivities can meet this requirement. At room temperature, the conductivities characteristic of metals are of the order of 104 to 106 ohm-1 cm-1, while those of insulators may range from 10-22 to 10-10. The materials classed as semiconductors generally have conductivities from about 10-9 to 103. ' Materials which fall in this conductivity range, but which are largely ionic conductors, will not be of interest to us; it is electronic conduction with which we shall be concerned.

Some materials show conductivities which approach those of certain metals, and yet their conduction process is found to be like that of other semiconductors. Insulators may, under certain conditions, show conduction behavior which is characteristic of semiconduction. Another criterion commonly associated with semiconduction is a negative temperature coefficient of resistance. Semiconductors depend in many cases on crystal imperfections for their unique properties. These may be foreign atoms incorporated into the crystal lattice, small deviations from stoichiometry, or lattice defects. As might be expected from the wide range in conductivities encountered, a large number of materials can be considered as semiconductors.

Among the most investigated, and best understood, of these, are germanium and silicon among the elements, and indium antimonide, zinc oxide, and cadmium sulphide among the compounds. Semiconductors are of practical importance in a number of connections. Their most direct uses, of course, take advantage of their unique electrical behavior, as in transistors, crystal rectifiers, and thermisters. Closely related to these are the applications which combine electrical and optical effects, as in luminescent materials and photocon-ductors.

Furthermore, semiconductors are used in many other ways, in which any connection between their semiconducting behavior and the particular application is much more subtle. An example of this, of particular interest to is that of the oxide catalysts.

ELECTRONS AND HOLES

In many semiconductors it is of great importance to recognize two kinds of carriers of electrical current: electrons and holes. While the latter, in the final analysis, represent motion of electrons also, the separation of the two basic conduction processes is clear. The concept involved will be illustrated in terms of chemical bonds, by reference to the elements of Group IV although they are quite general for solids.

The covalently bonded carbon atoms, in the diamond modification, are shown in Fig. Since each carbon contributes four valence electrons, and it is tetrahedrally bonded to four neighboring carbons, all of the electrons are used up in forming the covalent bonds. In this situation no net flow of electrons through the solid is possible, and the material is an insulator. If an extra electron is added to the structure, however, no empty bonds are available, and the electron is free to wander through the solid. It will move through the crystal in the opposite direction from an applied electric field, and can thus contribute to the electrical conductivity.

Electrons which are not bound in the valence bonds, and thus free to move in this way, are called conduction electrons. If conduction electrons can be produced in some manner in sufficient quantity, the material Is no longer an insulator, but shows appreciable electrical conductivity. There is a second way in which the total number of electrons fails to match the number of available bonding sites, i.e., when there are too few electrons. This missing bonding electron is called a "hole". It, like the conduction electron, is free to wander through the crystal. An electron in a bond adjacent to the one-electron bond where the "hole" is localized, can jump into the empty position, leaving a vacancy behind as it goes. As this process is repeated, the net effect is for the hole to move through the crystal under the influence of an electric field; it can be seen that the hole will move in the opposite! direction from the conduction electron, since the motion of the hole is opposite to that of the valence electrons.

ELECTRIC CAR

The electric car is not a new idea. It had success with American women in the early 1900s. Women liked electric cars because they were quiet and, what was more important, they did not pollute the air.

Electric cars were also easier to start than gasoline-powered ones. But the latter was faster, and in the 1920s they became much more popular. The electric car was not used until the 1970s, when there were serious problems with the availability of oil. The General Motors Co. had plans to develop an electric car by 1980. However, soon oil became available again, and this car was never produced.

Today there is a new interest in the electric car. The Toyota Co. recently decided to spend $800 million a year on the development of new car technology. Many engineers believe that the electric car will lead to other forms of technology being used for transportation.

Car companies are working at developing a supercar. A super-efficient car will have an electric motor. Four possible power sources are being investigated. The simple one is batteries. Another possibility is fuel cells, which combine oxygen from air with hydrogen to make electricity. Yet another approach would be a flywheel (маховик), an electric generator consisting of free-spinning wheels with magnets in the rims that can produce a current. A fourth possible power source for the super-car would be a small turbine engine, running on a clean fuel like natural gas. It would run at a constant speed, generating electricity for driving vehicles or for feeding a bank of batteries, storing energy for later use.

THERMAL POWER-STATION

A modern thermal power-station is known to consist of four principal components, namely, coal handling and storage, boiler house, turbine house, switchgear. If you have not seen a power-station boiler it will be difficult for you to imagine its enormous size. Besides the principal components mentioned above there are many additional parts of the plant.

The most important of them is the turbogenerator in which the current is actually generated. A steam turbine requires boilers to provide steam. Boilers need a coal-handling plant on the one hand and an ash-disposal plant on the other. Large fans are quite necessary to provide air for the furnaces. Water for the boilers requires feed pumps. Steam must be condensed after it has passed through the turbines, and this requires large quantities of cooling water. The flue gases carry dust which must be removed by cleaning the gases before they go into the open air.

A modern thermal power-station is equipped with one or more turbine generator units which convert heat energy into electric energy. The steam to drive the turbine which, in its turn, turns the rotor or revolving part of the generator is generated in boilers heated by furnaces in which one of three fuels may be used–coal, oil and natural gas. Coal continues to be the most important and the most economical of these fuels. Large installations with mighty turbogenerators are operating at a number of thermal power-stations in the USSR.

It is necessary to point out that the power machine building industry has started to manufacture even greater capacity installations for thermal power-stations. At present great attention is paid to combined generation of heat and electricity at heat-and-power plants and to centralized heat supply. One of the world's largest heat-and-power installations is operating at the Moskowskaya thermal power-station. Thermal power-stations are considered to be the basis of the Soviet power industry. More than 80% of the country's total power output comes from the above stations.

It is necessary to say that separate power-stations in our country are integrated into power systems. Integration of power systems is a higher stage in scientific and technical development of power engineering. The Integrated Power System in the central part of the USSR is one of the largest in the world. It covers the territory from the Volga river to the Western boundaries of our country and is connected with power systems of the European socialist countries.

ТАБЛИЦА НЕПРАВИЛЬНЫХ ГЛАГОЛОВ

Infinitive	Past Simple	Past Participle	Перевод
be	was, were	been	быть, являться
beat	beat	beaten	бить, колотить
become	became	become	становиться
begin	began	begun	начинать
bend	bent	bent	гнуть
bet	bet	bet	держать пари
bite	bit	bitten	кусать
blow	blew	blown	дуть, выдыхать
break	broke	broken	ломать, разбивать, разрушать
bring	brought	brought	приносить, привозить, доставлять
build	built	built	строить, сооружать
buy	bought	bought	покупать, приобретать
catch	caught	caught	ловить, поймать, схватить
choose	chose	chosen	выбирать, избирать
come	came	come	приходить, подходить
cost	cost	cost	стоить, обходиться
cut	cut	cut	резать, разрезать
deal	dealt	dealt	иметь дело, распределять
dig	dug	dug	копать, рыть
do	did	done	делать, выполнять
draw	drew	drawn	рисовать, чертить
drink	drank	drunk	пить

Infinitive	Past Simple	Past Participle	Перевод
drive	drove	driven	ездить, подвозить
eat	ate	eaten	есть, поглощать, поедать
fall	fell	fallen	падать
feed	fed	fed	кормить
feel	felt	felt	чувствовать, ощущать
fight	fought	fought	драться, сражаться, воевать
find	found	found	находить, обнаруживать
fly	flew	flown	летать
forget	forgot	forgotten	забывать о (чём-либо)
forgive	forgave	forgiven	прощать
freeze	froze	frozen	замерзать, замирать
get	got	got	получать, добираться
give	gave	given	дать, подать, дарить
go	went	gone	идти, двигаться
grow	grew	grown	расти, вырастать
hang	hung	hung	вешать, развешивать, висеть
have	had	had	иметь, обладать
hear	heard	heard	слышать, услышать
hide	hid	hidden	прятать, скрывать
hit	hit	hit	ударять, поражать
hold	held	held	держать, удерживать, задерживать
hurt	hurt	hurt	ранить, причинять боль, ушибить
keep	kept	kept	хранить, сохранять, поддерживать

Infinitive	Past Simple	Past Participle	Перевод
know	knew	known	знать, иметь представление
lay	laid	laid	класть, положить, покрывать
lead	led	led	вести за собой, сопровождать, руководить
leave	left	left	покидать, уходить, уезжать, оставлять
lend	lent	lent	одалживать, давать взаймы (в долг)
let	let	let	позволять, разрешать
lie	lay	lain	лежать
light	lit	lit	зажигать, светиться, освещать
lose	lost	lost	терять, лишаться, утрачивать
make	made	made	делать, создавать, изготавливать
mean	meant	meant	значить, иметь в виду, подразумевать
meet	met	met	встречать, знакомиться
pay	paid	paid	**платить**, оплачивать, рассчитываться
put	put	put	ставить, помещать, класть
read	read	read	читать, прочитать
ride	rode	ridden	ехать верхом, кататься
ring	rang	rung	звенеть, звонить
rise	rose	risen	восходить, вставать, подниматься
run	ran	run	бежать, бегать
say	said	said	говорить, сказать, произносить
see	saw	seen	видеть
seek	sought	sought	искать, разыскивать
sell	sold	sold	продавать, торговать

Infinitive	Past Simple	Past Participle	Перевод
send	sent	sent	посылать, отправлять, отсылать
set	set	set	устанавливать, задавать, назначать
shake	shook	shaken	трясти, встряхивать
shine	shone	shone	светить, сиять, озарять
shoot	shot	shot	стрелять
show	showed	shown, showed	показывать
shut	shut	shut	закрывать, запирать, затворять
sing	sang	sung	петь, напевать
sink	sank	sunk	тонуть, погружаться
sit	sat	sat	сидеть, садиться
sleep	slept	slept	спать
speak	spoke	spoken	говорить, разговаривать, высказываться
spend	spent	spent	тратить, расходовать, проводить (время)
stand	stood	stood	стоять
steal	stole	stolen	воровать, красть
stick	stuck	stuck	втыкать, приклеивать
strike	struck	struck, stricken	ударять, бить, поражать
swear	swore	sworn	клясться, присягать
sweep	swept	swept	мести, подметать, смахивать
swim	swam	swum	плавать, плыть
swing	swung	swung	качаться, вертеться
take	took	taken	брать, хватать, взять
teach	taught	taught	учить, обучать

Infinitive	Past Simple	Past Participle	Перевод
tear	tore	torn	рвать, отрывать
tell	told	told	рассказывать
think	thought	thought	думать, мыслить, размышлять
throw	threw	thrown	бросать, кидать, метать
understand	understood	understood	понимать, постигать
wake	woke	woken	просыпаться, будить
wear	wore	worn	носить (одежду)
win	won	won	победить, выиграть
write	wrote	written	писать, записывать

ИНОСТРАННЫЙ ЯЗЫК (АНГЛИЙСКИЙ)

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