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# INSTRUMENTATION & ELECTRICAL ENGINEERING

# (ПРИБОРОСТРОЕНИЕ И ЭЛЕКТРОТЕХНИКА)

Практикум по английскому языку

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Включает в себя аутентичные тексты по приборостроению, приборам, охранным системам, электротехнике, энергоснабжению, развитию нанотехнологий. Цель практикума – обучение студентов чтению и пониманию научно-технических текстов, а также умению говорить на профессиональные темы, знакомит с тем, как составить резюме для приёма на работу и написать деловое письмо с элементами реферирования и аннотирования. Обеспечивает коммуникативную и профессиональную направленность обучения иностранному языку, учитывая межкультурологический и страноведческий аспекты.

Предназначен для студентов 2-го курса факультета радиофизики, электроники и медицинской техники по специальностям – приборостроение, технология приборостроения и энергоснабжение. Составлено в соответствии с требованиями программы по иностранным языкам для вузов неязыковых специальностей.

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## ВВЕДЕНИЕ

Данный практикум рассчитан на 80 – 100 часов аудиторной работы и примерно такое же количество часов самостоятельной работы студентов. Практикум включает две части. Первая часть, состоящая из восьми разделов, предназначена для студентов, обучающихся по специальности «Приборостроение», вторая часть – из пяти разделов – для студентов специальности «Электроснабжение». Однако данное разделение и специализация во многом являются весьма условными. Практикум построен таким образом, что многие тексты и разделы можно использовать как для студентов одной, так и другой специальностей. Например, тексты по нанотехнологии и разделы, связанные с корреспонденцией и устройством на работу, в первой части и третий раздел, посвященный известным учёным, а также тексты об электроприборах в четвёртом разделе второй части можно использовать как для студентов специальности «Приборостроение», так и для студентов специальности «Электроснабжение». То же самое относится к упражнениям по словообразованию и реферированию текстов.

Все тексты аутентичны и происходят из оригинальных источников, главным образом из энциклопедии «Британика», «Википедии» и иностранных технических журналов. Тексты даны без адаптации, лишь в некоторых случаях авторы позволили себе сокращение текстов из-за небольшого формата данного издания.

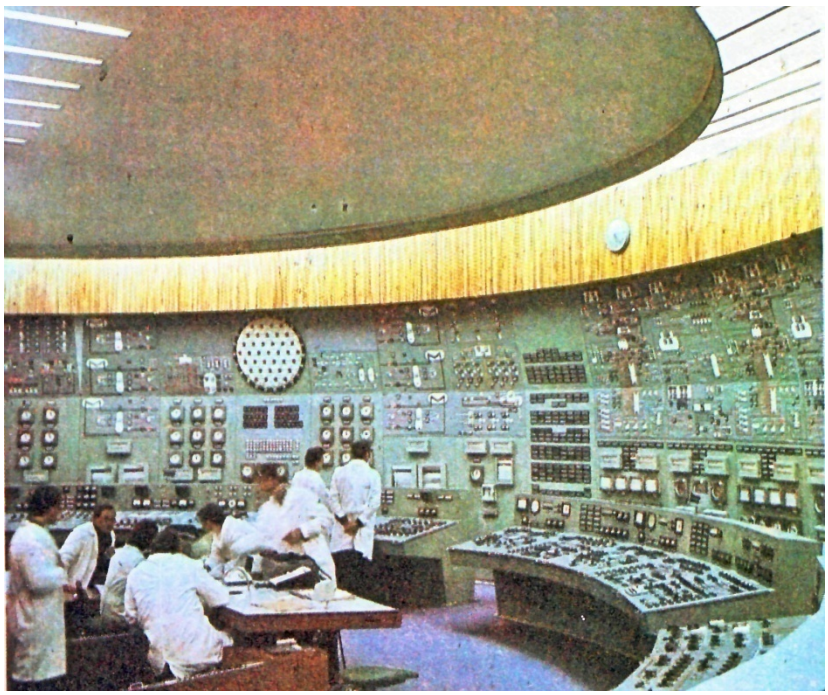
Почти все тексты первой части, отличающиеся большей сложностью, снабжены переводом, что даёт возможность привить навыки перевода студентам как первой, так и второй специальностей. Этот принцип также дает более глубокое понимание текстов и позволяет лучше организовать изучение профессиональной лексики.

Тексты мыслятся не только как основа для пересказа и развития монологической речи, они также предназначены в качестве базы для развития диалогической речи и умения вести профессиональную беседу. С этой же целью в практикуме даны образцы диалогов, а также упражнения по их составлению.

Авторы надеются, что работа с данным пособием будет интересной, полезной и несложной как для преподавателей, так и для студентов.

# *PART ONE*

# *INSTRUMENTATION*



## UNIT 1

# *INSTRUMENTATION*

***1. Study the words and find the sentences with these words in the text, translate them***

| | | | |
|---|---|---|---|
| 1. | instrumentation | – | применение, использование приборов;<br>– контрольно-измерительные приборы;<br>– приборостроение |
| | instrument-making<br>instrument-engineering | – | приборостроение |
| 2. | precise measuring equipment | – | точное измерительное оборудование |
| 3. | sensory organs | – | органы чувств |
| 4. | sensitive | – | восприимчивый |
| 5. | responsive | – | чувствительный |
| 6. | to rely on | – | опираться, полагаться, доверять |
| 7. | monitoring | – | (текущий) контроль, наблюдение |
| 8. | the armillary sphere | – | армиллярная сфера |
| 9. | skeletal celestial globe | – | каркас небесной сферы |
| 10. | astrolabe ['xstrqleib] | – | астролябия |
| 11. | solar | – | солнечный |
| 12. | lunar | – | лунный |
| 13. | altitude ['xltitjHd] | – | высота, угол возвышения (светила) |
| 14. | compass [´kAmpqs] | – | компас, циркуль |
| 15. | to make reference to | – | ссылаться на кого-либо, что-либо; упоминать о ком-либо, чем-либо |
| 16. | Lippershey | – | Липперсгей |

17. Galileo – Галилей
18. to involve – включать, содержать; подразумевать, предполагать
19. the thermostatic furnace – термостатическая печь
20. rod – стержень, штанга, прут, шток, тяга
21. lever ['li:və] – рычаг, рукоятка, вага
22. a centrifugal governor – центробежный регулятор (скорости)
23. to maintain – поддерживать, сохранять
24. at a predetermined rate – на заданном уровне
25. dimensional measurements – линейные и угловые измерения
26. electrical measurements – электрические измерения
27. linear precision – линейная точность
28. incandescent substances – раскалённые вещества
29. to meet (met) standards (requirements) – соответствовать, отвечать, удовлетворять стандартам (требованиям)
30. wavelength – длина волны
31. to emit – испускать
32. physical properties – физические свойства
33. current – ток
34. voltage – напряжение
35. resistance – сопротивление
36. advent ['ædvent] – прибытие, приход, появление, (здесь) начало
37. space exploration – космическое исследование
38. to spur – побуждать, толкать, способствовать
39. transducer – преобразователь, датчик
40. photocell – фотоэлемент
41. thermocouple – термопара

| | | | |
|---|---|---|---|
| 42. | a sample | – | образчик, образец, проба, порция, выборка |
| | a sample of the energy | – | некоторое количество энергии |
| | a sample of a substance | – | проба какого-либо вещества |
| 43. | capacity | – | (функциональные) возможности, мощность |
| 44. | information processing and storage | – | обработка и хранение информации |
| 45. | feedback system | – | система обратной связи |

***2. Find the English equivalents of the following both in the vocabulary and in the text***

Точное измерительное оборудование; обработка и хранение информации; появление компьютеризации; соответствовать стандартам; некоторое количество энергии; линейные и угловые измерения; ссылаться на что-либо; точное измерительное оборудование; каркас небесной сферы; космическое исследование; органы чувств человека; на заданном уровне; угол возвышения Солнца или Луны; выдающееся достижение в приборостроении; как измерительные функции, так и функции управления; производственные процессы; центробежный регулятор; термостатическая печь; преобразовать одну форму энергии в другую; быстрыми темпами; промышленное применение электричества; системы обратной связи; введение, внедрение.

***3. Word-building***

1. -tion V+ tion = N, *relate* + tion = *relation. Give the verbs from which the words below were formed and your own examples of the words thus formed*
   instrumentation, navigation, functions, application, composition, introduction, computerization, exploration, information, operation.
2. -ment V + ment = N (result or means of an action), *govern* + ment = *government. Give the verbs from which the words below were formed, give your own examples of the words thus formed.*

equipment, development, measurement, judgment, movement .

*4. Read the text and study its translation, think the title of its first part*

## INSTRUMENTATION

I

Instrumentation, in technology, is the development and the use of precise measuring equipment. Although the sensory organs of the human body can be extremely sensitive and responsive, modern science and technology rely on the development of much more precise measuring and analytical tools for studying, monitoring, or controlling all kinds of phenomena. Some of the earliest instruments of measurement were used in astronomy and navigation. The armillary sphere, the oldest known astronomical instrument, consisted essentially of a skeletal celestial globe whose rings represent the great circles of the heavens. The armillary sphere was known in ancient China, the ancient Greeks were also familiar with it and modified it to produce the astrolabe, which could tell the time or length of day or night as well as measure solar and lunar altitudes. The compass, the earliest instrument for direction finding that did not make reference to the stars, was a striking ad-

Приборостроение в технологии – это разработка и использование точного измерительного оборудования. Хотя органы чувств человека могут быть очень восприимчивыми и чувствительными, при изучении, наблюдении и управлении всеми видами явлений современная наука и техника полагаются на разработку более точных измерительных и аналитических инструментов. Некоторые из самых ранних измерительных приборов использовались в астрономии и навигации. Армиллярная сфера, древнейший известный астрономический прибор, состоял главным образом из каркаса небесной сферы, кольца которого представляли небесные сферы. Армиллярная сфера была известна в древнем Китае, древние греки также были знакомы с ней и видоизменили её, создав астролябию, которая показывала время или продолжительность дня или ночи, а также угол возвышения Солнца или Луны.

vance in instrumentation made about the 11th century. The telescope, the primary astronomical instrument, was invented about 1608 by the Dutch optician Hans Lippershey and first used extensively by Galileo.

*Chinese armillary sphere*

Instrumentation involves both measurement and control functions. An early instrumental control system was the thermostatic furnace developed by the Dutch inventor Cornelius Drebbel (1572 – 1634), in which a thermometer controlled the temperature of a furnace by a system of rods and levels. Devices to measure and regulate steam pressure inside a boiler appeared at about the same time. In I788 the Scotsman James Watt invented a centrifugal governor to maintain the speed of a steam engine at a predetermined rate. Instrumentation

Компас, древнейший прибор, указывающий направление безотносительно звёзд, был выдающимся достижением в приборостроении, совершенным приблизительно в 11-м веке. Телескоп, главный астрономический прибор, был изобретён примерно в 1608 г. Гансом Липперсгеем, и впервые широко использовался Галилеем. Использование измерительных приборов включает в себя как измерительные функции, так и функции управления. Одной из первых систем управления с помощью приборов была разработанная голландским изобретателем Корнелиусом Дребблом (1572 – 1634 гг.) термостатическая печь, в которой термометр регулировал температуру в печи с помощью системы тяг и рычагов. Устройство для измерения и регулирования давления пара в котле появилось приблизительно в то же самое время. В 1788 г. шотландец Джеймс Уатт изобрёл центробежный регулятор для поддержания скорости парового двигателя на заданном уровне. Приборостроение развивалось быстрыми темпами

developed at a rapid pace in the Industrial Revolution of the 18th and 19th centuries, particularly in the areas of dimensional measurement, electrical measurement, and physical analysis. Manufacturing processes of the time required instruments capable of achieving new standards of linear precision. The industrial application of electricity required instruments to measure current, voltage, and resistance. Analytical methods, using such instruments as the microscope and the spectroscope, became increasingly important; the latter instrument, which analyzes by wave length the light radiation given off by incandescent substances, began to be used to identify the composition of chemical substances and stars.

In the 20th century the growth of modern industry, the introduction of computerization, and the advent of space exploration spurred still greater development of instrumentation, particularly of electronic devices. Often a transducer, an instrument that changes energy from one form into another (such as the photocell, thermocouple,

во время Промышленной революции 18 – 19-го вв., особенно в областях линейных и угловых, и электрических измерений, и физического анализа. Для производственных процессов того времени требовались приборы, способные достичь новых стандартов линейной точности. Промышленное применение электричества требовало приборов для измерения тока, напряжения и сопротивления. Аналитические методы с использованием таких приборов, как микроскоп и спектроскоп становились всё более важными; последний, анализирующий по длине волны излучение, испускаемое раскаленными веществами, начал использоваться для определения химического состава веществ и звёзд.

В 20-м веке рост современной промышленности, внедрение компьютеризации и появление космических исследований в ещё большей степени стимулировали развитие приборостроения, в особенности электронных средств. Часто преобразователь, прибор (такой как фотоэлемент, термопара или микрофон),

or microphone) is used to transform a sample of the energy to be measured into electrical impulses that are more easily processed and stored. The introduction of the electronic computer in the 1950s, with its great capacity for information processing and storage, virtually revolutionized methods of instrumentation, for it allowed the simultaneous comparison and analysis of large amounts of information. At much the same time, feedback systems were perfected in which data from instruments monitoring stages of a process are instantaneously evaluated and used to adjust parameters affecting the process. Feedback systems are crucial to the operation of automated processes.

преобразующий одну форму энергии в другую, используется для превращения некоторого количества энергии, которое надо измерить, в электрические импульсы, которые гораздо легче обработать и сохранить. В 1950-е гг. появление компьютера с его большими функциональными возможностями для обработки и хранения информации практически революционизировало приборостроение, поскольку позволило (сделало возможным) одновременное сравнение и анализ большого количества информации. В то же самое время совершенствовались системы обратной связи, в которых данные от приборов, контролирующих этапы процесса, мгновенно оцениваются и используются для регулировки параметров, влияющих на процесс. Системы обратной связи важны для работы автоматизированных процессов.

### *5. Answer the questions given below*

1. What is the text about?
2. What is instrumentation?

3. Do modern science and technology rely on the sensory organs of the human body for studying, monitoring, or controlling all kinds of phenomena?
4. What fields of human activities were the earliest instruments of measurement used in?
5. What is the oldest known astronomical instrument?
6. How did the ancient Greeks modify it?
7. When was the compass invented?
8. Who was the telescope invented and first used by?
9. What functions does instrumentation involve?
10. What was an early instrumental control system?
11. What other control systems appeared at about the same time?
12. What did James Watt invent in 1788?
13. When and where did instrumentation developed at a rapid pace?
14. What instruments did manufacturing processes of the time require?
15. What instruments were these requirements in part met by?
16. What precision could special models of this instrument attain?
17. What did the industrial application of electricity require?
18. What methods became increasingly important at that time?
19. What is the spectroscope and where is it used?
20. What processes spurred still greater development of instrumentation in the 20th century?
21. What devices were particularly developed?
22. What is a transducer and what is it used for?
23. In what way did the introduction of the electronic computer in the 1950s change methods of instrumentation?
24. How were feedback systems perfected?
25. In what area are feedback systems crucial?

***6. Translate this short annotation to the text without a dictionary. Pay attention to the inverted order of words and passive constructions characteristic of annotations***

This text is about instrumentation, its history and current conditions. Considered is the role and functions of instrumentation in technology. Compared are different stages of instrumentation development. Analyzed is the instrumentation progress as well as its advantages and drawbacks.

***7. Make the plan of the retelling and retell the first part of the text about instrumentation***

***8. Study the words and find the sentences with these words in the second part of the text, translate them***

1. instruments monitoring stages of a process – приборы, контролирующие этапы производственного процесса
2. to adjust – регулировать, настраивать
3. to affect – воздействовать, влиять
4. chemical, physical, and environmental properties – химические, физические и экологические свойства
5. the performance of production lines – работа производственных линий
6. refractometer – рефрактометр
7. infrared analyzer – инфракрасный анализатор
8. chromatograph – хроматограф
9. pH sensor – датчик pH
10. the bending of a beam of light – отклонение луча света
11. solution – раствор
12. catsup (catchup) [ˊkætsəp] – кетчуп
13. acidity [ə'siditi] – кислотность
14. alkalinity ["ælkə'liniti] – щёлочность
15. turbidity [tə:'biditi] – мутность, помутнение

16. water purification – очистка воды
17. petroleum refining – очистка (перегонка) нефти
18. turbidimeter ["tWbi'dimitq] – нефелометр (оптический прибор для измерения степени мутности жидкости и газов)
19. density – плотность
20. hydrometer [hai'dr0mitq] – ареометр, плотномер
21. buoyancy ['b0iqnsi] – плавучесть, подъёмная сила
22. an object of known volume – объект, объём которого известен
23. to immerse – погружать
24. the flow rate – расход, скорость потока
25. turbine flowmeter – турбинный расходомер, турборасходомер
26. revolutions – обороты
27. the viscosity of a fluid – вязкость жидкости
28. by a number of techniques – посредством нескольких приёмов
29. to dampen – гасить
30. the oscillations of a steel blade – колебания стальной лопатки
31. blood pressure – кровяное давление
32. sphygmomanometer ["sfigmqmq'n0mitq] – сфигмометр
33. lung capacity – емкость лёгких
34. spirometer [spaiq'r0mitq] – спирометр
35. X-ray machine – рентгеновский аппарат
36. computerized axial tomography – компьютерная осевая томография
37. nuclear magnetic resonance – ядерный магнитный резонанс (ЯМР)
38. tomographic scanner – томограф
39. to visualize – делать видимым, зримым, наглядным (наглядно представлять)
40. sophisticated – сложный, усложнённый

***9. Read the text and study its translation, think the title of the second part***

II

Most manufacturing processes rely on instrumentation for monitoring chemical, physical, and environmental properties, as well as the performance of production lines. Instruments to monitor chemical properties include the refractometers, infrared analyzers, chromatographs, and pH sensors. A refractometer measures the bending of a beam of light as it passes from one material to another, such instruments are used, for instance, to determine the composition of sugar solutions or the concentration of tomato paste in catsup. Infrared analyzers can identify substances by the wavelength and amount of infrared radiation that they emit or reflect. Chromatography, a sensitive and swift method of chemical analysis used on extremely tiny samples of a substance, relies on the different rates at which a material will adsorb different types of molecules. The acidity or alkalinity of a solution can be measured by pH sensors.

Большинство производственных процессов зависят от приборов для контроля химических, физических и экологических свойств, а также работы производственных линий. Приборы для контроля химических свойств включают в себя рефрактометры, инфракрасные анализаторы, хроматографы и датчики pH. Рефрактометр измеряет отклонение луча света по мере того как он проходит из одного материала в другой, такие приборы используются, например, для определения состава сахарного раствора или концентрации томатной пасты в кетчупе. Инфракрасные анализаторы могут определять вещества по длине волны и количеству инфракрасного излучения, которое они испускают или отражают. Хроматография, чувствительный и быстрый метод химического анализа, используемый на очень небольших пробах какого-либо вещества, основывается на

*Nuclear magnetic resonance scanner*

Instruments are also used to measure physical properties of a substance, such as its turbidity, or amount of particulate matter in a solution. Water purification and petroleum-refining processes are monitored by a turbid meter, which measures how much light of one particular wavelength is absorbed by a solution. The density of a liquid substance is determined by a hydrometer, which measures the buoyancy of an object of known volume immersed in the fluid to be measured. The flow rate of a substance is measured by a turbine flowmeter, in which the revolutions of a freely spinning turbine immersed in a fluid are measured, while the viscosity of a fluid is measured by a number of techniques, including how much it dampens the oscillations of a steel blade.

разнице в скорости, с которой материал поглощает различные типы молекул. Кислотность или щёлочность какого-нибудь раствора можно измерить с помощью датчика pH. Приборы также используются для измерения физических свойств вещества, таких как его мутность или количество определённого вещества в растворе. Процессы очистки воды и переработки нефти контролируются турбидиметром (нефелометром), который измеряет, какое количество света определённой длины волны поглощается раствором. Плотность жидкого вещества определяется гидрометром, измеряющим плавучесть объекта известного объёма, погружённого в жидкость, плотность которой предстоит измерить. Расход вещества измеряется турборасходометром, в котором измеряются обороты свободно вращающейся погружённой в жидкость турбины, в то время как вязкость жидкости измеряется посредством ряда методов, включая то, насколько

Instruments used in medicine and biomedical research are just as varied as those in industry. Relatively simple medical instruments measure temperature, blood pressure (sphygmomanometer), or lung capacity (spirometer). More complex instruments include the familiar X-ray machines and electroencephalographs and electrocardiographs, which detect electrical signals generated by the brain and heart, respectively. Two of the most complex medical instruments now in use are the CAT (computerized axial tomography) and NMR (nuclear magnetic resonance) scanners, which can visualize body parts in three dimensions. The analysis of tissue samples using highly sophisticated methods of chemical analysis is also important in biomedical research.


*BP 126/70 mmHg as result on electronic sphygmomanometer*

она глушит колебания стальной лопасти. Приборы, используемые в медицине и биомедицинском исследовании, столь же разнообразны, как и в промышленности. Относительно простые медицинские приборы измеряют температуру, давление крови (сфигмометр) или емкость лёгких (спирометр). Более сложные приборы – известные рентгеновские аппараты и электроэнцефалографы, и электрокардиографы, которые регистрируют электрические сигналы, вырабатываемые мозгом и сердцем соответственно. Двумя самыми сложными из ныне использующихся медицинских приборов являются компьютерный осевой томограф и анализатор ядерного магнитного резонанса, которые могут давать трёхмерное изображение органов тела. Анализ образцов тканей с использованием сложных методов химического анализа также важен для биомедицинского исследования.

### *10. Answer the questions given below*

1. What do most manufacturing processes rely on instrumentation for?
2. What instruments are used to monitor chemical properties?
3. What is a refractometer used for?
4. What can infrared analyzers do?
5. What kind of process is chromatography and what is it based on?
6. How can the acidity or alkalinity of a solution be measured?
7. What physical properties can be measured by instruments?
8. What is a turbidimeter and where is it used?
9. What instrument is used to determine density and how is it done?
10. What instrument is used to measure the flow rate and how?
11. What are the functions of relatively simple medical instruments?
12. What instruments are used to measure temperature, blood pressure, and lung capacity?
13. What do electroencephalographs and electrocardiographs do?
14. What are the most complex medical instruments now in use?
15. What are the CAT and NMR scanners used for?
16. What is important in biomedical research?

### *11. Give the summary of the previous text in 10 sentences*

### *12. Insert the missing words and translate the text*

**PH meter**

A **pH meter** is an electronic … used to measure the pH (…or alkalinity) of a liquid (though special probes are sometimes used to measure the pH of semi-solid substances, such as cheese). A typical pH … consists of a special measuring probe (a glass electrode) connected to an … meter that measures and …the pH reading.

The pH probe … pH as the … of hydrogen ions surrounding a thin-walled glass bulb at its tip. The probe produces a small

1. displays
2. variation
3. electronic
4. entered
5. inputs
6. acidity
7. instrument
8. applications

| | |
|---|---|
| voltage (about 0.06 volt per pH unit) that is measured and displayed as pH units by the meter.<br>… range from simple and inexpensive pen-like devices to complex and expensive laboratory instruments with computer … and several … for indicator, reference electrodes, and temperature sensors such as thermoresistors or … . Cheaper models sometimes require that temperature measurements be … to adjust for the slight … in pH caused by temperature. … meters and probes are … for use in special …, harsh environments, etc | 9. available<br>10. PH meters<br>11. interfaces<br>12. meter<br>13. specialty<br>14. thermocouples<br>15. measures<br>16. concentration |

***13. Read the beginning of the dialogue and finish it using the texts and questions to the texts as well as the expressions below***

**Commentator:** Good morning, ladies and gentlemen. This is Bill Smith with the programme "Science and technology". Today we are going to speak about instruments and instrumentation. Our guest is Mr. Black, an expert on everything connected with instruments and instrumentation.

**Mr. Black:** Good morning, thank you for inviting me to say a few words on such an important question as instruments and instrumentation...

***Expressions to be used in the dialogue***

| | |
|---|---|
| Видите ли… | Well... |
| Дело в том, что... | Well, the thing is... |
| Откровенно говоря... | Frankly speaking... |
| Желаю Вам всего хорошего | My best wishes / All the best |
| Всего доброго / всего наилучшего/ счастья / успехов / удачи | (I wish you) good luck / I wish you every success! |
| Не могли бы Вы сказать... | Could you tell me (us)... |
| Можно обратиться /спросить? | May I (we) ask? |
| Скажи(те), пожалуйста... | Tell me, please... |
| Что Вы об этом думаете? | What do you think about it? |

| | |
|---|---|
| А как это понимать? | And what does it mean? |
| Теперь понятно? | Is it clear now? |
| А потом? | And after that? /And then? |
| Да, а почему? | Yes, but why? |
| Ну, и...? | Well, and...? |
| Объясни, пожалуйста. | Please, explain it. |
| Простите, не понял(а). | Sorry, I didn't quite catch it. |
| Что ты имеешь в виду? | What do you mean? |
| Понятно. | It's clear. |
| Я тебя (Вас) хорошо понимаю, продолжай(те). | I follow you, go on. |
| Да, с удовольствием! | Yes, with pleasure. |
| Да, а почему бы и нет? | Yes, why not? |
| Разумеется! | Sure! |
| Конечно! | Certainly! |
| Вероятно. | Probably. |
| Возможно. | Possibly. |
| Вполне возможно. | Quite possible. |
| Я сейчас не готов(а) говорить на эту тему. | I'm not ready to speak on this subject just now. |
| Дайте подумать. | Let me see. |
| Теперь ясно. | Now I see. |
| Я все понял. | I understand everything./I get it. |
| Я не могу Вас понять. | I can't understand/get you. |
| Говорите, пожалуйста, медленнее. | Could you speak slower, please? |
| К сожалению, не могу сказать. | Sorry, I can't tell you anything. |
| Мне надо подумать. | I must think it over. |

## UNIT 2

# *INSTRUMENTATION AND RELATED PROFESSIONS*

***1. Study the words and find the sentences with these words in the text, translate them***

| | | |
|---|---|---|
| 1. | SCADA (supervisory control and data acquisition) | – диспетчерское управление и сбор данных |
| 2. | control system | – система управления |
| 3. | Programmable Logic Controller (PLC) | – программируемый контроллер |
| 4. | Remote Terminal Unit (RTU) | – удалённый терминал, дистанционный терминал |
| 5. | Distributed Control System (DCS) | – распределённая система управления |
| 6. | radar gun | – радар-детектор |
| 7. | Doppler Effect | – эффект Доплера, доплеровский эффект |
| 8. | Peltier-Seebeck effect | – эффект Пельтье – Зеебека |
| 9. | the counterpart | – аналог, эквивалент |
| 10. | control engineering | – техника автоматического управления |
| 11. | troubleshoot | – обнаружение неисправностей |
| 12. | instrumentation engineering | – приборостроение |
| 13. | instrumentation systems | – измерительные системы |

***2. Word-building***

*Give the initial words from which the words below were formed and your own examples of the words thus formed*

-er, -or, V+-er, -or = N (person or device carrying out the action of the verb)

*run* + -er = *runner, elevate* + -or = *elevator*.

sensor, divider, processor, scanner, analyzer, reflector, emitter, governor, reader, speaker, controller, translator, writer, pointer, watcher.

*3. Read the text and study its translation*

## INSTRUMENTATION AND RELATED PROFESSIONS

1. Instrumentation is defined as "the art and science of measurement and control". Instrumentation can be used to refer to the field in which instrument technicians and engineers work, or it can refer to the available methods of measurement and control and the instruments which facilitate this. Instruments are devices which are used to measure attributes of physical systems. The variable measured can include practically any measurable variable related to the physical sciences. These variables commonly include: pressure, flow, temperature, level, density, viscosity, radiation, current, voltage, inductance, capacitance, frequency, chemical composition, chemical properties, various physical properties, etc.

1. Измерение определяется как технология и наука измерения и управления. Этот термин может использоваться в отношении области работы инженеров и техников или он может использоваться в отношении имеющихся методов измерения и управления и приборов, которые для этого используются. Приборы – это средства, которые используются для измерения характеристик физических систем. Измеряемая переменная может быть практически любой измеряемой переменной, имеющей отношение к физическим наукам. Эти переменные обычно представляют собой: вязкость, текучесть, температуру, уровень, излучение, ток, напряжение, индукцию, емкость, частоту, химический состав, химические свойства, различные физические свойства и т. д.

2. Instruments can often be viewed in terms of a simple input-output device. For example, if we "input" some tem-

2. Приборы могут рассматриваться как простые устройства с приспособлениями вывода и ввода. Напри-

perature into a thermocouple, it "outputs" some sort of signal. (This can later be translated into data.) In the case of this thermocouple, it will "output" a signal in millivoltage. SCADA is the term used to denote large-scale, distributed measurement systems. Instruments communicate with some sort of signal, often adhering to a standard. This signal may be defined by standards associations, or it may be a proprietary standard. Some standards include analog and digital signals. These devices are generally connected to some sort of control system which responds to the instrument's measurement. The response programmed into the control system manipulates control devices attached to the process. This cycle of changing of manipulated variables, measurement of controlled variables and proper response is the basic concept behind process control. The control systems used are often considered part of the field of instrumentation, and can include simple Programmable Logic Controllers (PLCs) or

мер, если мы вводим какие-то температурные данные в термопару, она даёт на выходе какой-то сигнал. (Это можно далее преобразовать в данные.) В случае с этой термопарой она даст на выходе сигнал в милливольтах. SCADA (диспетчерское управление и сбор данных) – это понятие используется для определения крупномасштабной распределённой системы управления. Приборы получают определённый сигнал, часто соответствующий какому-то стандарту. Этот сигнал можно определить посредством соотношения с каким-то стандартом или это может быть стандарт предприятия. Некоторые стандарты представляют собой аналоговые и цифровые сигналы. Эти устройства обычно соединяются с какой-нибудь системой управления, которая реагирует на измерение прибора. Это реагирование, заложенное в программу системы управления, манипулирует устройствами управления, включёнными в процесс. Такой цикл изме-

Remote Terminal Units (RTUs), to more advanced Distributed Control Systems (DCSs). Inputs can vary from a few measured variables, to thousands of measured variables.


*Radar guns use the Doppler Effect to measure the speed of oncoming vehicles*

3. Instrumentation engineering deals with the design of devices to measure physical quantities such as pressure, flow and temperature. The design of such instrumentation requires a good understanding of physics that often extends beyond electromagnetic theory. For example, radar guns use the Doppler Effect to measure the speed of oncoming vehicles. Similarly, thermocouples use the Peltier-Seebeck effect

нения обрабатываемых переменных, измерение контролируемых переменных и соответствующее срабатывание является основным принципом процесса управления. Используемые системы управления часто считаются частью измерительного оборудования и могут включать в себя простой программируемый контроллер, удалённый терминал, вплоть до распределённых систем управления. Вводимые переменные могут быть самыми разнообразными от нескольких до нескольких тысяч измеренных переменных.

3. Приборостроение связано с проектированием устройств для измерения физических величин, таких как давление, текучесть и температура. Для проектирования данных приборов необходимо хорошее понимание физических явлений, часто выходящих за рамки электромагнитной теории. Например, в радардетекторе для измерения скорости приближающихся автомобилей

to measure the temperature difference between two points.

используется доплеровский эффект. Подобным образом в термопарах для измерения разницы температур между двумя точками используется эффект Пельтье – Зеебека.

4. Often instrumentation is not used by itself, but instead as the sensors of larger electrical systems. For example, a thermocouple might be used to help ensure a furnace's temperature remains constant. For this reason, engineering is often viewed as the counterpart of control engineering.

4. Часто приборы используются не сами по себе, а как датчики более крупных электрических систем. Например, термопара может использоваться для обеспечения постоянной температуры в печи. В этом случае создание измерительного оборудования рассматривается как аналог создания системы управления.

5. Instrumentation engineers largely design control and measurement systems primarily for industrial processes, although instruments are present in almost any modern technology today including vehicles, computers, appliances etc.

5. Инженеры-приборостроители в основном проектируют контрольно-измерительные системы главным образом для промышленных процессов, хотя приборы присутствуют почти во всех областях современной техники, включая транспортные средства, компьютеры, бытовую технику и т. д.

| | |
|---|---|
| 6. Instrumentation technologists, technicians and mechanics largely troubleshoot, repair, and install instruments and instrumentation systems. This trade is so intertwined with electricians, pipe fitters, power engineers, and engineering companies, that one can find him in extremely diverse working situations. | 6. Технологи, техники и механики в области приборостроения в основном занимаются обнаружением неисправностей, ремонтом и установкой приборов и измерительных систем. Их профессиональная деятельность настолько переплелась с профессиональной деятельностью электриков, слесарей трубоукладчиков, энергетиков и конструкторских компаний, что можно обнаружить их работающими в самых разнообразных областях. |

***4. Answer the questions given below***

1. How is instrumentation defined?
2. Where can instrumentation be used?
3. What kind of devices are instruments?
4. What do the variables measured include?
5. How can instruments often be viewed? What is their input and output?
6. What is SCADA? How does it work?
7. What is the basic concept behind process control?
8. What can they include?
9. What does instrumentation deal with?
10. What does the design of such instrumentation require?
11. What do instrumentation engineers do?
12. What is the duty of instrumentation technologists, technicians and mechanics?

***5. Arrange the sentences below in the way they appear in the text. Use them in your summary of the text (10 sentences)***

1. Instrumentation technologists, technicians and mechanics largely troubleshoot, repair, and install instruments and instrumentation systems. 2. Instrumentation is defined as "the art and science of measurement and control". 3. Instruments are devices which are used to measure attributes of physical systems. 4. Instrumentation engineers largely design control and measurement systems primarily for industrial processes. 5. Instruments can often be viewed in terms of a simple input-output device. 6. Often instrumentation is not used by itself, but instead as the sensors of larger electrical systems. 7. These devices are generally connected to some sort of control system which responds to the instrument's measurement.

***6. Read and translate one student's story about his future profession, prepare your questions to him and tell about your profession***

**MY PROFESSION IS INSTRUMENTATION**

I study at the Faculty of Radio physics, Electronics and Medical Equipment of the Vladimir State University. It is one of the ten faculties of the University and trains engineers in various fields: radio engineers, engineers in computerized measurements, in protection systems and devices, in medical equipment, as well as engineers in electronics. I am going to specialize (major) in instrumentation.

Instrumentation, in technology, is the development and the use of precise measuring equipment. Although the sensory organs of the human body can be extremely sensitive and responsive, modern science and technology rely on the development of much more precise measuring and analytical tools for studying, monitoring, or controlling all kinds of phenomena.

Measurements are the main source of information about the world, on their basis scientists make discoveries and formulate laws. Data gathered by means of various instruments help to control production processes. So we have to deal with

measurements and various measuring instruments in science, production and everyday life. In our everyday life we use meters to learn how much we are to pay for electricity, gas and water. Different timepieces tell us the right time. Instruments on the car panel show the speed we travel at, the exact car mileage, the quantity of fuel in the fuel tank, and so on. Instruments used in medicine and biomedical research are just as varied as those in industry. Instruments are practically used everywhere. There are gauges, meters, counters, timers, sensors, transducers, controllers, etc. All of them employ different principles of work. Some are based on transistors, integral circuits (ICs) and microprocessors; others use semiconductors, ultrasonic, magnetic and piezoelectric properties. In addition there are also optical and mechanical devices.

An engineer specializing in instruments and measurement should know everything about their design, work principle and application. He should be well informed about the latest achievements and developments in the world of instruments. And, what's more, it is also necessary to be a good specialist in computers and computer-aided measuring systems. To become good specialists students study various subjects: mathematics, physics, electrical engineering, electronics, computer science, etc. They specialize in designing and manufacturing high-accuracy instruments and electronic-mechanical systems as well as microprocessor-based instruments and computer-aided measuring and information systems.

Instrumentation engineers largely design control and measurement systems primarily for industrial processes, although instruments are present in almost any modern technology today including vehicles, computers, appliances etc.

Measurements are performed everywhere, it is impossible to do without them, that's why specialists in measuring will always be necessary and the graduates are sure to find a job at different industrial enterprises, research institutions, state technical-supervision laboratories, transport and many other places.

*7. Read classified advertisements and translate it, answer the questions below*

## CLASSIFIED ADS

**Vocabulary**

| | |
|---|---|
| 1. classified ads | тематические объявления (здесь требуются) |
| 2. commitment | обязательство |
| 3. to create an exciting opportunity | создать привлекательную возможность |
| 4. a degreed engineer | дипломированный инженер |
| 5. BS degree | степень бакалавра |
| 6. 5 years instrumentation experience | 5-летний опыт в приборостроении |
| 7. HVAC (heating, ventilation and air conditioning) | отопление, вентиляция и кондиционирование воздуха |
| 8. startup | запуск, ввод в действие |
| 9. to provide counsel in | предоставлять консультации по… |
| 10. a challenging position | перспективная должность |
| 11. a competitive salary | конкурентная зарплата |
| 12. salary history | сведения о зарплате |
| 13. Equal Opportunity Employer M/F | компания, нанимающая на работу как мужчин, так и женщин на равной основе |

**INSTRUMENT ENGINEER**

**New plans, new commitments at Mallinckrodt, a highly successful and broadly diversified chemical and manufacturing company, create an exciting opportunity for a degreed Engineer.**

**An outstanding position exists for an Instrument Engineer with the following:**

- **BS degree in Electrical Engineering preferred. Other Engineering disciplines considered.**
- **5 years instrumentation experience in chemical, petroleum or related field.**
- **HVAC system experience.**

**Additionally, the selected candidate will design project instrumentation, supervise instrument startups, troubleshoot instrument control problems, provide counsel in instrument selection and review instrument efficiency.**

**We offer a challenging position, a competitive salary and comprehensive benefits. For prompt consideration, please send your resume (no agencies please) and salary history to: Jonathan K. Hate; Manager. Human Resources; MALLINCKRODT. INC.; P.O. Box 5439; St. Louis. MO63147. An Equal Opportunity Employer M/F.**

Mallinckrodt

**Questions on the ad**

1. What vacancy is advertised?
2. What is the name of the company placing the ad?
3. How is the company characterized in the ad?
5. What does the company specialize in?
6. What requirements should the candidate meet?
7. What will his future duties and responsibilities be?
8. What remunerations (оплата) does the company promise?
9. What documents are necessary to apply for the position?
10. What is the name and position of the contact person?
11. What is the company mail address?
12. What do the words *An Equal Opportunity Employer M/F* mean?

***8. Read and translate the résumé and letter of application, write your own résumé and letter of application***

**Letter of Application**

**1010 Payne Drive**
**Smith Village, NY 10344**

**Jonathan K. Hate**
**Human Resources Manager** **June 5, 2008**
**MALLINCKRODT. INC.**
**P.O. Box 5439**
**St. Louis. MO63147**

**Dear Mr. Williams:**

**I would like to apply for the position of Instrument Engineer that you advertised in Instruments and Control Systems journal.**

**As you can see from the enclosed resume, I have both a BS degree in electrical engineering and HVAC system experience. I am very eager to advance into this position you have available. I feel that, given a chance, I will be an asset to your company.**

**I would like to meet with you to discuss my qualifications for this job. You can contact me at 914-555-1865.**

**Sincerely,**

**Al Berman**
**Alexander Berman**

## Résumé

| | | |
|---|---|---|
| 1. Name / Surname | Alexander Berman | |
| 2. Address | 376 West 186th Street,<br>Apartment # 6-J<br>New-York, NY 100033 | |
| 3. Contact telephone | (212) 973-6792 | |
| 4. Qualifications | 6 years instrumentation experience in chemical field, HVAC system experience, project instrumentation design and instrument startups supervision, deep knowledge of engineering technologies and industrial instrumentation operation, an advanced computer user: MS Office, AutoCAD | |
| 5. Work experience | 2003 – 2008 | Weksler Instruments Corp., Freeport, NY |
| | 2000 – 2003 | Vladimir Chemical Plant, Vladimir, Russia |
| 6. Education | 1995 – 2000 | Vladimir State University, Russia, Diploma of Engineer in Instrumentation |
| 7. Salary history | $ 3000 + lunch and transportation | |
| 8. Personal | Arrived in the USA in August 2003, USA citizen, married, two children | |
| 9. References | Supplied on the request | |

**Notes**

There are different kinds and forms of résumé. Some companies have their own résumé forms. Mind that your résumé should contain the most important information to your advantage, it must not be very long and begin with the personal information: name, address, contact telephone, age, nationality, if required, etc.

## UNIT 3

# *MEASUREMENT*

***1. Study the words and find the sentences with these words in the text, translate them***

| | | | |
|---|---|---|---|
| 1. | associating numbers with physical quantities and phenomena | – | соотнесение чисел с физическими величинами и явлениями |
| 2. | technical matters | – | технические вопросы |
| 3. | to be fundamental to | – | быть в основе чего-либо |
| 4. | estimate | – | оценка |
| 5. | rule | – | линейка, масштаб, правило |
| 6. | measurand | – | измеряемая величина |
| 7. | accessible | – | доступный, достижимый |
| 8. | interaction | – | взаимодействие |
| 9. | everyday | – | обычный, часто встречающийся; |
| 10. | applications | – | применение, приложение |
| 11. | negligible ['negliGbl] | – | ничтожный, не принимаемый в расчёт, мелкий, незначительный |
| 12. | considerable [kqn'sidqrqbl] | – | значительный, большой, важный |
| 13. | to limit accuracy | – | ограничить точность |
| 14. | to discriminate the measurand | – | выделять измеряемую величину |
| 15. | to sense its dimensions | – | распознавать, считывать размеры |
| 16. | to transmit throughout the system | – | передавать, посылать по всей системе |
| 17. | frequency | – | частота |
| 18. | to power the signal | – | снабжать энергией сигнал |
| 19. | to trigger the signal | – | включать сигнал |

20. an energetic probe – электрод
21. a light source – источник света
22. an X-ray tube – рентгеновская трубка
23. a carrier signal – сигнал носителя
24. a reference signal – опорный сигнал
25. calibration – поверка, градуировка, калибровка
26. an analogue process – аналоговый процесс
27. continuous dimension – непрерывное измерение
28. to be brought to equality – уравнять
29. quantization by counting – квантование посредством счёта
30. dividing – деление
31. adding up – сложение
32. to facilitate – облегчать, помогать, способствовать
33. amplification – усиление
34. to ensure – обеспечивать, гарантировать
35. to reduce – сокращать
36. degradation ["degrq'deiSn] – деградация, уменьшение, ослабление
37. magnification – увеличение, усиление
38. output – выходной сигнал, выход, вывод
39. input – вход, ввод, входной сигнал, входные данные
40. to match – соответствовать, подбирать
41. the readout meter – измеритель с устройством считывания
42. the discerning power of the eye – различительная способность глаза
43. a calibrated chart and a pointer – градуированная таблица и указатель прибора (стрелка)
44. harmonic analysis – гармонический анализ
45. visual display – видеотерминал, устройство отображе-

ния, дисплей

46. an integrated display – комбинированный (многофункциональный) индикатор
47. a digital readout – цифровой отсчёт, цифровой индикатор
48. a writing stylus – перо (самописца или графопостроителя)
49. a chart – схема, график, таблица
50. noise and interference – шум и интерференция
51. to mask – маскировать, прятать, вуалировать, перекрывать
52. to distort – деформировать(ся), искажать(ся)
53. linearity – линейность, отклонение от прямой
54. resolution – разрешение
55. precision – точность, прецизионность, погрешность, сходимость, воспроизводимость
56. accuracy – точность, погрешность, правильность
57. dynamic response – динамичное срабатывание
58. drift – сдвиг, смещение; погрешность
59. hysteresis ["histq'rJsis] – гистерезис, запаздывание

***2. Match the English words and expressions with their Russian equivalents below the line***

Unaided human senses; beyond the capabilities of senses; analogous instrument signal; to complete the measurement; in order; visual display systems; feedback reading devices; associating numbers with physical quantities and phenomena; an energetic probe; a definition of the measurand; quantization by counting; an energetic probe; method of displaying the signal to an observer.

---

Соотнесение чисел с физическими величинами и явлениями; при помощи органов чувств (без помощи приборов); чтобы; считывающие устройства обратной связи; за пределами возможностей органов чувств; завершить измерение; системы видеотерминалов; определение измеряемой величины; метод демонстрации сигнала наблюдателю; аналогичный сигнал измери-

тельного прибора; квантование посредством счёта.

***3. Word-building***

*Give the initial words from which the words below were formed and your own examples of the words thus formed*

-al, N+-al = Adj, *magic* + -al = *magical; verb* + al = *verbal*

-ally, N + -ally = Adv, *magic* +-ally = *magically*

*magical* +-ly = *magically*

physical, fundamental, technical, usually, mathematically, digital

V+-al = N, *recite* + -al = *recital*; *survive* + -al = *survival*.

-ic, N +-ic = Adj, *poet* + *-ic* = *poetic; romant(ce)* + *-ic* = *romantic*

subatomic, basic, magnetic, scientific, democratic, harmonic

***4. Read the text and study its translation, divide it into several parts, think the title of each part***

**MEASUREMENT**

| | |
|---|---|
| Measurement is the process of associating numbers with physical quantities and phenomena. Measurement is fundamental to the sciences, to engineering, building and their technical matters, and to much everyday activity. | Измерение – это процесс соотношения чисел с физическими величинами, явлениями. Измерение является основой науки, техники, строительства и связанных с ними технических вопросов, а также лежит в основе многих видов повседневной деятельности. |
| Measurements may be made by unaided human senses – in which case they are often called estimates – or more usually, by the use of instruments, which may range in complexity from simple rules for measuring lengths to highly sophisticated systems | Измерения можно проводить просто с помощью органов чувств, в таком случае они называются оценкой, или, что более обычно, с помощью приборов, различных по сложности, от простых измерительных линеек до очень сложных систем для опре- |

designed to detect and measure quantities entirely beyond the capabilities of senses, such as radio waves from a distant star or the magnetic moment of a subatomic particle.

деления и измерения величин за пределами возможностей органов чувств человека, таких как радиоволны, идущие от далёкой звезды, или магнитный момент элементарной частицы.

Measurement begins with a definition of the measurand, the quantity that is to be measured, and it always involves a comparison of the measurand with some known quantity of the same kind. If the measurand is not accessible for direct comparison, it is converted or "transduced" into analogous instrument signal. Since measurement always involves some interaction between the measurand and the observer or observing instrument, there is always an exchange of energy, which, although in everyday applications is negligible, can become considerable in some types of measurement and thereby limit accuracy.

Измерение начинается с определения измеряемой величины, т. е. какой-то величины, которую необходимо измерить, и это всегда включает в себя сравнение измеряемой величины с известной величиной такого же рода. Если измеряемая величина недоступна для прямого сравнения, её преобразуют в аналогичный сигнал измерительного прибора. Поскольку измерение является взаимодействием между измеряемой величиной и наблюдателем или прибором наблюдения, то здесь всегда присутствует обмен энергии, который, хотя в обычных случаях незначителен, может стать значительным в ряде измерений и таким образом ограничить их точность.

In general, measuring systems comprise a number of functional elements. One element is required to discriminate the measurand and sense its dimen-

В общем, измерительные системы включают ряд функциональных элементов. Один элемент необходим для того, чтобы выделить измеряе-

sions or frequency. This information is then transmitted throughout the system by physical signals. If the measurand is itself active, such as water flow, it may power the signal, if passive; it must trigger the signal by interaction either with an energetic probe, such as a light source or X-ray tube, or with a carrier signal. Eventually the physical signal is compared with a reference signal of known quantity that has been subdivided or multiplied to suit the range of measurement required. The reference signal is derived from measurands of known quantity by a process called calibration. The comparison may be an analogue process in which signals in a continuous dimension are brought to equality. An alternative comparison process is quantization by counting; *i. e.* dividing the signal into parts of equal and known size and adding up the number of parts.

мую величину, определить её параметры или частоту. Эта информация затем передаётся по всей системе с помощью физических сигналов. Если измеряемая величина сама по себе активна, например поток воды, она может дать энергию сигналу, если же она пассивна, ей необходимо инициировать сигнал путём взаимодействия с энергетическим датчиком: источником света, рентгеновской трубкой или сигналом носителя информации. В конечном итоге полученный сигнал сравнивается с опорным сигналом известной величины, который делится или умножается для соответствия диапазону необходимого измерения. Опорный сигнал получается из измеряемых величин известных параметров с помощью процесса, называемого калиброванием. Сравнение может быть аналоговым процессом, при котором сигналы непрерывно подстраиваются в определённом измерении. Альтернативным процессом сравнения является квантование путём вычислений, т.е. деление сигнала на равные части известного размера и

Other functions of measurement systems facilitate the basic process described above. Amplification ensures that the physical signal is strong enough to complete the measurement. In order to reduce degradation of the measurement as it progresses through the system, the signal may be converted to coded or digital form. Magnification, enlarging the measurement signal without increasing its power, is often necessary to match the output of one element of the system with the input of another, such as matching the size of the readout meter with the discerning power of the eye.

One important type of measurement is the analysis of resonance, or the frequency of variation within a physical system. This is determined by harmonic analysis, commonly exhibited in the sorting of signals by a radio receiver. Computation is another important measurement process, in which measurement signals are manipulated mathematically typically by some form of

сложение количества частей.

Другие функции измерительных систем способствуют выполнению вышеперечисленных функций. Усиление способствует тому, чтобы сигнал был достаточно сильным для завершения измерения. Чтобы уменьшить деградацию измерения по мере его выполнения в системе, сигнал может быть преобразован в закодированную или цифровую форму. Увеличение размеров отображения сигнала без увеличения его мощности часто необходимо для приведения в соответствие выхода одного элемента системы с входом другого элемента, например соответствие размеров показаний счётчика способности глаз их различать.

Важным типом измерения является анализ резонанса или частоты изменений внутри физической системы. Это определяется гармоническим анализом, обычно представляемым сортировкой сигналов радиоприёмником. Вычисление – ещё один важный процесс измерения, при котором с сигналами измерений выполняются те или иные математиче-

analogue or digital computer. Computers may also provide a control function in monitoring system performance.

ские действия с помощью аналогового или цифрового компьютера. Компьютеры могут также осуществлять функцию управления, контролируя работу системы.

Measuring systems may also include devices for transmitting signals over great distances. All measuring systems, even highly automated ones, include some method of displaying the signal to an observer. Visual display systems may comprise a calibrated chart and a pointer, an integrated display on a cathode-ray tube, or a digital readout. Measurement systems often include elements for recording. A common type utilizes a writing stylus that records measurements on a moving chart. Electrical recorders may include feedback reading devices for greater accuracy.

Измерительные системы могут также включать в себя устройства для передачи сигналов на большие расстояния. Все измерительные системы, даже с высоким уровнем автоматизации, содержат способ демонстрации сигнала наблюдателю. Устройство отображения может представлять собой шкалу и стрелку, индикатор, комбинированный с катодно-лучевой трубкой, или устройство цифровой индикации. Измерительные системы часто включают записывающие элементы. В обычном типе устройств используется самописец, который записывает измерения на движущейся шкале. Электрические записывающие устройства содержат считывающие устройства с обратной связью для большей точности измерений.

The actual performance of measuring instruments is affected by numerous external and internal factors. Among

На качество работы измерительных приборов влияют многочисленные внутренние и внешние факторы.

| | |
|---|---|
| external factors are noise and interference, both of which tend to mask or distort the measurement signal. Internal factors include linearity, resolution, precision, and accuracy, all of which are characteristic of a given instrument or system; and dynamic response, drift and hysteresis, which are effects produced in the process of measurement itself. | Среди внешних факторов – шум и интерференция, перекрывающие и искажающие сигналы измерений. Внутренние факторы включают в себя линейность, разрешение, точность и погрешность, всё это является характерной особенностью данного прибора или системы, а также динамическую характеристику, дрейф (показаний прибора) и гистерезис, что представляет собой воздействия, возникающие в процессе самих измерений. |

***5. Answer the questions given below***

1. What is measurement?
2. What is the role of measurement?
3. By what means may measurement be made? When are sophisticated measurement systems used?
4. How does measurement begin?
5. What is there always in the process of measurement?
6. What elements do measuring systems comprise?
7. How is the physical signal compared with a reference signal in measuring systems?
8. How do amplification and magnification facilitate the basic measurement process?
9. What is the analysis of resonance?
10. What is computation?
11. What methods of displaying the signal to an observer do all measuring systems include?

***6. Find below the line synonyms for the following words from the text***

Accurate, considerable, theoretical, characteristic fundamental;
measurement, computation, factor, estimate, instrument, matter;
transmit utilize include affect associate.

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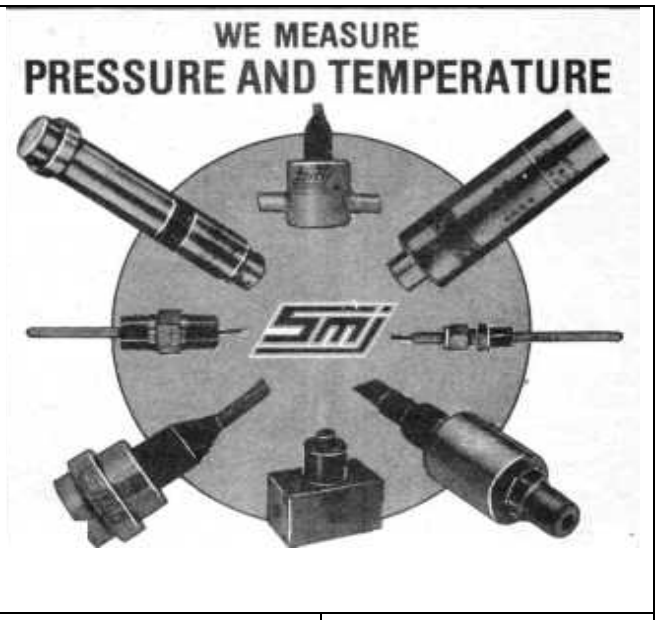
Significant, typical, basic, precise, abstract;
calculation, aspect, approximation, dimension, issue, device;
use comprise pass on relate influence.

**7. *Read the advertisement from "Instruments & Control Systems" journal of October 1990 and answer the questions***




**Senso-Metric specializes in designing, development and manufacturing a wide range of transducers and associated instrumentation to solve most measurement problems. Our capability includes the measurement of pressure, temperature and signal conditioning for all types of sensors. SMI also manufactures customized equipment for individual requirement or special applications. We supply total instrument packages, including recording and display, with all interconnecting materials.**

***SENSO-METRICS INCORPORATED 4584 RUNWAY STREET • SIMI VALLEY • CA* 93063*(805)527-3640 • FAX 805-584-2960***

**Questions**

1. What is the company name and address?
2. What does the company specialize in?
3. What does the company capability include?
4. Does the company manufacture customized equipment for individual requirement?
5. What does the company supply?

You are working for ***SNS Company*** in Vladimir. Write an enquiry letter to ***Senso-Metrics Incorporated.*** Use the letter below as a model.

**THE JAMESON CONSTRUCTION CO. PTY.**
Harbour Road
MELBOURNE, AUSTRALIA

The Aluminium Alloy Co. Ltd.
79 Prince Albert St.
Birmingham B21 8DJ
Great Britain

25 June 2008

Dear Sirs

We have seen your advertisement in The Metal Worker, and would be grateful if you would kindly send us details of your aluminium fittings.

Please quote us for the supply of the items listed on the enclosed enquiry's form, giving your prices to Melbourne. Will you please also indicate delivery times, your terms of payment, and details of discounts for regular purchases and large orders.

Our annual requirements for metal fittings are considerable, and we may be able to place substantial orders with you if your prices are competitive and your deliveries prompt.

We look forward to receiving your quotation.

Yours faithfully
THE JAMESON CONSTRUCTION CO. PTV.

H. Smithers
Buyer

***8. Arrange the sentences below in the way they appear in the text. Use them in your summary of the text (14 sentences)***

1. Amplification ensures that the physical signal is strong enough to complete the measurement. 2. The actual performance of measuring instruments is affected by numerous external and internal factors. 3. Measuring systems may also include devices for transmitting signals over great distances. 4. One element is required to discriminate the measurand and sense its dimensions or frequency. 5. Measurement is the process of associating numbers with physical quantities and phenomena. 6. Other functions of measurement systems facilitate the basic process described above. 7. Computation is another important measurement process, in which measurement signals are manipulated mathematically, typically by some form of analogue or digital computer. 8. Measurements may be made by unaided human senses or by the use of instruments. 9. Measurement begins with a definition of the measurand. 10. In general, measuring systems comprise a number of functional elements. 11. Measurement systems often include elements for recording.

***9. Translate this short annotation to the text into English***

В этом тексте рассказывается о процессе измерения, даётся его определение и рассматривается значение измерений в науке и технике, а также в повседневной жизни. Описывается сам процесс измерения, типы измерений, измерительные системы и их функциональные элементы, а также внутренние и внешние факторы, влияющие на точность измерений.

## UNIT 4

# *THEORY OF MEASUREMENT*

***1. Study the words and find the sentences with these words in the text, translate them***

1. to assign – присваивать, назначать
2. assignment – присваивание, назначение
3. number – число, количество, номер, цифра; показатель, индекс
4. number assignment – присваивание числа
5. concern [kqn'sWn] – отношение, касательство, интерес
6. error – ошибка
7. general theory – общая теория
8. come to grips with the problem – серьёзно взяться за (пытаться разрешить) проблему
9. uniqueness [jH'nJknqs] – однозначность
10. axiom ['xksiqm] – аксиома
11. assumption [q'sAmpSqn] – предположение, допущение
12. conjointness [kqn'G0intnqs] – общность, совместимость
13. to ensure [in'Suq] – обеспечивать, гарантировать
14. attribute – атрибут, признак, показатель, характеристика
15. to concatenate [kPn'kxtineit] – сцеплять, связывать, соединять (воедино)
16. representation – представление, отображение, обозначение
17. speculative ['spekjulqtiv] – созерцательный, умозрительный, теоретический, гипотетический
18. measuring sequences – последовательность (порядок) проведения измерений

***2. Find the English equivalents of the following both in the vocabulary and in the text***

Теория измерений, явления, пытаться разрешить проблему, аксиомы порядка, физические измерения, общая теория, ошибочные измерения, по своей природе умозрительны, переменные, прямые и косвенные ошибки, величин, поддающихся количественному определению, однако фундаментальная работа по теории ошибок, единственно возможному.

***3. Find below the line synonyms for the following words from the text***

1. Process, error, problem, representation, axiom, phenomenon, observation, uniqueness, assignment, intelligence, question random.
2. Utilitarian, axiomatic, various, central, general, systematic contemporary.

---

1. Maxim, chance, difficulty, task, matter, surveillance, mistake, fact, intellect, symbol, exceptionality, procedure.
2. Diverse, vital, self-evident, regular, current, practical, universal.

***4. Read the text and study its translation***

**THEORY OF MEASUREMENT**

Measurement theory is the study of how numbers are assigned to objects and phenomena, and its concerns include the kinds of things that can be measured, how different measures relate to each other, and the problem of error in the measurement process. Any general theory of measurement must come to grips with three basic problems: error; representation, which is the justification of number assignment; and uniqueness, which is the degree to

Теория измерений изучает, каким образом числа используются для определения объектов и явлений, она касается всего, что можно измерить, того, как различные измерения связаны друг с другом и проблемами ошибок в процессе измерений. Любая общая теория измерений должна пытаться разрешить три основные проблемы: ошибки; обозначение, которое является подтверждением числового определения, и

which the kind of representation chosen approaches being the only one possible for the object or phenomenon in question.

Various systems of axioms, or basic rules and assumptions, have been formulated as a basis for measurement theory. Some of the most important types of axioms include axioms of order, axioms of extension, axioms of difference, axioms of conjointness, and axioms of geometry. Axioms of order ensure that the order imposed on objects by assignment of numbers is the same order attained in actual observation or measurement. Axioms of extension deal with the representation of such attributes as time duration, length, and mass, which can be combined or concatenated, for multiple objects exhibiting the attribute in question. Axioms of difference govern the measuring of intervals. Axioms of cojointness postulate that attributes that cannot be measured empirically (for example, loudness, or intelligence**,** or hunger) can be measured by observing the way their component dimensions change in rela-

однозначность, что является выражением степени приближения выбранного обозначения к единственно возможному варианту для данного объекта или явления.

В качестве основы теории измерений были сформулированы различные системы аксиом или основных правил и допущений. Некоторые из самых важных аксиом – это аксиомы порядка, аксиомы увеличения, аксиомы различия, аксиомы совместимости и геометрические аксиомы. Аксиомы порядка обеспечивают то, что порядок, приданный объектам присваиванием чисел, является тем самым порядком, который действительно достигается в ходе наблюдений или измерений. Аксиомы увеличения имеют дело с такими атрибутами, как продолжительность времени, длина и масса, которые можно комбинировать или соединять для множественных объектов, имеющих атрибуты, о которых идёт речь. Аксиомы различия регулируют измерение интервалов. Аксиомы соединения допускают что атрибуты, которые невозможно измерить

tion to each other. Axioms of geometry govern the representation of dimensionally complex attributes by pairs of numbers, triples of number, or even ***n***-tuples of numbers.

эмпирически (например, громкость, интеллект или голод), можно измерить, наблюдая то, как составляющие их параметры изменяются по отношению друг к другу. Геометрические аксиомы регулируют отображение сложномерных атрибутов посредством двойных, тройных и множественных чисел.

The problem of error is one of the central concerns of measurement theory. At one time it was believed that errors of measurement could eventually be eliminated through the refinement of scientific principles and equipment. This belief is no longer held by most scientists, and almost all physical measurements reported today are accompanied by some indication of the limitation of accuracy or the probable degree of error. Among the various types of error that must be taken into account are errors of observation (which include instrumental errors, personal errors, systematic errors, and random errors) errors of sampling, and direct and indirect errors (in which one erroneous measurement is used in computing other measurements).

Проблема ошибки – один из центральных вопросов теории измерений. Когда-то полагали, что с ошибками измерения можно покончить посредством совершенствования научных принципов и оборудования. Большинство учёных уже не придерживаются этого мнения, и почти все физические измерения, о которых сообщается сегодня, сопровождаются обозначением ограничения точности или возможной степени ошибки. Среди различных типов ошибок, которые следует принимать в расчёт, ошибки при наблюдении (которые включают ошибки приборов, ошибки человека, систематические ошибки и случайные ошибки), ошибки выборки, прямые и косвенные ошибки (когда одно ошибочное

Measurement theory dates back to the 4th century BC, when a theory of magnitudes developed by the Greek mathematicians Eudoxus of Cnidus and Thaecatetus was included in Euclid's ***Elements***. The first systematic work on observational error was produced by the English mathematician Thomas Simpson in 1757, but the fundamental work on error theory was done by two 18th-century French astronomers, Joseph-Louis, Count de Lagrange, and Pierre-Simon, Marquess de Laplace. The first attempt to incorporate measurement theory into the social sciences also occurred in the 18th century, when Jeremy Bentham, a British utilitarian moralist, attempted to create a theory for the measurement of value. Modern axiomatic theories of measurement derive from the work of two German scientists, H. L. F. von Helmholtz and L.O. Hölder, and contemporary work on the application of measurement theory to psychology and economics derives in large part from the work of Oskar Morgenstern and John von Neumann.

измерение используется для расчёта других измерений).

Теория измерений восходит к 4-му веку до н.э., когда теория величин, разработанная греческими математиками Евдоксом Книдским и Феэтетом (Теэтетом) Афинским была включена в ***Начала*** Евклида. Первая систематическая работа по ошибкам наблюдения проводилась английским математиком Томасом Симпсоном в 1757 г., однако, фундаментальная работа по теории ошибок была проделана французскими астрономами 18-го века Жозефом Луи графом де Лагранжем и Пьером Симоном маркизом де Лапласом. Первые попытки включить теорию измерений в социальные науки также предпринимались в 18-м веке, когда Иеремия Бентам, английский философ-моралист, основоположник философии утилитаризма, попытался создать теорию измерения ценности. Современные аксиоматические теории измерения развиваются на основе работы двух немецких учёных Г.Л.Ф. Гельмгольца и Л.О. Гольде, а современные работы по примене-

нию теории измерений в психологии и экономике по большей части берут своё начало в работах Оскара Моргенштерна и Джона фон Ньюмана.

Since most social theories are speculative in nature, attempts to establish standard measuring sequences or techniques for them have met with limited success. Some of the problems involved in social measurement include the lack of universally accepted theoretical frameworks and thus of quantifiable measurands**,** sampling errors, problems associated with the intrusion of the measurer on the object being measured, and the subjective nature of the information received from human subjects**.** Economics is probably the social science that has had the most success in adopting measurement theories, primarily because many economic variables (like price and quantity**)** can be measured easily and objectively. Demography has successfully employed measurement techniques as well, particularly in the area of mortality tables.

Поскольку социальные теории по своей природе умозрительны, попытки разработать стандартную последовательность проведения или приёмы измерений имели ограниченный успех. Некоторые проблемы социальных измерений – это отсутствие универсально принятых теоретических стержневых систем и, таким образом, измеряемых величин, поддающихся количественному определению, ошибки выборки, проблемы, связанные с воздействием измеряющего на измеряемый объект, и субъективный характер информации, получаемой от испытуемых людей. Экономика, возможно, является той социальной наукой, в которой теории измерений применяются наиболее успешно, так как многие переменные в экономике (такие как цена и количество) можно измерить просто и объективно. В демографии также используются методы измерения, в особенности при составлении таблиц смертности.

***5. Answer the questions given below, retell the text using these questions as a plan***

1. What does measurement theory study?
2. What problems does it deal with?
3. What is the basis for measurement theory?
4. What are the most important types of axioms?
5. What is one of the central concerns of measurement theory?
6. What types of errors should be taken into account?
7. What period of time does measurement theory date back?
8. Whose works do modern axiomatic theories and work on application measurement theory to psychology and economics derive from?
9. Why have attempts to establish standard measuring sequences or techniques in social theories met with limited success?
10. What are the problems in social measurement?
11. What social sciences have had the most success in adopting measurement theories?

***6. Insert the missing words and translate the text making necessary changes in the word forms. Translate the text***

Measurement is accomplished through the comparison of a … with some known …of the same kind. The term weights and measures … those … quantities by which such comparisons are achieved. Standard quantities may be established … or by reference to some universal …. Standards for different … of quantities may develop separately or may be … into logical systems of units. Originally standard … were four in number: those for mass (…), volume **(**liquid or dry measure), length, and area. To

1. quantity
2. measurand
3. measure
4. constant
5. kinds
6. weight
7. arbitrarily
8. others

these have been added standard measurement of temperature, luminosity, pressure, electric current, and....

9. integrate
10. standard
11. signify

### *7. Make the written translation of the following*

Now the standard system in most nations, the metric system has been modernized to take into account 20th-century technological advances. In Paris in I960 an international convention agreed on a new metric-based system of units. This was the Systéme Internationale (SI). Six base units were adopted: the metre (length), the kilogram (mass), second (time), the ampere (electric current), the degree Kelvin (temperature), and the candela (luminosity). Each was keyed to a standard value. The kilogram was represented by a cylinder of platinum-indium alloy kept at the International Bureau of Weights and Measures in Sévres, France, with a duplicate at the U.S. National Bureau of Standards. The kilogram is the only one of the six units represented by a physical object as a standard. In contrast, the metre was set to be 1,650,763.73 wavelengths in vacuum of the orange-red line of the spectrum of krypton-86, and the other units were related to similarly derived natural standards.

Other units derived from basic SI units include the coulomb (charge), joule (energy), newton (force), hertz (frequency), watt (power), ohm (resistance), and cubic metre (volume).

## UNIT 5

# *SENSORS*

***1. Study the words and find the sentences with these words in the text, translate them***

| | | |
|---|---|---|
| 1. | to sense | – определять, обнаруживать, распознавать, опознавать, воспринимать, считывать, зондировать, измерять, контролировать |
| 2. | sensor | – датчик, чувствительный элемент, сенсор; детектор, устройство считывания |
| 3. | to detect | – обнаруживать, выпрямлять, детектировать, демодулировать |
| 4. | detector | – обнаружитель, устройство обнаружения, индикатор, детектор, демодулятор, чувствительный (воспринимающий) элемент, датчик, первичный измерительный преобразователь |
| 5. | compound | – состав, смесь, составной, сложный, (химическое) соединение |
| 6. | to indicate | – указывать, показывать, обозначать, измерять индикатором, снимать индикаторные диаграммы |
| 7. | indicator | – индикатор, указатель, (измерительный) прибор, стрелка, указатель (измерительного прибора), устройство отображения |
| 8. | mercury['mWkjVri] | – ртуть, ртутный |
| 9. | to meter | – измерять, мерить, замерять |
| 10. | meter | – метр, измерительный прибор, измеритель, счётчик, дозатор |
| 11. | an analog to digital converter | – аналого-цифровой преобразователь (АЦП) |
| 12. | MEMS (microelectro-mechanical systems) | – МЭМС (микроэлектромеханические системы) |

13. property ['prɔpqti] – свойство, качество, характеристика, способность
14. proportional [prq'pLSnql] – пропорциональный, соразмерный
15. gain – увеличение, усиление, (при)рост, коэффициент усиления
16. to clip – зажимать, крепить, отрубать, обрезать, ограничивать, отсекать, отбрасывать
17. offset – смещение, сдвиг, уход, отклонение
18. bias – смещение, отклонение, систематическое отклонение (погрешность, ошибка)
19. amount – величина, степень, количество, доза, сумма
20. behaviour – характеристика, свойства, поведение (системы), режим (работы), протекание (процесса), работа (конструкции, материала), характер изменения (кривой)
21. range – диапазон, интервал, пределы, зона, область, амплитуда, область значений
22. to note – записывать, составлять комментарии, упоминать, обозначать, значить, указывать
23. dynamic error – динамическая погрешность
24. function – функция, назначение, функциональная зависимость
25. approximation error – погрешность приближения, погрешность аппроксимации
26. digitization error – погрешность оцифровки (дискретизации)
27. sampling frequency – частота дискретизации
28. calibration – поверка (средств измерения), градуирование, калиброваниe, точное измерение, точное определение (характеристики или свойства средств измерений)
29. strategy – стратегия, концепция, методология, методика, алгоритм, поведение
30. to fluctuate – флуктуировать, колебаться, пульсировать, отклоняться
31. digital display – цифровая индикация, цифровое отображение, цифровой дисплей, цифровой индикатор
32. electron tunneling – туннелирование электронов

***2. Match the pairs of antonyms above and below the line***

Physical; output; progress; sensitivity; discrete; systematic; limited; different; error.

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Retreat; boundless; mental; random; similar; indifference; accuracy; continuous; input.

***3. Word-building***

*1. Form from the verbs given below nouns denoting persons or devices carrying out the action of the verb and translate them*: to sense, to detect, to indicate, to direct, to read, to scan, to process.

2. *Form from the adjectives with the help of the negative prefixes according to the model and translate them.*

in-, il-, im-, ir- + Adj = Adj (not) *infinite; illicit; immoral*; *irrelevant*

sensitive, significant, direct, dependent, discrete, personal, perfect, mobile, literate, logical, regular, resolute.

***4. Read the text and study its translation***

**SENSORS**

A sensor is a physical device or biological organ that detects, or senses, a signal or physical condition and chemical compounds. Most sensors are electrical or electronic, although other types exist. A sensor is a type of transducer. Sensors are either direct indicating (e.g. a mercury thermometer or electrical meter) or are paired with an indicator (perhaps indirectly through an analog to digital converter, a computer and a display) so that the value sensed becomes human readable. In addition to other applications, sensors

Датчик – физический прибор или биологический орган, который обнаруживает или определяет какой-либо сигнал или физическое состояние и химический состав. Большинство датчиков электрические или электронные, однако, существуют и другие типы. Датчик – своего рода преобразователь. Датчики либо непосредственно являются контрольно-измерительными приборами (например, ртутный термометр или электрический счётчик) либо подсоединяются к контрольно-измери-

are heavily used in medicine, industry and robotics. Technical progress allows more and more sensors to be manufactured with MEMS technology. In most cases this offers the potential to reach a much higher sensitivity. Sensors can be classified according to the type of energy transfer that they detect:

1. Thermal sensors
2. Electromagnetic sensors
3. Mechanical sensors
4. Chemical sensors
5. Optical and radiation sensors
6. Acoustic sensors

and other types of sensor.

A good sensor obeys the following rules: the sensor should be sensitive to the measured property, the sensor should be insensitive to any other property, and the sensor should not influence the measured property. In the

тельным приборам (возможно через аналогово-цифровой преобразователь, компьютер или дисплей), таким образом, чтобы зарегистрированную величину можно было прочитать. Помимо прочего, датчики широко используются в медицине, промышленности и робототехнике. Технический прогресс позволяет производить всё большее количество датчиков с использованием технологии микроэлектромеханических систем. Датчики можно классифицировать по типу передачи энергии, которую они обнаруживают:

1. Тепловые датчики
2. Электромагнитные датчики
3. Механические датчики
4. Химические датчики
5. Оптические и радиационные датчики
6. Акустические датчики и другие типы датчиков.

Хороший датчик соответствует следующим правилам: датчик должен быть чувствителен по отношению к измеряемой характеристике, датчик не должен быть чувствителен по отношению к любой другой характе-

ideal situation, the output signal of a sensor is exactly proportional to the value of the measured property. The gain is then defined as the ratio between output signal and measured property. For example, if a sensor measures temperature and has a voltage output, the gain is a constant with the unit.

If the sensor is not ideal, several types of deviations can be observed: the gain may in practice differ from the value specified. This is called a gain error. Since the range of the output signal is always limited, the output signal will eventually clip when the measured property exceeds the limits. The full scale range defines the outmost values of the measured property where the sensor errors are within the specified range. If the output signal is not zero when the measured property is zero, the sensor has an offset or bias. This is defined as the output of the sensor at

ристике и датчик не должен воздействовать на определяемую характеристику. В идеальной ситуации выходной сигнал датчика в точности соответствует величине измеряемой характеристики. Коэффициент усиления тогда определяется как соотношение между выходным сигналом и измеряемой характеристикой. Например, если датчик измеряет температуру и даёт выходные данные в вольтах, усиление является постоянной величиной с определённой единицей измерения.

Если датчик не идеален, можно наблюдать несколько типов отклонений. Усиление на практике может отличаться от указанной величины. Это называется погрешностью усиления. Поскольку диапазон выходного сигнала всегда ограничен, выходной сигнал будет в конечном итоге ограничиваться, когда измеряемая характеристика превысит ограничения. Полный диапазон определяет самые крайние величины измеряемой характеристики, когда погрешности датчика находятся в точно определённых пределах. Если

zero input. If the gain is not constant, this is called nonlinearity. Usually this is defined by the amount the output differs from ideal behaviour over the full range of the sensor, often noted as a percentage of the full range. If the deviation is caused by a rapid change of the measured property over time, there is a dynamic error. Often, this behaviour is described with a Bode plot showing gain error and phase shift as function of the frequency of a periodic input signal. If the output signal slowly changes independent of the measured property, this is defined as drift. Long term drift usually indicates a slow degradation of sensor properties over a long period of time. Noise is a random deviation of the signal that varies in time. Hysteresis is an error caused by the fact that the sensor not instantly follows the change of the property being measured, and therefore involves the history of the measured property. If the sensor has a digital output, the signal is discrete and is essentially an approximation of the measured property. The approximation error is also called digitization error. If

выходной сигнал не равняется нулю, когда измеряемая характеристика равна нулю, у датчика имеется отклонение или систематическая погрешность. Это определяется как выходной сигнал датчика при нулевом входном сигнале. Если усиление не является постоянным, это называется нелинейной характеристикой. Обычно это определяется степенью отклонения выходного сигнала от идеального поведения в пределах всей области значений датчика, часто обозначаемого как процент от всей области значений. Если отклонение вызвано быстрым изменением измеряемой характеристики в течение какого-то промежутка времени, то это динамическая погрешность. Часто данная характеристика описывается с помощью графика Боде, изображающего погрешность усиления и фазовый сдвиг как функцию частоты периодического входного сигнала. Если выходной сигнал медленно изменяется независимо от измеряемой характеристики, это называется дрифт (отклонение). Долговременный

the signal is monitored digitally, limitation of the sampling frequency also causes a dynamic error. The sensor may to some extent be sensitive for other properties than the property being measured. For example, most sensors are influenced by the temperature of their environment.


дрифт является показателем ухудшения характеристик датчика в течение длительного периода времени. Шум – это случайное отклонение сигнала, которое со временем меняется. Гистерезис – это погрешность по причине того, что датчик не мгновенно отражает изменения измеряемой характеристики и поэтому включает всю динамику процесса измерения данной величины. Если выходной сигнал датчика в цифровом виде, этот сигнал дискретен и представляет собой в основном приблизительное значение измеряемой характеристики. Эта погрешность приближения также называется погрешностью оцифровки. Если сигнал регулируется дискретно, ограниченность частоты дискретизации также вызывает динамическую погрешность. Датчик в некоторой степени может быть чувствителен к другим характеристикам, а не только по отношению к измеряемой характеристике. Например, на показания большей части датчиков оказывает воздействие температура окружающей среды.

All these deviations can be classified as systematic errors or random errors. Systematic errors can sometimes be compensated for by means of some kind of calibration strategy. Noise is a random error that can be reduced by signal processing, such as filtering, usually at the expense of the dynamic behaviour of the sensor.

The resolution of a sensor is the smallest change it can detect in the quantity that it is measuring. Often in a digital display, the least significant digit will fluctuate, indicating that changes of that magnitude are only just resolved. The resolution is related to the precision with which the measurement is made. For example, a scanning probe (a fine tip near a surface collects an electron tunnelling current) can resolve atoms and molecules.

Все эти отклонения можно классифицировать как систематические и случайные погрешности. Систематические погрешности можно иногда компенсировать посредством какого-нибудь метода поверки. Шум – случайная погрешность, которую можно снизить с помощью обработки сигнала, такой как фильтрация обычно за счёт динамической характеристики датчика.

Разрешение датчика – это самое маленькое изменение, которое он может обнаружить в измеряемой величине. Очень часто наименее значительные цифры на цифровом отображении пульсируют, отмечая, что только что получили разрешение изменения данной величины. Это разрешение отражает точность, с которой проводится измерение. Например, сканирующая головка (тонкий наконечник у поверхности собирает ток электронов, совершающих туннельный переход) может давать разрешение для атомов и молекул.

### *5. Find the English equivalents of the following in the text*

ограниченность частоты дискретизации; туннелирование электронов; при нулевом входном сигнале; аналогово-цифровой преобразователь; с использованием технологии микроэлектромеханических систем; выходной сигнал датчика; соотношение между выходным сигналом и измеряемой характеристикой; в точно определённых пределах; погрешность приближения; случайное отклонение сигнала; воздействие температуры окружающей среды; в точности соответствует величине измеряемой характеристики; систематические погрешности; за счёт динамической характеристики датчика; приблизительное значение измеряемой характеристики; можно наблюдать несколько типов отклонений; разрешение; химический состав.

### *6. Say whether the following is true, partially true or false*

1. A sensor is a biological organ that is sensitive to different physical aspects of the external environment.
2. Sensors are practically used everywhere.
3. All sensors are paired with an indicator through an analog to digital converter, a computer and a display so that the value sensed becomes human readable.
4. Hysteresis is an error of approximation.
5. Technical progress allows more and more sensors to be manufactured with MEMS technology.
6. If the sensor has a digital output, the signal is analog and exactly corresponds to the measured property.
7. Sensors can be classified according to the output signal.
8. If the output signal is not zero when the measured property is zero, the sensor has an offset or bias.
9. Long term drift usually indicates that the output signal needs filtering.
10. Noise is a systematic error that can sometimes be compensated for by means of some kind of calibration strategy.

### *7. Answer the questions given below and retell the text according to them*

1. What is a sensor?
2. What types of sensors exist?
3. How do sensors work?
4. Where are sensors applied?

5. In what way does technical progress affect sensors manufacturing?
6. How can sensors be classified?
7. What rules does a good sensor obey?
8. How does the output signal of a sensor behave in the ideal situation?
9. How is the gain defined?
10. What errors or deviations can be observed in the work of a sensor if the situation is not ideal?
11. How can sensor errors be classified and compensated?
12. What is the resolution of a sensor?
13. How can the resolution be observed and what is it related to?

## *LEVEL SENSOR*

***1. Study the words and find the sentences with these words in the text, translate them***

1. physical variables – физические параметры, переменные
2. monitoring – (текущий) контроль, наблюдение
3. to affect [q'fect] – воздействовать, влиять
4. criterion (pl.criteria) [krai'ti(q)riqn] – критерий, мерило, признак, условие
5. state – состояние
6. liquid – жидкий, жидкость
7. solid – твёрдый, твёрдое тело, сухое вещество
8. slurry – взвесь, раствор, шлам
9. vacuum – вакуум, разреженное пространство
10. chemistry – химия, химический состав
11. pressure – давление
12. dielectric constant of medium – диэлектрическая постоянная среды
13. density – плотность

14. medium ['mJdiqm] – окружающая среда, атмосфера, среда, вещество, материал;
15. specific gravity – удельный вес
16. agitation ["xGi'teiS(q)n] – возмущение, возбуждение
17. acoustical or electrical noise – акустический или электрический шум
18. mechanical shock – механический удар
19. tank – резервуар, цистерна
20. bin – бункер
21. size – размер
22. shape – форма
23. application constraints – ограничения использования
24. appearance – внешний вид
25. response – реакция (на воздействие), срабатывание (устройства), ответ, отклик, выходной сигнал
26. response rate – скорость срабатывания
27. calibration – калибровка
28. mounting – монтаж
29. continuous – непрерывный
30. discrete – дискретный
31. level – уровень
32. level sensor – датчик уровня
33. highly fluidized ['flHidaizd] powders – (псевдоожиженные) порошкообразные вещества с повышенной текучестью
34. chemical compatibility – химическая совместимость
35. buildup – увеличение, нарастание (параметров), накопление, нарост, наплыв
36. conductivity – проводимость, удельная проводимость

37. humidity – влажность
38. moisture content – содержание влаги
39. viscosity – вязкость, коэффициент вязкости
40. induced – вызванный, индуцированный
temperature-induced changes – изменения, вызванные температурой
41. buoyancy ['bOiqnsi] – плавучесть, подъёмная сила
42. shield – защита, защитное устройство, щит, щиток, козырёк, (защитный) экран
43. turbulence – турбулентность
44. wave motion – движение волн
45. solvent – растворитель
46. to verify – проверять, контролировать, поверять, выверять, подтверждать, устанавливать подлинность (чего-либо)
47. sludge [slAG] – грязь, слякоть, ил, осадок, отстой
48. technology – техника, технология, техническое решение, метод, способ
49. interface – поверхность раздела, граница раздела, межфазная граница

***2. Find below the line the English equivalents of the following Russian words and expressions from the texts of task 4***

Диэлектрическая постоянная, удельный вес, вибрационные датчики уровня, быстрота срабатывания, поплавковые датчики уровня, включение или выключение механического переключателя, легкость калибровки, акустический или электрический шум, выбор частоты вибрации, другие датчики, сухие гранулированные вещества, содержание влаги.

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Other sensing technologies, acoustical or electrical noise, the opening or closing of a mechanical switch, vibrating level sensors, float level sensors, granular solids response rate, ease of calibration,moisture content, selection of vibration frequency, dielectric constant, specific gravity.

***3. Read the texts and study their translations, answer the questions below the texts***

## LEVEL SENSORS

There are many physical and application variables that affect the selection of the optimal level monitoring solution for industrial and/or commercial processes. The selection criteria include the physical: state (liquid, solid or slurry), temperature, pressure or vacuum, chemistry, dielectric constant of medium, density or specific gravity of medium, agitation, acoustical or electrical noise, vibration, mechanical shock, tank or bin size and shape; and the application constraints: price, accuracy, appearance, response rate, ease of calibration or programming, physical size and mounting of the instrument, monitoring or control of continuous or discrete (point) levels.

Имеется множество параметров, связанных с физическим состоянием веществ и областью применения оборудования, которые влияют на выбор оптимального решения при контроле уровня вещества в промышленных и/или коммерческих процессах. Критерии выбора включают физические параметры: состояние вещества (жидкое, твёрдое или взвесь), температуру, давление и вакуум, химический состав, диэлектрическую постоянную среды, её плотность или удельный вес, возбуждение, акустический или электрический шум, вибрацию, механический удар, размер или форму резервуара или бункера, а также параметры, связанные с ограничениями сферы применения, такие как: цена, точность, внешний вид, быстрота срабатывания, легкость калибровки или программирования, габаритные размеры и монтаж прибора, контроль или управление непрерывным или дискретным (точечным) измерением уровня.

**Questions**

1. What affects the selection of the optimal level monitoring solution?
2. What do the selection criteria include?

### *Vibrating Point Level Sensors*

Vibrating level sensors are designed for level detection of very fine powders and granular solids. With proper selection of vibration frequency and density, suitable sensitivity adjustments, the level of highly fluidized powders and electrostatic materials can also be sensed. Single-probe vibrating level sensors are ideal for highly static bulk powder environments. Since only one sensing element contacts the powder, bridging between two probe elements is eliminated and media buildup is minimized. Vibrating level sensor technology offers other advantages: The vibration of the probe itself tends to eliminate buildup of material on the probe element; and they are not affected by dust, static-charge buildup from dielectric powders, or changes in conductivity, temperature, pressure or humidity/moisture content. Tuning fork style vibration sensors are another alternative. They tend to have a lower price point, but are prone to material buildup between the forks.

### *Вибрационные датчики уровня для точечных измерений*

Вибрационные датчики уровня предназначены для определения уровня очень тонких порошкообразных и сухих гранулированных веществ. При должном выборе частоты вибрации и плотности, а также необходимой наладке чувствительности можно также определять уровень порошкообразных веществ, обладающих повышенной текучестью, и электростатических материалов. Вибрационные датчики уровня с одним сенсорным щупом являются идеальным средством для нерасфасованных порошкообразных веществ, обладающих повышенными статическими свойствами. Поскольку с порошком контактирует только один чувствительный элемент, устраняется возникновение мостового соединения между двумя чувствительными элементами и минимизируется формирование налёта. Технология применения вибрационных датчиков уровня имеет ряд других преимуществ: вибрация самого сенсорного щупа предотвращает налипание на нем вещества, и на них

*Rugged Miniature Vibration Sensor*

также не воздействует пыль, не налипают частички диэлектрических порошков, обладающих статическим зарядом, не влияют изменения проводимости, температуры или уровень влажности/содержания влаги. Другой альтернативой являются настраивающиеся вибрационные датчики вилочного типа. Как правило, они недороги, но предрасположены к скоплению вещества в вилочных деталях.

**Questions**

1. What are vibrating level sensors designed for?
2. How can the level of highly fluidized powders and electrostatic materials be sensed?
3. Why are single-probe vibrating level sensors ideal for highly static bulk powder environments?
4. What other advantages does vibrating level sensor technology offer?
5. Are there any disadvantages of vibrating level sensor technology? What are they, if any?

### *Magnetic and Mechanical Float Level Sensors*

The principle behind magnetic, mechanical, cable, and other float level sensors involves the opening or closing of a mechanical switch, either through direct contact with the switch, or magnetic operation of a reed. With magnetically actuated float sensors, switching occurs when a permanent magnet sealed inside a float rises or falls to the actuation level. With a me-

### *Магнитные и механические поплавковые датчики уровня*

Принцип, лежащий в основе работы магнитных, механических, кабельных и других поплавковых датчиков уровня, заключается во включении или выключении механического переключателя либо посредством прямого контакта с переключателем, либо с помощью приводимого в движение магнитом язычка. В магнитных поплавковых датчиках

chanically actuated float, switching occurs as a result of the movement of a float against a miniature (micro) switch. For both magnetic and mechanical float level sensors, chemical compatibility, temperature, specific gravity (density), buoyancy, and viscosity affect the selection of the stem and the float. For example, larger floats may be used with liquids with specific gravities as low as 0.5 while still maintaining buoyancy. The choice of float material is also influenced by temperature-induced changes in specific gravity and viscosity changes that directly affect buoyancy.

Float-type sensors can be designed so that a shield protects the float itself from turbulence and wave motion. Float sensors operate well in a wide variety of liquids, including corrosives. When used for organic solvents, however, one will need to verify that these liquids are chemically compati-

уровня включение происходит, когда постоянный магнит, герметически запаянный внутри поплавка, либо поднимается, либо опускается для включения. В механических поплавковых датчиках уровня включение происходит в результате движения поплавка с помощью миниатюрного (микро) переключателя. И для магнитных, и для механических поплавковых датчиков уровня такие качества, как химическая совместимость, температура, удельный вес (плотность), плавучесть и вязкость, влияют на выбор стержня и поплавка. Например, поплавки больших размеров могут использоваться в жидкостях с низкой удельной плотностью до 0,5, при этом сохраняя плавучесть. На выбор материала для поплавка также влияют зависящие от изменений температуры изменения удельной плотности и вязкости, которые прямо влияют на плавучесть.

Датчики поплавкового типа можно спроектировать таким образом, чтобы защитное устройство защищало поплавок от турбулентности и движения волн. Поплавковые датчики хорошо работают в самых разнообразных жидкостях, включая коррозийные (агрес-

ble with the materials used to construct the sensor. Float-style sensors should not be used with high viscosity (thick) liquids, sludge or liquids that adhere to the stem or floats, or materials that contain contaminants such as metal chips; other sensing technologies are better suited for these applications.

A special application of float type sensors is the determination of interface level in oil-water separation systems. Two floats can be used with each float sized to match the specific gravity of the oil on one hand, and the water on the other. Another special application of a stem type float switch is the installation of temperature or pressure sensors to create a multi-parameter sensor. Magnetic float switches are popular for simplicity, dependability and low cost.

сивные). Однако при их использовании в органических растворителях необходимо проверить, чтобы эти жидкости были химически совместимы с материалами, использованными для создания датчика. Датчики поплавкового типа не рекомендуется использовать в работе с жидкостями с высокой вязкостью (густых жидкостях), с отстоем или жидкостями, которые налипают на стержень или поплавок, или с материалами, которые содержат загрязнения, такие как металлическая стружка, для этих случаев лучше подходят другие датчики.

Особая область применения датчиков поплавкового типа – определение уровня границы раздела в системе сепарации нефтеводяной смеси. Можно использовать два поплавка, размеры которых соответствуют удельной плотности нефти, с одной стороны, и воды – с другой. Ещё одна особая область применения переключателя поплавкового типа – установка датчиков температуры или давления для создания многопараметрового датчика. Популярны магнитные поплавковые переключатели из-за их простоты, надёжности и низкой стоимости.

**Questions**

1. What does the principle behind magnetic, mechanical, cable, and other float level sensors involve?
2. How does switching occur with magnetic and mechanical float sensors?
3. What affects the selection of the stem and the float for both magnetic and mechanical float level sensors?
4. What is the choice of float material also influenced by?
5. In what way can float-type sensors be protected from turbulence and wave motion?
6. What media do float sensors operate well in?
7. What should be done when float sensors are used for organic solvents?
8. What media should float-style sensors not be used in?
9. What are the special applications of float type sensors?
10. What float switches are popular and why?

***4. Tell about level sensors according to the plan***

1. Variables affecting the selection of the level monitoring sensors for industrial and/or commercial processes.
2. Materials that vibrating level sensors are designed for level detection of.
3. Advantages and disadvantages of vibrating level sensors.
4. The principle behind the work of magnetic, mechanical, cable, and other float level sensors.
5. Factors affecting the selection of the stem and the float.
6. Materials with which float sensors are used.
7. Special applications of float sensors.
8. Advantages and disadvantages of float level sensors.

***5. Make the written translation of the following using a dictionary and vocabulary to the previous texts***

***CAPACITANCE LEVEL SENSORS***

Capacitance level sensors (also called RF) excel in sensing the presence of a wide variety of solids, liquids, and slurries. The technique is frequently referred

to as RF for the radio frequency signals applied to the capacitance circuit. Dual-probe capacitance dielectric constant level sensors can also be used to sense the interface between two immiscible liquids with substantially different dielectric constants, providing a solid state alternative to the magnetic float switch for the "oil-water interface" application.

Since capacitance level sensors are electronic devices, phase modulation and the use of higher frequencies makes the sensor suitable for applications in which dielectric constants are similar. The sensor contains no moving parts, is rugged, simple to use, easy to clean, and can be designed for high temperature and pressure applications. A danger exists from build up and discharge of a high-voltage static charge that results from the rubbing and movement of low dielectric materials, but this danger can be eliminated with proper design and grounding.

Appropriate choice of probe materials reduces or eliminates problems caused by abrasion and corrosion.

***6. Read the beginning of the dialogue and finish it using the texts and questions to the texts as well as the expressions on pages 16 – 17***

– Do you know that overfill of a tank or vessel is one of the largest single causes of fire, explosion, and toxic waste spills in the process field? And the only practical way to prevent spillage was to measure the level with a level sensor.
– And there are many physical and application variables that affect the selection of the optimal level sensor for industrial and/or commercial processes. We should take into account the physical factors such as: state, temperature, pressure or vacuum, chemistry, dielectric constant density or specific gravity; and the application constraints: price, accuracy, appearance, response rate, ease of calibration or programming and so on…
– Some level sensors are used for solids only, some for liquids, others for both solids and liquids. Let's take vibrating level sensors for example they are deigned for...
– And if we consider magnetic and mechanical float level sensors ...

## UNIT 6

# *BURGLAR ALARM*

***1. Study the words and find the sentences with these words in the text, translate them***

| | |
|---|---|
| 1. alarm | – тревога, сигнал тревоги, сигнальное устройство, сигнализация, аварийная сигнализация |
| 2. burglar (or intrusion) alarm | – охранная сигнализация |
| 3. fire alarm | – пожарная сигнализация |
| 4. safety alarm | – аварийная сигнализация |
| 5. to elicit | – извлекать, выявлять, делать вывод, добиться |
| 6. sophistication | – утончённость, изощрённость, усложнение, усложнённость |
| 7. to range (from... to...) | – колебаться в определённых пределах (от… до…) |
| 8. alarm systems | – система аварийной сигнализации |
| 9. intrusion detector | – устройство охранной сигнализации |
| 10. photocell | – фотоэлемент |
| 11. beam | – пучок, луч |
| 12. fibre-optic bend sensor | – волоконно-оптический изгибный датчик |
| 13. fibre-optic stress sensor | – волоконно-оптический датчик напряжений |
| 14. proximity switch | – бесконтактный переключатель |
| 15. ultrasonic transducer | – ультразвуковой измерительный преобразователь |
| 16. passive infrared (heat) detector | – пассивный детектор ИК-излучения, (тепловой детектор) |
| 17. surveillance | – наблюдение, контроль, обзор |
| 18. fire alarm sensor | – датчик пожарной сигнализации |
| 19. smoke detector | – индикатор дыма |
| 20. flame detector | – пламенно-температурный детектор |

*2. Read the text and study its translation, make the plan of the text*

## BURGLAR ALARM

Burglar (or intrusion), fire and safety alarms are found in electronic form today. A system of sensors is connected to a control unit, which in turn connects to a means for announcing the alarm, to elicit some response. Some systems are dedicated to one mission; others handle fire, intrusion, and safety alarms simultaneously. Sophistication ranges from small, self-contained noisemakers, to complicated, multizoned digital systems with colour-coded computer monitor outputs. Many of these concepts also apply to portable alarms for protecting cars, trucks or other vehicles and their contents (i.e., "car alarms"). Burglar alarms are sometimes referred to as alarm systems.

Охранная, пожарная и аварийная сигнализации существуют сейчас в электронном виде. Система датчиков подсоединена к блоку управления, который в свою очередь подсоединяется к извещателю, чтобы вызвать его срабатывание. Некоторые системы выполняют какую-то одну задачу, другие оповещают и о пожаре, и о проникновении, и о нарушении безопасности. Сложность устройств самая разнообразная − от небольших шумовых устройств до сложных многозоновых цифровых систем с выделяемыми цветом выходными сигналами на мониторе компьютера. Многие из этих идей используются в портативных сигнализациях для защиты легковых и грузовых автомобилей и других транспортных средств и их содержимого (так называемые «автомобильные сигнализации»). Охранные сигнализации часто называют просто системами аварийной сигнализации.

Intrusion detectors are generally of two

Датчики охранной сигнализации

classes: point detectors and area (or volume) detectors. Point detectors indicate an intrusion at a specific point, and types include mechanical or magnetic contacts on doors and windows to detect when they are opened or broken, photocell or microwave beams across pathways, pressure-sensitive mats, fibre-optic bend or stress sensors (e.g., for wire fences), proximity switches that detect humans, and vibration sensors, among others. Area detectors indicate an intruder's presence within the protected area and use such technologies as ultrasonic transducers, passive infrared (heat) detectors, and microwave transducers (sometimes in combinations within one sensor). In general, area sensors detect a sudden change in the measurements being taken and trigger at some predetermined threshold. They are much more prone to false alarms than point sensors, often because of improper aiming or other adjustments. Sophisticated computer-aided sensors include image-processing systems to detect and filter changes in a surveillance video picture (possibly using infrared or other light

бывают обычно двух типов: точечные и поверхностные (или пространственные) датчики. Точечные датчики обнаруживают проникновение нарушителя в определённой точке и включают в себя механические или магнитные контакты на дверях и окнах для того, чтобы обнаружить, когда они открыты или взломаны; микроволновые лучи или лучи фотокамер на тропинках; чувствительные к давлению коврики; оптоволоконные изгибные датчики или датчики давления (например для проволочных заборов); бесконтактные переключатели, реагирующие на присутствие людей, и вибрационные датчики наряду с другими. Поверхностные датчики определяют присутствие нарушителя на охраняемой территории, и в них используются такие устройства, как ультразвуковые датчики-преобразователи, пассивные инфракрасные датчики (датчики тепла) и микроволновые датчики-преобразователи (иногда в сочетании с одним чувствительным элементом). В общем, поверхностные датчики регистрируют внезапное изменение в снимаемых измерениях и включаются на определён-

sources for the image), and can be programmed to detect or ignore different types of motion in different parts of the scene, and can tell the difference between a person and other moving objects. All of these sensors can be used separately or in combinations with others, often depending upon the value of what is being protected, and the budget allocated to reducing the risk of loss.

*Burglar alarm*

Fire alarm sensors are of three general categories: smoke, flame and heat. Smoke detectors are sensors that detect the chemical by-products of fire optically or by ionized conduction. Flame detectors react to the light spectrum of flames, either infrared or ultraviolet, or both. Modern designs can ignore welding flash and solar light. Heat detectors

ном уровне. Они более подвержены ложным срабатываниям, чем точечные датчики, часто из-за нечёткого наведения или других видов настройки. Сложные компьютеризированные датчики включают в себя систему обработки изображения для определения и фильтрования изменений картинки видеонаблюдений (возможно с использованием источников инфракрасного излучения или других световых источников в качестве изображения) и могут быть запрограммированы на детектирование и пропускание различных типов движения в разных частях охраняемой территории, они могут отличать людей от других движущихся объектов. Все эти датчики можно использовать по отдельности или в сочетании друг с другом, часто в зависимости от ценности охраняемого и от бюджета, предусмотренного для снижения риска потери.

Датчики пожарной сигнализации бывают трёх основных типов: индикаторы дыма, пламенно-температурные детекторы и детекторы тепла. Индикаторы дыма – это такие датчики, которые обнаруживают химические побочные продукты горения с помощью оптики или по-

react to a high temperature, or a rapid rate of temperature rise.


*A fire alarm sensor*

Safety detectors are more varied than the other sensors. They include thermostats for detecting excessively high or low temperatures, water sensors for flooding, excessive carbon monoxide concentrations (also available for other gases), low oxygen concentrations, electrical current on or off, gates and valves open or closed, water pressure available in sprinkler systems. Some intrusion detectors can also be used as safety sensors as well, such as detecting whether anyone is moving inside a room before a dangerous system is activated, or flashing a warning light if a cover is removed from an equipment panel. Similarly, a flame detector could serve a purpose as a safety sensor

средством ионной проводимости. Пламенно-температурные детекторы реагируют на световой спектр пламени либо инфракрасный, либо ультрафиолетовый, либо тот и другой вместе. Современные модели не реагируют на вспышку сварки и солнечный свет. Тепловые детекторы реагируют на высокую температуру или быстрое повышение температуры.

Датчики безопасности более разнообразны, чем другие виды датчиков. Они включают в себя (сюда относятся) термостаты для определения очень высокой или низкой температуры, датчики воды для определения затопления, датчики избыточной концентрации окиси углерода (а также других газов), низкой концентрации кислорода, наличия или отсутствия электрического тока, открытых или закрытых клапанов и затворов, давления воды в системе разбрызгивателей. Иногда датчики охранной сигнализации могут использоваться так же как датчики безопасности, к примеру, для определения, не передвигался кто-

where a flame is required, as in a heating system. A popular safety sensor for the elderly includes a portable transmitter that sends a signal to a local receiver when a button is pressed. The possibilities are endless, with inexpensive sensors for such things as whether the television set is on, or any other electrical appliance is on or off.

*Residential ceiling-mounted smoke detector*

нибудь по комнате до включения аварийной сигнализации или до того, как зажегся предупредительный световой сигнал, если снята защитная панель. Так, датчик пламени мог бы служить как датчик безопасности там, где пламя необходимо, например в обогревательной системе. Популярный датчик безопасности для пожилых людей снабжён портативным передатчиком, который посылает сигнал одному из местных приёмников при нажатии кнопки. Его возможности бесконечны, с помощью недорогого датчика можно узнать, включён или выключен телевизор или какой-то другой электрический прибор.

***3. Answer the questions given below and retell the text using the questions as a plan of your story***

1. In what form are different alarms found today?
2. What devices do they consist of?
3. How does the sophistication of alarm systems range?
4. What is a car alarm?
5. What classes of intrusion detectors can we come across today?
6. What is a point detector?
7. What types do point detectors include?

8. What do area detectors indicate and what technologies do they use?
9. What do area sensors detect in general?
10. What sensors are much more prone to false alarms and why?
11. What do computer-aided sensors include?
12. How can sophisticated computer-aided sensors be programmed?
13. How can all these sensors be used and what does it depend upon?
14. What categories of fire alarm sensors are there?
15. What are smoke detectors?
16. What do flame detectors react to? How precise are modern designs of flame detectors?
17. What do heat detectors react to?
18. What detectors are more varied? What devices do they include?
19. Can some detector change their mission? When?
20. What does a popular safety sensor for the elderly include? What are its possibilities?

### *4. Find the Russian equivalents of the following below the line*

To elicit response; serve a purpose as a safety sensor; an intruder's presence within the protected area; self-contained noisemakers; prone to false alarms; when a button is pressed; excessive carbon monoxide concentrations; to handle fire, intrusion and safety alarms simultaneously; reducing the risk of loss; proximity switches that detect humans; a control unit.

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Служить в качестве датчика безопасности; сокращение риска утраты; автономные шумовые устройства; если нажать кнопку; повышенная концентрация окиси углерода; блок управления; быть одновременно и пожарной, и охранной, и аварийной сигнализацией; добиться срабатывания; присутствие нарушителя на охраняемой территории; бесконтактные переключатели, реагирующие на присутствие людей; подвержены ложным срабатываниям.

### *5. Translate into English*

1. Датчики безопасности более разнообразны, чем другие виды датчиков.
2. Тепловые детекторы реагируют на высокую температуру или быстрое повышение температуры.

3. Так, датчик пламени мог бы служить как датчик безопасности там, где пламя необходимо, например в обогревательной системе.
4. Датчики охранной сигнализации бывают обычно двух типов: точечные и поверхностные (или пространственные) датчики.
5. Поверхностные датчики более подвержены ложным срабатываниям, чем точечные датчики, часто из-за нечёткого наведения или других видов настройки.
6. Популярный датчик безопасности для пожилых людей снабжён портативным передатчиком, который посылает сигнал одному из местных приёмников при нажатии кнопки.
7. Система датчиков подсоединена к блоку управления, который в свою очередь подсоединяется к извещателю, чтобы вызвать его срабатывание.

***6. Read and translate one student's story about his future profession, prepare your questions to him and tell about your future profession***

***MY PROFESSION IS PROTECTION SYSTEMS AND DEVICES OF LAW ENFORCEMENT***

I study at the Faculty of Radiophysics, Electronics and Medical Equipment of the Vladimir State University. It is one of the ten faculties of the University and trains engineers in various fields: radio engineers, engineers in computerized measurements, in protection systems and devices, in medical equipment, as well as engineers in electronics. I am going to specialize in electrical protection systems and devices for law-enforcement system.

Nowadays it has become extremely important to provide the adequate protection of industrial enterprises, power plants, banks, offices, places of residence, cars and valuables, computer information and, what is most significant, people.

The modern protection systems and devices are extremely diverse from the most sophisticated burglar-alarm systems to various intricate locks having different degrees of safety and secrecy.

To become good specialists in modern protection devices and systems students study electronics, applied optics, optical electronics, fibre optics, video and computers, new composite and high-strength materials, new technologies in design, manufacturing, maintenance and repairing various protection systems and devises.

Alongside with different technical disciplines students study special ones concerned with explosion techniques, assault and defense methods, law, different protection systems and the way they work, technical surveillance systems, the latest alarm systems and self-defense devices.

There is a great demand for specialists in protection systems at different enterprises and organizations because these systems are getting more and more sophisticated and diverse.

After the graduation we'll be able to work at different enterprises employing protection systems and organizations dealing in trading and servicing such systems.

### *7. Translate into Russian in writing using a dictionary*

**PASSIVE INFRARED SENSORS**

Passive infrared sensors are electronic devices which are used in some security alarm systems to detect motion of an infrared emitting source, usually a human body.

All objects, living or not, whose temperature is anything above absolute zero (−273,15 °C or −459,67 °F) emit infrared radiation. This radiation (energy) is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The term 'passive' in this instance means the passive infrared sensor does not emit any energy of any type but merely sits 'passive' accepting infrared energy through the 'window' in its housing. The heart of the sensor is a solid state 'chip', approximately ¼ inch square made from a pyroelectric material. This chip is mounted on a printed circuit board which also contains the necessary electronics required to interpret the signals from the chip. The printed circuit board is contained in the housing which is then mounted in a location where the chip can 'see' the area to be 'protected'. The window in the housing allows infrared energy to reach the chip. The window is covered with an infrared-

transparent (but only translucent to visible light) plastic sheet which may or may not have Fresnel lenses moulded into it. This plastic sheet prevents the intrusion of dust and insects while the Fresnel lenses, if present, focus the infrared energy onto the surface of the chip.

An intruder entering the protected area is detected when the infrared energy emitted from the intruder's body is focused by a Fresnel lens or a mirror segment and overlaps a section on the chip which had previously been looking at some much cooler part of the protected area. That portion of the chip is now much warmer than when the intruder was not there. As the intruder moves, so does the hot spot on the surface of the chip. This moving hot spot causes the electronics connected to the chip to de-energize the relay, operating its contacts, thereby activating the detection input on the alarm control panel.

**Notes**

| | |
|---|---|
| housing | корпус |
| window | отверстие |
| printed circuit board | печатная плата |
| Fresnel lens | линза Френеля |
| infrared-transparent | пропускающий инфракрасный свет |

***8. Translate into Russian in writing using a dictionary, write similar annotation about an alarm system***

***АННОТАЦИЯ К ДИПЛОМУ***

В данной работе рассмотрены конструкция / принципы действия / методы использования измерительного устройства, которое позволяет собирать информацию о технологических процессах. В работе приведены расчёты, экспериментальные исследования, характеристика данного устройства.

В технологической части проекта дано описание технических процессов обработки деталей конструкции с учётом безопасности жизнедеятельности, приведены расчёты влияния электромагнитных полей на безопасность человека.

В экономической части проекта дан расчёт себестоимости рассматриваемого устройства.

## UNIT 7

# *CLOCKS AND WATCHES*

***1. Study the words and find the sentences with these words in the text, translate them***

1. timekeeping device – хронометрирующий механизм
2. counting mechanism – счётный механизм
3. pointer (hand) – стрелка
   the hour hand – часовая стрелка
   the minute hand – минутная стрелка
   the second hand – секундная стрелка
4. sweep – большого охвата, быстрый
5. face (dial) – циферблат
6. spindle – ось, стержень, шпиндель, валик
7. series – серия, ряд, группа
8. train – передача, ряд, серия, цепочка, группа
9. tooth (**pl**. teeth) – зуб (зубы)
   toothed – зубчатый
10. gear ['giq] wheel – зубчатое колесо, шестерня
    toothed gear wheel – зубчатое колесо
11. movement – ходовой механизм
12. to mesh – зацепляться, сцепляться
13. revolution – оборот
14. weight – вес, гиря
15. spring – пружина
16. to whirr – с шумом поворачиваться (вращаться)
17. to wind ['waind] (wound ['waund]) – заводить (часы)

18. escapement – анкерный механизм, спуск
19. pendulum ['pendjVlqm] – маятник
20. toothed escape wheel – зубчатое спусковое колесо
21. pallet ['pxlit] – анкер (якорь)
22. swing (swung) – качаться, колебаться
23. pivot ['pivqt] point – точка (ось) поворота
24. weight – тяжесть, груз, нагрузка, вес
25. balance wheel – баланс
26. spoke wheel – бездисковое колесо, колесо со спицевой ступицей
27. hairspring – волосок
28. oscillating – качание, колебание
29. heavy points – точки нагрузки
30. arm – ручка, заводной ключ
31. lever escapement – анкерная вилка
32. forked – раздвоенный
33. to engage with – находиться в зацеплении (о зубчатых колёсах), включать, соединять
34. pin – эллипс
35. clock – часы, генератор частоты, генератор тактовых импульсов, генератор синхроимпульсов, синхронизирующий сигнал (импульс), тактовый сигнал (импульс)
36. to clock – хронометрировать, синхронизировать, тактировать
37. synchronous clock – синхронизирующий генератор
38. master clock – главные электрочасы
39. to vibrate – качаться, раскачиваться, вибрировать, колебаться, резонировать
40. electronic circuit – электронная схема

41. integrated circuit, (IC) – интегральная схема (ИС)
42. stepping motor – шаговый (электро)двигатель
43. liquid crystal display (LCD) – дисплей на жидких кристаллах, жидкокристаллический индикатор

***2. Read and translate the texts below and answer the questions following them***

## CLOCKS AND WATCHES

Clocks and watches are instruments for measuring time. Their essential parts are a timekeeping device that makes regular movements at equal intervals of time, and a counting mechanism that records the number of movements. Analogue clocks and watches indicate the time by means of pointers (or hands) that go around a dial (or face) marked with intervals of time. Digital clocks and watches show the time by numbers displayed, usually, by liquid crystals.

**Questions**

1. What kind of instruments are clocks and watches?
2. What are their essential parts?
3. How do analogue clocks and watches indicate the time?
4. How do digital clocks and watches show the time?

## MECHANICAL CLOCKS

The hour hand of a mechanical clock goes around the dial once every 12 hours, or twice a day. The minute hand, which is longer than the hour hand, goes around once an hour, or 24 times a day. The second hand may be much smaller, with its own dial set into the main one, or be a large sweep hand, going around the dial once a minute.

To allow the hands to move at different speeds, the spindles on which they are mounted are connected by a series, or "train", of toothed gear wheels, called the movement. The teeth of the gears mesh together. The gears have different numbers of teeth, which cause the spindles to rotate at different speeds. If a gear wheel with 10 teeth is meshed with one having 50 teeth (a ratio of 1 to 5), then

the larger wheel will make only one revolution for every five revolutions of the smaller one. By selecting the number of teeth to give a ratio of 1 to 60, the minute and hour hands will move at the correct relative speeds.

To keep a clock running, there must be a source of power to drive the movement. This may be a falling weight or a spring, or electricity. The work done in winding the clock is stored as potential energy in the raised weight or wound-up spring, and is slowly released to drive the movement. This can keep the clock running for at least 24 hours.

The movement as described so far has no timekeeping properties. If the clock were wound, and the weight or spring were allowed to release its energy unrestricted, the hands would simply whirr round at high speed and compress a 24-hour day into a few seconds. To prevent this from happening, the energy must be released regularly and in small amounts. This is done through an escapement connected to the timekeeping device, such as a pendulum. The escapement is essentially a "catch and release" mechanism that operates on a toothed escape wheel turned by the gear train, allowing it to rotate tooth by tooth. At each forward movement the escape wheel tooth catches against a pallet. On a pendulum clock, this action also helps keep the pendulum swinging.

The escape wheel is also the counting mechanism – each swing of the pendulum advances it one tooth, so if it has 60 teeth it will make one complete revolution every 60 swings.

The time taken by a pendulum to make one complete swing back and forth (its period) depends on the length from its pivot point to the center of its weight: the greater the length, the slower the time of swing, or the longer the period. A pendulum, therefore, is a simple but accurate timekeeper. The pendulum of Big Ben, the clock of the Houses of Parliament in London, is 4 meters (13 feet) long and has a period of four seconds. Adjustment of the period can be carried out to a high degree of accuracy by changing the position of the weight on the rod, usually by means of a nut on a screw thread. The main cause of inaccuracy in pendulum clocks is

change in temperature. This alters the length of the pendulum and makes the clock run fast or slow.

**Questions**

1. How often do the hour, minute and second hands go round the clock?
2. What may the second hand be like?
3. What is the movement?
4. How do the gear wheels of the movement work?
5. What must be there to keep a clock running?
6. What is done to provide the energy release regularly and in small amounts?
7. What is the function of escapement?
8. What is another function of the escape wheel?
9. What does the time taken by a pendulum to make one complete swing back and forth (its period) depend on?
10. What is a pendulum?
11. How long is the pendulum of Big Ben?
12. How can adjustment of the pendulum period be carried out?
13. What is the main cause of inaccuracy in pendulum clocks?

## SMALL MECHANICAL CLOCKS AND WATCHES

It is easy to see that a pendulum would not be a suitable timekeeping device for portable clocks and watches, as even the slightest movement would interrupt the regularity of its swing. In its place a balance wheel is used. This is a spoke wheel which, instead of revolving steadily, turns first one way and then the other, continually reversing its direction. To it is attached a flat spiral hairspring. When the balance wheel turns in one direction, the hairspring is tightened or "wound", slowing the wheel until it stops. The hairspring then unwinds, reversing the balance wheel. Without a source of power the balance wheel would soon stop oscillating, or moving back and forth. The power is supplied by a main spring driving a movement through an escapement, in the same way as a pendulum clock.

The balance wheel has to be accurately balanced, like the wheels of a car, so that it has no heavy points that would make it run unevenly. It is usually designed to make 2.5 back-and-forth oscillations (5 ticks) each second, or 9,000 oscillations per hour. The speed of the balance wheel is regulated by moving a small arm that alters the working length of the balance spring. Shortening the spring speeds up the balance and makes the watch run faster; lengthening it makes the watch run more slowly.

The escapement in this case is a lever escapement. One end of it has two pallets which mesh with the pallets on the escape wheel, allowing it to turn tooth by tooth. The other end is forked and engages with a pin on the balance wheel. In this way it gives pushes, or impulses, to the balance wheel to keep it oscillating and receives the rocking motion it needs to release the escape wheel. The pin is usually made from ruby, a jewel, which is hard-wearing and can be highly polished, to reduce friction.

**Questions**

1. What timekeeping device do portable clocks and watches have instead of a pendulum? Why?
2. What does this device look like and how does it work?
3. What is a source of power for the balance wheel?
4. How many oscillations is the balance wheel usually designed to make?
5. In what way is the speed of the balance wheel regulated?
6. What does a lever escapement look like and how does it work?
7. What is the pin usually made from and why?

## ELECTRIC CLOCKS

A supply of electricity can be used as the timekeeping device as well as the power source. Alternating current electricity, as supplied to most houses, changes direction 100 (or 120 times) a

Источник электричества может использоваться как хронометрирующее устройство и как источник питания. Переменный ток, поступающий в большинство домов, меняет

second and is said to have a frequency of 50 (or 60) hertz. (1 hertz is equal to 1 cycle per second.) When connected to such a supply, a type of electric motor, known as a synchronous motor will rotate in time with the frequency. Clocks powered like this are now rapidly being replaced by battery-powered quartz clocks, but synchronous clocks are still used to control video recorders, central heating programmers, and other line-powered electrical appliances. In industry and commerce, the master clock system is widely used. In this case, a pendulum is the timekeeping device. It moves a toothed wheel in much the same way as a conventional pendulum clock. As the wheel completes each rotation it releases a lever that falls and gives a push to the pendulum. At the same time the lever activates an electromagnet that returns it to the raised position and moves on the minute hand half a minute. The pulse of electricity simultaneously moves the hands of every other clock in the building that is connected to the master clock. Electricity in this case is used only as the power source to operate the electromagnet and move the hands.

своё направление 100 (или 200) раз в секунду и, как говорится, обладает частотой 50 (или 60) герц (1 герц равен одному периоду в секунду.) Если подсоединить к такому источнику один из электродвигателей, известный как асинхронный двигатель, он будет совершать вращательные движения с той же частотой. Часы, имеющие такое питание, в настоящее время быстро заменяются кварцевыми часами с питанием от батареек, но синхронизирующий генератор (часы) всё ещё используется для управления устройствами видеозаписи, программирующими устройствами центрального отопления и другими электроприборами, питающимися от сети. В промышленности и бизнесе широко используется система измерения времени с главными электрочасами. В этом случае хронометрирующим устройством является маятник. Он приводит в движение зубчатое колесо точно так же, как маятник обычных часов. Когда колесо завершает каждый оборот, оно освобождает рычаг, который падает и толкает маятник. В

*A wall clock*

то же самое время рычаг активирует электромагнит, который возвращает его в прежнее положение и передвигает минутную стрелку на полминуты. Одновременно электрический импульс передвигает стрелки всех остальных часов в здании, связанных с главными электрочасами. Электричество в данном случае используется только для работы электромагнита и движения стрелок.

**Questions**

1. How can a supply of electricity be used as the timekeeping device?
2. Where are synchronous clocks still used?
3. What clock system is widely used in industry and commerce?
4. How does this system work?
5. What is electricity in this case used for?
6. What clocks replace electric clocks?

## QUARTZ CLOCKS AND WATCHES

In battery-operated electric clocks, electricity does not act as the timekeeping device. Instead, a quartz crystal does the job. Quartz is an abundant mineral and is found in different forms. The crystals used in making clocks and watches must be very pure, and are usually synthetic (man-made). A quartz crystal of a particular size has a natural frequency at which it vibrates. In clocks this is usually about 1,000,000 hertz. By attaching electrodes (metal contacts) to the surface of the crystal, it can be made part of an electronic circuit that will count the pulses of the crystal. As the frequency is much too high for convenient time measurement it is reduced using a combination of electrical and mechanical gearing, and ap-

plied to a stepping motor that drives the hands. A crystal with a frequency of 1,000,000 hertz, for example, would be reduced by a ratio of 1,000,000 to 1 to give one pulse per second. The vibrations of the crystal are so regular that the clock will lose or gain only one second in 10 years.

The mechanism of a quartz watch is called the module. The timekeeping device is a paper-thin slice of synthetic quartz that vibrates at a frequency of 32,768 hertz. The power source is a button battery with a life of at least one year. The power is transmitted to the quartz crystal by an integrated circuit, which consists of a large number of electronic components – transistors, resistors, and capacitors – set into a tiny silicon chip. This acts as the "brain" of the watch, and uses power from the battery to keep the quartz crystal vibrating. At each vibration, the quartz crystal sends an impulse to the integrated circuit, which, by a process known as "division", reduces these impulses to 1 per second.

From here the mechanism depends on the type of display:

An analogue watch has a tiny stepping motor. This is an electromagnetic device, part of which – the rotor – rotates. At each impulse from the integrated circuit, the rotor turns, and drives the hands through a gear train.

A digital watch has no stepping motor. In this case the integrated circuit, which is larger than in an analogue watch, controls the liquid crystal display (LCD) and supplies it with information to show the time.

Quartz watches have the same degree of accuracy as quartz clocks.

**Questions**

1. What acts as the timekeeping device in battery-operated electric clocks? Why?
2. What crystals are used in making clocks and watches?
3. How can a quartz crystal be used as the timekeeping device?
4. What is done with the quartz crystal frequency that is much too high for convenient time measurement?
5. What is reduced to reduce frequency?

6. How accurate are the quartz clocks and watches?
7. What is the mechanism of a quartz watch called?
8. What is the timekeeping device of a quartz watch?
9. What is the power source of a quartz watch?
10. How is the power transmitted to the quartz crystal?
11. In what way are quartz crystal impulses reduced to 1 per second?
12. How is the time shown by an analogue and digital watch?

### *3. Find the English equivalents in the words below the line*

Чтобы позволить стрелкам двигаться с различной скоростью; в равные промежутки времени; показывают время с помощью стрелок; источник энергии; качательное движение; зубчатая передача; часы с маятником; счётный механизм; главная причина неточности; приборы измерения времени; электрические часы на батарейках; аккумулятор кнопочного (таблеточного) типа (маленькая круглая батарейка); такая же степень точности; используя электромеханическую передачу; основная пружина, приводящая в движение ходовой механизм через анкерный механизм.

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At equal intervals of time; counting mechanism; indicate the time by means of pointers (or hands); to allow the hands to move at different speeds; a source of power; the gear train; the main reason of inaccuracy; a pendulum clock; a main spring driving a movement through an escapement; instruments for measuring time; a button battery; the same degree of accuracy; battery-operated electric clocks; using a combination of electrical and mechanical gearing.

### *4. Say whether the following is true, partially true or false*

1. Analogue clocks and watches show the time by numbers displayed, usually, by liquid crystals.
2. The movement in the pendulum clock is the main timekeeping device
3. Portable clocks and watches have a balance wheel instead a pendulum, as the main timekeeping device.

4. In industry and commerce, the battery-powered quartz clocks are widely used.
5. In battery-operated electric clocks, a quartz crystal acts as the timekeeping device.
6. In a digital watch the integrated circuit, which is larger than in an analogue watch, controls the liquid crystal display (LCD) and supplies it with information to show the time.
7. Quartz watches are the most accurate watches.

***5. Give in writing the summary of all the texts about clocks and watches dwelling on their main ideas and tracing the clock and watch development (10 sentences)***

***6. Discuss different types of clocks and watches speaking of their mechanisms, accuracy and popularity. You can use the following as the beginning***

– Excuse me, what time is now by your watch?
– To be more precise by my clock, let me have a look the clock of my mobile phone. It's a shame but the display is dark, the battery is discharged.
– I should say it is one of the disadvantages of the mobile phones, batteries may fail you. I think that a mechanical watch is much better, it has no batteries and...

(Go on discussing different watches and clocks.)

# Unit 8

## *NANOTECHNOLOGY*

***1. Study the words and find the sentences with these words in the text, translate them***

1. ongoing ['ɔn"gouiŋ] – непрерывный, постоянный, происходящий сейчас
2. quest ['kwest] – поиски
3. opaque [ou'peik] – непрозрачный, непроницаемый, непроводящий, тёмный, матовый
4. substance ['sʌbstqns] – вещество
5. transparent [trʌn'spʌrqnt] – прозрачный
6. inert [i'nWt] – инертный, неактивный
7. catalyst ['kʌtqlist] – катализатор
   catalytic ["kʌtq'litik] – каталитический
8. combustible [kqm'bʌstqbl] – горючий, легко воспламеняющийся
9. to exhibit [ig'zIbIt] – показывать, проявлять, обнаруживать
10. novel ['nPvql] – новый, новейшей конструкции
11. to enhance [In'hRns] – увеличивать, усиливать, улучшать

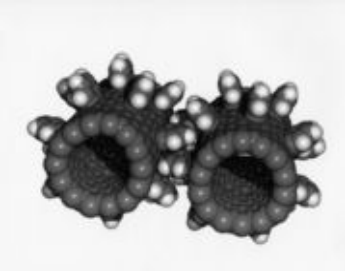
    enhanced (materials) – усовершенствованные материалы
12. spintronics – спинотроника
13. magnetoresistance – магнитное сопротивление
14. bandwidth – ширина спектра, диапазон рабочих частот, пропускная способность
15. capacity [kq'pʌsItI] – электрическая ёмкость, объём (информационная) ёмкость
16. band gap – запрещённая (энергетическая) зона
17. non-volatile ["nPn'vPlqtaIl] main memory – постоянная оперативная (основная) память
18. magnetic random access memory – магнитная память с произвольным доступом
19. refractive index – коэффициент преломления

20. lattice ['lxtls] constant – постоянная (кристаллической) решётки
21. carbon nanotube – углеродные нанотрубки
22. field emission display – дисплей с электронной эмиссией

***2. Read the text and study its translation, make the plan of the text***

## NANOTECHNOLOGY

Nanotechnology is the design, characterization, production and application of structures, devices and systems by controlling shape and size at the nanoscale. Eight to ten atoms span one nanometer (nm). A human hair is approximately 70,000 to 80,000 nm thick. Nanotechnology should really be called "nanotechnologies": There is no single field of nanotechnology. The term broadly refers to such fields as biology, physics or chemistry, any scientific field, or a combination thereof that deals with the deliberate and controlled manufacturing of nanostructures. Nanotechnology is the world of atoms, molecules, macromolecules, quantum dots, and macromolecular assemblies.



*Nanogears from one molecule*

Нанотехнология – это проектирование, описание, производство и практическое применение структур, устройств и систем посредством управления их формами и размерами на наноуровне. Восемь-десять атомов образуют один нанометр. Толщина человеческого волоса составляет приблизительно 70 000 – 80 000 нанометров. Термин «нанотехнология» в действительности следует заменить термином «нанотехнологии», поскольку не существует нанотехнологии как единой области. Этот термин относится к широкому кругу областей, таких как биология, физика или химия – к любой области науки или нескольким наукам, связанным с чётко разработанным и управляемым производством наноструктур. Нанотехнология – это мир атомов, молекул, макромолекул, квантовых точек и соединений макромолекул.

The ongoing quest for miniaturization has resulted in tools such as the atomic force microscope (AFM) and the scanning tunnelling microscope (STM). Combined with refined processes such as electron beam lithography, these instruments allow us to deliberately manipulate and manufacture nanostructures. Materials reduced to the nanoscale can suddenly show very different properties compared to what they show on a macroscale. For instance, opaque substances become transparent (copper); inert materials become catalysts (platinum); stable materials turn combustible (aluminum); solids turn into liquids at room temperature (gold); insulators become conductors (silicon). Another important aspect of the nanoscale is that the smaller a nanoparticle gets, the larger its ratio of surface area to volume becomes. Its electronic structure changes dramatically, too. Both effects lead to greatly improved catalytic activity but can also lead to aggressive chemical reactivity.

Постоянное стремление к миниатюризации привело к созданию таких инструментов, как атомно-силовой микроскоп (АСМ) и сканирующий туннельный микроскоп (СТМ). В сочетании с точными процессами, такими как электронно-лучевая литография, эти приборы позволяют нам тщательно разрабатывать и производить наноструктуры. Материалы, уменьшенные до наноуровня, могут неожиданно проявлять совершенно иные свойства в сравнении с теми, которые проявлялись на макроуровне. Например, непрозрачные вещества становятся прозрачными (медь), инертные материалы становятся катализаторами (платина), прочные материалы становятся горючими (алюминий), твёрдые вещества превращаются в жидкие при комнатной температуре (золото), диэлектрики становятся проводниками (кремний). Ещё одним важным аспектом наноуровня является то, что чем меньше становится наночастица, тем больше у неё отношение площади поверхности к объёму. Её электронная структура также сильно меняется. Оба эти изменения приводят к значительному улучшению

The fascination with nanotechnology stems from these unique quantum and surface phenomena that matter exhibits at the nanoscale, making possible novel applications and interesting materials.

With nanotechnology, a large set of materials with distinct properties (optical, electrical, or magnetic) can be fabricated. Such nanotechnologically enhanced materials will enable a weight reduction accompanied by an increase in stability and an improved functionality. An example of such novel devices is based on spintronics. The dependence of the resistance of a material (due to the spin of the electrons) on an external field is called magneto resistance. This effect can be significantly amplified (GMR – Giant Magneto-Resistance) for nanosized objects, the GMR effect has led to a strong increase in the data storage density of hard disks and made the gigabyte range possible. The so called tunneling magnetoresistance (TMR) is very simi-

каталитических свойств, но могут также привести к способности вступать в бурную химическую реакцию.

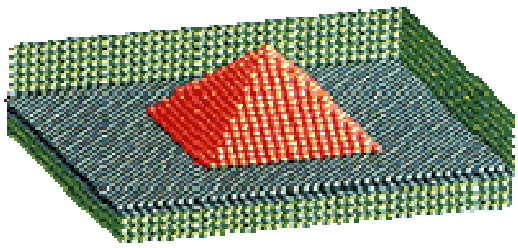
Интерес к нанотехнологии вызван уникальными квантовыми и поверхностными свойствами, которые вещества проявляют на наноуровне, что даёт возможность их новому практическому применению и созданию новых материалов.

С применением нанотехнологий может быть создан большой ряд материалов с определёнными свойствами (оптическими, электрическими или магнитными). Такие нанотехнологически усовершенствованные материалы позволят уменьшить вес устройств при одновременном улучшении их стабильности и функциональности. Один из примеров таких новых устройств основывается на спинотронике. Зависимость сопротивления материала (из-за спина электронов) от внешнего магнитного поля называется магнитным сопротивлением. Этот эффект можно значительно усилить (ГМС – гигантское магнитное сопротивление) для нанообъектов,

lar to GMR and based on the spin dependant tunneling of electrons through adjacent ferromagnetic layers. Both the GMR- and the TMR-effect can be used to create a non-volatile main memory for computers, such as the so called magnetic random access memory or MRAM. In the modern communication technology traditional analog electrical devices are increasingly replaced by optical or optoelectronic devices due to their enormous bandwidth and capacity, respectively. Two promising examples are photonic crystals and quantum dots. Photonic crystals are materials with a periodic variation in the refractive index with a lattice constant that is half the wavelength of the light used. They offer a selectable band gap for the propagation of a certain wavelength, thus they resemble a semiconductor, but for light or photons instead of electrons. Quantum dots are nanoscaled objects, which can be used, among many other things, for the construction of lasers. The advantage of a quantum dot laser over the traditional semiconductor laser is that their emitted wavelength depends on the diameter of the dot. Quantum dot lasers are cheaper and offer a higher beam qual-

эффект ГМС привёл к значительному увеличению емкости памяти на жестких дисках и позволил увеличить её диапазон до уровня гигабитов. Так называемое туннельное магнитное сопротивление (ТМС) очень похоже на ГМС и основано на зависящем от спина электронов их туннелировании сквозь близлежащие ферромагнитные слои. Как эффект ГМС, так и эффект ТМС можно использовать для создания долговременной основной памяти компьютеров, такой как магнитная память с произвольной выборкой (MRAM). В современных коммуникационных технологиях традиционные аналоговые электрические устройства всё больше заменяются оптическими или оптоэлектронными устройствами из-за их обширного диапазона рабочих частот и соответственно мощности. Два многообещающих примера – фотонные кристаллы и квантовые точки. Фотонные кристаллы – это материалы с периодическим изменением коэффициента преломления и постоянной кристаллической решётки, равной половине длины используемой световой волны. Они дают возмож-

ity than conventional laser diodes. The production of displays with low energy consumption could be accomplished using carbon nanotubes; they can be used as field emitters with extremely high efficiency for field emission displays (FED). Entirely new approaches for computing exploit the laws of quantum mechanics for novel quantum computers, which enable the use of fast quantum algorithms.



*A picture of a quantum dot*

ность выбора запрещённой зоны для распространения какой-то определённой волны, таким образом, они похожи на полупроводник, но только для света и фотонов вместо электронов. Квантовые точки – это нанообъекты, которые можно использовать наряду со многими другими объектами для создания лазеров. Преимущество лазера на квантовых точках перед обычным полупроводниковым лазером в том, что длина излучаемой им волны зависит от диаметра квантовой точки. Лазеры на квантовых точках дешевле и качество их луча лучше, чем у обычных лазерных диодов. Производство дисплеев с низким уровнем потребления энергии можно было бы осуществить с помощью углеродных нанотрубок, их можно использовать как высокоэффективные автоэлектронные эмиттеры для дисплеев с автоэлектронной эмиссией (FED). Совершенно новый подход к вычислениям связан с использованием законов квантовой механики для создания новых квантовых компьютеров, позволяющих быстрое создание квантовых алгоритмов.

***3. Answer the questions given below and retell the text using the questions as a plan of your story***

1. What is nanotechnology?
2. How large is a nanometer?
3. How large is a human hair in nanometers?
4. What should we better call nanotechnology and why?
5. What has the ongoing quest for miniaturization resulted in?
6. What do these instruments allow us to do?
7. What properties can materials reduced to the nanoscale show?
8. What can be fabricated with the help of nanotechnology?
9. What will nanotechnologically enhanced materials enable?
10. What can you tell about giant magneto-resistance and tunneling magneto resistance? How can they be used to improve computers?
11. What are photonic crystals and how they can be used?
12. What are quantum dots and their future application?

***4. Tell about the prospects of nanotechnology in engineering.***

***5. Translate the text in writing***

**NANOMOTOR**

Nanomotor has been constructed at University of California, Berkeley. The motor is about 500nm across: 300 times smaller than the diameter of a human hair

Researchers at University of California, Berkeley, have developed rotational bearings based upon multiwall carbon nanotubes. By attaching a gold plate (with dimensions of order 100nm) to the outer shell of a suspended multiwall carbon nanotube (like nested carbon cylinders), they are able to electrostatically rotate the outer shell relative to the inner core. These bearings are very robust: Devices have been oscillated thousands of times with no indication of wear. The work was done in situ in an SEM. These nanoelectromechanical systems (NEMS) are the next step in miniaturization that may find their way into commercial aspects in the future.

rotational – вращательные
bearings – опоры
multiwall – многослойный
shell – оболочка
in situ ["In'sItjH] – на месте
SEM(scanning electron microscope) – растровый электронный микроскоп

# *PART TWO*

# *ELECTRICAL ENGINEERING*

## UNIT 1

# *ELECTRICITY*

***1. Study the words and find the sentences with these words in the text, translate them***

1. to encompass [In'kAmpqs] – заключать (в себе), касаться
2. phenomenon (phenomena) – явление (явления)
3. electric charge – электрический заряд
4. the flow of electric charge – движение (перемещение, течение) электрических зарядов
5. lightning – молния
6. electromagnetic field – электромагнитное поле
7. electromagnetic induction – электромагнитная индукция
8. adequate ['xdIkwIt] – соответствующий, адекватный, надлежащий
9. subatomic ["sAbq't0mIk] – субатомный, элементарный
10. particle ['pRtIkql] – частица
11. property ['prPpqtI] – свойство, качество, характеристика, способность
12. interaction – взаимодействие
13. electric current – электрический ток
14. to measure – измерять
15. ampere ['xmpeq] – ампер
16. influence ['InflVqns] – влияние, воздействие
17. vicinity [vI'siniti] – соседство, близость (к чему-либо)
18. capacity – способность
19. presence – присутствие, наличие
20. motion – движение
21. antiquity [xn'tIkwItI] – античность, древность

22. scientific advance [qd'vRns] – научный прогресс
23. forthcoming ["fLT'kAmIN] – грядущий, приближающийся, наличный, поступивший в распоряжение
24. extraordinary [Ik'strLdqnqr ] – необычайный, необычный, удивительный, исключительный
25. versatility ["vWsq'tIlItI] – универсальность, разносторонность
26. source of energy – источник энергии
27. transport – перевозка, транспортировка, транспорт
28. heating – отопление
29. lighting – освещение
30. communications – средства связи
31. backbone – (позвоночник), основа, суть, сущность

***2. Read and translate the text***

## 1. ELECTRICITY

Electricity is a general term that encompasses a variety of phenomena resulting from the presence and flow of electric charge. These include many easily recognizable phenomena such as lightning and static electricity, but in addition, less familiar concepts such as the electromagnetic field and electromagnetic induction. In general usage, the word 'electricity' is adequate to refer to a number of physical effects. In scientific usage the term is better identified by more precise terms:

- electric charge – a property of some subatomic particles, which determines their electromagnetic interactions. Electrically charged matter is influenced by, and produces, electromagnetic fields,
- electric current – a movement or flow of electrically charged particles, typically measured in amperes,

- electric field – an influence produced by an electric charge on other charges in its vicinity,
- electric potential – the capacity of an electric field to do work, typically measured in volts,
- electromagnetism – a fundamental interaction between the magnetic field and the presence and motion of an electric charge.

Electricity has been studied since antiquity, though scientific advances were not forthcoming until the seventeenth and eighteenth centuries. It would not be until the late nineteenth century, however, that engineers were able to put electricity to industrial and residential use. This period witnessed a rapid expansion in the development of electrical technology. Electricity's extraordinary versatility as a source of energy means it can be put to an almost limitless set of applications which include transport, heating, lighting, communications, and computation. The use of electrical power is the backbone of modern industrial society, and it can be expected to remain for the foreseeable future.

***3. Answer the questions given below***

1. What does the term “electricity” encompass?
2. What do phenomena resulting from the presence and flow of electric charge include?
3. What more precise terms is the term “electricity” better identified by in scientific usage?
4. What is electric charge (electric current, electric field, electric potential, electromagnetism)?
5. Since what period of time has electricity been studied?
6. What period witnessed a rapid expansion in the development of electrical technology?
7. Why can electricity be put to an almost limitless set of applications?
8. What does the set of electricity applications include?

### *4. Match the term and its definition*

| | | |
|---|---|---|
| 1. Electric field | a) | a property of some subatomic particles, which determines their electromagnetic interactions |
| 2. Electric charge | b) | the capacity of an electric field to do work, typically measured in volts |
| 3. Electric current | c) | a fundamental interaction between the magnetic field and the presence and motion of an electric charge |
| 4. Electric potential | d) | a movement or flow of electrically charged particles, typically measured in amperes |
| 5. Electromagnetism | e) | an influence produced by an electric charge on other charges in its vicinity |

### *5. Translate into English*

1. Электричество изучалось со времен античности (since antiquity), но научные достижения появились лишь в семнадцатом и восемнадцатом веках.

2. Многообразие электричества как источника энергии означает, что области его применения почти безграничны.

3. Невозможно представить современную цивилизацию без электричества.

4. Сегодня потребление энергии на душу населения (consumption of electricity per capita) является показателем (an indicator) экономического здоровья нации.

5. Термин электричество включает в себя разнообразие явлений, возникающих от присутствия и движения заряда.

6. Самое важное преимущество электричества состоит в том, что это чистая, легко получаемая энергия, не дающая побочных продуктов.

## *ELECTRIC CHARGE*

***1. Study the words and find the sentences with these words in the text, translate them***

1. to give rise to – вызывать, причинять, быть источником, иметь результатом
2. to interact with – взаимодействовать, воздействовать, влиять друг на друга
3. the four fundamental forces of nature – четыре фундаментальных взаимодействия
4. carrier ['kxrIq] – носитель (*например* заряда)
5. electron [I'lektrPn] – электрон
6. proton ['preVtPn] – протон
7. a conserved quantity – сохранённое количество
8. the net charge – результирующий заряд, полный (общий) заряд
9. to pass along – проходить по
10. conducting material – проводящий материал
11. the net presence – общее (суммарное) наличие (присутствие)
12. imbalance [Im'bxlqns] – отсутствие равновесия, диспропорция, дисбаланс
13. to exert [Ig'zWt] a force – прикладывать силу, прилагать усилие
14. lightweight – легкий
15. to suspend from a string – вешать (подвешивать) на нитке
16. a glass rod – стеклянная палочка
17. to deduce [dI'djHs] – выводить (заключение…), делать вывод, заключать
18. to manifest – ясно показывать, проявлять, служить доказательством
19. like-charged objects – одноимённо заряженные объекты
20. to repel – отталкивать(ся)
21. opposite-charged objects – разноимённо заряженные объекты

22. to attract – притягивать(ся)
23. the strong interaction – сильное взаимодействие
24. Coulomb's law – закон Кулона
25. Coulomb (coulomb) ['kHl0m] – Кулон (кулон)
26. the magnitude of the electromagnetic force – величина электромагнитного воздействия
27. the product of the charges – произведение величины зарядов
28. inverse-square relation to the distance – обратно пропорциональна квадрату расстояния
29. to spread itself – распространяться
30. evenly – равномерно, гладко, ровно, одинаково
31. a conducting surface – проводящая поверхность
32. gravitational force – гравитационная сила, сила тяготения
33. gravitational attraction – гравитационное притяжение
34. to pull them together – притягивать их друг к другу
35. opposite in sign – противоположные по знаку
36. the amount of charge – количество заряда
37. matter – материя, вещество
38. antimatter – антиматерия, антивещество
39. antiparticle – античастица
40. to supersede ["sjHpq'sJd] – заменять, сменять, превосходить
41. electrometer [Ilek'trPmItq] – электрометр

***2. Read and translate the text***

## 2. ELECTRIC CHARGE

Electric charge is a property of certain subatomic particles, which gives rise to and interacts with, the electromagnetic force, one of the four fundamental forces of nature. Charge originates in the atom, in which its most familiar carriers are

the electron and proton. It is a conserved quantity, that is, the net charge within an isolated system will always remain constant regardless of any changes taking place within that system. Within the system, charge may be transferred between bodies, either by direct contact, or by passing along a conducting material, such as a wire. The informal term static electricity refers to the net presence (or 'imbalance') of charge on a body, usually caused when dissimilar materials are rubbed together, transferring charge from one to the other.

The presence of charge gives rise to the electromagnetic force: charges exert a force on each other, an effect that was known, though not understood, in antiquity. A lightweight ball suspended from a string can be charged by touching it with a glass rod that has itself been charged by rubbing with a cloth. If a similar ball is charged by the same glass rod, it is found to repel the first: the charge acts to force the two balls apart. Two balls that are charged with a rubbed amber rod also repel each other. However, if one ball is charged by the glass rod, and the other by an amber rod, the two balls are found to attract each other. These phenomena were investigated in the late eighteenth century by Charles-Augustin de Coulomb, who deduced that charge manifests itself in two opposing forms, leading to the well-known axiom: like-charged objects repel and opposite-charged objects attract.

The force acts on the charged particles themselves, hence charge has a tendency to spread itself as evenly as possible over a conducting surface. The magnitude of the electromagnetic force, whether attractive or repulsive, is given by Coulomb's law, which relates the force to the product of the charges and has an inverse-square relation to the distance between them. The electromagnetic force is very strong, second only in strength to the strong interaction, but unlike that force it operates over all distances. In comparison with the much weaker gravitational force, the electromagnetic force pushing two electrons apart is 1042 times that of the gravitational attraction pulling them together.

The charge on electrons and protons is opposite in sign, hence an amount of charge may be expressed as being either negative or positive. By convention, the charge carried by electrons is deemed negative and that by protons positive, a custom that originated with the work of Benjamin Franklin. The amount of charge is usually given the symbol Q and expressed in coulombs; each electron carries the same charge of approximately $-1.6022\times10^{-19}$ coulomb. The proton has a charge that is equal and opposite, and thus $+1.6022\times10^{-19}$ coulomb. Charge is possessed not just by matter, but also by antimatter, each antiparticle bearing an equal and opposite charge to its corresponding particle.

Charge can be measured by a number of means, an early instrument being the gold-leaf electroscope, which although still in use for classroom demonstrations, has been superseded by the electronic electrometer.

### *3. Answer the questions given below*

1. What is a charge?
2. Where does a charge originate?
3. What are its most familiar carriers?
4. What is the net charge within an isolated system?
5. How may charge be transferred within the system?
6. What does the informal term static electricity refer to?
7. What does the presence of charge give rise to the electromagnetic force?
8. How can a suspended ball be charged?
9. How do the charged balls interact?
10. What did Charles-Augustin de Coulomb deduce?
11. What is the magnitude of the electromagnetic force given by Coulomb's law?
12. How strong is the electromagnetic force?
13. How did the notions of the negative and positive charge originate?
14. What is the symbol of the amount of charge and how is it measured?
15. What is the charge of the electron and proton?
16. What can possess charge?
17. In what way can charge be measured?

***4. Find in the text the English equivalents of the following***

Четыре фундаментальных взаимодействия; обратно пропорциональна квадрату расстояния; величина электромагнитного воздействия; элементарные (субатомные) частицы; путём прямого контакта; пропусканием через проводящий материал; одноимённо заряженные объекты отталкиваются, а разноимённо заряженные объекты притягиваются; сила тяготения; величина электромагнитного воздействия; антиматерия; произведение величины зарядов.

## *ELECTRIC CURRENT*

***1. Study the words and find the sentences with these words in the text, translate them***

| | | |
|---|---|---|
| 1. | ampere ['xmpeq] | ампер |
| 2. | current | ток |
| 3. | by historical convention | как исторически сложилось |
| 4. | conventional | стандартный |
| 5. | electric circuit | электрическая цепь |
| 6. | explicitly | ясно, точно |
| 7. | state | излагать, формулировать, заявлять, утверждать, определять |
| 8. | nature | природа, характер |
| 9. | to vary | изменяться |
| 10. | to term | выражать, называть |
| 11. | electrical conduction | электропроводность |
| 12. | electrolysis [Ilek'tr0IIsIs] | электролиз |
| 13. | ionion ['alqn] | ион |
| 14. | liquid ['IIkwId] | жидкость |
| 15. | average drift velocity | средняя скорость дрейфа |
| 16. | fraction | дробь, часть, доля |
| 17. | wire | проволока, провод |
| 18. | the means of recognising its presence | средство обнаружения его присутствия |

| | | |
|---|---|---|
| 19. | to decompose ["dJkqm'pqVz] | разлагать на составные части |
| 20. | voltaic [v0l'teIIk] pile | вольтов столб |
| 21. | magnetics | учение о магнетизме |
| 22. | engineering applications | применение в технике |
| 23. | household applications | применение в быту |
| 24. | direct current (DC) | постоянный ток |
| 25. | alternating ['LltqneltiN] current (AC) | переменный ток |
| 26. | sinusoidal ["salnq's0ldl] wave | синусоидальная волна |
| 27. | to affect [q'fekt] | (воз)действовать, влиять |
| 28. | inductance | индукция |
| 29. | capacitance | емкость, ёмкостное сопротивление |
| 30. | transients ['trxnzlqnts] | переходный процесс, промежуточное состояние, внезапный подъём (электрического напряжения и т. п.) |
| 31. | to energise ['enqGalz] | питать энергией, поставить под напряжение |

***2. Read and translate the text***

## 3. ELECTRIC CURRENT

The movement of electric charge is known as an electric current, the intensity of which is usually measured in amperes. Current can consist of any moving charged particles; most commonly these are electrons, but any charge in motion constitutes a current.

By historical convention, a positive current is defined as having the same direction of flow as any positive charge it contains, or to flow from the most positive part of a circuit to the most negative part. Current defined in this manner is called conventional current. The motion of negatively-charged electrons around an electric circuit, one of the most familiar forms of current, is thus deemed positive in the opposite direction to that of the electrons. However, depending on

the conditions, an electric current can consist of a flow of charged particles in either direction or even in both directions at once. The positive-to-negative convention is widely used to simplify this situation.

The process by which electric current passes through a material is termed electrical conduction, and its nature varies with that of the charged particles and the material through which they are travelling. Examples of electric currents include metallic conduction, where electrons flow through a conductor such as metal, and electrolysis, where ions (charged atoms) flow through liquids. While the particles themselves can move quite slowly, sometimes with an average drift velocity only fractions of a millimetre per second, the electric field that drives them itself propagates at close to the speed of light, enabling electrical signals to pass rapidly along wires. Current causes several observable effects, which historically were the means of recognising its presence. That water could be decomposed by the current from a voltaic pile was discovered by Nicholson and Carlisle in 1800, a process now known as electrolysis. Their work was greatly expanded upon by Michael Faraday in 1833. Current through a resistance causes localised heating, an effect James Prescott Joule studied mathematically in 1840. One of the most important discoveries relating to current was made accidentally by Hans Christian Oersted in 1820, when, while preparing a lecture, he witnessed the current in a wire disturbing the needle of a magnetic compass. He had discovered electromagnetism, a fundamental interaction between electricity and magnetics.

In engineering or household applications, current is often described as being either direct current (DC) or alternating current (AC). These terms refer to how the current varies in time. Direct current, as produced by example from a battery and required by most electronic devices, is a unidirectional flow from the positive part of a circuit to the negative. If, as is most common, this flow is carried by electrons, they will be travelling in the opposite direction. Alternating current is any current that reverses direction repeatedly; almost always this takes the

form of a sinusoidal wave. Alternating current thus pulses back and forth within a conductor without the charge moving any net distance over time. The time-averaged value of an alternating current is zero, but it delivers energy in first one direction, and then the reverse. Alternating current is affected by electrical properties that are not observed under steady state direct current, such as inductance and capacitance. These properties however can become important when circuitry is subjected to transients, such as when first energised.

### *3. Answer the questions given below*

1. What is an electric current?
2. What particles can current consist of?
3. What is called conventional current?
4. What is one of the most familiar forms of current?
5. What is the positive-to-negative convention widely used for?
6. What is needed to be done if another definition, for example, "electron current" is used?
7. How is the process by which electric current passes through a material termed?
8. What does the nature of the process depend on?
9. What is metallic conduction?
10. What is electrolysis?
11. What speed does the electric field that drives the charged particles propagate?
12. What observable effects does current cause?
13. How is current often described in engineering or household applications? What do these terms refer to?
14. What is direct current? What is alternating current?
15. What is alternating current affected by?

### *4. Find in the text the English equivalents of the following sentences*

1. Процесс, с помощью которого электрический ток протекает в материале, называется электрической проводимостью, характер её меняется в зависимости от заряженных частиц и материала, через который они проходят.
2. Движение электрического заряда известно как электрический ток, сила которого обычно измеряется в амперах.
3. Переменный ток многократно пульсирует внутри проводника, при этом не происходит никакого суммарного перемещения заряда за данное время.
4. В технике и быту ток часто называется постоянным или переменным.
5. Однако электрический ток может состоять из потока заряженных частиц, движущихся в любом из направлений или в том и другом направлении сразу.
6. Переменный ток изменяется под воздействием таких свойств, как индукция и емкостное сопротивление, что не наблюдается у постоянного тока.
7. Движение в цепи отрицательно заряженных электронов – одна из наиболее знакомых форм тока – таким образом, считалось положительным в направлении, противоположном движению электронов.

### *5. Translate in writing from English into Russian*

1. Electric current is the flow of electric charge. The electric charge may be either electrons or ions. Electric current is measured using an ammeter.
2. A solid conductive metal contains a large population of mobile, or free, electrons.
3. The electric currents in electrolytes are flows of electrically charged atoms (ions), which exist in both positive and negative varieties.
4. Electric currents in sparks or plasma are flows of electrons as well as positive and negative ions.

5. Current density is a measure of the density of an electric current. In SI units, the current density is measured in amperes per square meter.
6. Any accelerating (ускоряющийся) electric charge, and therefore any changing electric current, gives rise to an electromagnetic wave that propagates (распространяется) at very high speed outside the surface of the conductor.
7. In alternating current (AC, also ac) the movement (or flow) of electric charge periodically reverses direction. In direct current (DC), the movement (or flow) of electric charge is only in one direction.

## *ELECTRIC FIELD*

***1. Study the words and find the sentences with these words in the text, translate them***

1. space – пространство
2. to surround – окружать
3. gravitational field – гравитационное поле, поле тяготения
4. mass – масса
5. infinity [ɪn'fɪnɪtɪ] – бесконечность
6. inverse square relationship with distance – обратно пропорционально квадрату расстояния
7. repulsion – отталкивание
8. per unit charge – на единицу заряда
9. stationary ['steɪʃnərɪ] – неподвижный, постоянный, неизменный, стабильный
10. negligible ['neglɪʤəbl] – ничтожный, не принимаемый в расчёт, мелкий, незначительный
11. vector – вектор
12. magnitude – величина
13. to visualize ['vɪʒʊəlaɪz] – мысленно представлять себе, делать видимым, наглядным
14. direction – направление
15. electrostatics – электростатика

16. lines of force – линии силы
17. to make path – проделывать путь
18. point positive charge – точечный положительный заряд
19. to seek (sought) – искать, пытаться найти
    to seek to do smth. – стремиться к чему-либо
20. to force – заставлять, вынуждать, принуждать
21. an imaginary concept with no physical existence – воображаемое, реально не существующее понятие
22. to permeate ['pWmIeIt] – проникать, проходить сквозь, распространяться, охватывать
23. the intervening space – промежуточное пространство
24. to emanate – происходить (from), исходить, истекать, излучать, испускать
25. at right angle – под прямым углом
26. to cross – пересекать
27. to close in on themselves – сближаться друг с другом
28. items of high-voltage equipment – виды высоковольтного оборудования
29. finite ['faInaIt] limit – конечный предел
30. field strength – сила поля
31. electrical breakdown – электрический пробой
32. to occur – случаться, происходить, встречаться
33. electric arc – дуговой разряд, электрическая дуга
34. to cause – быть причиной, вызывать
35. flashover – дуговой разряд; перекрытие дугой
36. gap – зазор, просвет, промежуток
37. natural occurance – естественное появление, возникновение
38. clouds – электронное облако, пространственный заряд, заряженное облако
39. rising columns of air – поднимающиеся столбы воздуха

40. discharge energies – энергия разряда
41. lightning conductor – молниеотвод, громоотвод
42. spike – острый выступ
43. to encourage – способствовать, содействовать
44. the lightning stroke – удар молнии
45. charge carrier – носитель заряда

***2. Read and translate the text***

## 4. ELECTRIC FIELD

The concept of the electric field was introduced by Michael Faraday. An electric field is created by a charged body in the space that surrounds it, and results in a force exerted on any other charges placed within the field. The electric field acts between two charges in a similar manner to the way that the gravitational field acts between two masses, and like it, extends towards infinity and shows an inverse square relationship with distance. However, there is an important difference. Gravity always acts in attraction, drawing two masses together, while the electric field can result in either attraction or repulsion. Since large bodies such as planets generally carry no net charge, the electric field at a distance is usually zero. Thus gravity is the dominant force at distance in the universe, despite being much weaker.

An electric field generally varies in space, and its strength at any one point is defined as the force (per unit charge) that would be felt by a stationary, negligible charge if placed at that point. As the electric field is defined in terms of force, and force is a vector, so it follows that an electric field is also a vector, having both magnitude and direction. Specifically, it is a vector field.

The study of electric fields created by stationary charges is called electrostatics. The field may be visualized by a set of imaginary lines whose direction at any

point is the same as that of the field. This concept was introduced by Faraday, whose term 'lines of force' still sometimes sees use. The field lines are the paths that a point positive charge would seek to make as it was forced to move within the field; they are however an imaginary concept with no physical existence and the field permeates all the intervening space between the lines. Field lines emanating from stationary charges have several key properties: first, that they originate at positive charges and terminate at negative charges; second, that they must enter any good conductor at right angles, and third, that they may never cross nor close in on themselves.

The principles of electrostatics are important when designing items of high-voltage equipment. There is a finite limit to the electric field strength that may withstood by any medium. Beyond this point, electrical breakdown occurs and an electric arc causes flashover between the charged parts. Air, for example, tends to arc at electric field strengths which exceed 30 kV per centimetre (кВ/см) across small gaps. Over larger gaps, its breakdown strength is weaker, perhaps 1 kV per centimetre. The most visible natural occurrence of this is lightning, caused when charge becomes separated in the clouds by rising columns of air, and raises the electric field in the air to greater than it can withstand. The voltage of a large lightning cloud may be as high as 100 MV and have discharge energies as great as 250 kWh. The field strength is greatly affected by nearby conducting objects, and it is particularly intense when it is forced to curve around sharply pointed objects. This principle is exploited in the lightning conductor, the sharp spike of which acts to encourage the lightning stroke to develop there, rather than to the building it serves to protect.

An electric field is zero inside a conductor. This is because the net charge on a conductor only exists on the surface. External electrostatic fields are always perpendicular to the conductors surface. Otherwise this would produce a force on the charge carriers inside the conductor and so the field would not be static as we assume.

### *3. Answer the questions given below*

1. Who was the concept of the electric field introduced by?
2. How is an electric field created? What does it result in?
3. How does the electric field acts between two charges?
4. What is the difference between gravity and the electric field?
5. How is the strength of electric field at any one point defined?
6. What is electrostatics?
7. How may the field be visualized? Who was this concept introduced by?
8. What are the field lines?
9. What key properties do field lines emanating from stationary charges have?
10. What field are the principles of electrostatics important? Why?
11. What principle is exploited in the lightning conductor?
12. What is an electric field inside a conductor? Why is it so?
13. In what way are external electrostatic fields directed to the conductor surface? Why?

### *4. Translate into English*

Электрическое поле – особая (specific, particular) форма поля, существующая вокруг тел (bodies) или частиц, обладающих электрическим зарядом (carrying an electric charge), а также в свободном виде в электромагнитных волнах. Электрическое поле непосредственно невидимо (invisible), но может наблюдаться (can be observed) благодаря (due to) его действию на заряженные тела: заряженные тела (charged bodies), будучи помещёнными в электрическое поле, испытывают действие силы (undergo the force impact). Поэтому основным действием (the main action) электрического поля является ускорение (acceleration of) тел или частиц, обладающих электрическим зарядом.

Электрическое поле можно рассматривать (can be considered as) как математическую модель, описывающую значение величины напряжённости электрического поля в данной точке пространства (describing the field strength value at this point). В классической физике, применимой при рас-

смотрении крупномасштабных (больше размера атома) взаимодействий (large scale more than atom interaction), электрическое поле рассматривается как одна из составляющих (components) единого (single) электромагнитного поля и проявление (manifestation) электромагнитного взаимодействия. В классической физике система уравнений Максвелла (the set Maxwell's equations) описывает взаимодействие электрического поля, магнитного поля и воздействие зарядов на эту систему полей.

Основным действием электрического поля является силовое воздействие на неподвижные (относительно наблюдателя) (immobile in regard to an observer) электрически заряженные тела или частицы.

## *ELECTRIC POTENTIAL*

***1. Study the words and find the sentences with these words in the text, translate them***

1. concept ['kɔnsept] – понятие, идея, общее представление, концепция
2. to experience a force – испытывать воздействие
3. against the force – противоположно воздействию (действию силы)
4. joule ['ʤHl] – джоуль
5. to expend – тратить, затрачивать, расходовать
6. infinity – бесконечность, бесконечно удаленная точка
7. conservative property – консервативное
8. irrelevant [I'relIvqnt] – неприменимый, лишний, ненужный
9. unique [jH'nJk] value – единственное значение
10. to state – формулировать, утверждать, устанавливать, точно определять
11. voltage – напряжение
12. a reference point – контрольная точка, точка отчёта
13. a scalar quantity – скалярная величина
14. gradient ['greIdIqnt] – градиент

15. the driving force – движущая сила
16. heat flow – тепловой поток
17. analogous [q'nxlqgqs] – аналогичный, сходный
18. a difference in heights – разница (перепад) высот

***2. Read and translate the text***

## 5. ELECTRIC POTENTIAL

The concept of electric potential is closely linked to that of the electric field. A small charge placed within an electric field experiences a force, and to have brought that charge to that point against the force requires work. The electric potential at any point is defined as the energy required to bring a unit test charge from an infinite distance slowly to that point. It is usually measured in volts, and one volt is the potential for which one joule of work must be expended to bring a charge of one coulomb from infinity. This definition of potential, while formal, has little practical application, and a more useful concept is that of electric potential difference, and is the energy required to move a unit charge between two specified points. An electric field has the special property that it is conservative, which means that the path taken by the test charge is irrelevant: all paths between two specified points expend the same energy, and thus a unique value for potential difference may be stated. The volt is so strongly identified as the unit of choice for measurement and description of electric potential difference that the term voltage sees greater everyday usage.

For practical purposes, it is useful to define a common reference point to which potentials may be expressed and compared. While this could be at infinity, a much more useful reference is the Earth itself, which is assumed to be at the same potential everywhere. This reference point naturally takes the name earth or ground. Earth is assumed to be an infinite source of equal amounts of positive and negative charge, and is therefore electrically uncharged – and unchargeable.

Electric potential is a scalar quantity, that is, it has only magnitude and not direction. It may be viewed as analogous to temperature: as there is a certain temperature at every point in space, and the temperature gradient indicates the direction and magnitude of the driving force behind heat flow, similarly, there is an electric potential at every point in space, and its gradient, or field strength, indicates the direction and magnitude of the driving force behind charge movement. Equally, electric potential may be seen as analogous to height: just as a released object will fall through a difference in heights caused by a gravitational field, so a charge will 'fall' across the voltage caused by an electric field.

The electric field was formally defined as the force exerted per unit charge, but the concept of potential allows for a more useful and equivalent definition: the electric field is the local gradient of the electric potential. Usually expressed in volts per metre, the vector direction of the field is the line of greatest gradient of potential.

### *3. Answer the questions given below*

1. What is the concept of electric potential closely linked to?
2. What does a small charge placed within an electric field experience?
3. How is the electric potential at any point defined and measured?
4. What is one volt equal to?
5. What definition has more practical application that of potential or electric potential difference?
6. What does electric potential difference mean?
7. Why may a unique value for potential difference be stated?
8. What is the reason that the term voltage sees greater everyday usage?
9. What kind of quantity is electric potential?
10. What is the gradient of electric potential and what does it indicate?
11. What definition of electric field does the concept of potential allow?
12. What is the vector direction of the electric field?

***4. Find the English equivalents in the text***

Это определение потенциала; направление и величина движущей силы теплового потока; в любой точке; испытывает воздействие силы; скалярная величина; понятие электрического потенциала; практическое применение; может рассматриваться как векторное направление поля, сходное с температурой; на все пути между двумя определёнными точками тратится то же количество энергии; общая точка отсчёта; и поэтому электрически незаряженная и незаряжаемая; бесконечность (бесконечно удаленная точка).

## *ELECTROMAGNETISM*

***1. Study the words and find the sentences with these words in the text, translate them***

1. reciprocal – взаимный, равный, эквивалентный, аналогичный, соответственный, обратный
2. current-carrying wire – провод с током
3. homopolar motor – униполярный двигатель
4. permanent magnet – постоянный магнит
5. pool of mercury – резервуар с ртутью
6. pivot – точка опоры, точка вращения, стержень
7. dip – погружение, погружать
8. tangential [txn'GenSql] force – касательная составляющая силы
9. further analysis – дальнейший анализ
10. electromagnetic induction – электромагнитная индукция
11. law [lL] of induction – закон индукции
12. to induce – побуждать, воздействовать, вызывать, индуцировать
13. closed circuit ['sWkIt] – замкнутая цепь
14. rate of change – скорость изменения
15. magnetic flux – магнитный поток, поток магнитной индукции

16. loop – контур схемы
17. exploitation ["eksplOI'teISqn] – использование, эксплуатация
18. to convert – превращать, обращать
19. electromagnetic wave – электромагнитная волна
20. set of equations – система уравнений
21. unambiguous ["An x m'bIjuqs] – точно выраженный
22. interrelationship – взаимосвязь, соотношение
23. milestone – веха

***2. Read and translate the text***

## 6. ELECTROMAGNETISM

Oersted's discovery in 1821 that a magnetic field existed around all sides of a wire carrying an electric current indicated that there was a direct relationship between electricity and magnetism. Oersted did not fully understand his discovery, but he observed the effect was reciprocal: a current exerts a force on a magnet, and a magnetic field exerts a force on a current. The phenomenon was further investigated by Ampère, who discovered that two parallel current-carrying wires exerted a force upon each other: two wires conducting currents in the same direction are attracted to each other, while wires containing currents in opposite directions are forced apart. This relationship between magnetic fields and currents is extremely important, for it led to Michael Faraday's invention of the electric motor in 1821. Faraday's homopolar motor consisted of a permanent magnet sitting in a pool of mercury. A current was allowed through a wire suspended from a pivot above the magnet and dipped into the mercury. The magnet exerted a tangential force on the wire, making it circle around the magnet for as long as the current was maintained.

Experimentation by Faraday in 1831 revealed that a wire moving perpendicular to a magnetic field developed a potential difference between its ends. Further analysis of this process, known as electromagnetic induction, enabled him to

state the principal, now known as Faraday's law of induction, that the potential difference induced in a closed circuit is proportional to the rate of change of magnetic flux through the loop. Exploitation of this discovery enabled him to invent the first electrical generator in 1831, in which he converted the mechanical energy of a rotating copper disc to electrical energy. Faraday's disc was inefficient and of no use as a practical generator, but it showed the possibility of generating electric power using magnetism, a possibility that would be taken up by those that followed on from his work.

Faraday's and Ampère's work showed that a time-varying magnetic field acted as a source of an electric field, and a time-varying electric field was a source of a magnetic field. Thus, when either field is changing in time, then a field of the other is necessarily induced. Such a phenomenon has the properties of a wave, and is naturally referred to as an electromagnetic wave. Electromagnetic waves were analysed theoretically by James Clerk Maxwell in 1864. Maxwell discovered a set of equations that could unambiguously describe the interrelationship between electric field, magnetic field, electric charge, and electric current. He could moreover prove that such a wave would necessarily travel at the speed of light, and thus light itself was a form of electromagnetic radiation. Maxwell's Laws, which unify light, fields, and charge are one of the great milestones of theoretical physics.

### *3. Answer the questions given below*

1. What did Oersted's discovery in 1821 that a magnetic field existed around all sides of a wire carrying an electric current indicate?
2. What did Oersted observe?
3. What did Ampere discover further investigating the phenomena?
4. Why is this relationship between magnetic fields and currents extremely important?
5. What was Faraday's homopolar motor made of and how did it work?
6. What did experimentation by Faraday in 1831 reveal?
7. What is Faraday's law of induction?

8. What does exploitation of this discovery enabled Faraday to do? What was the significance of this development?
9. What did Faraday's and Ampère's work show?
10. What properties does such a phenomenon have?
11. What did Maxwell to study electromagnetism?

### *4. Answer the questions given below*

1. Эта связь между магнитным полем и током очень важна, так как она привела к изобретению Фарадеем в 1821 году электродвигателя.
2. Эрстед не в полной мере осознал своё открытие, но он наблюдал, что воздействие было взаимным: ток воздействует на магнит, а магнитное поле оказывает воздействие на ток.
3. Магнит оказывал касательное воздействие на проводник, заставляя его кружиться вокруг всё время, пока поддерживался ток.
4. Диск Фарадея был неэффективен и не мог практически использоваться в качестве генератора, но он продемонстрировал возможность генерировать электрическую энергию, используя магнетизм, чем впоследствии воспользуются те, кто продолжит его работу.
5. Это явление имело свойства волны, и, естественно, стало называться электромагнитной волной.
6. Он смог к тому же доказать, что такие волны обязательно распространяются со скоростью света, и, таким образом, сам свет является формой электромагнитного излучения.

### *5. Say if it is true or false*

1. Oersted studied his discovery and formulated some laws of electromagnetism.
2. Ampère discovered two wires conducting currents in the same direction are attracted to each other, while wires containing currents in opposite directions are forced apart.
3. Faraday's law of induction says that the potential difference induced in a closed circuit is proportional to the density of magnetic flux.

4. Faraday discovered electromagnetic waves and proved that light itself was a form of electromagnetic radiation.
5. Maxwell discovered a set of equations that could unambiguously describe the interrelationship between electric field, magnetic field, electric charge, and electric current.

## *ELECTRIC CIRCUITS*

***1. Study the words and find the sentences with these words in the text, translate them***

| | | |
|---|---|---|
| 1. circuit | – | цепь, схема |
| 2. interconnection | – | соединение, схема включения (соединения) |
| 3. return path | – | обратная цепь, путь возврата, обратный путь |
| 4. source | – | источник |
| 5. resistor | – | резистор, прибор омического сопротивления |
| 6. capacitor | – | конденсатор, ёмкость |
| 7. switch | – | переключатель |
| 8. transformer | – | трансформатор |
| 9. electronics | – | электронное оборудование |
| 10. to exhibit non-linear behavior | – | проявлять нелинейность |
| 11. behavior | – | поведение, свойства, характеристики, режим |
| 12. temporarily | – | временно |
| 13. to store energy | – | накапливать, хранить |
| 14. stimuli (stimulus ) ['stImjulaI] (['stImjulqs]) | – | раздражители, возбуждение, стимул |
| 15. to dissipate | – | рассеивать |
| 16. conducting plate | – | проводящая пластина |
| 17. insulating layer | – | изоляционный слой |

18. metal foil – металлическая фольга, станиоль
19. to coil – свёртывать кольцом, спиралью, обматывать, наматывать
20. capacitance – ёмкость, ёмкостное сопротивление
21. to allow current – пропускать ток
22. to oppose current – противодействовать; противостоять

***2. Read and translate the text***

## 7. ELECTRIC CIRCUITS

An electric circuit is an interconnection of electric components, usually to perform some useful task, with a return path to enable the charge to return to its source. The components in an electric circuit can take many forms, which can include elements such as resistors, capacitors, switches, transformers and electronics. Electronic circuits contain active components, usually semiconductors, and typically exhibit non-linear behavior, requiring complex analysis. The simplest electric components are those that are termed passive and linear: while they may temporarily store energy, they contain no sources of it, and exhibit linear responses to stimuli.

The resistor is perhaps the simplest of passive circuit elements: as its name suggests, it resists the current through it, dissipating its energy as heat. Ohm's law is a basic law of circuit theory, stating that the current passing through a resistance is directly proportional to the potential difference across it. The ohm, the unit of resistance, was named in honour of Georg Ohm, and is symbolized by the Greek letter Ω. 1 Ω is the resistance that will produce a potential difference of one volt in response to a current of one amp.

The capacitor is a device capable of storing charge, and thereby storing electrical energy in the resulting field. Conceptually, it consists of two conducting plates separated by a thin insulating layer; in practice, thin metal foils are coiled together, increasing the surface area per unit volume and therefore the capacitance. The unit of capacitance is the farad, named after Michael Faraday, and given the symbol F: one farad is the capacitance that develops a potential difference of one volt when it stores a charge of one coulomb. A capacitor connected

to a voltage supply initially causes a current as it accumulates charge; this current will however decay in time as the capacitor fills, eventually falling to zero. A capacitor will therefore not permit a steady state current, but instead blocks it. The inductor is a conductor, usually a coil of wire that stores energy in a magnetic field in response to the current through it. When the current changes, the magnetic field does too, inducing a voltage between the ends of the conductor. The induced voltage is proportional to the time rate of change of the current. The constant of proportionality is termed the inductance. The unit of inductance is the henry, named after Joseph Henry, a contemporary of Faraday. One henry is the inductance that will induce a potential difference of one volt if the current through it changes at a rate of one ampere per second. The inductor's behaviour is in some regards converse to that of the capacitor: it will freely allow an unchanging current, but opposes a rapidly changing one.

***3. Answer the questions given below***

1. What is an electric circuit?
2. What forms can the components in an electric circuit take?
3. What are passive and active components of electronic circuits and behavior they exhibit?
4. What is the simplest of passive circuit elements and its function?
5. What is a basic law of circuit theory and what does it state?
6. What is the unit of resistance and who was named after?
7. How can 1 Ω be defined?
8. What is a capacitor and what parts does it consists of?
9. What is the unit of capacitance, its symbol is why is it named so?
10. What does one farad show?
11. Will a capacitor permit a steady state current or block it?
12. What is a inductor?
13. What is inductance?
14. What is the unit of inductance? Who was it named after?
15. How large is one henry?
16. What is the inductor's behaviour?

***4. Match the terms and definitions***

| | | | |
|---|---|---|---|
| 1. | electric circuit | a) | an interconnection of electric components, usually to perform some useful task, with a return path to enable the charge to return to its source |
| 2. | resistor | b) | a device capable of storing charge |
| 3. | capacitor | c) | an electrical component which can break an electrical circuit |
| 4. | inductor | d) | a material that has electrical conductivity between those of a conductor and an insulator |
| 5. | switch | e) | a device that transfers electrical energy from one circuit to another |
| 6. | transformer | f) | a passive electrical component that can store energy in a magnetic field created by the electric current passing through it. |
| 7. | semiconductor | g) | a two-terminal electronic component designed to oppose an electric current |

***5. Name the units according to their symbols:*** V, A, Ω, H, F,C, J

## *PRODUCTION AND USES OF ELECTRICAL ENERGY*

***1. Study the words, find the sentences with these words in the text and translate them***

| | | |
|---|---|---|
| 1. Thales ['TelIJz] | – | Фалес |
| 2. triboelectric effect | – | трибоэлектрический эффект |
| 3. voltaic pile | – | вольтов столб |
| 4. viable | – | приемлемый, пригодный |
| 5. to generate | – | порождать, производить, генерировать |
| 6. to transmit | – | передавать, переносить (энергию) |
| 7. in bulk | – | большими партиями, в целом, оптом |
| 8. steam | – | пар |
| 9. fossil fuel combustion | – | органическое топливо, природное топливо, ископаемое топливо |
| 10. to release | – | высвобождать, отпускать (о реле), деблокировать |

| | | |
|---|---|---|
| 11. nuclear reaction | – | ядерная реакция |
| 12. kinetic energy | – | кинетическая энергия |
| 13. to extract | – | извлекать, добывать |
| 14. transformer | – | трансформатор |
| 15. to store | – | хранить |
| 16. to meet demands on a national scale | – | удовлетворять спрос (требования) в национальных масштабах |
| 17. to make careful predictions | – | делать осторожные прогнозы |
| 18. their electrical loads | – | электропотребитель, электрическая нагрузка |
| 19. to cushion | – | смягчать, амортизировать |
| 20. disturbance | – | местное искажение, помехи, неполадка, возмущение энергосистемы, технологическое нарушение в энергосистеме |
| 21. a rate of growth | – | темп роста, темп увеличения |
| 22. experience | – | испытывать, переживать, ощущать, чувствовать |
| 23. emerging economies | – | страны с формирующейся рыночной экономикой |
| 24. electricity demand | – | спрос на электроэнергию |
| 25. environmental concerns | – | озабоченность состоянием окружающей среды (экологическими проблемами) экологическая проблема, экологический фактор |
| 26. to outstrip | – | опережать, превосходить, обогнать |
| 27. renewable sources | – | возобновляемые источники, возобновляемые ресурсы |

***2. Read and translate the text***

## 8. *ELECTRICAL ENERGY GENERATION*

Thales' experiments with amber rods were the first studies into the production of electrical energy. While this method, now known as the triboelectric effect, is capable of lifting light objects and even generating sparks, it is extremely inefficient. It was not until the invention of the voltaic pile in the eighteenth century that a viable source of electricity became available. The voltaic pile, and its

modern descendant, the electrical battery, store energy chemically and make it available on demand in the form of electrical energy. The battery is a versatile and very common power source which is ideally suited to many applications, but its energy storage is finite, and once discharged it must be disposed of or recharged. For large electrical demands electrical energy must be generated and transmitted in bulk.

Electrical energy is usually generated by electro-mechanical generators driven by steam produced from fossil fuel combustion, or the heat released from nuclear reactions; or from other sources such as kinetic energy extracted from wind or flowing water. Such generators rely on Faraday's electromagnetic principle that a conductor linking a changing magnetic field induces a potential difference across its ends. The invention in the late nineteenth century of the transformer meant that electricity could be generated at centralized power stations, benefiting from economies of scale, and be transmitted across countries with increasing efficiency. Since electrical energy cannot easily be stored in quantities large enough to meet demands on a national scale, at all times exactly as much must be produced as is required. This requires electricity utilities to make careful predictions of their electrical loads, and maintain constant co-ordination with their power stations. A certain amount of generation must always be held in reserve to cushion an electrical grid against inevitable disturbances and losses.

Demand for electricity grows with great rapidity as a nation modernizes and its economy develops. The United States showed a 12 % increase in demand during each year of the first three decades of the twentieth century, a rate of growth that is now being experienced by emerging economies such as those of India or China. Historically, the growth rate for electricity demand has outstripped that for other forms of energy, such as coal.

Environmental concerns with electricity generation have led to an increased focus on generation from renewable sources, in particular from wind- and hydropower. While debate over the environmental impact of different means of electricity production can be expected to continue, its final form is relatively clean.

***3. Answer the questions given below***

1. What were the first studies into the production of electrical energy?
2. What is this method now known as? What is it capable of? Is it efficient?
3. When did a viable source of electricity become available?
4. How do the voltaic pile, and its modern descendant, the electrical battery, store energy?
5. What are the advantages and disadvantages of the battery?
6. What must be done for large electrical demands?
7. How is electrical energy generated?
8. What principle do generators rely on?
9. How much electricity must be produced to meet demands on a national scale?
10. What does the production of electricity to meet demands on a national scale require of electricity utilities?
11. Why must a certain amount of generation always be held in reserve?
12. Why does demand for electricity grow with great rapidity? Has the growth rate for electricity demand outstripped the demand for other forms of energy?
13. What has led to an increased focus on generation from renewable sources?

## *USES OF ELECTRICITY*

***1. Study the words, find the sentences with these words in the text and translate them***

1. flexible form of energy – универсальный вид энергии
2. incandescent ["ɪnkɤn'desnt] light bulb – лампочка накаливания
3. fire hazards – угроза пожара
4. to target – намечать, планировать, выявлять
5. the burgeoning ['bWGqnIN] market – нарождающийся рынок

6. to issue legislation – вводить законодательство, принимать законы
7. to restrict – ограничивать
8. to ban the use of electric heating – запрещать использование электроотопления
9. refrigeration – охлаждение, замораживание
10. air conditioning – кондиционирование воздуха
11. electricity utilities – электроэнергетические компании
12. the effects of electricity demand – результаты спроса на электричество
13. to accommodate – обеспечивать, удовлетворять
14. optical fibre – оптическое волокно
15. satellite communication technology – технология спутниковой связи
16. a share of the market – доля рынка
17. winch – лебёдка, подъёмник
18. supply of power – энергообеспечение
19. pantograph ['pxntqgrRf] – токоприёмник
20. integrated circuit – интегральная схема

***2. Read and translate the text***

## 9. USES OF ELECTRICITY

Electricity is an extremely flexible form of energy, and has been adapted to a huge, and growing, number of uses. The invention of a practical incandescent light bulb in the 1870s led to lighting becoming one of the first publicly available applications of electrical power. Although electrification brought with it its own dangers, replacing the naked flames of gas lighting greatly reduced fire hazards within homes and factories. Public utilities were set up in many cities targeting the burgeoning market for electrical lighting.

The Joule heating effect employed in the light bulb also sees more direct use in electric heating. While this is versatile and controllable, it can be seen as wasteful, since most electrical generation has already required the production of heat at a power station. A number of countries, such as Denmark, have issued legislation restricting or banning the use of electric heating in new buildings. Electrici-

ty is however a highly practical energy source for refrigeration, with air conditioning representing a growing sector for electricity demand, the effects of which electricity utilities are increasingly obliged to accommodate.

Electricity is used within telecommunications, and indeed the electrical telegraph, demonstrated commercially in 1837 by Cooke and Wheatstone, was one of its earliest applications. With the construction of first intercontinental, and then transatlantic, telegraph systems in the 1860s, electricity had enabled communications in minutes across the globe. Optical fibre and satellite communication technology have taken a share of the market for communications systems, but electricity can be expected to remain an essential part of the process.

The effects of electromagnetism are most visibly employed in the electric motor, which provides a clean and efficient means of motive power. A stationary motor such as a winch is easily provided with a supply of power, but a motor that moves with its application, such as an electric vehicle, is obliged to either carry along a power source such as a battery, or by collecting current from a sliding contact such as a pantograph, placing restrictions on its range or performance.

Electronic devices make use of the transistor, perhaps one of the most important inventions of the twentieth century, and a fundamental building block of all modern circuitry. A modern integrated circuit may contain several billion miniaturized transistors in a region only a few square centimetres.

### *3. Answer the questions given below*

1. Why is electricity an extremely flexible form of energy?
2. What led to lighting becoming one of the first publicly available applications of electrical power?
3. What benefits did electricity bring in spite of its own dangers?
4. What were public utilities set up in many cities?
5. Why have a number of countries, such as Denmark, issued legislation restricting or banning the use of electric heating in new buildings?
6. What applications is electricity a highly practical energy source for?

7. What field can electricity be expected to remain an essential part of the process?
8. Where are the effects of electromagnetism most visibly employed?
9. How can a stationary motor and a motor that moves with its application be provided with a supply of power?
10. What is a fundamental building block of all modern circuitry?

***4. Using the texts given above write an essay (20 – 25 sentences) about electricity, its phenomena, generation, use and prospects for future.***

## UNIT 2

# *MY PROFESSION*

### Electrical engineering

Electrical engineering (sometimes referred to as electrical and electronics engineering) is a professional engineering discipline that deals with the study and application of electricity, electronics and electromagnetism. The field first became an identifiable occupation in the late nineteenth century with the commercialization of the electric telegraph and electrical power supply. The field now covers a range of sub-disciplines including those that deal with power, control systems, electronics and telecommunications.

The term electrical engineering may or may not encompass electronics engineering. Where a distinction is made, electrical engineering is considered to deal with the problems associated with large-scale electrical systems such as power transmission and motor control, whereas electronics engineering deals with the study of small-scale electronic systems including computers and integrated circuits. Another way of looking at the distinction is that electrical engineers are usually concerned with using electricity to transmit energy, while electronics engineers are concerned with using electricity to transmit information.

**Questions**

1. What is electrical engineering? What does it sometimes referred to?
2. When did the field first become an identifiable occupation? Why?
3. What disciplines does the field now cover?
4. What is the difference between electrical engineering and electronics engineering?
5. What are electrical engineers and electronics engineers concerned with?

## EDUCATION

***1. Study the words, find the sentences with these words in the text and translate them***

| | | |
|---|---|---|
| 1. | to be designated | – давать название, именовать, маркировать, назначаться, предназначаться |
| 2. | Bachelor of Engineering | – бакалавр технических наук |
| 3. | Bachelor of Science | – бакалавр наук |
| 4. | Bachelor of Technology | – бакалавр технологии |
| 5. | Bachelor of Applied Science | – бакалавр прикладных наук |
| 6. | initially | – с самого начала, первоначально, на ранней стадии, вначале |
| 7. | to pursue a postgraduate degree | – продолжить |
| 8. | choose | – выбирать, предпочитать, решать, решить, предпочесть, хотеть, считать необходимым |
| 9. | Master of Engineering | – магистр технических наук |
| 10. | Master of Science | – магистр естественных наук |
| 11. | Master of Engineering Management | – магистр управления технологическими процессами |
| 12. | Doctor of Philosophy in Engineering | – доктор технических наук |
| 13. | Engineer's degree | – диплом (степень) инженера |

***2. Read the text and study its translation***

| | |
|---|---|
| Electrical engineers typically possess an academic degree with a major in electrical engineering. The length of study for such a degree is usually four or five years and the completed degree may be designated as a Bachelor of Engineering, Bachelor of Science, Bachelor of Technology or Bachelor of Applied | Обычно инженеры-электрики имеют учёную степень со специализацией в электротехнике. Продолжительность обучения для получения такой степени составляет 4 года или 5 лет, и полученная степень именуется: бакалавр технических наук, бакалавр наук, бакалавр технологии или бакалавр прикладных |

Science depending upon the university. The degree generally includes units covering physics, mathematics, project management and specific topics in electrical engineering. Initially such topics cover most, if not all, of the sub-disciplines of electrical engineering. Students then choose to specialize in one or more sub-disciplines towards the end of the degree.

Some electrical engineers also choose to pursue a postgraduate degree such as a Master of Engineering, Master of Science, a Master of Engineering Management, a Doctor of Philosophy in Engineering or an Engineer's degree.

The Master and Engineer's degree may consist of either research, coursework or a mixture of the two. The Doctor of Philosophy consists of a significant research component and is often viewed as the entry point to academia. In the United Kingdom and various other European countries, the Master of Engineering is often considered an undergra-

наук в зависимости от университета. Программа на получение данной степени обычно включает изучение таких предметов, как физика, математика, управление проектами и какие-то конкретные темы в области электротехники. Первоначально эти темы включают в себя большую часть, если даже не все подразделы электротехники. Затем к концу обучения студенты выбирают специализацию в одном или нескольких подразделах электротехники.

Некоторые инженеры-электрики считают необходимым получить более высокие учёные степени магистра технических наук, магистра естественных наук, магистра управления технологическими процессами, доктора технических наук или диплом инженера.

Программа на получение степени магистра или диплома инженера может состоять либо из исследовательской, либо курсовой работы, или из того и другого вместе. Программа на получение степени доктора наук состоит из существенного научного компонента и зачастую рассматривается как вступление в мир науки. В Великобритании и других ев-

| | |
|---|---|
| duate degree of slightly longer duration than the Bachelor of Engineering. | ропейских странах степень магистра технических наук можно получить по окончании университета, проучившись немного дольше, чем по программе для получения степени бакалавра. |

**Questions**

1. What degree do electrical engineers typically possess?
2. What is the length of study for such a degree?
3. How may the completed degree be designated?
4. What subjects does the study for degree generally include?
5. What postgraduate degrees do some electrical engineers choose to pursue?
6. What may the Master and Engineer's degree consist of?
7. What does the Doctor of Philosophy degree consist of?
8. What is the Master of Engineering often considered in the United Kingdom?

## PRACTICING ENGINEERS

***1. Study the words, find the sentences with these words in the text and translate them***

1. certification – аккредитация, сертификация
2. to certify – удостоверять, свидетельствовать, сертифицировать, проводить аттестацию, аккредитовать
3. certified degree – аккредитованная степень
4. to satisfy a range of requirements – удовлетворять ряд требований
5. to be designated the title of ... – присваивается звание
6. Professional Engineer – профессиональный инженер
7. Chartered Engineer – дипломированный инженер
8. Quebec's Engineers Act – Закон провинции Квебек о профессиональной деятельности инженеров
9. legislation – законодательство

10. certifying body – орган сертификации, сертификационный центр, сертификационная организация
11. Institute of Electrical and Electronics Engineers (IEEE) – Институт инженеров по электротехнике и электронике
12. Institution of Electrical Engineers (IEE) – Институт инженеров-электриков
13. to claim – утверждать
14. obsolescence of skills – устаревание профессии
15. concern – обеспокоенность
16. to maintaining proficiency – сохранять профессиональный уровень
17. labour force – рабочая сила, трудоспособное население

***2. Read and translate the text***

In most countries, a Bachelor's degree in engineering represents the first step towards professional certification and the degree program itself is certified by a professional body. After completing a certified degree program the engineer must satisfy a range of requirements (including work experience requirements) before being certified. Once certified the engineer is designated the title of Professional Engineer (in the United States, Canada and South Africa ), Chartered Engineer (in the United Kingdom, Ireland, India and Zimbabwe), Chartered Professional Engineer (in Australia and New Zealand) or European Engineer (in much of the European Union).

The advantages of certification vary depending upon location. For example, in the United States and Canada "only a licensed engineer may seal engineering work for public and private clients". This requirement is enforced by state and provincial legislation such as Quebec's Engineers Act. In other countries, such as Australia, no such legislation exists. Practically all certifying bodies maintain a code of ethics that they expect all members to abide by or risk expulsion. In this way these organizations play an important role in maintaining ethical standards for the profession. Even in jurisdictions where certification has little or no legal bearing on work, engineers are subject to contract law. In cases where an

engineer's work fails he or she may be subject to the tort of negligence and, in extreme cases, the charge of criminal negligence. An engineer's work must also comply with numerous other rules and regulations such as building codes and legislation pertaining to environmental law.

Professional bodies of note for electrical engineers include the Institute of Electrical and Electronics Engineers (IEEE) and the Institution of Electrical Engineers (IEE). The IEEE claims to produce 30 percent of the world's literature in electrical engineering, has over 360,000 members worldwide and holds over 300 conferences annually. The IEE publishes 14 journals, has a worldwide membership of 120,000, and claims to be the largest professional engineering society in Europe. Obsolescence of technical skills is a serious concern for electrical engineers. Membership and participation in technical societies, regular reviews of periodicals in the field and a habit of continued learning are therefore essential to maintaining proficiency.

In countries such as Australia, Canada and the United States electrical engineers make up around 0.25 % of the labour force. Outside of these countries, it is difficult to gauge the demographics of the profession due to less meticulous reporting on labour statistics. However, in terms of electrical engineering graduates per-capita, electrical engineering graduates would probably be most numerous in countries such as Japan and South Korea.

***Answer the questions and use them as a plan for your retelling of the text***

1. What does a Bachelor's degree in engineering represent in most countries?
2. Whom is the degree program certified?
3. What must the engineer satisfy after completing a certified degree program?
4. What title is the engineer designated once certified?
5. What are the advantages of certification?
6. What is requirement of certification enforced by?
7. What do all certifying bodies maintain?
8. Why do all certifying bodies maintain code of ethics?

9. Are engineers subject to contract law even in jurisdictions where certification has little or no legal bearing on work?
10. What happens in cases where an engineer's work fails?
11. Must an engineer's work also comply with numerous other rules and regulations such as building codes and legislation pertaining to environmental law?
12. What are professional bodies of note for electrical engineers?
13. What is the professional activity of the IEEE?
14. What does the IEE do?
15. What is a serious concern for electrical engineers?
16. What is essential to maintaining proficiency?
17. What is the number of electrical engineers in such countries as Australia, Canada and the United States?
18. Where would electrical engineering graduates be most numerous in terms of electrical engineering graduates per-capita?

***3. Using the texts given above and the words on pages 16 – 17 discuss the profession of electrical engineer. Finish the dialogue given below***

– Hello everybody, and welcome to today's ***World of Professions***, the programme that examines world issues and the way they affect each and every one of us. Today we turn our attention to the profession of electrical engineer, or more specifically, to a person connected with electrical engineering. So what is electrical engineering? What does it sometimes referred to? When did the field first become an identifiable occupation? Why? All these questions and many more will be answered for you by an expert in this area. So meet Mr. Smith, an electrical engineer.

– Good morning, ladies and gentlemen, hope that my talk will be useful and interesting for you. So I should say that electrical engineering (sometimes referred to as electrical and electronics engineering) is a professional engineer-

ing discipline that deals with the study and application of electricity, electronics and electromagnetism. The field first became an identifiable occupation in the late nineteenth century with the commercialization of the electric telegraph and electrical power supply.

– This field now covers a range of sub-disciplines including those that deal with power, control systems, electronics and telecommunications, doesn't it?
– Quite right, the term ***electrical engineering*** also may or may not encompass ***electronics engineering …***

***4. First study the vocabulary, then read one student's story about his profession, be ready to ask him questions***

**My Specialty is Electric Power Supply**

1. to train – готовить, обучать
2. to provide training – обеспечивать подготовку
3. to get (to receive) training) – получать подготовку
4. to specialize (major) in – специализироваться в чем-либо
5. computer-aided measurements – компьютеризированные измерения
6. alarm systems – системы охранной сигнализации
7. to be concerned with – быть связанным с чем-либо
8. electric power supply – электроснабжение
9. application – применение
10. to cover all fields of human activity – затрагивать все виды человеческой деятельности
11. truly – поистине
12. systems of life support – системы жизнеобеспечения
13. office building – административное здание
14. public building – общественное здание
15. residentional building – жилое здание
16. to design – проектирование
17. to operate – вводить в эксплуатацию

18. to maintain – обслуживать, поддерживать в хорошем состоянии
19. to obtain (get) knowledge – получать знания
20. up-to-date, state-of-the-art – современный
21. space-launch complex – космодром
22. flight control centre – центр по контролю за полетами
23. to be in (great) demand – пользоваться (большим) спросом
24. a shortage – нехватка

I study at the faculty of Radiophysics, Electronics and Medical Equipment of the Vladimir State University. It is the largest faculty of the University and provides training in different specialties. It trains radio engineers, electrical engineers and engineers, specializing in computer-aided measurements, medical engineering, alarm systems, radio electronics and other areas. I am going to be an electrical engineer.

I think that the profession of electrical engineer is very important nowadays because it is concerned with electric power supply. Our life is practically impossible without electricity. Electric power has become universal; its applications now cover all fields of human activity from washing machines to the latest laser devices. Truly electricity provides mankind with the energy of the future. Alongside with other systems of life support electric power supply forms the basis of modern economy. All the industrial, transport and communication enterprises; office, public, and residentional buildings are full of electric power supply systems. And electrical engineers are required to design, install, operate and maintain all these systems.

The Vladimir State University has been training electrical engineers since 1997. According to the curriculum students going to become electrical engineers

study general educational and specialized subjects. In the process of study the future electrical engineers obtain enough knowledge and are taught to design, construct and operate up-to-date electric power supply systems. Much attention is paid to computer application to electric power supply. Engineers specializing in electric power supply also get (receive) training in designing and maintaining state-of-the-art electromagnetic, electromechanical and electronic instruments, devices, machines and electric power supply systems.

Electrical engineers can easily find an employment in various companies in Vladimir and the Region, because not a single enterprise (from a small farm up to huge industrial giants, space-launch complexes and flight control centres) can work properly without electrical engineers. They are in great demand everywhere; there is the shortage of them in the Vladimir Region. So I am sure to find an interesting, worthy and well-paid job.

***5. Read the dialogue and make your own dialogue using vocabulary from the previous text and expressions on pages 16 – 17***

***MY SPECIALTY IS ELECTRIC POWER SUPPLY***

– What do you major in?
– Electrical engineering. I am going to become an electrical engineer.
– They say the term electrical engineering may or may not encompass electronics engineering. What is the difference between electrical and electronics engineers?
– You see, electrical engineering is considered to deal with the problems associated with large-scale electrical systems such as power transmission and motor control, whereas electronics engineering deals with the study of small-scale electronic systems including computers and integrated circuits.
– So it means that electrical engineers are usually concerned with using electricity to transmit energy, while electronics engineers are concerned with using electricity to transmit information. But why have you chosen this specialty?

– I think that the profession of electrical engineer is very important nowadays because it is concerned with electric power supply.
– Our life is practically impossible without electricity. Electric power has become universal; its applications now cover all fields of human activity.
– You are quite right. I think that electrical engineers are required everywhere. All the industrial, transport and communication enterprises; office, public, and residential buildings are full of electric power supply systems. And electrical engineers are required to design, install, operate and maintain all these systems.
– I think that they are in great demand.
– Yes, that's why the Vladimir State University has been training electrical engineers since 1997.
– And what do you study to become good engineers?
– A lot of different things. According to the curriculum we study general educational and specialized subjects and learn to design, construct and operate up-to-date electric power supply systems. Much attention is paid to computer application to electric power supply.
– And what about employment prospects? Are you sure you'll find a job?
– You know, there is the shortage of electrical engineers in the Vladimir Region. So I am sure to find an interesting, worthy and well-paid job.
– I wish you good luck.

***6. Look through tasks 7 – 8 pages 27 – 29. Read and translate the résumé and letter of application, write your own résumé and letter of application or the job advertised on page 28.***

## UNIT 3

# *FAMOUS PEOPLE*

***1. Before reading the texts answer the following questions***

1. Have you ever heard about Edison, Tesla and Faraday? What are they famous for?
2. What do they all have in common?
3. Name some other scientists and inventors working in the same sphere?

***2. Study the words, find the sentences with these words in the text and translate them***

1. inspiration – вдохновение
2. perspiration – пот
3. to be credited – приписывать *(кому-либо что-либо)*
4. long-lasting – долговечный
5. to contribute – вносить вклад
6. to originate – давать начало, порождать
7. rags-to-riches – от нищеты к богатству
8. to be venerated – быть почитаемым
9. to be mourned – быть оплакиваемым
10. polyphase – многофазный, полифазный
11. patent ['peItqnt] – патент
12. groundbreaking importance – инновационное значение
13. to usher in – возвещать, знаменовать
14. to pioneer – прокладывать путь
15. to rival [ˈraIvql] – соперничать
16. eccentric personality [Ik'sentrIk] – чудаковатая, странная личность
17. bizarre [bI'zR] claims – странные, эксцентричные утверждения
18. to ostracize ['0strqsaIz] – подвергать остракизму, изгонять из общества
19. to die impoverished – умереть в нищете
20. measuring magnetic flux density – измерение плотности магнитного потока

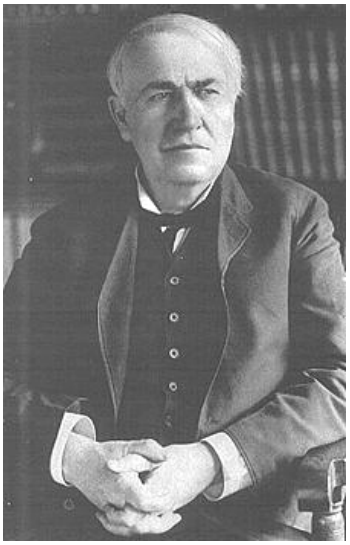
21. magnetic induction – магнитная индукция
22. wireless energy transfer – беспроводная передача энергии
23. robotics – робототехника
24. remote control – дистанционное управление
25. computer science – вычислительная техника
26. expansion – дополнение
27. elementary education – начальное образование
28. rudiments – первичные знания
29. to pay tributes – отдавать дань, воздать должное
30. list of scientific discoveries – перечень научных открытий
31. a committed Christian – убеждённый христианин
32. faith – вера
33. to shape – сформировать
34. diamagnetism – диамагнетизм
35. a pattern of experimentation – разработка экспериментов
36. reasoning – обоснование

### *3. Read and translate the texts*

**Thomas Alva Edison**

***"Genius is one percent inspiration, ninety-nine percent perspiration."***

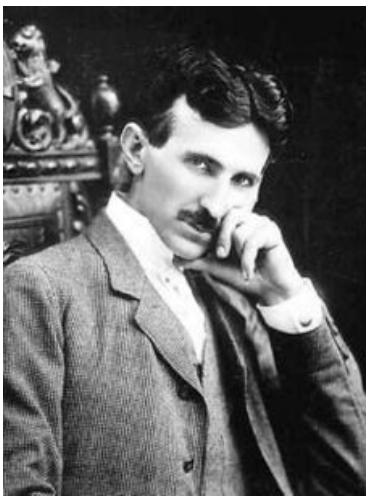
*Thomas Alva Edison, Harper's Monthly (September 1932)*



Thomas Alva Edison (February 11, 1847 – October 18, 1931) was an American inventor and businessman who developed many devices that greatly influenced life around the world, including the phonograph and the long-lasting, practical electric light bulb. He was one of the first inventors to apply the principles of mass production and large teamwork to the process of invention, and therefore is often credited with the creation of the first industrial research laboratory.

Edison is considered one of the most prolific inventors in history, holding 1,093 U.S. patents in his name, as well as many patents in the United Kingdom, France and Germany. He is credited with numerous inventions that contributed to mass communication and, in particular, telecommunications. Edison originated the concept and implementation of electric-power generation and distribution to homes, businesses, and factories – a crucial development in the modern industrialized world. His first power plant was on Manhattan Island, New York. Edison's career, the fulfillment of the American dream of rags-to-riches through hard work and intelligence, made him a folk hero to his countrymen. By the time he was in his middle 30s Edison was said to be the best-known American in the world. When he died he was venerated and mourned as the man who, more than any other, had laid the basis for the technological and social revolution of the modern electric world. Now there is ***Edison Medal*** presented by the Institute of Electrical and Electronics Engineers (IEEE) "for a career of meritorious achievement in electrical science, electrical engineering or the electrical arts." It is the oldest and most coveted medal in this field of engineering in the United States. The award consists of a gold medal, bronze replica, small gold replica, certificate and honorarium.

## Nikola Tesla



Nikola Tesla (10 July 1856 – 7 January 1943) was an inventor and a mechanical and electrical engineer. Born in Austrian Empire, he was an ethnic Serb subject of the Austrian Empire and later became an American citizen. Tesla is best known for many revolutionary contributions in the field of electricity and magnetism in the late 19th and early 20th centuries. Tesla's patents and theoretical work formed the basis of modern alternating current electric power (AC) systems, including the polyphase power distribution systems and the AC motor, with which

he helped usher in the Second Industrial Revolution. Contemporary biographers of Tesla have regarded him as "The Father of Physics", "The man who invented the twentieth century" and "the patron saint of modern electricity."

He was widely respected as one of the greatest electrical engineers who worked in America. Much of his early work pioneered modern electrical engineering and many of his discoveries were of groundbreaking importance. During this period, in the United States, Tesla's fame rivaled that of any other inventor or scientist in history or popular culture, but due to his eccentric personality, seemingly unbelievable and sometimes bizarre claims about possible scientific and technological developments, Tesla was ultimately ostracized and regarded as a mad scientist. Never having put much focus on his finances, Tesla died impoverished at the age of 86.

The SI unit measuring magnetic flux density or magnetic induction, the tesla, was named in his honour, as well as the Tesla effect of wireless energy transfer to wirelessly power electronic devices.

Aside from his work on electromagnetism and electromechanical engineering, Tesla has contributed in varying degrees to the establishment of robotics, remote control, radar and computer science, and to the expansion of ballistics, nuclear physics, and theoretical physics. Tesla is honoured in Serbia and Croatia, as well as in the Czech Republic.

**"Patron-saint" of Electrical Engineers**

Michael Faraday had only an elementary education, "little more than the elementary education of reading, writing and arithmetic at a common day school, as he himself described it. Yet the Encyclopaedia Britannica has called him "possibly the greatest experimental genius the world has known". Many equally generous tributes have been paid to this unique man. He has been called the patron saint of electrical

engineers and Humphry Davy's greatest discovery. Most of Faraday's long list of scientific discoveries lie in the fields of chemistry and electricity. Of his 158 published papers, about half relate to electrical science and a third to chemistry. His contemporaries said he was a kind, gentle and proud man who had a simple manner and attitude. As well as being one of the world's greatest scientists lie was also a committed Christian and that must say something about those who profess that science and religion do not mix. His personal faith helped shape his philosophy and led him to accept the unity of the universe. He established several of our common terms, including electrode, anode, cathode, electrolysis, electrolyte, paramagnetism and diamagnetism (which he discovered) and dielectric. Faraday played a major role in a pattern of experimentation and reasoning on electro-magnetism and related sciences, which began with Oersted and culminated with Einstein and Planck.

***4. Find in the texts the English equivalents of the following expressions***

Принципы массового производства и коллективной работы; устройства, оказавшие большое влияние на жизнь в мире; один из самых плодотворных изобретателей в истории; многие открытия, которые произвели переворот в науке об электричестве и магнетизме; был прост в поведении и отношении с людьми; «вероятно, величайший гений эксперимента, которого когда-либо знал мир»; ввёл некоторые из широко употребляемых нами терминов.

***5. Answer the questions***

1. When and where was each of these scientists born?
2. What field of science did they work?
3. What kind of people were they?
4. What inventions and discoveries did they make?
5. How was their names perpetuated in science?

***6. Make up your own story about a famous scientist working in the field of electricity. Use the questions given above as the plan of your story.***

## UNIT 4

# *ELECTRIC MACHINES AND INSTRUMENTS*

***1. Study the words, find the sentences with these words in the text and translate them***

1. academic study – чисто теоретические академические исследования
2. electric motor – электрический двигатель
3. electric generator – электрический генератор
4. electro-mechanical energy converters – электромеханические преобразователи энергии
5. dynamic movement of the mechanical power – динамическое перемещение механической энергии
6. rotating – вращательный, поворотный
7. linear – линейный
8. machinery – механизмы, механическое оборудование
9. grinding wheels – шлифовальные круги
10. rolling mills – прокатные станы
11. road vehicles – дорожные машины
12. armature ['RmqCq] – арматура (*электродвигателя*)
13. rotor – ротор электрической машины, якорь (электродвигателя)
14. shaft – вал
15. wire coil – катушка с проволокой
16. split cylindrical drum – разрезанный цилиндрический барабан
17. commutator – коллектор (электрической машины)
18. the main supply – питание от сети переменного тока
19. carbon blocks – бруски графита
20. brushes – щётки
21. to wipe against – скользить, тереться
22. to couple – соединять

23. gearing ['gIqrIN] – приводной механизм, зацепление
24. to come to rest – приходить в состояние покоя
25. field coils – индукторная катушка
26. inertia [I'nWSq] – сила инерции
27. turning force – вращающая сила
28. universal motor – универсальный электродвигатель
29. induction motor – асинхронный электродвигатель, индукционный двигатель
30. synchronous motor – синхронный электродвигатель

***2. Read and translate the text***

**Electric motor**

The academic study of electric machines is the universal study of electric motors and electric generators. By classic definition, electric machine is synonymous with electric motor or electric generator, which are electro-mechanical energy converters: converting electricity to mechanical power (i.e., electric motor) or mechanical power to electricity (i.e., electric generator).

A machine that is fed with electric current and gives out mechanical power is called an electric motor. Examples are found in the vacuum cleaner and in the starter motor of a motor vehicle, while in industry, electric motors drive all kinds of machinery, ranging from small grinding wheels in workshops to big rolling mills in steel plants. Also they are used to drive electric trains, and some road vehicles.

If a wire carrying an electric current is brought near a magnetic needle it causes the needle to move away from its north-south direction. This is the principle of the electric motor, which makes use of the relationship between electricity and magnetism to produce movement.

In a simple electric motor, the wire carrying the electric current moves in the magnetic field of a permanent magnet. The moving part of the motor, around which the wire is coiled, is made of iron, and is called the armature or rotor.

A shaft passing through the rotor allows it to rotate between the ends, or poles, of the permanent magnet. Each end of the wire coil is connected to a separate copper plate, the two plates forming the outside sections of a split cylindrical drum called the commutator. An electric current is fed to the coil from the main supply through carbon blocks called brushes, which wipe against the commutator. One end of the armature shaft is coupled, or linked, to the machinery that is to be driven by the motor either directly or through gearing.

When the electric current is switched on, the armature behaves like an electromagnet. Which end is north and which end is south depend on the direction of the current. Like poles repel and unlike poles attract. So the south pole of the armature is repelled from the south pole of the permanent magnet and attracted towards the north pole of the permanent magnet. And the north pole of the armature is repelled from the north pole of the permanent magnet and attracted towards the south pole of the permanent magnet. These forces of magnetic repulsion and attraction cause the armature to start rotating.

The armature does not come to rest when its north and south poles are opposite the south and north poles of the permanent magnet. Instead, the inertia of the moving armature carries it a little way past this position and, in so doing, reverses the connections between the commutator and the brushes. So the current now flows through the armature coil in the opposite direction, and therefore the poles of the armature are reversed. As a result, they are repelled from the nearby like poles of the permanent magnet and attracted towards its opposite poles. This causes the armature to continue to rotate. Each time the armature's poles pass those of the permanent magnet, the commutator reverses the direction of current flow, so the armature continues to rotate so long as the current continues to flow.

The simple electric motor runs on direct current (d.c), and in some cases the fixed magnet as well as the armature is an electromagnet. Most d.c. motors have several coils of wire, called field coils, each connected between a different pair of commutator plates. This arrangement produces a more even turning force.

Some electric motors, mostly small ones, are designed to run on either d.c. or alternating current (a.c), and are called universal motors. Generally speaking, however, special types of motor are made for use with a.c. The two main types are the induction motor, the speed of rotation of which alters with the work it has to do, and the synchronous motor, which rotates at a constant speed.

***3. Answer the questions***

1. What is the electric machine by classic definition?
2. What machine is called an electric motor?
3. Where can we find electric motors?
4. What principle is used in electric motors?
5. What is the moving part of an electric motor?
6. How is the armature linked to the machinery to be driven by the motor?
7. What causes the armature rotating?
8. Why does the armature continue to rotate as long as the current flows?
9. What components do most of d.c. motors have?
10. What motors are designed to work either on d.c. or a.c. current?
11. What are the two main types of motors?

## *TRANSFORMER*

***1. Study the words, find the sentences with these words in the text and translate them***

1. inductively coupled – связанных посредством индукции
2. transformer's coils – катушки трансформатора
3. windings – обмотки
4. to utilise – использовать
5. air-core transformer – трансформатор с воздушным сердечником
6. to wind (wound) – наматывать
7. primary winding – первичная обмотка
8. secondary winding – вторичная обмотка
9. mutual induction – взаимная индукция
10. the ratio of the number of turns – соотношение количества витков
11. stepped up – повышенный
12. stepped down – пониженный
13. coupling transformer – трансформатор межкаскадной связи
14. thumbnail-sized – миниатюрный

15. unit – установка, агрегат
16. to eliminate the need – устранить потребность
17. household ("mains") voltage – напряжение в сети

***2. Read and translate the text, ask questions on it***

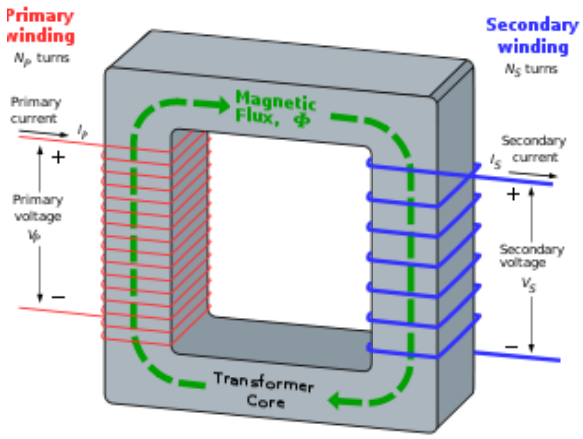
A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors – the transformer's coils or "windings". Although transformers do not contain any moving parts they are also included in the family of electric machines because they utilise the electromagnetic phenomena. Except for air-core transformers, the conductors are commonly wound around a single iron core, or around separate magnetic coupled cores. A varying current in the first or "primary" winding creates a varying magnetic field in the core (or cores) of the transformer. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the "secondary" winding. This effect is called mutual induction.

If a load is connected to the secondary, an electric current will flow in the secondary winding and electrical energy will flow from the primary circuit through the transformer to the load. In an ideal transformer, the induced voltage in the secondary winding is in proportion to the primary voltage, and is given by the ratio of the number of turns in the secondary to the number of turns in the primary as follows: By appropriate selection of the ratio of turns, a transformer thus allows an alternating current (AC) voltage to be "stepped up" by making the number of turns in the secondary greater than the number of turns in the primary, or "stepped down" by making the number of turns in the secondary less than the number of turns in the primary.

Transformers come in a range of sizes from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used to interconnect portions of national power grids. All operate with the same basic principles, although the range of designs is wide. While new technologies have eliminated the need for transformers in some electronic circuits, transformers are still found in nearly all electronic devices designed for

household ("mains") voltage. Transformers are essential for high voltage power transmission, which makes long distance transmission economically practical.

The transformer is based on two principles: firstly, that an electric current can produce a magnetic field (electromagnetism) and secondly that a changing magnetic field within a coil of wire induces a voltage across the ends of the coil (electromagnetic induction). Changing the current in the primary coil changes the magnitude of the applied magnetic field. The changing magnetic flux extends to the secondary coil where a voltage is induced across its ends.




*An ideal step-down transformer showing magnetic flux in the core*

A simplified transformer design is shown to the left. A current passing through the primary coil creates a magnetic field. The primary and secondary coils are wrapped around a core of very high magnetic permeability, such as iron; this ensures that most of the magnetic field lines produced by the primary current are within the iron and pass through the secondary coil as well as the primary coil.

### *3. Translate the text summary from Russian into English*

Этот текст о трансформаторах. Трансформатор – электрическая машина, которая переносит электрическую энергию из одной цепи в другую посредством электромагнитной индукции без существенных потерь мощности. Трансформатор может состоять из одной  или нескольких изолированных проволочных обмоток, намотанных на сердечник из ферромагнитного материала. Они называются первичная и вторичная обмотки. Посредством соотношения витков первичной и вторичной обмотки можно получить повышающий и понижающий трансформаторы. Трансформаторы выпускают разных размеров – от крошеч-

ных, использующихся в микрофонах, до огромных весом в несколько тонн, используемых в электросетях. Главная область использования трансформаторов – преобразование электрической энергии с одним напряжением в электрическую энергию с другим.

## *ELECTRICAL INSTRUMENTS*

### *1. Study the words, find the sentences with these words in the text and translate them*

1. ohmmeter – омметр
2. aka ['eI"keI'eI] (also known as) – также называемый, иначе называемый
3. values of resistance – величины сопротивления
4. accurate ['xkjqrqt] – точный, правильный
5. accuracy ['xkjqrqsI] – точность, правильность
6. constant current – постоянный (по величине) ток
7. equation [I'kweIZqn] – уравнение
8. to derive – выводить
9. high-precision measurements – высокоточные измерения
10. inadequate – (не)отвечающий требованиям, (не)точный
11. the meter's reading – показания измерителя
12. current drop – уменьшение силы тока
13. ammeter ['xmItq] – амперметр
14. moving iron ammeter – электромагнитный амперметр
15. zero-center ammeter – амперметр с нулевой отметкой в центре шкалы
16. analog meter – аналоговый измеритель
17. digital meter – цифровой измеритель
18. analog to digital converter (ADC) – аналогово-цифровой преобразователь (АЦП)
19. shunt – шунт, соединение, параллельное включение
20. short circuit – короткое замыкание (КЗ), цепь КЗ
21. to blow a fuse – сделать короткое замыкание

22. to damage – повреждать, портить
23. to expose – подвергать
24. observer – наблюдатель
25. injury – травма
26. pointer – стрелка (часов, весов и т. п.), указатель
27. scale – шкала
28. numerical display – цифровой дисплей
29. calibrated – градуированный, калиброванный

### *2. Read and translate the text, make its summary*

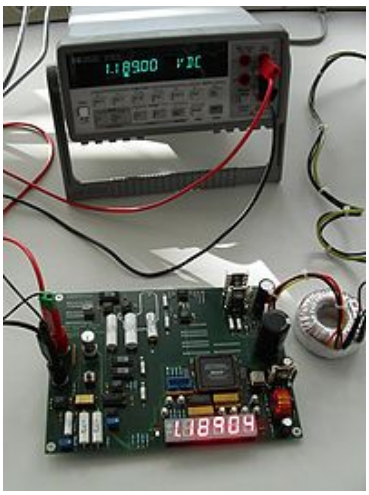
*An ohmmeter*

An ***ohmmeter*** is an electrical instrument that measures electrical resistance, the opposition to an electric current. Micro-ohmmeters (microhmmeter or microohmmeter) make low resistance measurements. Megohmmeters (aka megaohmmeter or megger) measure large values of resistance. They are measured in ohms (Ω). A more accurate type of ohmmeter has an electronic circuit that passes a constant current (I) through the resistance, and another circuit that measures the voltage (V) across the resistance. According to the following equation, derived from Ohm's Law, the value of the resistance (R) is given by: $R = \frac{V}{I}$.

For high-precision measurements the above types of meter are inadequate. This is because the meter's reading is the sum of the resistance of the measuring leads, the contact resistances and the resistance being measured. To reduce this effect, a precision ohmmeter has four terminals, called Kelvin contacts. Two terminals carry the current from the meter, while the other two allow the meter to measure the voltage across the resistor. With this type of meter, any current drop due to the resistance of the first pair of leads and their contact resistances is ignored by the meter.

*Zero-center ammeter*

An ***ammeter*** is a measuring instrument used to measure the electric current in a circuit. Electric currents are measured in amperes (A), hence the name. Moving iron ammeters use a piece of iron which moves when acted upon by the electromagnetic force of a fixed coil of wire. This type of meter responds to both direct and alternating currents (as opposed to the moving coil ammeter, which works on direct current only). Zero-center ammeters are used for applications requiring current to be measured with both polarities, common in scientific and industrial equipment. Zero-center ammeters are also commonly placed in series with a battery. In this application, the charging of the battery deflects the needle to one side of the scale (commonly, the right side) and the discharging of the battery deflects the needle to the other side. Digital ammeter designs use an analog to digital converter (ADC) to measure the voltage across the shunt resistor; the digital display is calibrated to read the current through the shunt. Since the ammeter shunt has a very low resistance, mistakenly wiring the ammeter in parallel with a voltage source will cause a short circuit, at best blowing a fuse, possibly damaging the instrument and wiring, and exposing an observer to injury.


*Two digital voltmeters*

A ***voltmeter*** is an instrument used for measuring the electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter. Voltmeters are made in a wide range of styles. Instruments permanently mounted in a panel are used to monitor generators or other fixed apparatus.

Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter, are standard test instruments used in electrical and elec-

tronics work. Any measurement that can be converted to a voltage can be displayed on a meter that is suitably calibrated; for example, pressure, temperature, flow or level in a chemical process plant.

General purpose analog voltmeters may have an accuracy of a few per cent of full scale, and are used with voltages from a fraction of a volt to several thousand volts. Digital meters can be made with high accuracy, typically better than 1%. Specially calibrated test instruments have higher accuracies, with laboratory instruments capable of measuring to accuracies of a few parts per million. Meters using amplifiers can measure tiny voltages of microvolts or less.

### *3. Answer the questions*

1. What is an ohmmeter?
2. What units is resistance measured in?
3. What ohmmeters are used to make low and high resistance measurements?
4. How does a more accurate type of ohmmeter work?
5. What meters are adequate for high-precision measurements?
6. What is an ammeter used to measure?
7. Where does the name of this instrument come from?
8. How do moving iron ammeters work?
9. What current does moving iron ammeter respond to?
10. Where are zero-center ammeters used?
11. How do they work?
12. How do digital ammeters work?
13. What damage can wiring the ammeter in parallel with a voltage source cause?
14. What is a voltmeter used for?
15. How do analog and digital voltmeters work?
16. Where are instruments permanently mounted in a panel used?
17. When are portable instruments used?

18. What measurements can be displayed on a meter?
19. What accuracy do general purpose analog and digital voltmeters have?
20. What voltmeters have the highest accuracies?
21. What meters can measure tiny voltages?

***4. Tell whether it is true or false***

1. An ohmmeter is used to measure current.
2. The meter's reading is the sum of the resistance of the measuring leads, the contact resistances and the resistance being measured.
3. Four-point-probe can also be ultilized to conduct accurate measurements of high resistances.
4. An ammeter is a measuring instrument used to measure the electric current in a circuit.
5. Moving iron ammeters use the moving coil when acted upon by the electro-magnetic force.
6. Zero-center ammeters are also commonly placed in parallel with a battery.
7. Analog voltmeters give a numerical display of voltage by use of an analog to digital converter.
8. Digital meters have highest accuracies, typically better than 1 %.

***5. You are working for SNS Company in Vladimir. See pages 40 – 41 and write an enquiry letter to Senso-Metrics Incorporated. Ask them whether they manufacture any electric measuring instruments. Use the letter on page 40 as a model.***

## UNIT 5

# *ELECTRICITY RETAILING*

***1. Study the words, find the sentences with these words in the text and translate them***

1. electricity retailing – розничная продажа электрической энергии
2. street lighting – освещение улиц
3. tram – трамвай
4. to purchase – покупать
5. large scale electric company – крупная энергетическая компания
6. provision of services – предоставление услуг
7. municipal authorities – муниципальные власти
8. to be confined to – ограничиваться
9. domestic consumer – бытовой потребитель
10. the amount charged for – то количество, за которое взимается плата
11. electricity meter – электросчётчик
12. monthly service fee – ежемесячная плата за услуги
13. pricing scheme – система ценообразования
14. electric appliance usage – использование электроприборов
15. to contribute to – поспособствовать, содействовать
16. explosive growth in electrification – быстрое (бурное) развитие электрификации
17. supply of electricity – электроснабжение
18. responsibility – обязанность
19. public utility – коммунальное предприятие
20. deregulated – без государственного регулирования
21. electricity pool – энергопул (объединения производителей электроэнергии)
22. spot market – наличный рынок, спотовый рынок электроэнергии
23. competition – конкуренция, соревнование

24. competing suppliers – конкурирующие поставщики
25. to account for – являться причиной, объяснять
26. the type of fuel – вид топлива
27. government subsidies – правительственные субсидии
28. weather pattern – погодные условия, тип погоды

### *2. Read and translate the text, make its summary and retell*

### *ELECTRICITY RETAILING*

Electricity retailing is the final process in the delivery of electricity from generation to the consumer. The other main processes are transmission and distribution.

Electricity retailing began at the end of the 19th century. In the beginning, electricity was primarily used for street lighting and trams. The general public was allowed to purchase electricity only after large scale electric companies were started.

The provision of these services was generally the responsibility of electric companies or municipal authorities. Residential, commercial and industrial use of electricity was confined, initially, to lighting but this changed dramatically with the development of electric motors, heaters and communication devices.

The basic principle of supply has not changed much over time. The amount of energy used by the domestic consumer, and thus the amount charged for, is measured through an electricity meter that is usually placed near the input of a home to provide easy access to the meter reader.

Customers are usually charged a monthly service fee and additional charges based on the electrical energy (in kWh) consumed by the household or business during the month. Commercial and industrial consumers normally have more complex pricing schemes.

The rapid growth in electric appliance usage in the early part of the 20th century contributed to an explosive growth in electrification around the world. The

supply of electricity to homes, offices, shops, factories, farms, and mines became the responsibility of public utilities, which were either private organizations subject to monopoly regulation or public authorities owned by local, state or national bodies.

In 1990 there was a significant development in the way electricity was bought and sold. In many countries, the electricity market was deregulated to open up the supply of electricity to competition. Electricity retailers now provide fixed prices for electricity to their customers and manage the risk involved in purchasing electricity from spot markets or electricity pools. Customers may choose from a number of competing suppliers. An electricity provider is often known as "the electric company" or "the power company". Electricity tariffs on the whole are government regulated. Yet under the climate of deregulation and privatisation worldwide, some have risen already and others are set to do so. Electricity tariffs vary from country to country. There are many reasons that account for this difference in price. The cost of power generation depends largely on the type of fuel used, government subsidies and even the weather pattern. There are a number of organisations and social movements representing the poor that have emerged in response to the privatization of electricity all over the world.

### *3. Answer the questions below*

1. Is electricity retailing the final process in the delivery of electricity from generation to the consumer? What are the two other processes?
2. When did electricity retailing begin?
3. What was electricity primarily used for in the beginning?
4. When was the general public allowed to purchase electricity?
5. Whose responsibility was generally the provision of electricity?
6. What was initially residential, commercial and industrial use of electricity confined to?
7. Has the basic principle of supply changed much over time?
8. How is the amount of energy used by the domestic consumer measured?

9. How are customers usually charged for electricity?
10. What contributed to an explosive growth in electrification around the world?
11. What organizations are public utilities and what are they responsible for?
12. What happened in 1990 in the way electricity was bought and sold?
13. How do electricity retailers now sell electricity to their customers?
14. Are electricity tariffs on the whole government regulated?
15. What became with tariffs under the climate of deregulation and privatization?
16. Do electricity tariffs vary from country to country?
17. What do tariffs depend on?
18. What has emerged in response to the privatization of electricity all over the world?

## *ENERGY POLICY OF RUSSIA*

### *1. Study the words, find the sentences with these words in the text and translate them*

1. Energy Policy of Russia – энергетическая политика России
2. to set out – подробно излагать
3. provision – положение (договора и т. п.)
4. to confirm – подтверждать
5. priority – приоритет(ное направление)
6. energy efficiency – энергоэффективность
7. reducing impact – уменьшающееся воздействие
8. environment – окружающая среда
9. sustainable development – устойчивое развитие
10. effectiveness – эффективность, экономичность
11. competitiveness – конкурентоспособность
12. natural gas (coal, oil) reserves – запасы природного газа (угля, нефти)
13. thermal plants – теплоэлектростанции
14. hydropower – гидроэнергетика
15. nuclear reactors – ядерные реакторы
16. CIS – СНГ
17. the Unified Energy System – Объединённая энергетическая система
18. blackout – аварийное отключение, блэкаут
19. renewable energy – энергия от возобновляемого источника
20. geothermal ["GIq'TWmqI] energy – геотермальная энергия
21. Caucasus ['kLkqsqs] – Кавказ

### *2. Read and translate the text*

The Energy Policy of Russia is contained in an Energy Strategy document, which sets out policy for the period up to 2020. In 2000 the Russian government approved the main provisions of the Russian energy strategy to 2020, and in 2003 the new Russian energy strategy was confirmed by the government. The Energy Strategy document outlines several main priorities: an increase in energy efficiency, reducing impact on the environment, sustainable energy and technology development, as well as its improved effectiveness and competitiveness.

Russia, one of the world's two energy superpowers, is rich in natural energy resources. It has the largest known natural gas reserves of any state on earth, along with the second largest coal reserves, and the eighth largest oil reserves. Russia is the world's fourth largest electricity producer after the USA, China, and Japan. Russia is the world's leading net energy exporter and a major supplier to the European Union. In 2005, Russia produced 951 TWh and exported 23 TWh of electricity. Roughly 63 % of Russia's electricity is generated by thermal plants, 21 % by hydropower and 16 % comes from nuclear reactors. Russia exports electricity to the CIS countries, Latvia, Lithuania, China, Poland, Turkey and Finland.

The Russian energy market is dominated by the Unified Energy System. While production and sale will be opened up to competition, transmission and distribution remain under state control. In recent years there were several blackouts, notably the 2005 Moscow power blackouts.

Renewable energy in Russia is largely undeveloped although there is considerable potential for its use. Geothermal energy, which is used for heating and electricity production in some regions of the Northern Caucasus and the Far East, is the most developed renewable energy source in Russia.

### *Notes*

TeraWatt Hours – миллиард киловатт-часов

GW – ГВт (сокр. от "гигаватт" (gigawatt), т.е. миллиард ватт или миллион киловатт)

***3. Answer the questions below***

1. What document does the Energy Policy of Russia contain?
2. When did the Russian government approve the main provisions of the Russian Energy Strategy to 2020?
3. What was confirmed in 2003?
4. What priorities does the Energy Strategy document outline?
5. What energy resources does Russia have?
6. What is the condition of renewable energy in Russia?
7. What is the most developed renewable energy source?

***4. Speak about the Energy Policy of Russia.***

## ЗАКЛЮЧЕНИЕ

Высокий уровень профессиональной компетенции специалиста достигается наличием у него определенного набора профессиональных умений и навыков. Иноязычные умения и навыки успешно реализуются в составе коммуникативной компетенции лишь тогда, когда они соответствуют профессиональным умениям и навыкам, зафиксированным в нашей стране Государственным образовательным стандартом высшего профессионального образования.

Авторы выражают уверенность, что в результате занятий по данному практикуму студенты смогут общаться в конкретных профессиональных и деловых ситуациях, читать с интересом и пользой для себя статьи из различных иноязычных источников: Интернета, энциклопедий и справочников, а также технических и научных журналов. Хочется пожелать всем дальнейших успехов в процессе изучения и овладения английским языком.

## LIST OF SOURCES


1. URL: http://en.wikipedia.org/wiki (дата обращения: 5.09.2008).
2. URL: http://en.wikipedia.org/wiki/Energy Portal (дата обращения: 5.09.2008).
3. URL: http://www.multitran.ru (дата обращения: 5.09.2008).
4. *Children's Britannica*. Encyclopeadia Britannica, Inc. 1994.
5. *The New Encyclopeadia Britannica.* Encyclopeadia Britannica, Inc. 1994.
6. Michael Swan *Practical English Usage.* Moscow, Vysšaja Škola, 1984.
7. Murphy R. *English Grammar in Use. A Self-study Reference and Practice Book for Intermediate Students*. Cambridge, University Press, 1994.
8. *Webster's Third New International Dictionary*. Encyclopeadia Britannica, Inc., 1994.
9. *Webster's New Collegiate Dictionary*, Indian Edition C&C Mirriam Company Springfield Massachusetts, USA Scientific Book Agency, 1980.
10. *Oxford Advanced Learner's Dictionary of Current English*, London, Oxford University Press, 1974.
11. *New English-Russian Dictionary*, three volumes, Moscow, Russky Jazyk, 2003.
12. Каушанская, В.Л. Грамматика английского языка / В.Л. Каушанская [и др.]. – Л. : Просвещение. Ленингр. отд-ние, 1967. – 128 с.

## CONTENTS

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INSTRUMENTATION & ELECTRICAL ENGINEERING

(ПРИБОРОСТРОЕНИЕ И ЭЛЕКТРОТЕХНИКА)

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