O.A. Semina, N.S. Klimenko,
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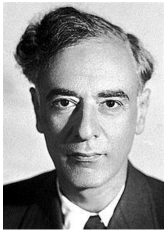
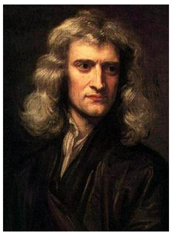



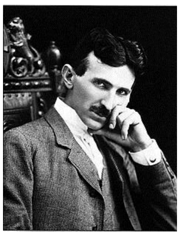


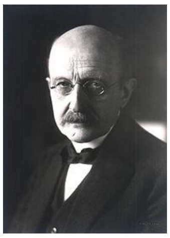
FAMOUS INVENTORS AND SCIENTISTS IN PHYSICS



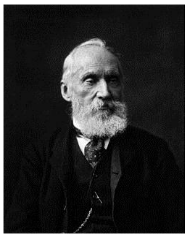
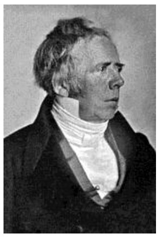
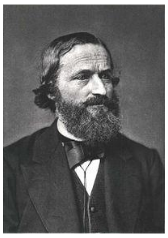










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Федеральное государственное бюджетное образовательное учреждение
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«Сибирский государственный индустриальный университет»

О.А. Семина, Н.С. Клименко, А.П. Семин,
В.Е. Громов, С.В. Коновалов

FAMOUS INVENTORS AND SCIENTISTS IN PHYSICS

Допущено Научно-методическим Советом по физике
Министерства образования и науки Российской Федерации
в качестве учебного пособия для студентов
технических специальностей и направлений подготовки
высших учебных заведений

Новокузнецк
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F22 Famous Inventors and Scientists in Physics (Известные ученые и изобретатели в физике): учеб. пособие / О.А. Семина, Н.С. Клименко, А.П. Семин, В.Е. Громов, С.В. Коновалов / Сиб. гос. индустр. ун-т. – Новокузнецк : Изд. центр СибГИУ, 2013. – 356 с.

Учебное пособие отражает историю развития физики, а изложение материала на английском языке способствует мотивации в обучении и физики, и иностранного языка, а также расширению и углублению межпредметных связей.

В учебном пособии представлены научно-популярные, общетехнические и специальные тексты для внеаудиторного чтения о выдающихся учёных и изобретателях, внёсших большой вклад в научный прогресс человечества и истории знаменательных открытий.

Предназначено для студентов технических специальностей и направлений, а также может быть использовано при подготовке магистров.

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ВВЕДЕНИЕ

Цель учебного пособия – формирование у студентов неязыковых вузов технических специальностей умений и навыков читать и переводить оригинальные тексты, а также понимать, извлекать, обрабатывать и воспроизводить информацию из англо-язычной общетехнической и научно-популярной литературы. Студенты смогут расширить лексический запас общеупотребительной лексики и ознакомиться с приемами, средствами и способами выражения мысли в научно-популярной литературе, т.е. научно-техническим стилем.

Тематика учебного пособия – вклад ученых и изобретателей в научный прогресс человечества и история знаменательных открытий. Особенностью данных методических указаний является аутентичность англоязычных текстов и структура, состоящая из разделов, представленных основным текстом и двумя-тремя дополнительными текстами (related texts), позволяющими представить уровень и значимость работы ученого или изобретателя, и развивающих или углубляющих тему. К каждому тексту даются примечания, разъясняющие наиболее сложные слова и выражения. После текстов даются упражнения на проверку понимания прочитанного материала. В конце учебного пособия даются рекомендации по составлению аннотации и афоризмы выдающихся людей.

В учебном пособии представлены материалы различной степени трудности и профессионально ориентированной направленности. В зависимости от уровня подготовленности и интересов группы, преподаватель может начать работу с любого тематического раздела. Материал может быть использован полностью или выборочно, а упражнения могут выполняться в аудитории или задаваться на дом.

Учебное пособие предназначено для студентов 1 и 2 курсов технических специальностей и направлений подготовки, изучающих английский язык, а также магистров. Приводимый в пособии материал имеет самостоятельное познавательное значение и направлен на повышение интереса к изучению иностранного языка, а также технических дисциплин, учитывает и расширяет межпредметные связи.

Связь естественных, гуманитарных и общественных наук осуществляется через мировоззрение, вмещающее многовековой материальный и духовный опыт всемирной культуры. Структура культуры включает формы общественного сознания: искусство, философию, литературу, мораль, религию и т.д., причём к основной форме общественного сознания относится наука.

Наука является важнейшей частью духовной культуры. В современной культуре она занимает особое место, выполняя роль мощнейшего средства реализации потребности человека и общества, появления новых потребностей, связанных с возникновением новых ценностей, которые современная культура рождает благодаря науке, создавая спрос на её достижения. Наука – это особая сфера деятельности человека, направленная как на получение новых знаний, так и на разработку новых методов их получения.

Важнейшая особенность современного естествознания связана с тем, что осмысление накопленного знания невозможно без исследования процедур его получения, т.е. знания истории науки и техники. Они принципиально влияют на результаты, формируя стратегию научного мышления. Современное естествознание интегрирует совокупные знания о природе и включает прошлые, настоящие и новые знания в систему познания.

Исследование феномена истории науки непременно приводит к конкретным личностям – учёным, сделавшим открытия, изобретения. Они являются ‘посредниками’ в инновационной среде развития цивилизации. Современное естествознание немыслимо без знаний истории науки и техники. В инновационной культуре связь прошлого, современного и нового осуществляется по принципу преемственности традиций с непременным сохранением и усилением новизны.

SECTION 1

TEXT 1.1. INVENTION PROCESS

1. An invention is a new composition, device or process. An invention may be derived from a preexisting model or idea, or it could be independently conceived ***in which case*** it may be a ***radical breakthrough***. Inventions often extend the boundaries of human knowledge or experience. An invention that is novel and not obvious to others skilled in the same field may be able to obtain the ***legal*** production of a patent.

2. Invention is a creative process. An open and curious mind allows an inventor to see ***beyond*** what is known. Seeing a new possibility, a new connection or relationship can spark an invention. Sometimes inventors disregard the boundaries between distinctly separate territories or fields. Ways of thinking, materials, processes or tools from one ***realm*** are used as no one else has imagined in a different realm.

3. Play can lead to invention. Childhood curiosity, experimentation and imagination can develop one's play instinct. Inventing can also be an obsession. To invent is to see a new. Inventors often envision a new idea, seeing it in their mind's eye. New ideas can arise while relaxing or sleeping. A novel idea may come in a flash – a Eureka! moment. Inventions can also be accidental. ***Insight*** is also a vital element of invention. It may begin with questions, doubt or a hunch. It may begin by recognizing that something unusual or accidental may be useful or it can open a new avenue for exploration.

4. Invention is often an exploratory process, with an uncertain or unknown outcome. There are failures as well as successes. Inspiration can start the process but ***no matter*** how complete the initial idea, inventions typically have to be developed. Inventors believe in their ideas and they do not give up in the face of one or many failures. Inventors are often famous for their confidence, their perseverance and their passion.

5. Necessity may be the mother of invention or invention can create necessity. The idea for an invention may be developed on paper or on a computer, by writing or drawing, ***by trial and error***, by making models, by experimenting, by testing and/or by making the invention in its whole form. ***Brainstorming*** can spark new ideas. Collaborative creative processes are frequently used by designers, architects and scientists. Co-inventors are frequently named on patents.

6. Many inventors keep records of their working process – notebooks, photos, etc., including Leonardo da Vinci, Thomas Jefferson and

Albert Einstein. In the process of developing an invention, the initial idea may change. The invention may become simpler, more practical, it may expand, or it may even ***morph*** onto something totally different. Working on one invention can lead to others too [22].

Notes:

1. in which case – в этом случае
2. radical breakthrough – коренной (основной), прорыв, достижение, переворот в науке
3. legal – юридический, правовой, узаконенный
4. beyond – сверх, выше, помимо
5. realm – область, сфера
6. insight – проницательность
7. no matter – независимо от того
8. by trial and error – методом проб и ошибок
9. brainstorming – мозговой штурм, мозговая атака (групповая генерация идей)
10. morph – измениться

I. Find Russian equivalents for:

invention, device, novel idea, human knowledge and experience, creative process, open and curious mind, possibility, connection, separate fields, way of thinking, realm, childhood curiosity, imagination, flash, vital element, useful, failure and success, give up the idea, famous, perseverance, necessity, brainstorming, designers, scientists, collaborative creative process, co-inventors, working process, change, different

II. Find English equivalents for:

состав, задумывать независимо, простираться (распространяться) за границы, получать, соотношение, побуждать (зажигать), пренебрегать (игнорировать), инструменты (средства), приводить к, развивать, рисовать в своем изображении (представлять себе) новую идею, случайный, проницательность, предчувствие (подозрение), исследование, неизвестный результат (исход), вдохновение, уверенность, энтузиазм (страстность), вести записи, изменяться

III. Read and translate text 1.1. Answer the following questions:

1. What is an invention?

2. What is necessary to obtain the legal production of a patent?
3. Why is invention a creative process?
4. When can new ideas arise?
5. What is a vital element of invention?
6. Why is invention not always a successful process?
7. What traits are inventors famous for?
8. How may the idea for invention be developed?
9. What process can help spark the new ideas?
10. What can happen to the initial idea and invention?

TEXT 1.2. INVENTION AND SCIENCE

1. Invention and science are closely interwined. Both require creativity and the ability to solve a problem and logically develop conclusions. Times and needs were different in various countries. Inventions and science built on the work of many people. Communications, ***sharing*** and equipment are vital to any program.

2. A scientist seeks to understand the principles of the universe, large or small. An inventor is a technologist. He uses those scientific principles to solve practical problems. An inventor does not seek to discover new understanding of nature, he seeks to create ways to apply that understanding of nature. For example, a scientist identifies the relationship between electric resistance, heat and ***incandescence***. An inventor uses that relationship to build a better light bulb.

3. ***From a legal point of view***, an invention provides a new solution to a technical problem. An invention can be a product, the use of a product, an application of a product, a chemical compound, a treatment, ***a kit*** or a process. An invention can be protected by a patent only if it satisfies the following criteria:

a) The invention must be novel: If it has been published or described (written or oral) before or used publicly (Internet forum, exhibition etc.) or disclosed to third parties without confidentiality agreement, this criterion is not fulfilled.

b) The invention must be innovative. It shall not be ***obvious*** for a person skilled in the art and shall not be deduced from the technical field of the invention.

c) The invention must have an industrial application [22, 23].

Notes:
1. sharing – разделение, участие

2. incandescence – накаливание, тепловое излучение
3. from a legal point of view – с юридической точки зрения
4. a kit – комплект, набор
5. obvious – банальный

IV. Read and translate text 1.2. Work in pairs, identify, define, or explain each of the following:

1. Invention and science
2. Importance of some processes to any program
3. Difference between a scientist and inventor
4. Invention
5. Patent criteria

TEXT 1.3. INVENTORS

1. Inventors are unusual people. They look at things that we all see, and they think of something new. Then they often have to work for years to turn their ideas into something that works. They might spend all their money and still not find a company that believes in their new product. Sometimes inventors start their own companies to sell their ideas. They can make a lot of money doing this – or lose everything they have.

2. People invent for all kinds of ***reasons***. Some want to discover more about the world around them. Others want to communicate more easily. Some want to make life better for all of us. Others are simply looking for power and money. Whatever the reason is, many inventors have ideas that change our lives. This change is not always an improvement; inventions can be used ***to harm*** people as well as to help them. Many inventions, though, have really changed the world.

3. The creation of an invention and its use can be affected by ***practical considerations***. Visionary inventors commonly collaborate with technical experts, manufactures, investors and /or business people to turn an invention from idea into reality, and possibly even to turn invention into innovation. Nevertheless, there are inventions that are too expensive to produce and inventions that require scientific advancements that have not yet occurred. These barriers can erode or disappear as the economic situation changes or as science develops.

4. But history shows that turning the idea of an invention into reality is not always swift or a direct process, even for terrific inventions. It took centuries for some of Leonardo da Vinci’s and Nikola Tesla’s inventions to become reality. Inventions may also become more useful after time

passes and other changes occur. For example, the parachute became more useful once powered flight was a reality.

5. An invention can serve many purposes, these purposes might differ significantly and they may change over time. An invention or a further developed ***version*** of it may serve purposes never envisioned by its original inventor or by others living at the time of its original invention [23].

Notes:

1. reason – причина, мотив
2. harm – вредить, наносить ущерб
3. practical considerations – практические соображения
4. version – вариант

V. Read and translate text 1.3. Work in groups/pairs. Discuss each of the following:

1. Inventors and their difficulties
2. Reasons for invention
3. Collaboration with experts
4. Economic barriers for invention
5. Terrific inventions
6. Purpose of invention

TEXT 1.4. SCIENCE AND TECHNOLOGY

1. Technology means the use of people's inventions and discoveries to satisfy their needs. Since people have appeared on the earth, they have had to get food, clothes, and shelter. Through the ages, people have invented ***tools***, machines, and materials to make work easier.

2. Nowadays, when people speak of technology, they generally mean industrial technology. Industrial technology began about 200 years ago with the development of the steam engine, the growth of factories, and with the development and the mass production of goods. It influenced different aspects of people's lives. The development of the car influenced where people lived and worked. Radio and television changed their leisure time. The telephone revolutionized communication.

3. Technology is the ***application*** of science to the practical aims of human life or to the change and manipulation of the human environment. The term originally signified the study of or a ***discourse*** upon the ***arts***, both ***fine and applied***. By the late 20th century it had become to mean the pursuit of results, especially the useful results of scientific research and it had become a global term connoting not only the ***tangible*** products of

science but also the associated attitudes, processes, artifacts and consequences.

4. Science has contributed much to modern technology. Science attempts to explain how and why things happen. Technology makes things happen. But not all technology is based on science. For example, people had made different objects from iron for centuries before they learnt the structure of the metal. But some modern technologies, such as ***nuclear power*** production and space travel, depend heavily on science [13].

Notes:

1. tool – инструмент
2. application – применение, использование
3. discourse – рассуждение
4. art – мастерство, искусство, технология, ремесло
5. fine art – изобразительное искусство
6. applied art – прикладное искусство (технология, ремесло)
7. tangible – реальный, материальный, осязаемый
8. nuclear power – ядерная энергия

VI. Read and translate text 1.4. Identify, define, or explain each of the following:

1. Technology
2. Development of technology
3. Industrial technology
4. The term 'technology'
5. Science and technology

TEXT 1.5. SCIENTIFIC METHOD

1. Scientific method refers to a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. It is based on gathering observable, empirical and measurable evidence ***subject to*** specific principles of reasoning. Scientific method is a method of procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, experiment, and the formulation, testing and modification of hypotheses.

2. Scientific researches propose hypotheses as explanations of phenomena and design experimental studies to test these hypotheses. These steps must be repeatable ***to predict*** future results. Theories that encompass wider domains of inquiry may bind many independently derived hypotheses

together in a ***coherent***, supportive structure. Theories, in turn, may help form new hypotheses or place groups of hypotheses into context.

3. Scientific inquiry is generally intended to be as objective as possible to reduce ***biased*** interpretations of results. Another basic expectation is to document, archive and share all data and methodology so they are available for careful scrutiny by other scientists, giving them the opportunity to verify results by attempting to reproduce them. This practice, called ***full disclosure***, also allows statistical measures of the reliability of these data to be established [21].

Notes:

1. subject to – подвергать; с соблюдением; в соответствии с; в зависимости от
2. predict – прогнозировать
3. coherent – логически последовательный, связный, понятный
4. biased – тенденциозный, предвзятый, необъективный
5. full disclosure – полное раскрытие (выдача сведений)

VII. Read and translate text 1.5. Work in pairs. Explain each of the following:

1. Scientific method
2. Basis of scientific method
3. Steps for prediction the results
4. Theory
5. Scientific inquiry
6. Full disclosure

TEXT 1.6. SCIENCE PARK

1. Science park (or business park) is a cluster of firms, mainly high-technology business, which are located together on a purpose-built site ***adjacent*** to a university, polytechnic or some other center of research, which facilitates the transfer of basic technology and ***know-how*** from research laboratories to ***commercial applications***.

2. The term is also applied more generally to embrace technology parks or technopoles (commonly found in Continental Europe), where emphasis is on attraction established research-based companies and innovation centers which ***cater for*** smaller high-technology companies.

3. In most countries a large proportion of the investment in science park infrastructure and buildings is provided by the ***public sector*** as a part of a wider programme to stimulate regional enterprises and promote technological advance [17].

Notes:
1. adjacent – прилегающий, примыкающий
2. know-how – научно-технические знания, секреты производства (опыт)
3. commercial application – промышленное применение
4. cater for – обслуживать
5. public sector – государственный сектор

VIII. Read and translate text 1.6. In groups/pairs discuss the importance of science technology parks.

IX. Make a report about one of such science parks in Russia or in your city.

X. Make up the abstracts of texts 1.1-1.6 (in English or in Russian).

XI. Comment on the following quotations. Do you agree or disagree with them?

1. The history of science, like the history of all human ideas, is a history of irresponsible dreams, of obstinacy and of error. But science is one of the very few human activities – perhaps the only one – in which errors are systematically criticized and fairly often, in time, corrected. This is why we can say that, in science, we often learn from our mistakes, and why we can speak clearly and sensibly about making progress there. (Karl Raimund Popper 1902–1994, – Austrian-born British philosopher of science)
2. To solve a problem is to create new problems, new knowledge immediately reveals new areas of ignorance and the need for new experiments. At least, in the field of fact reactions, the experiments do not take very long to perform. (George Porter 1920–2002, – British chemist)
3. Progress, therefore, is not an accident, but a necessity. (Herbert Spencer 1820–1903, – British philosopher and psychologist)

SECTION 2

TEXT 2.1. JAMES JOULE

1. James Prescott Joule (1818-1889) was an English physicist who established that the various forms of energy – mechanical, electrical and

heat – are basically the same and can be changed, one into another. Thus he formed the basis of the law of conservation of energy, the first law of thermodynamics. His work contributed towards Helmholtz's formulation of the law of conservation of energy.

2. Joule studied with the noted English chemist John Dalton at the University of Manchester in 1835. Describing 'Joule's law' in a paper 'On the production of Heat by Voltaic Electricity' (1840), he stated that the heat produced in a wire by an electric current is proportional to the ***product*** of the resistance of the wire and the square of the current. In 1843 he published his value for the amount of work required to produce a unit of heat, called the mechanical ***equipment*** of heat. He used four increasingly accurate methods of determining this value. By using different materials, he also established that heat was a form of energy ***regardless*** of the substance that was heated.

3. In 1852 Joule and William Thomson (later Lord Kelvin) discovered that when a gas is allowed to expand without performing external work, the temperature of the gas falls. This 'Joule-Thomson effect' was used to build a large refrigeration industry in the 19th century. The value of the mechanical equivalent of heat is generally represented by the letter J, and a standard unit of work and energy is called the joule. Energy is measured in calories, one calorie being 4.187 joules.

Notes:

1. product – произведение (матем.)
2. equipment – снаряжение, снабжение, оборудование
3. regardless – независимо от, несмотря на

I. Find Russian equivalents for:

physicist, various forms of energy, basically, form the basis, law of conservation of energy, the first law of thermodynamics, describe, electric current, resistance, product, publish, unit of heat, use, different materials, fall, build, latter, calorie

II. Find English equivalents for:

выяснять (определять), тепловая энергия, одинаковый (тот же самый), меняться, вносить вклад, статья (доклад), проволока, квадрат, величина (значение), точные методы, устанавливать, вещество, определять, расширять, измерять, без выполнения внешней работы, представлять

III. Read and translate text 2.1. Answer the following questions:

1.What was J.P. Joule?
2.What was he famous for?
3.Where did J. Joule study?
4.What did he state?
5.What did he establish?
6.What did Joule and W. Thomson discover?
7.Where was Joule-Thomson effect used?
8.What is a standard unit of work?
9.What is a unit of energy measurement?

TEXT 2.2. THERMODYNAMICS

1. Thermodynamics is the study of laws affecting processes that involve heat changes and energy transfer. Heat transfer from one body to another, the link between heat and work, and changes of state in a fluid all come within the field of thermodynamics; it is the prerequisite to analysis of work by machinery.

2. There are essentially three laws of thermodynamics. The first law says that heat is a form of energy and is conserved, and any work energy produced in a closed system must arise from the conversion of existing energy, i.e. energy cannot be created or destroyed. All natural processes conform to this law, but not all processes conforming to it can occur in nature. Most natural processes are ***irreversible***, i.e. they will only proceed in one direction. The direction that a natural process can take is the subject of the second law thermodynamics. The second law states that the ***entropy*** of any closed system cannot decrease and if the system undergoes a reversible process it remains constant, otherwise it increases. The result of this is that heat always flows from a hot body to a cooler one.

3. The third law of thermodynamics provides an absolute scale of values for entropy by stating that for changes involving only perfect crystalline solids at absolute zero, the change of the total entropy is zero and absolute zero can never be attained. One other law is used in thermodynamics. The zeroth law of thermodynamics states that if two bodies are each in thermal equilibrium with a third body, then all three bodies are in thermal equilibrium with each other.

Notes:
1. irreversible – необратимый
2. entropy – энтропия

IV. Find Russian equivalents for:

heat changes, energy transfer, study of laws, fluid, create or destroy, nature processes, occur in nature, subject, remain constant, undergo, increase, flow, hot body, cooler body, perfect crystalline solid, thermal equilibrium, absolute zero, work energy, analysis of work by machinery, within the field of thermodynamics

V. Find English equivalents for:

влиять на, теплоперенос, изменения состояния, сохранять, замкнутая система, возникать, преобразование существующей энергии, сообразоваться (приводить в соответствие), необратимый, происходить в одном направлении, обратимый процесс, иначе, обеспечивать, шкала значений, включать в себя, достигать

VI. Read and translate text 2.2. Identify, define, or explain each of the following:

1. Thermodynamics
2. Field of thermodynamics
3. The first law of thermodynamics
4. The second law ofthermodynamics
5. The third law of thermodynamics
6. The zeroth law of thermodynamics

TEXT 2.3. JOULE'S LAW

1. Joule's law in electricity is the mathematical description of the rate at which resistance in a circuit converts electric energy into heat energy. The English physicist James Prescott Joule discovered in 1840 that the amount of heat per second that develops in a wire carrying a current is proportional to the electrical resistance of the wire and the square of the current. He determined that the heat ***evolved*** per second is equivalent to the electric power absorbed, or the power loss.

2. A quantitative form of Joule's law is that the heat evolved per second, or the electric power loss, equals the current squared times the resistance, or $P = I^2R$. The power has units of watts, or joules per second, when the current is expressed in amperes and the resistance in ohms.

3. Joule-Thomson effect is the change in temperature that accompanies expansion of a gas without production of work or transfer of heat. At ordinary temperatures and pressures, all ***real gases*** except hydrogen and helium cool upon such expansion; this phenomenon is often utilized in liquefying gases. Hydrogen and helium cool upon expansion only if their initial temperatures are very low.

Notes:
1. evolve – образовываться, развиваться, выделяться
2. real gas – реальный газ

VII. Find Russian equivalents for:

law, mechanical description, convert electrical energy into heat energy, discover, amount of heat per second, electrical resistance of a wire, heat evolved per second, absorb, equal, times, watt, ampere, ohm, change in temperature, without production of work, accompany, hydrogen and helium, phenomenon, utilize, initial temperature

VIII. Find English equivalents for:

скорость, сопротивление в электрической цепи; проволока, проводящая электрический ток; квадрат тока, определять, электрическая энергия, потеря энергии, расширение газа, передача тепла, при обычной температуре и давлении, кроме, охлаждаться, сжижение газа, низкий

IX. Read and translate text 2.3. Identify, define, or explain each of the following:

1. Joule’s law
2. Discovery of Joule’s law
3. Quantitative form of Joule’s law
4. Joule-Thomson effect
5. Real gases
6. Units of power, current and resistance

X. Make up the abstracts of texts 2.1, 2.2, 2.3 (in English or in Russian).

XI. Comment on the following quotation. Do you agree or disagree with it?

1. There is nothing without a reason. (Gottfried Wilhelm Leibniz 1646–1716)

SECTION 3

TEXT 3.1. HEIKE KAMERLINGH ONNES

1. Heike Kamerlingh Onnes (1853-1926) was Dutch winner of the Nobel Prize for Physics in 1913 for his work on low-temperature physics

and his production of liquid helium (1908). He discovered superconductivity (1911), the almost total lack of electric resistance in certain materials when cooled to a temperature near absolute zero.

2. From 1871 until 1973 Kamerlingh Onnes studied and worked at Heidelberg University, notably with the German physicist Robert Bunsen and Gustav Kirchhoff. Awarded a doctorate by the University of Groningen (1879), he taught at the Polytechnic School in Delft (1878-1882). From 1882 to 1923 he served as professor of experimental physics at the University of Leiden.

3. Influenced by the work of Johannes van der Waals, Kamerlingh Onnes investigated the equations describing the states of matter and studied the general thermodynamic properties of liquids and gases over a wide ***range*** of pressures and temperatures. He founded (1894) and built up the ***Cryogenic*** Laboratory (now known by his name) that established Leiden as the low-temperature research centre of the world.

4. From 1895 to 1906 he concentrated on perfecting cryogenic experimental techniques and studied metals and liquids at low temperatures. Having built an improved hydrogen-***liquefaction*** machine two years previously, he succeeded in liquefying helium in 1908. Attempts to solidify helium were fruitless until William Hedrik Keason, his student and successor as director of the Kamerlingh Onnes Laboratory, achieved in 1926.

Notes:
1. range – диапазон
2. cryogenic – низкотемпературный
3. liquefaction machine – машина для сжижения

I. Find Russian equivalents for:

Dutch winner of the Nobel Prize for Physics, low-temperature physics, liquid helium, superconductivity, cool, study and work, professor of experimental physics, pressure and temperature, found and build, research centre, previously, liquefy and solidify

II. Find English equivalents for:

открывать, температура близкая к абсолютному нулю, получать докторскую степень, влиять, исследовать; уравнения, описывающие состояния вещества, свойства жидкостей и газов, совершенствовать

III. Read and translate text 3.1. Answer the following questions:

1. What was H.K. Onnes?
2. What was he famous for?
3. What is superconductivity?
4. Where did H.K. Onnes study?
5. Where did he work?
6. Who influenced his work?
7. What H.K. Onnes investigate?
8. What laboratory did he found?
9. What machine did he build?

IV. What do the following dates refer to?

1853, 1871-1879, 1878-1882, 1882-1923, 1894, 1895-1906, 1908, 1911, 1926

TEXT 3.2. JOHANNES VAN DER WAALS

1. Johannes Diederik van der Waals (1837-1923) was Dutch physicist, winner of the 1910 Nobel Prize for physics, for his research on the gaseous and liquid states of matter. His work made the study of temperatures near absolute zero possible.

2. Van der Waals first attracted notes in 1873 with his treatise 'On the Continuity of the Liquid Gaseous State', for which he was awarded a doctor's degree. In 1881 he introduced into the ideal-gas law two parameters (representing size and attraction) and worked out a more exact formula, known as van der Waals equation. Since the parameters were distinct for each gas, he continued his work and arrived at an equation (the law of corresponding states) that is the same for all substances.

3. It was this work that brought him the Nobel Prize and also led Sir James Dewar of England and Heike Kamerlingh Onnes of the Netherlands to the determination of the necessary data for the liquefaction of hydrogen and helium. A self-taught scientist who took advantage of the opportunities offered by the University of Leiden, van der Waals, was appointed professor of physics at the University of Amsterdam in 1877, a post he retained until 1907. The van der Waals forces, weak attractive forces between atoms or molecules, were named in his honour.

V. Find Russian equivalents for:

research on the gaseous and liquid states of matter, possible, ideal-gas law, size and attraction, equation, continue his work, self-taught scientist, offer, post, weak attractive forces between atoms or molecules

VI. Find English equivalents for:

трактат, вводить два параметра, разработать более точную формулу, отличающийся, закон соответствующих состояний, одинаковый (тот же самый), вещество, определение необходимых данных, воспользоваться возможностью, назначать профессором физики, назвать в честь

VII. Read and translate text 3.2. Answer the following questions:

1. What was J.D. van der Waals?
2. What was he famous for?
3. What did he study?
4. What tritise did he write?
5. How did he improve the ideal-gas law?
6. What scientists made contribution to the liquefaction of hydrogen and helium?
7. Where did he work?
8. What forces were named in his honour?

TEXT 3.3. KARL MÜLLER

1. Karl Alexander Müller (1927-) is a Swiss physicist who, along with J. Georg Bednorz, was awarded the 1887 Nobel Prize for Physics for their joint discovery of superconductivity in certain substances at higher temperatures than had previously been thought attainable.

2. Müller received the Ph.D. degree from the Swiss Federal Institute of Technology in 1958, and beginning in 1963 he performed research in solid-state physics at the IBM Zürich Research Laboratory, heading the physics department there for several years and becoming an IBM fellow in 1982. A specialist in the ceramic compounds known as oxides, Müller in the early 1980s began searching for substances that would become superconductive (i.e., conduct electricity with no resistance) at higher temperature than therefore been obtained.

3. The highest ***transition temperature*** (the temperature below which a material loses all electrical resistance) attainable at that time was about 23 K (-250^{o} C [-418^{o} F]). In 1983 Müller recruited Bednorz to help him systematically test various oxides, materials which a few recent studies had indicated might be suitable for superconductivity. In 1986 the two men succeeded in achieving superconductivity in a recently developed barium-lanthanum-copper oxide at temperature of 35 K (-238^{o} C [-396^{o} F]), 12 K higher than had previously been achieved.

4. Their discovery immediately prompted a wave of renewed superconductivity experiments by other scientists worldwide, this time using oxides, and within a year transition temperatures approaching 100 K (-173^{o} C [-280^{o} F]) had been achieved. The intense research generated by Müller's and Bednorz's discovery raised the prospect that superconductivity could be achieved at temperatures high enough for the generation and transmission of electric power, a feat that would have important economic implications.

Notes:

1. transition temperature – температура (фазового) перехода

VIII. Find Russian equivalents for:

Swiss physicist, joint discovery, attainable, receive the Ph.D. degree, solid-state physics, research laboratory, ceramic compounds, conduct electricity, below, test various oxides, help systematically, barium-lanthanum-copper oxide, worldwide, high enough, have important economic implications

IX. Find English equivalents for:

вместе с, в некоторых веществах, ранее, выполнять исследование, возглавлять физический факультет, в течение нескольких лет, член научного общества, окись (окисел), при отсутствии сопротивления, получать, терять, принимать на работу, подходящий материал, удаваться достичь, побуждать (вызывать) волну экспериментов, перспектива, выработка (производство) и передача электроэнергии

X. Read and translate text 3.3. Answer the following questions:

1. What was K.A. Müller?
2. What was he famous for?
3. Where did Müller study?
4. Where did he work?
5. What specialist was he?
6. Who helped Müller in his work?
7. What did they discover?
8. What was the result of their discovery?

TEXT 3.4. SUPERCONDUCTIVITY

1. At temperatures closer to absolute zero (-273^{o} C) the thermal, electric and magnetic properties of many substances undergo great change, many chemical elements, compounds and alloys show no resistance whatsoever to the flow of electricity.

2. Superconductivity was discovered in 1911 by the Dutch physicist Heiker Kamerlingh Onnes. Kamerlingh Onnes found that the electrical resistivity of a mercury wire disappears suddenly when it is cooled below a temperature of about 4 K (-269^{o} C); absolute zero is the temperature at which all matter loses its disorder. He soon discovered that a superconducting material can be returned to the normal (nonsuperconducting) state either by passing a sufficiently large current through it or by applying a sufficiently strong magnetic field to it.

3. In 1957 fundamental theory of superconductivity was presented by the physicists John Bardeen, Leon N. Cooper and John Robert Schrieffer of the United States; it was for them the Nobel Prize for Physics in 1972. It was called the BCS theory in their honour, and most later theoretical work is based on it. The BCS theory provided a foundation for an earlier model that had been introduced by the Russian physicist Lev Davidovich Landau and Vitaly Lazarevich Ginzburg (1950). This model has been useful in understanding electromagnetic properties, including the fact that any internal magnetic flux in superconductors exists only in ***discrete*** amounts (instead of in a ***continuous*** spectrum of values), an effect called the ***quantization of magnetic flux***.

4. Hundreds of materials are known to become superconducting at low temperatures. Twenty-seven of the chemical elements, all of them being metals, are superconductors in their usual crystallographic forms at low temperatures and low atmospheric pressure. Among these are commonly known metals such as aluminium, tin, lead and mercury and less common ones such as rhenium, lanthanum and protactinium. In addition, 11 chemical elements that are metals, semimetals or semiconductors are superconductors at low temperatures and high pressures. Among them are uranium, cerium, silicon and selenium. Bismuth and five other elements, though not superconducting in their usual crystallographic form, can be made superconducting. Superconductivity is not exhibited by any of the magnetic elements – chromium, manganese, iron, cobalt or nickel.

5. Most of the known superconductors are alloys or compounds. It is possible for a compound to be superconducting even if the chemical elements constituting it are not (e.g., a compound of carbon and potassium). Some semiconducting compounds, such as tin telluride, become superconducting if they are properly doped with impurities.

Notes:

1. discrete – дискретный, прерывистый

2. continuous – непрерывный
3. quantization of magnetic flux – квантование (дискретизация) магнитного потока

XI. Read and translate text 3.4. Identify, define, or explain each of the following:

1. Properties of substances at absolute zero
2. Discovery of superconductivity
3. Fundamental theory of superconductivity
4. Russian physicists and their model
5. Metal superconductors
6. Semimetals and semiconductors
7. Magnetic elements
8. Alloys or compounds

TEXT 3.5. VITALY GINZBURG

1. Vitaly Lazarevich Ginzburg (1916-2009) was a Soviet physicist and astrophysicist whose research ranged over superconductivity, theories of radio-wave propagation, radio astronomy and the origin of cosmic rays, plasma physics.

2. After graduating from Moscow University in 1938, Ginzburg was appointed to the Lebedev Physical Institute of the U.S.S.R. Academy of Sciences. He also taught at Gorky University (1945 – 1968) and from 1968 at Moscow Technical Institute of Physics. Ginzburg received the State Prize of the Soviet Union in 1953 and Lenin Prize in 1966.

3. One of the Ginzburg's most significant theories was that cosmic radiation in ***interstellar space*** is produced not by thermal radiation but by acceleration of high-energy electrons in magnetic fields, a process known as synchrotron radiation. In 1955 Ginzburg (with I.S. Shklovsky) discovered the first quantitative proof that cosmic rays observed near the Earth originated in supernovae. Upon the discovery in 1969 of pulsars (believed to be neutron stars formed in ***supernova*** explosions), he expanded his theory to include pulsars as a related source of cosmic rays.

Notes:
1. interstellar space – межзвёздное пространство
2. supernova – сверхновая звезда

XII. Read and translate text 3.5. Answer the following questions:

1. What was V. L. Ginzburg?
2. What was he famous for?
3. Where did he study?
4. Where did Ginzburg work?

5. What did he receive?
6. What did he discover?
7. What was Ginzburg's most significant theory?

XIII. Make up the abstracts of texts 3.1–3.5 (in English or in Russian).

XIV. Comment on the following quotation. Do you agree or disagree with it?

1. According to my views, aiming at quantitative investigations, that is at establishing relations between measurements of phenomena, should take first in the experimental practice of physics. 'By measurement to knowledge' I should like to write as a motto above the entrance to every physics laboratory. (Heike Kamerlingh Onnes 1853–1926, – Dutch physicist)

SECTION 4

TEXT 4.1. PYOTR KAPITSA

1. Pyotr Leonidovich Kapitsa (1894-1984) was a Soviet physicist who was awarded the Nobel Prize for Physics in 1978 for his research in magnetism and low-temperature physics. He discovered that helium II (the stable form of liquid helium below 2.174 K, or 270.976^{o} C) has almost no ***viscosity*** (i.e. resistance to flow). This property is called superfluidity.

2. P.L. Kapitsa was born in Krondshtadt. Educated at the Petrograd Polytechnical Institute, Kapitsa remained there as a lecturer until 1921. After his first wife and their two small children died of illness during the chaos of the civil war that followed the revolution, he went to England to study at the University of Cambridge. There he worked with Ernest Ruherford and became assistant director of magnetic research at the Cavendish Laboratory in 1924, designing apparatus that achieved a magnetic field of 500,000 gauss, which was not surpassed in strength until 1956. He was made a ***fellow*** of Trinity College in Cambridge (1925) and elected to the Royal Society in 1929, one of only a small number of foreigners to become a fellow. The Royal Society Mond Laboratory was built at Cambridge especially for him in 1932.

3. In 1934, before he had published his paper on an ***expansion engine*** that liquefies helium, Kapitsa went to a professional meeting in the Soviet Union, where his passport was seized and he was detained there by

Stalin's orders. In 1935 he was made director of the Institute of Physical Problems of the Soviet Academy of Science in Moscow and managed through the ***intercession*** of Rutherford to have the Mond Laboratory apparatus shipped to Moscow. He continued his research in low-temperature physics and discovered superfluidity in helium II while investigating its heat-conduction properties.

4. His findings were first published in 1938, with further research on the subject described in "The heat transfer and superfluidity of helium II (1941)" and "Research into the mechanism of heat transfer in helium II (1941)". In 1939 he built apparatus for producing large quantities of liquid oxygen for the Soviet steel industry during World War II. For his achievements in science during the 1930s and 1940s, Kapitsa was given many honours by the Soviet government, including the title Hero of Socialist Labour (1945), the Soviet Union's highest civilian award.

5. In 1946 Kapitsa apparently refused to work on nuclear weapons development and as a result fell out of favour with Stalin. He was dismissed from his post as head of the Institute of Physical Problems and resided at his country house, or dacha, until Stalin's death in 1953. He conducted original researches on ball lightning during his seclusion. Kapitsa was then restored (1955) as director of the institute, a position he kept until his death.

6. Kapitsa's research on high-power microwave generators in the late 1950s turned his interests to control thermonuclear ***fusion***, upon which he published a series of papers beginning in 1969. An outspoken advocate of free scientific thought, in the 1960s he was one of the Soviet scientists who campaigned to preserve Lake Baikal from industrial pollution. He was also active in the ***Pugwash movement***, a series of international conferences aimed at channeling scientific research into constructive rather than destructive purposes.

Notes:

1. viscosity – вязкость
2. fellow – член научного общества
3. expansion engine – детандер (машина для охлаждения газа путем его расширения)
4. intercession – заступничество, хода́тайство
5. fusion – ядерный синтез
6. Pugwash movement – Па́гуошское движение (общественное движение за мир, разоружение, международную безопасность и научное

сотрудничество. Среди инициаторов (1955 г.) были А. Эйнштейн, Ф. Жолио-Кюри, Б. Рассел. Первая конференция сторонников этого движения состоялась в Пáгуоше (Канада) в 1957 г.)

I. Find Russian equivalents for:

research, low-temperature, helium, stable form, below, resistance of flow, superfluidity, civil war, assistant director, magnetic field, elect to Royal Society, publish his paper, the Soviet Academy of Science, investigate, liquid oxygen, Soviet government, nuclear weapons development, head of the Institute of Physical Problems, ball lightning, control thermonuclear fusion, free scientific thought

II. Find English equivalents for:

жидкий гелий, вязкость, свойство, конструировать прибор, сжигать гелий, задерживать (арестовывать) по приказу Сталина, отправлять (транспортировать) в Москву, полученный, данные (добытые сведения), теплопередача (теплоперенос), его достижения в науке, почести (награды), звание Герой социалистического труда, отказаться работать, потерять благосклонность Сталина, уволить с должности, жить на даче, уединение, сохранять от загрязнения, созидательные, а не разрушительные цели

III. Read and translate text 4.1. Answer the following questions:

1. What was P.L. Kapitsa ?
2. What was he famous for?
3. Where was P. Kapitsa born?
4. Where did he get education?
5. Where did Kapitsa study abroad?
6. Who did he work with?
7. What apparatus did Kapitsa design?
8. What Institute did he work in Russia?
9. What articles did Kapitsa publish?
10. Why was he given many honours?
11. What can you say about his social life?
12. Why was Kapitsa dismissed from his post?

TEXT 4.2. CRYOGENICS

1. ***Cryogenics*** is the production, effects and uses of very low temperatures, usually meaning from – 150^{o} C down to absolute zero (-273.15^{o} C or 0^{o} K). The most common method of producing cryogenic temperatures is to use adiabatic processes (in which heat neither enters nor leaves a

system and such processes change the temperature of the system). Cryogenic effects include changes in electrical properties, such as superconductivity, and changes in mechanical properties, such as superfluidity. Cryogenics has been applied to food preservation, life-support systems in space, and liquid ***propellants***.

2. Cryogenics is also the study of very low temperatures and the techniques for producing them. Objects are mostly simply cooled by placing them in a bath containing liquefied gas contained at a constant pressure. In general, a liquefied gas can provide a constant bath temperature from its ***triple point*** to its critical temperature and the bath temperature can be varied by changing the pressure above the liquid. The lowest practical temperature for liquid bath is 0.3 K.

3. Refrigerators consist essentially of devices operating on a repeated cycle, in which a low-temperature reservoir is a continuously replenished liquid bath. Above 1^{o} K they work by compressing and expanding suitable gases. Below this temperature liquids or solids are used and by ***adiabatic demagnetization*** it is possible to reach 10^{-6} K. In general, an adiabatic change involves a fall or rise in temperature of the system. For example, if a gas expands under adiabatic conditions, its temperature falls. The adiabatic equation describes the relationship between the pressure of an ideal gas and its volume.

Notes:
1. cryogenics – физика низких температур
2. propellant – ракетное топливо
3. triple point – тройная точка (фазовой диаграммы)
4. adiabatic demagnetization – адиабатическое размагничивание

IV. Find Russian equivalents for:

cryogenics, production, enter and leave the system, change the temperature, electrical property, food preservation, superconductivity, superfluidity, cool, contain liquefied gas, at constant pressure, above, refrigerator, devices operating on a repeated cycle, compress, below, possible, fall or rise, adiabatic equation, volume

V. Find English equivalents for:

воздействие и использование, самый распространенный метод, тепло (теплота), применять (использовать), жидкое ракетное топливо, помещать в ванну, обеспечивоть, состоять из, расширять, снова наполнять (пополнять), жидкости и твердые тела, достичь, отношение (связь)

VI. Read and translate text 4.2. Answer the following questions:

1. What is cryogenics?
2. What are adiabatic processes?
3. What do cryogenic effects include?
4. Where is cryogenics used?
5. How are objects cooled?
6. Can you describe the refragirator and its work?
7. What does an adiabatic change include?

TEXT 4.3. SUPERFLUIDITY

1. Superfluidity is the unusual properties of liquid helium, when it is cooled below 2.18 K (-270.97^{o} C), called the lambda (λ) point. The term was coined in 1938 by Pyotr Kapitsa, a Soviet physicist, following an extensive series of experiments showing that in this state of helium, called helium II (He II), there is an apparent enormous rise in heat conductivity, rapid flow through capillaries or over the ***rim*** of its containment vessel as a thin film, and that a number of other unusual properties also appear.

2. In order ***to account for*** such behaviour, the 'two fluid' model, as proposed by Laszlo Tisza, described HE II as a mixture of normal helium and superfluid helium. The normal component is attributed to helium atoms in excited energy states, whereas the superfluid component is attributed to atoms all in the ***ground state*** (having lowest or zero-point energy). As the temperature continues to be lower below the lambda point, more of the He II becomes superfluid. It is assumed that this superfluid component is able to move through its container without friction, thereby explaining most the unusual behaviour of helium II.

Notes:
1. rim – край, кромка
2. to account for – объяснять
3. ground state – основное (квантовое) состояние

VII. Read and translate text 4.3. Identify, define, or explain each of the following:

1. Superfluidity
2. Coining of the term
3. Helium II
4. Normal helium
5. Superfluid helium

TEXT 4.4. HELIUM

1. Helium (He) is one of the inert gases (or noble gases) called so because it has a stable electronic configuration and no chemical reactivity as such. It occurs naturally in very small quantities as being non-inflammable. It has a variety of uses, including the provision of inert atmospheres for ***welding*** and semiconductor manufacture, as a refrigerant for superconductors, and as a ***diluent*** in breathing apparatus for deep-sea drivers. It is also used in filling balloons. Helium has the lowest boiling point of all substances and can be solidified only under pressure. Helium liquefies below 4 K (-269^{o} C / - 452^{o} F) and is used extensively in cryogenics – the study of materials at very low temperature.

2. Helium has no colour, taste, or smell and was named after ‘helios’, the Greek word for ‘sun’. It is formed in stars such as the Sun as hydrogen nuclei are pressed together in the processes of nuclear fusion. Natural helium is mostly helium–4, with a small amount of helium–3. There are also two short-lived radioactive isotopes: helium–5 and –6. It occurs in ores of uranium and thorium and in some natural gas deposits. It was discovered in the solar spectrum in 1868 by Joseph Lockyer (1836-1920).

Notes:
1. welding – сварка
2. diluent – разбавитель

VIII. Read and translate text 4.4. Explain each of the following:

1. Helium is a gas
2. Physical properties of helium
3. Natural helium and its isotopes
4. Discovery of helium
5. Application of helium

IX. Make up the abstracts of texts 4.1– 4.4 (in English or in Russian).

X. Comment on the following quotation. Do you agree or disagree with it?

1. Nothing occurs at random, but everything for a reason and by necessity. (Leucippus 5th century B.C., – Greek philosopher)

SECTION 5

TEXT 5.1. KELVIN (W. THOMSON)

1. William Thomson (1824-1907) was British engineer, mathematician and physicist, who was knighted in 1866 and was raised to the peerage in 1892 (as Baron Kelvin of Largs) in recognition of his work in engineering and physics. He was foremost among the small group of British scientists who helped to lay the foundations of modern physics. His contributions to science included a major role in the development of the second law of thermodynamics, the absolute temperature scale (measured in kelvins); the dynamic theory of heat; the mathematical analysis of electricity and magnetism, including the basic ideas for the electromagnetic theory of light; the geophysical determination of the age of the Earth; and fundamental work in hydrodynamics. His theoretical work on submarine telegraphy and his inventions for use on submarine cables aided Britain in capturing a preeminent place in world communication during the 19^{th} century.

2. The style and character of Thomson's scientific and engineering work reflected his personality. Until student at the University of Cambridge, he was awarded silver sculls the winning the university championship in racing single-seater rowing shells. He was an inveterate traveller all of his life, spending much time on the Continent and making several trips to the United States. Thomson risked his life several times during the laying of the first transatlantic cable.

3. He brought together disparate areas of physics–heat, thermodynamics, mechanics, hydrodynamics, magnetism and electricity – and thus played a principle role in the great and final synthesis of 19^{th} century science, which viewed all physical change as energy–related phenomena. Thomson was also the first to suggest that there were mathematical analogies between kinds of energy. His success as a synthesizer of theories about energy places him in the same position in 19^{th} century physics as Sir Isaac Newton has in 17^{th} century physics or Albert Einstein in 20^{th} century physics. All of these great synthesizers prepared the ***ground*** for the next grand leap forward in science.

4. William Thomson was born in Belfast (Ireland), the fourth child in a family of seven. His mother died when he was six years old. His father, James Thomson, who was a textbook writer, taught mathematics, first in Belfast and later as a professor at the University of Glasgow (Scotland). He taught his sons the most recent mathematics, much of which had not

yet become a part of the British university curriculum. William, age 10, and his brother James, age 11, matriculated at the University of Glasgow in 1834. There he read the advanced book of Jean-Baptiste-Joseph Fourier 'The Analytical Theory of Heat', which applied abstract mathematical techniques to the study of heat flow through any solid object. Thomson was the first to promote the idea that Fourier's mathematics, although applied solely to a flow of heat, could be used in the study of other forms of energy – whether fluids in motion or electricity flow through a wire.

5. Thomson won many university awards of Glasgow, and at the age of 15 he won a gold medal for 'An Essay on the Figure of the Earth', in which he exhibited exceptional mathematical ability. Thomson's first published articles appeared when he was 16 and 17 years old. Thomson entered Cambridge in 1841 and took his B.A. degree four years later with high honours. In 1845 he read a copy of George Green's 'An Essay on the Application of Mathematical Analysis to the Theories of Electricity and Magnetism'. That book and Fourier's book were the components from which Thomson shaped his world view and which helped him in his pioneering synthesis of the mathematical relationship between electricity and heat. After graduating from Cambridge, Thomson went to Paris, where he worked in the laboratory of the physicist and chemist Henri-Victor Regnault to gain practical, experimental competence to supplement his theoretical education.

6. In 1846, at the age of 22 William was unanimously elected to the chair of natural philosophy (later called physics) at the University of Glasgow. Thomson remained at Glasgow for the rest of his career. He resigned his university chair in 1899, at the age of 75, after 53 of a fruitful and happy association with the institution.

Notes:

1. ground – почва

I. Find Russian equivalents for:

British engineer, mathematician and physicist; engineering and physics, foremost, development of the second law of thermodynamics, temperature scale, heat, light, hydrodynamics, invention,world communication, scientific work, reflect his personality, several times, synthesis of 19th century science, physical change, phenomena, synthesizer of theories, textbook writer, university curriculum, promote the idea, fluids in motion, practical and experimental competence, at the age of, to elect

II. Find English equivalents for:

признание его работы, заложить основы современной физики, вклад в науку, измерять, определение возраста Земли, подводный кабель, выдающееся место, закоренелый путешественник, подготавливать почву, играть основную роль, большой скачок вперёд, твердый предмет, поток электричества через проволоку, с отличием, математическая взаимосвязь, дополнить теоретическое образование, кафедра натуральной философии, уходить в отставку

III. Read and translate text 5.1. Answer the following questions:

1. What was Kelvin (Thomson)?
2. What was he famous for?
3. Where was he born?
4. What can you say about his parents?
5. Where did W. Thomson study?
6. Where did he work?

IV. What do the following dates refer to?

1824, 1834, 1841, 1845, 1846, 1866, 1892, 1899, 1907

V. Read and translate text 5.1 and find the information to prove that:

1. Kelvin (W. Thomson) took part in sport competitions.
2. He was a traveller.
3. W. Thomson is compared with great scientists.
4. He read the books of the French and English scientists.
5. Thomson won many University awards of Glasgow.
6. He worked at Glasgow for many years.

TEXT 5.2. THOMSON'S SCIENTIFIC WORK

1. Thomson's scientific work was guided by the conviction that the various theories dealing with matter and energy were converging toward one great, ***unified theory***. By the middle of the 19^{th} century it had been shown that magnetism and electricity, electromagnetism and light were related, and Thomson had shown by mathematical analogy that there was a relationship between hydrodynamic phenomena and an electric current flowing through wires. James Prescott Joule also claimed that there was a relationship between mechanical motion and heat, and his idea became the basis for the science of thermodynamics.

2. Thomson's contributions to 19th century science were many. He advanced the ideas of Michael Faraday, Fouler, Joule and others. Using mathematical analysis, Thomson ***drew generations*** from experimental results. He formulated the concept that was to be generalized into the dynamic theory of energy. He also collaborated with a number of leading scientists of the time, among them Sir George Gabriel Stokes, Hermann von Helmholtz, Peter Guthrie Tait and Joule. With these partners, he advanced the frontiers of science in several areas, particularly hydrodynamics. Furthermore, Thomson originated the mathematical analogy between the flow of heat in solid bodies and the flow of electricity in conductors.

3. His work on the project of the ***feasibility*** of laying a transatlantic cable began in 1854. Thomson's idea about the mathematical analogy between heat flow and electric current worked well in his analysis of the problem of sending telegraph messages through the planned 3,000-mile (4,800 km) cable. His equations describing the flow of heat through a solid wire provided applicable to questions about the velocity of a current in a cable. Thomson participated, as a chief consultant, in the hazardous early cable-laying expeditions. In 1858 Thomson patented his telegraph receiver, called a mirror galvanometer, for use on the Atlantic cable. (The device, along with his later modification called the siphon recorder, came to be used on most of the worldwide network of submarine cables). The directors of the Atlantic Telegraph Company adopted Thomson's suggestions for the design of the cable and decided in favour of the mirror galvanometer. Thomson was knighted in 1866 by Queen Victoria for his work.

4. After the successful laying of the transatlantic cable, Thomson became a partner in two engineering consulting firms, which played a major role in the planning and construction of submarine cables during the frenzied era of expansion that resulted in a global network of telegraph communication. Thomson became a wealthy man who could afford a 126-ton yacht and a baronial estate. His interest in the sea, roused aboard his yacht, the Lalla Rookh, resulted in a number of patents: a compass that was adopted by the British Admiralty; a form of analog computer for measuring tides in a harbour and for calculating tide for any hour, past or future; and ***sounding*** equipment. He established a company to manufacture these items and a number of electrical measuring devices.

5. On the basis of thermodynamic theory and Fourier's studies, Thomson estimated in 1862 that more than one million years ago the Sun's heat and the temperature of the Earth must have been considerably greater and that these conditions had produced violent storms and floods and an

entirely different types of vegetation. His views were published in 1869 and his contention that biological and geologic theory had to conform to the well-established theories of physics.

6. Thomson published a textbook 'Treatise on Natural Philosophy' (1867), a work on physics coauthored with Tait that helped shape the thinking of generation of physicists. He received honorary degrees from universities throughout the world and was lauded by engineering societies and scientific organizations. From 1900 to 1904 he was President of the Royal Society, elected a fellow of the Royal Society in 1851. He published more than 600 papers and was granted dozens of patents. He died in 1907, at Netherhall, his estate near Largs, Scotland, and was buried in Westminster Abbey in London.

Notes:

1. unified theory – обобщённая теория
2. draw generations – делать выводы (обобщения)
3. feasibility – возможность, осуществимость
4. sounding – зондирование, промер глубины лотом

VI. Find Russian equivalents for:

matter and energy, electromagnetism and light, relationship, electric current flowing through wires, advanced the ideas, leading scientists, originate the mathematical analogy, flow of electricity in conductor, send telegraph messages through a cable, flow of heat through a solid wire, provide, mirror galvanometer, submarine cable, design, planning and construction, telegraph communication, manufacture, electrical measuring device

VII. Find English equivalents for:

убеждение (уверенность), сходиться в одну точку, быть связанным, явления, заявлять (утверждать), вклад в науку, сотрудничать, закладка трансатлантического кабеля, применимый (пригодный), скорость тока, принимать участие, решить в пользу, приводить к, создавать компанию, условия, шторм и наводнение, публиковать учебник, поколение физиков, хвалить, член Королевского общества

VIII. Read and translate text 5.2. Answer the following questions:

1. What was Thomson's conviction?
2. What did Thomson estimate?

3. What device did he patent?
4. What was his contribution to laying a transatlantic cable?
5. What did he publish?
6. Where was he buried?

IX. What do the following dates refer to?

1854, 1858, 1862, 1866, 1867, 1851, 1900-1904, 1907

X. Find in the text the information to prove that:

1. Thomson had shown a relationship by mathematical analogy.
2. Thomson's contributions to science were many.
3. He collaborated with many leading scientists of the time.
4. Thomson originated the mathematical analogy.
5. He participated in an important expedition.
6. Thomson was a partner in consulting firms.
7. He had a number of patents.

TEXT 5.3. UNDERSEA CABLE

1. Undersea cable (also called marine cable) is assembly of conductors enclosed by an insulating ***sheath*** and laid on the ocean floor for the transmission of messages. Undersea cables for transmitting telegraph signals antedated the invention of the telephone. The first undersea telegraph cable was laid in 1850 between England and France. The Atlantic was spanned in 1858 between Ireland and Newfoundland, but the cable's insulation failed and it had to be abandoned.

2. The first permanently successful transatlantic cable was laid in 1866 and in the same year another cable, partially laid in 1865, was also completed. The American financier Cyrus W. Field and the British scientist Lord Kelvin were closely associated with the two enterprises. Use of long undersea cable suitable for telephony followed the development in the 1950s of telephone ***repeaters*** with sufficiently long life to make the operation economically ***practical***.

3. The development of ***vacuum-tube*** repeaters that could operate continuously and flawlessly with no attention for at least 20 years, at depths up to 3,660 m (12,000 feet), made possible the first transatlantic telephone cable, from Scotland to Newfoundland (1956). The system provided 36 ***telephone circuits***. Similar undersea systems between Port Angeles (Washington), and Ketchikan (Alaska) and between California

and between California and Hawaii were later ***put into service***. A 5,300-nautical-mile (9,816 km) cable between Hawaii and Japan (1964) provided 128 voice circuits, the same number of circuits were provided in 1965 by a cable linking the United States and France. Newer cables use transistorized repeaters and provide even more voice circuits, some are capable of transmitting television programs.

Notes:
1. sheath – оболочка, покрытие
2. repeater – повторитель (сигналов, импульсов), ретранслятор
3. practical – целесообразный, полезный
4. vacuum-tube – вакуумная электронная лампа
5. telephone circuit – телефонная линия
6. put into service – вводить в эксплуатацию

XI. Read and translate text 5.3. Identify, define, or explain each of the following:

1. Undersea cable
2. The first undersea telegraph cable
3. The first transatlantic cable
4. American financier and British scientist
5. Development of repeaters
6. Undersea systems
7. Newer cables

XII. Make up the abstracts of texts 5.1-5.3 (in English or in Russian).

XIII. Comment on the following quotation. Do you agree or disagree with it?

1. Science attempts to find logic and simplicity in nature. Mathematics attempts to establish order and simplicity in human thought. (Edward Teller 1908–2003, – Hungarian-born American physicist)

SECTION 6

TEXT 6.1. GUSTAV KIRCHHOFF

1. Gustav Robert Kirchhoff (1824-1887) was a German physicist who, with the chemist Robert Bunsen, established the theory of spectrum analysis (a technique for chemical analysis by analyzing the light emitted by a

heated material), which Kirchhoff applied to determine the composition of the Sun.

2. In 1845 Kirchhoff first announced Kirchhoff's laws, which allow calculation of the currents, voltages and resistance of electrical networks. Extending the theory of the German physicist Georg Simon Ohm, he ***generalized*** the equations describing current flow to the case of electrical conductors in three dimensions. In further studies he demonstrated that current flew through a conductor at the speed of light.

3. In 1847 Kirchhoff became Privatdozent (unsalaried lecturer) at the University of Berlin and three years later accepted the post of extraordinary professor of physics at the University of Breslau. In 1854 he was appointed professor of physics at the University of Heidelberg, where he joined forces with Bunsen and founded spectrum analysis. They demonstrated that every element gives off a characteristic coloured light when heated to ***incandescence***. This light, when separated by a prism, has a ***pattern*** of individual wavelengths specific for each element. Applying this new research tool, they discovered two new elements, cesium (1860) and rubidium (1861).

4. Kirchhoff went further to apply spectrum analysis to study the composition of the Sun. He found that when light passes through a gas, the gas absorbs those wavelengths that it would emit if heated. He used this principle to explain the numerous dark lines (Fraunhofer lines) in the Sun's spectrum. That discovery marked the beginning of a new era in astronomy.

5. In 1875 Kirchhoff was appointed to the chair of mathematical physics at the University of Berlin. Most notable of his published works are 'Lectures on Mathematical Physics' (4 volumes, 1876-94) and 'Collected Essays' (1882, supplement 1891)

Notes:
1. generalize – обобщать
2. incandescence – накаливание, белое каление
3. pattern – изображение, спектр, картина

I. Find Russian equivalents for:

physicist and chemist, theory of spectrum analysis, technique, composition of the Sun; current, voltage and resistance, generalize the equations; current flow; conductor, speed of light, give off light, wavelength, pass through, explain, discovery, chair of mathematical physics, published works, volume, cesium and rubidium

II. Find English equivalents for:

создавать теорию; свет, испускаемый нагретым материалом, применять для определения, вычисление, продолжать (расширять) теорию, описывать, размер (измерение), назначать, объединить усилия, нагревать, применять спектральный анализ, поглощать, ознаменовать начало новой эры, выдающийся

III. Read and translate text 6.1. Answer the following questions:

1. What was G.R. Kirchhoff?
2. What was he famous for?
3. What are Kirchhoff's laws?
4. Where did he work?
5. What did Kirchhoff demonstrate?
6. What did G.R. Kirchhoff found?
7. What elements did he discover?
8. Where did Kirchhoff apply spectrum analysis?
9. What are his well-known published works?

IV. What do the following dates refer to?

1824, 1845, 1847, 1854, 1860, 1861, 1875, 1876-94, 1887

TEXT 6.2. KIRCHHOFF'S CIRCUIT RULES

1. Kirchhoff's ***circuit rules*** are two statements about ***multi-loop electric circuits*** that the law's of conservation of electric charge and energy and that are used to determine the value of the electric current in each ***branch*** of the circuit.

2. The first rule, the ***junction*** theorem (the current law), states that the sum of the currents into a specific junction in the circuit equals the sum of the currents out of the same junction, or the algebraic sum of the currents flowing through all the wires in a network that meet at a point is zero. Electric charge is conserved: it does not suddenly appear or disappear; it does not pile up at one point and thin out at another.

3. The second rule, the ***loop equation*** (or the voltage law), states that around each loop in an electric circuit the sum of the e.m.f.'s (electromotive forces or voltages, of energy sources such as batteries and generators) is equal to the sum of the potential drops, or voltages across each of the resistance, in the same loop, or the algebraic sum of the e.m.f.'s within any closed circuit is equal to the sum of the ***products*** of the currents and the resistances in the various portions of the circuit. All the energy

imparted by the energy sources to the charged particles that carry the current is just equivalent to that lost by the charge carriers in useful work and heat dissipation around each loop of the circuit. Kirchhoff's law of radiation is a law stating that the ***emissivity*** of a body is equal to its absorptance at the same temperature.

4. On the basis of Kirchhoff's two circuit rules, a sufficient number of equations can be written involving each of the currents so that their values may be determined by an algebraic solution. Kirchhoff's circuit rules are also applicable to complex alternating current circuits and with modifications to complex magnetic circuits.

Notes:
1. circuit rule – правило (закон) для электрической цепи
2. multi-loop electric circuit – многоконтурная электрическая цепь (схема)
3. branch – ответвление
4. junction – точка разветвления, узел
5. loop equation – уравнение контурных токов
6. product – произведение
7. emissivity – излучательная (эмиссионная) способность

V. Find Russian equivalents for:

circuit rules, electric charge and energy, sum of currents, meet at a point, conserve, suddenly, voltage, electromagnetic force, battery and generator, equal, resistance, charged particles, carry the current, lost energy, useful work, on the basis, equation, complex alternating current circuits

VI. Find English equivalents for:

формулировка (утверждение), определять значение (величину) электрического тока, проволока, появляться или исчезать, накапливаться и рассеиваться, источник энергии, падение напряжения, замкнутая цепь, носители заряда, рассеивание тепла, алгебраическое решение, применимый

VII. Read and translate text 6.2. Answer the following questions:

1. What are Kirchhoff's circuit rules?
2. What is the first rule?
3. What is the second rule?

4. What is the importance of these rules?
5. To what circuits are these ruls applied?

TEXT 6.3. P.S. LAPLACE

1. Pierre-Simon, marquis de Laplace (1749-1827), also called count de Laplace, was a French physicist who is best known for his investigations into the stability of the solar system. Laplace successfully applied the Newtonian theory of gravitation to the solar system by ***accounting for*** all of the observed deviations of the planets from their theoretical orbits and developed a conceptual view of evolutionary change in the physical universe. He also demonstrated the usefulness of the probabilistic interpretation of scientific data.

2. Laplace was the son of a peasant farmer. He quickly showed his mathematical ability at the military academy at Beaumont. At 18 he left his humble surroundings for Paris, determined to make his way in mathematics. He then composed a letter on principles of mechanics for the mathematician Jean d'Alembert, who recommended him to a professorship at the Military School.

3. Laplace announced the ***invariability*** of planetary ***mean motion***, carrying his proof to the cubes of the eccentricities and inclinations. This discovery in 1773, his first and most important step in establishing the stability of the solar system, was the most important advance in physical astronomy since Newton. It won his ***associate membership*** in the Academy of Sciences the same year.

4. Applying quantitative methods to a comparison of living and nonliving systems Laplace and the chemist Antoine Lavoisier in 1780, with the aid of an ice calorimeter that they had invented, showed respiration to be a form of combustion.

5. Examining the entire subject of planetary perturbations – mutual gravitational effects, Laplace in 1786 proved that the ***eccentricities*** and inclinations of planetary orbits to each other will always remain small, constant and self-correcting. The effects of ***perturbations*** were therefore conservative and periodic, not cumulative and disruptive. The opposite and ***secular*** inequalities of Jupiter and Saturn (acceleration and deceleration, respectively), for example, were ***due to*** a changing effect with a period of 929 years. Their inequalities were therefore not cumulative but periodic.

Notes:

1. account for – объяснять

2. invariability – неизменность
3. mean motion – средняя угловая скорость
4. eccentricity – эксцентриситет (внецентричность)
5. associate member – член-корреспондент (научного общества)
6. perturbation – возмущение, нарушение
7. secular – происходящий раз в сто лет, вековой
8. due to – из-за

VIII. Find Russian equivalents for:

mathematician, astronomer and physicist, investigation, solar system, evolutionary change, scientific data, mathematical ability, the most important advance, comparison, with the aid of, respiration, examine the subject, mutual gravitational effects, acceleration and deceleration

IX. Find English equivalents for:

известный, применять теорию гравитации, наблюдаемые отклонения планет, разработать концептуальную точку зрения, польза вероятностного толкования, предоставить доказательство, наклон (угол наклона), применять количественные методы, показывать (2), форма горения (сжигания), оставаться постоянным, умеренный и периодичный, несоответствие (неравенство), накопительный эффект

X. Read and translate text 6.3. Answer the following questions:

1. What was P.S. Laplace?
2. What was he famous for?
3. Where did he study?
4. What did Laplace discover?
5. Who helped him with his work?
6. What did Laplace prove?

XI. What do the following dates refer to:

1749, 1773, 1780, 1786

TEXT 6.4. LAPLACE'S RESEARCH WORK

1. In 1784-85 Laplace proved that his theorem concerning spheroids of revolution is true for any spheroids with common focuses, and he explored the problem of the attraction of spheroid upon a particle situated outside or upon its surface. Through his discovery that the attractive force

of a mass upon a particle, regardless of direction, could be obtained directly by a differentiating a single function, Laplace laid the mathematical foundation for the scientific study of heat, magnetism and electricity.

2. In 1878 Laplace announced that lunar acceleration depends on the eccentricity of the Earth's orbit. Although the mean motion (average angular velocity) of the Moon around the Earth depends mainly on the gravitational attraction between them, it is slightly diminished by the ***pull*** of the Sun on the Moon. This solar action depends, however, on changes in the eccentricity of the Earth's orbit ***resulting from*** perturbations by the other planets. As a result, the Moon's mean motion is accelerated as long as the Earth's orbit tends to become more circular; but, when the reverse occurs, this motion is retarded. The inequality is therefore not truly cumulative, Laplace concluded, but of a period running into millions of years.

3. In 1796 Laplace published 'The System of the World', a semipopular ***treatment*** of his work in ***celestial mechanics*** and a model of French prose. The book included his 'nebular hypothesis' – attributing the origin of the solar system to cooling and contracting of a ***gaseous nebula*** – which strongly influenced future thought on planetary origin. His 'Celestial Mechanics', appearing in five volumes between 1798 and 1827, summarized the results obtained by his mathematical development and application of the law of gravitation. He offered a complete mechanical interpretation of the solar system by devising methods for calculating the motions of the planets and their satellites and their perturbations, including the ***resolution*** of tidal problems. The book made him a celebrity.

4. In 1814 Laplace published a popular work for the general reader 'A Philosophical Essay on Probability'. This work was the introduction to the second edition of his comprehensive and important 'Analytic Theory of Probability', first published in 1812, in which he described many of the tools he invented for mathematically predicting the probabilities that particular events will occur in nature. He applied theory not only to the ordinary problems of chance but also to the inquiry into the causes of phenomena, ***vital statistics***, and future events, while emphasizing its importance for physics and astronomy.

5. Probably because he did not hold strong political views he escaped impisonment and execution during the Revolution. Laplace was president of the Board of Longitude, aided in the organization of the metric system, helped found the Societe d'Arcueil, a scientific society, and was created a marquis. He served for six weeks as minister of the interior under Napoleon, who thought his record as an administrator was undistinguished.

Notes:

1. pull – тяга, притяжение
2. result from – происходить в результате, являться следствием
3. treatment – трактовка
4. celestial mechanics – механика небесных тел
5. gaseous nebula – газообразная туманность (галактика)
6. resolution – решение, анализ
7. vital statistics – статистика естественного движения населения

XII. Read and translate text 6.4. Answer the following questions:

1. What did Laplace prove concerning spheroids?
2. What did he lay foundation for?
3. What did Laplace announce about lunar acceleration?
4. Where did he show the nebular hypothesis?
5. What book made Laplace a celebrity and why?
6. Where did he describe many tools he investigated?
7. Why did Laplace escape imprisonment?
8. Where did he work?

XIII. Make up the abstracts of texts 6.1– 6.4 (in English or in Russian).

XIV. Comment on the following quotation. Do you agree or disagree with it?

1. The simplicity of nature is not to be measured by that of our conceptions. Infinitely varied in its effects, nature is simple only in its causes, and its economy consists in producing a great number of phenomena, often very complicated, by means of a small number of general laws. (Pierre Simon, Marquis de Laplace 1749–1827, – French mathematician and physicist)

SECTION 7

TEXT 7.1. IGOR KURCHATOV

1. Igor Vasilyevich Kurchatov (1903-1960) was a Soviet nuclear physicist who guided the development of Russia's first atomic bomb, the

world's first ***practical*** thermonuclear bomb and the first atomic ***electric-power station*** in the Soviet Union.

2. After graduation (1923) from the Crimean University in Simferopol, Kurchatov joined (1927) the staff of the Physico-Technical Institute of the Academy of Sciences in Leningrad. His initial studies concerned ferroelectricity but by 1933 he was concentrating on nuclear physics. As director of the nuclear physics laboratory at the Physico-Technical Institute, he ***supervised*** the construction of the first Soviet cyclotrons.

3. In 1939 he and his associates published studies of nuclear chain reactions, and in 1940 he reported the ***spontaneous fission*** of uranium, previously reported only a year earlier by Otto Hahn and Fritz Strassmann in Germany. During World War II Kurchatov's nuclear research was suspended in favour of defense research concerning methods of protecting ships from magnetic mines.

4. Kurchatov directed the construction of the first Soviet ***cyclotron*** (1944) and, after the war, the first atomic reactor in Europe (1946). His team produced the first Soviet atomic bomb in 1949, four years after the United States. In 1953 the team detonated a thermonuclear (hydrogen) bomb, six months before the first U.S. thermonuclear bomb. Nonmilitary applications of atomic power explored and developed under Kurchatov's leadership included, besides electric-power stations (the first of which began operation in 1954), the nuclear-powered icebreaker 'Lenin'. Kurchatov also directed research on the 'ultimate power source', ***fusion*** energy, centering on a means of ***containment*** of the extremely high temperature that are needed to initiate the fusion process.

5. In 1956 Kurchatov was appointed director of the Institute of Atomic Energy of the Soviet Academy of Sciences (from 1960 called the I.V. Kurchatov Institute of Atomic Energy). The Kurchatov Medal was established by the Academy of Sciences for outstanding work in nuclear physics. Scientists in the Soviet Union proposed that the radioactive element with the atomic number 104 (which American scientists have called rutherfordium) be named kurchatovium.

Notes:

1. practical – фактический, настоящий, реальный
2. electric-power station – электростанция
3. supervise – наблюдать, руководить
4. spontaneous fission – спонтанное деление (расщепление)
5. cyclotron – циклотрон (резонансный циклический ускоритель ионов)

6. fusion – ядерный синтез
7. containment – локализация, сдерживание распространения

I. Find Russian equivalents for:

nuclear physicist, the world's first thermonuclear bomb, atomic power, electric-power station, nuclear physics laboratory, nuclear chain reactions, spontaneous fission of uranium, nuclear research, methods of protecting ships from magnetic mines, detonate the thermonuclear (hydrogen) bomb, application of atomic power, nuclear-powered icebreaker 'Lenin', fusion energy

II. Find English equivalents for:

руководить разработкой первой атомной бомбы, после окончания университета, руководить строительством циклотрона, его коллеги, временно приостановить в пользу оборонных исследований, исследовать и разрабатывать, под руководством, начинать, назначать директором, выдающаяся работа, предлагать, средства сдерживания чрезвычайно высокой температуры

III. Read and translate text 7.1. Answer the following questions:

1. What was I. Kurchatov?
2. What was he famous for?
3. Where did Kurchatov study?
4. Where did he work?
5. What reaction did he study?
6. What did Kurchatov's team produce?
7. What nonmilitary application of atomic power did Kurchatov investigate?

IV. What do the following dates refer to:

1903, 1923, 1927, 1933, 1939, 1940, 1946, 1949, 1953, 1954, 1956, 1960

V. Find in text 7.1 the information to prove that:

1. I.V. Kurchatov studied at the University in the South of Russia.
2. During World War II Kurchatov carried out defence research.
3. He directed the construction of important objects.
4. His team detonated a bomb.
5. The Russian Academy of Sciences established a medal.

TEXT 7.2. JULIUS OPPENHEIMER

1. Julius Robert Oppenheimer (1904-1967) was U.S. theoretical physicist and science administrator, noted as director of the Los Alamos laboratory during development of the atomic bomb (1943-45) and as a director of the Institute for Advanced Study in Princeton (1947-1966).

2. Oppenheimer was the son of a German immigrant who had made his fortune by importing textiles in New York City. During his undergraduate studies at Harvard University, Oppenheimer excelled in Latin, Greek, physics, chemistry, published poetry and studied Oriental philosophy. After graduating in 1925, he sailed for England to do research at the Cavendish Laboratory at the University of Cambridge, which, under the leadership of Lord Rutherford, had an international reputation for its pioneering studies on atomic structure. At the Cavendish laboratory, Oppenheimer had the opportunity to collaborate with the British scientific community in its efforts to advance the cause of atomic research.

3. Max Born (1882-1970), the British physicist, invited him to Göttingen University, where he met other prominent physicists, such as Niels Bohr and Paul Dirac, and where, in 1927, he received his doctorate. After short visits at science centres in Leiden and Zürich, he returned to the United States to teach physics at the University of California at Berkeley and the California Institute of Technology.

4. In the 1920s the new quantum and relativity theories were engaging the attention of science. Oppenheimer's early research was devoted in particular to energy processes of subatomic particles, including electrons, positrons and cosmic rays. The university post provided him an excellent opportunity to devote his entire career to the exploration and development of quantum theory. In addition, he trained a whole generation of U.S. physicists, who were greatly affected by his qualities of leadership and intellectual independence.

5. After the invasion of Poland by Nazi Germany in 1939, the physicists Albert Einstein (1879-1955) and Leo Szilard (1898-1964), warned the U.S. government of the danger threatening all of humanity if the Nazis should be first to make a nuclear bomb. Oppenheimer then began to seek a process for the separation of uranium-235 from natural uranium and to determine the critical mass of uranium required to make such a bomb. In August 1942 the U.S. Army was given the responsibility of organizing the efforts of British and U.S. physicists to seek a way to harness nuclear energy for military purposes, an effort that became known as the Manhattan

Project. Oppenheimer was instructed to establish and administer a laboratory to carry out this assignment. In 1943 he chose the plateu of Los Alamos, near Santa Fe (New Mexico) where he had spent part of his childhood in a boarding school.

6. The joined effort of outstanding scientists at Los Alamos culminated in the first nuclear explosion on July 16, 1945, at Alamogordo, (New Mexico) after the surrender of Germany. In October of the same year, Oppenheimer resigned his post. In 1947 he became head of the Institute for Advanced Study at Princeton University and served from 1947 until 1952 as a chairman of the General Advisory Committee of the Atomic Energy Commission, which in October 1949 opposed development of the hydrogen bomb. He spent the last years of his life working out ideas on the relationship between science and society. In 1963 he was presented Enrico Fermi Award of the Atomic Energy Commission. He retired from Princeton in 1966 and died the following year.

VI. Find Russian equivalents for:

theoretical physicist and science administrator, development of atomic bomb, Institute for Advanced Study, advance, prominent physicists, quantum and relativity theories, energy processes of subatomic particles, exploration and development of quantum theory, qualities of leadership and intellectual independence, separation of uranium, responsibility, seek a way, nuclear explosion, relationship between science and society

VII. Find English equivalents for:

разбогатеть, под руководством Резерфорда, сотрудничать с британским научным сообществом, включать, давать (обеспечивать) превосходную возможность, посвятить, подготовить целое поколение физиков, вторжение, опасность, угрожающая всему человечеству; определять критическую массу, использовать ядерную энергию в военных целях, создать лабораторию, выполнять задание, выступать против разработки водородной бомбы

VIII. Read and translate text 7.2. Answer the following questions:

1. What was J. R. Oppenheimer?
2. What was he famous for?

3. Where did Oppenheimer study?
4. Why did he leave the United States?
5. Where did Oppenheimer receive his doctorate?
6. What was his early research devoted to?
7. What was Oppenheimer instructed to do?
8. What ideas did he work out before retirement?

IX. What do the following dates refer to:

1904, 1925, 1927, 1939, 1942, 1945, 1947, 1966, 1967

X. Find in text 7.2 the information to prove that:

1. Oppenheimer's father was an immigrant.
2. He excelled in many subjects at University.
3. In Germany J. R. Oppenheimer worked with prominent physicists.
4. He taught physics at University of the United States.
5. Students and young physicists were affected by his qualities.
6. Oppenheimer studied uranium.
7. He worked as a chairman of committee.
8. Oppenheimer was given the Award.

TEXT 7.3. NUCLEAR ENERGY

1. Nuclear energy is the energy evolved by nuclear fission or nuclear fusion. Nuclear energy is produced by the ***controlled decay*** of radioactive elements. Upon decay, an element such as uranium releases energy as heat that can be harnessed. The decay can be accelerated by bombarding the material with neutron.

2. Nuclear fission is the ***splitting*** of atoms when a neutron strikes a nucleus of radioactive element. The nucleus splits into two and releases more neutrons and a lot of energy. A chain reaction develops when the neutrons go on to split further nuclei and the energy released becomes enormous. In nuclear power stations the fission reaction is harnessed to produce heat at a controlled rate (to raise steam to drive a turbine). Atomic bomb is a weapon with great explosive power that results from a sudden release of energy upon splitting or fission of the nuclei of such heavy elements as plutonium or uranium.

3. Nuclear fusion is a combination of two light nuclei, such as hydrogen, to form a single stable nucleus, such as helium with an accompanying

release of energy. Fusion is often called thermonuclear fusion. Thermonuclear reactor is a reactor in which a fusion reaction takes place with the controlled release of energy. The most readily achieved fusion reaction is the combination of deuterium and tritium to form helium. Fusion occurs in the Sun and in hydrogen bomb.

4. The first atomic bombs were built in the United States during World War II under a program called the Manhattan Project. One bomb, using plutonium, was tested on July 16, 1945, at a site 193 km south of Albuquerque (New Mexico). The first atomic bomb to be used in warfare used uranium. It was dropped by the United States on Hiroshima (Japan) on August, 1945. The explosion, which had the force of more than 15,000 tons of TNT (***trinitrotoluene***, a highly explosive solid), instantly and completely devastated 4 square miles of the centre of this city (343,000 inhabitants). More than 67% of the city's structures were destroyed or damaged. 66,000 were killed immediately and 69,000 were injured.

5. The next atomic bomb to be exploded was of the plutonium type. It was dropped on Nagasaki on August 9, 1945, producing a blast equal to 21,000 tons of TNT. But 39,000 persons were killed and 25,000 injured, about 40% of the city's structures were destroyed or seriously damaged. The Japanese initiated surrender negotiations the next day. After the war, the United States conducted dozens of ***test explosions*** of atomic bombs in the Pacific at Enewetak atoll and in Nevada. Great Britain, France, the Soviet Union and the People's Republic of China tested fission weapons of their own in subsequent years.

Notes:
1. controlled decay – управляемый (ядерный) распад
2. splitting – расщепление
3. trinitrotoluene – тринитротолуóл
4. test explosion – испытание (испытательный взрыв)

XI. Read and translate text 7.3. Identify, define or explain each of the following:

1. Nuclear energy
2. Nuclear fission
3. Chain reaction
4. Atomic bomb
5. Nuclear fusion
6. Thermonuclear reactor
7. Tests of U.S. atomic bombs

TEXT 7.4. ICEBREAKERS

1. Much of the world ***cargo*** travels by sea. But how can ships get to harbors when the sea is frozen? This is especially difficult in the busy Baltic Sea, which for many countries is the only passage to the open sea. Ice ***obstructs*** cargo traffic in Finland, North America on the Great Lakes, on the St. Lawrence River and along the Canadian coast. The Arctic and Antarctic areas are even more difficult to ***tackle*** during the icy winter. There the average thickness of ice is two to three meters.

2. In the era of sailing ships, the ice was an almost invincible obstacle. After the first ***steel-hulled*** steamships appeared, the situation improved. If the cargo ship was strong enough, it could pass through thin ice by itself. However, such ships were limited, even though some of them were specifically reinforced for ice. Building icebreakers provided a solution. The world's first icebreaker is said to have been "The City Ice Boat I", built in the United States in 1837. In Europe "The Eisbrecher" was built in Hamburg (Germany) in1871.

3. Experience soon taught what kind of vessels ***coped with*** ice, and at the turn of the 20^{th} century, certain fundamental designs had already been established. Icebreakers vary in size and construction, depending on where they operate – in harbors, in the open sea, or in the Polar Regions. The ***hull*** of an icebreaker has to ***withstand*** a pressure many times greater than the hull of a merchant ship. The steel plates in the ***bow*** may be well over three centimeters thick – on polar icebreakers even up to five centimeters thick – and the body of the ship has specific ice-reinforcement ***ribs*** in addition to the regular ones.

4. How strong are such ships? During World War II, when a bomb hit the icebreaker "Tarmo", the navigating deck and most of the cabins were destroyed, but the hull did not even spring a leak. The shape of the hull is crucial to an ice-breaking vessel. Often the most difficult task is not actually breaking the ice but pushing the broken pieces away. Many icebreakers have a somewhat shallow bow, shaped like a spoon. The vessel breaks the ice with its mass and pushes the blocks to the sides and below. The shape of the hull is carefully designed to minimize friction between the body of the vessel and the ice. In addition, the body is covered with stainless steel or extremely smooth and durable epoxy paint.

5. How are these iron giants powered? Modern icebreakers are diesel-electric, and their shaft output is similar to that of medium-sized tankers. To equip icebreakers to operate in Polar Regions without fear of

running out of fuel, some are powered by nuclear reactors. Nowadays, there is a new generation of vessels. These ***multipurpose*** icebreakers operate as ***conventional*** icebreakers in winter, but during open-water season they can be used for such things as cable laying, research operations, and maintenance of offshore ***oil rigs***.

Notes:
1. cargo – груз
2. to obstruct – затруднять
3. to tackle – совладать
4. steel-hulled – в стальном корпусе
5. to cope – справиться
6. hull – основной корпус (корабля)
7. to withstand – противостоять
8. bow – нос корабля
9. rib – шпангоут (ребро жесткости)
10. shaft output – выходной вал
11. multipurpose – универсальный
12. conventional – обычный
13. oil rig – нефтяная вышка

XII. Read and translate text 7.4. Identify, define or explain each of the following:

1. Cargo traffic in winter
2. First steel-hulled steamships
3. World's first icebreaker
4. Size and construction of icebreakers
5. Power for icebreakers
6. Universal icebreakers

XIII. Comment on the following quotation. Do you agree or disagree with it?

1. The scientist is not responsible for the laws of nature, but it is a scientist's job to find out how these laws operate. It is the scientist's job to find ways in which these laws serve the human will. However, it is not the scientist's job to determine whether a hydrogen bomb should be used. This responsibility rests with the American people and their chosen representatives. (Julius Robert Oppenheimer 1904–1967, – American physicist)

SECTION 8

TEXT 8.1. AUGUSTE LA RIVE

1. Auguste-Arthur de La Rive (1801-1873) was a Swiss physicist, one of the founders of the electrochemical theory of batteries.

2. La Rive was elected to the chair of natural philosophy at the Academy of Geneva in 1823, and for the next seven years he conducted studies on the ***specific heat*** of various gases and the temperature of the Earth' crust. His experiments in 1836 on the ***Voltaic cell***, an early type of battery, farthered the development of electrical theory. He shared the view of the English physicist Michael Faraday that voltaic electricity was caused by chemical action.

3. In 1840 he invented the process for ***electroplating*** gold onto silver and brass, and in 1841 he received a prize of 3,000 francs from the French Academy of Sciences for this process. His treatise on 'Theoretical and Applied Electricity' (1854-58) was translated into several languages. Later, while carrying out research of the discharge of electricity through gases, he discovered that ozone is created when electrical sparks pass through oxygen.

Notes:
1. specific heat – удельная теплоёмкость
2. Voltaic cell – химический источник тока, гальванический элемент
3. electroplating – нанесение гальванического покрытия, гальванизация

I. Find Russian equivalents for:

Swiss physicist, founder of the electrochemical theory of batteries, elect, to conduct studies, temperature of the Earth' crust, Voltaic cell, development of electrical theory, chemical action, gold, silver and brass, translate into several languages, carry out research, discover, create

II. Find English equivalents for:

кафедра натурфилософии, удельная теплоёмкость различных газов, разделять точку зрения, вызывать (являться причиной), изобретать процесс нанесения гальванического покрытия, получить премию, трактат, разряд электричества, когда электрические разряды проходят через кислород

III. Read and translate text 8.1. Answer the following questions:

1. What was A.A. la Rive?
2. What was he famous for?
3. Where did La Rive work?
4. What studies did he conduct?
5. What experiments did La Rive make?
6. What process did he invent?
7. What can you say about La Rive's treatise?
8. What did he discover later?

IV. What do the following dates refer to:

1801, 1823, 1836, 1840, 1841, 1854-58, 1873

TEXT 8.2. ELECTROPLATING

1. Electroplating is a method of plating metal with another by ***electrodeposition.*** Electrodeposition is the process of depositing one metal on another by electrolysis, as in electroforming or electroplating. The ***articles*** to be plated are made the cathode of an ***electrolytic cell*** and a rod or bar of the plating metal is made the anode. Electroplating is used for covering metal with a decorative, more expensive or corrosion-resistant layer of another metal.

2. Electrolytic cell is a cell in which electrolysis occurs, i.e. one in which current is passed through the electrolyte from an external source. Electrolyte is a liquid that conducts electricity as a result of the presence of positive or negative ions. Electrolytes are ***molten*** ionic compounds or solutions containing ions, i.e. solutions of ionic salts or of compounds that ionize in solution.

3. Electrolysis is the production of a chemical reaction by passing an electric current through an electrolyte. In electrolysis, positive ions migrate to the cathode and negative ions to the anode. Electrode is a conductor that emits or collects electrons in a cell, thermionic valve, semiconductor device, etc. The anode is the positive electrode and the cathode is the negative electrode.

Notes:
1. electrodeposition – электролитическое осаждение, нанесение покрытия методом электроосаждения
2. article – изделие
3. electrolytic cell – гальванический элемент
4. molten – расплавленный, жидкий

V. Find Russian equivalents for:

electroplating, electrodeposition, electrolysis, cathode, anode, cover, metal, pass current through the electrolyte, liquid that conducts electricity, presence of positive or negative ions, ionic salt, ionize, a conductor that emits or collects electrons

VI. Find English equivalents for:

покрытие металла другим, осаждение одного металла на другой, изделия, гальванический элемент, пруток или стержень, использовать, коррозионно-устойчивый слой, внешний источник, в результате, жидкие ионные соединения, путём пропускания электрического тока через электролит, растворы, содержащие ионы

VII. Read and translate text 8.2. Identify, define or explain each of the following:

1. Electroplating
2. Electrodeposition
3. Application of electroplating
4. Electrolytic cell
5. Electrolyte
6. Electrolysis
7. Electrode
8. Anode and Cathode

TEXT 8.3. HYPOTHESES, THEORIES AND LAWS

1. When we find that an idea explains or ***correlates*** a number of facts, we call this idea a hypothesis. We can ***subject*** it to further tests and to experimental checking of ***deductions***. If the hypothesis continues ***to agree with*** the results of experiment, we call it a theory or a law.

2. A theory, such as the atomic theory, usually involves some idea about the nature of some parts of the Universe, a law represents a summarizing ***statement*** about observed experimental facts. For example, there is a law of the constancy of the angles between the ***faces of crystals***. The law states that whenever we measure the angles between corresponding faces of various crystals of a pure substance, they will have the same value. It does not explain the fact. We find an explanation of the fact in the atomic theory of crystals, the theory that in crystals the atoms are in ***regular order***.

3. Chemists and other scientists use the word “theory” in two different senses. The first meaning of the word is the meaning described above

– namely, a hypothesis that has been ***verified***. The second use of the word “theory” is to represent a systematic ***body*** of knowledge, compounded of facts, laws, theories, deductive arguments and so on.

4. Thus, by the atomic theory we mean not only the idea that substances consist of atoms, but also all the facts about substances that can be explained and interpreted in terms of atoms and the arguments that explain the properties of substances in terms of their atomic structure.

Notes:

1. to correlate – соотносить, сопоставлять, коррелировать
2. to subject to – подвергать
3. deduction – вывод, заключение
4. to agree with – согласовывать(ся), соответствовать
5. statement – утверждение
6. faces of crystal – грани кристалла
7. regular order – правильный порядок
8. to verify – проверять, подтверждать
9. body – главная, основная часть (чего-либо), корпус

VIII. Read and translate text 8.3. Explain each of the following:

1. Hypothesis 2. Theory 3. Law 4. Two meanings of word’s theory

IX. Comment on the following quotation. Do you agree or disagree with it?

1. The man of science who cannot formulate a hypothesis is only an accountant of phenomena. (Pierre Lecomte de Nouy 1883–1947, – French biophysicist)

SECTION 9

TEXT 9.1. LEV LANDAU

1. Lev Davidovich Landau (1908-1968), was a Soviet physicist who worked in such fields as low-temperature physics, atomic and nuclear physics and solid-state, stellar-energy and plasma physics. Several physics terms bear his name. He was awarded the 1962 Nobel Prize for Physics.

2. His father was an engineer who worked in the Baku oil industry and his mother – a doctor who had at one time done physiological re-

search. Landau was graduated at 13 from the Gymnasium and, because he was too young to go to the University, attended the Baku Economical technical School. He ***matriculated*** in 1922 at Baku University, studying physics and chemistry, and transferred in 1924 to the Leningrad State University, which at that time was the centre of Soviet physics. Graduating in 1927, he continued research at the Leningrad Physico-Technical Institute.

3. Landau got his first chance to go abroad in 1929, on a Soviet government travelling ***fellowship*** supplemented by a Rockefekller Fellowship. After brief stays in Göttingen and Leipzing, he went to Copenhagen (where was the Western theoretical physics schools) to work in Niels Borh's Institute for Theoretical Physics. It is probably no exaggeration to say that the development of present-day theoretical physicists owes more to Bohr's Institute than to any other place in the world. Almost all of the leading theoretical physics of the 1920s and 1930s spent some period at this institute. Landau always considered himself a pupil of Bohr', and his attitude to physics was greatly influenced by Bohr. After his stay in Copenhagen he visited Cambridge and Zürich before returning to the Soviet Union. He visited Copenhagen in 1933 and 1934.

4. In 1932 Landau went to Kharkov to become the head of the Theoretical Division of the Ukrainian Physico-Technical Institute, a position he combined in 1935 with that of head of the Department of General Physics at the Kharkov A.M. Gorky State University. In Kharkov Landau began to build a Soviet school of theoretical physics, so that Kharkov soon became the centre of theoretical physics in the U.S.S.R. It was also in Kharkov that, with his friend and former student, E.M. Lifshifts, he started to write the well-known 'Course of Theoretical Physics', a set of nine volumes that together span the whole of the subject. His great interest in the teaching of physics is also shown in his plans for a 'Course of General Physics' and even a series 'Physics for Everybody'.

5. Landau required that his students master all necessary mathematical techniques before coming to him. After that he expected them to master the so-called theoretical minimum, which included a basic knowledge of all the ***domains*** of theoretical physics. Only the ablest of the students could pass this minimum. In this way his students became proper physicists, rather than narrow specialists.

Notes:

1. matriculate – быть принятым в вуз

2. fellowship – стипендия
3. domain – область, сфера

V. Find Russian equivalents for:

Soviet physicist, low-temperature physics, atomic and nuclear physics, plasma physics, award the Nobel Prize, oil industry, continue research, to go abroad, development of theoretical physics, pupil, volume, teaching of physics, theoretical minimum

VI. Find English equivalents for:

физика твердого тела, быть принятым в вуз, перевестись (для учебы) в другой вуз, стипендия, влиять, сочетать (соединять), бывший студент, требовать, овладеть всеми необходимыми математическими методами, включать в себя, область, сдавать минимум, настоящий физик, а не узкий специалист

III. Read and translate text 9.1. Answer the following questions:

1. What was L.D. Landau?
2. What was he famous for?
3. Where did Landau study?
4. What can you say about his parents?
5. Where did he go abroad?
6. Why did Landau go to Kharkov?
7. What did he require of his students?

IV. What do the following dates refer to:

1922, 1924, 1927, 1929, 1932, 1933, 1934, 1935

TEXT 9.2. LANDAU'S WORK IN MOSCOW

1. In 1937 Pyotr Leonidovich Kapitsa, a low temperature experimentalist, persuaded Landau to move to Moscow and to head the Theory Division of the S.I. Vavilov Institute of Physical Problems, which had been created by the U.S.S.R. Academy of Sciences. There, Landau's close interest in experimental physics led to his development of the theory of liquid helium. Kapitsa had found that liquid helium was ***superfluid*** that is, that it had less resistance against moving through a tube than any other known liquid. Landau's theory to explain this peculiar behaviour was the work for which he was awarded the Nobel Prize for Physics (1962). In

1937 Landau married K.T. Drobanzeva and in 1946 they had a son, Igor, who became an experimental physicist.

2. In Moscow Landau continued to make significant contributions to almost all parts of physics. The topics he covered range from low-temperature to nuclear physics, from the theory of metals to stellar energy, from cosmic rays to plasmas, from hydrodynamics to atomic physics. Landau's contributions are partly reflected in such terms as Landau diamagnetism and Landau levels in solid-state physics, Landau ***damping*** in plasma physics, the Landau energy spectrum in low-temperature physics, or Landau ***cuts*** in high-energy physics.

3. Apart from the Nobel Prize, Landau received many other honours. In the U.S.S.R. he was directly elected a member of the Academy of Sciences, was given the title of Hero of Socialist Labour, and was awarded three State Prizes, as well as Lenin Prize. He was foreign member of the Royal Society of London and of the academy of the Netherlands, Denmark, and the United States, as well as a recipient of the Max Planck Medal and the Fritz London Prize.

Notes:

1. superfluid – сверхтекучий
2. damping – гашение (колебаний), затухание
3. cut – скачок (переход)

V. Find Russian equivalents for:

low temperature experimentalist, move, S.I. Vavilov Institute of Physical Problems, liquid helium, less resistance, to award the Nobel Prize for Physics, topic, cosmic rays, high-energy physics, receive many honours, Academy of sciences, elect

VI. Find English equivalents for:

убеждать, создавать, разработка теории, обнаруживать, объяснять специфическое поведение, делать значительный вклад, диапазон, отражать, кроме, награждать государственной премией, иностранный член Королевского (научного) Общества, получатель

VII. Read and translate text 9.2. Answer the following questions:

1. Who persuaded Landau to move to Moscow?
2. What theory did he develop there?

3. What for was Landau awarded the Nobel Prize?
4. In what fields did he work?
5. What other honours did Landau receive?

TEXT 9.3. PHYSICS

1. Physics is the science that deals with the structure of matter and interactions between the fundamental ***constituents*** of the observable universe. Physics, which was long called natural philosophy is concerned with all aspects of nature on both the macroscopic and submicroscopic levels. Its scope of study encompasses not only behaviour of objects under the action of forces but also the nature and origin of gravitational, electromagnetic and nuclear force fields. Its ultimate objective is the formulation of comprehensive principles that bring together and explain different phenomena.

2. Physics is the science of matter, motion and energy, studying various phenomena in nature. Its object is to determine exact relations between physical phenomena. Physics is divided into two great branches, experimental and theoretical. The task of the former is to make observations and carry out experiments. On the basis of the experimental facts theoretical physics is to formulate laws and predict the behaviour of natural phenomena. Theoretical physics is the study of physics by formulating and analyzing theories that describe natural processes. A large part of theoretical physics consists of analyzing the results of experiments to see whether or not they obey particular theories.

3. The branch of the theoretical physics concerned with the mathematical aspects of theories in physics is called mathematical physics. Formulation of principles that summarize disparate phenomena are expressed with economy and precision in the language of mathematics. Both experiment (the observation of phenomena under conditions that are controlled as precisely as possible) and theory (the formulation of a unified conceptual framework) play essential and complementary roles in the advancement of physics. Physical experiments result in measurements, which are compared with the outcome predicted by theory. A theory that reliably predicts the results of experiments to which it is applicable is said to embody a law of physics.

4. Nuclear physics is the physics of atomic nuclei and their interactions, with particular reference to the generation of nuclear energy. Particle physics is the study of elementary particles (the fundamental

constituents of all the matter in the universe). The study of plasma is known as plasma physics. Plasma is a highly ionized gas in which the number of free electrons is approximately equal to the number of positive ions. The fourth state of matter, plasma occurs in interstellar space, in the atmospheres of stars (including the sun), in ***discharge tubes*** and in experimental thermonuclear reactors. Plasma can be created in the laboratory by heating a low-pressure gas until the mean kinetic energy of the gas particles is comparable to the ionization potential of the gas atoms or molecules.

Notes:
1. constituent – составная часть, компонент
2. discharge tube – газоразрядная трубка (лампа, прибор)

VIII. Find Russian equivalents for:

science, structure of matter, natural philosophy, all aspects of nature, behaviour of objects, nature and origin, different phenomena, matter, motion, branch, task, make observations, formulate laws and predict behaviour, describe, mathematical physics, observation, play essential and complementary role, measurement, applicable, nuclear physics, generation of nuclear energy, free electrons, by heating a low-pressure gas, ionization potential

IX. Find English equivalents for:

иметь дело с, взаимодействие, основные компоненты, называть, касаться (иметь отношение), её сфера изучения включает, под действием сил, её конечная цель, всесторонние принципы, сводить и объяснять, изучать различные явления природы, определять точные взаимосвязи (отношения), проводить эксперименты, состоять из, подчиняться теории, выражать экономно и точно, прогресс, надёжно прогнозировать результаты, приблизительно равный, средняя кинетическая энергия

X. Read and translate text 9.3. Identify, define or explain each of the following:

1. Physics
2. Object of physics
3. Experimental physics
4. Theoretical physics
5. Mathematical physics
6. Experiment
7. Theory
8. Nuclear physics
9. Plasma physics

XI. Make up the abstracts of texts 9.1–9.3 (in English or in Russian).

XII. Comment on the following quotation. Do you agree or disagree with it?

1. Science makes people reach selflessly for truth and objectivity; it teaches people to accept reality, with wonder and admiration, not to mention the deep awe and joy that the natural order of things brigs to the true scientists. (Lise Meitner 1878–1968, – Austrian physicist)

SECTION 10

TEXT 10.1. MAX LAUE

1. Max Theodor Felix von Laue (1879-1960) was a German recipient of the Nobel Prize for Physics in 1914 for his work on the diffraction of X-rays in crystals. This enabled scientists to study the structure of crystals and hence marked the origin of solid-state physics, an important field in the development of modern electronics.

2. Laue became professor of physics at the University of Zürich in 1912. In that year he was the first to use a crystal to diffract X-ray and thus demonstrated that X-rays are electromagnetic radiations similar to light. His success also provided experimental proof that the atomic structure of crystals is a regularly repeating arrangement. He ***championed*** Albert Einstein's theory, the Compton effect (change of wavelength in light under certain conditions) and the disintegration of atoms. He became director of the Institute for Theoretical physics at the University of Berlin in 1919 and director of the Max Planck Institute for Research in Physical Chemistry in Berlin (1951).

Notes:

1. champion – защищать, бороться за что-либо

I. Find Russian equivalents for:

recipient of the Nobel Prize for Physics, to study the structure of crystals, scientist, development of modern electronics, become professor of physics, electromagnetic radiation, success, change, disintegration of atoms

II. Find English equivalents for:

дифракция рентгеновских лучей в кристаллах, возникновение физики твердого тела, важная область, использовать кристалл, подобный свету, обеспечивать экспериментальное доказательство, постоянно повторяющееся расположение, при определенных условиях

III. Read and translate text 10.1. Answer the following questions:

1. What was M. von Laue?
2. What was he famous for?
3. Where did Laue work?
4. What did he study and demonstrate?
5. Was his study a success?
6. What did Laue support?

IV. What do the following dates refer to:

1879, 1912, 1914,1919, 1951, 1960

TEXT 10.2. SOLID-STATE PHYSICS

1. ***Solid-state physics*** is the study of the physical properties of solids, with special emphasis on the electrical properties of semiconducting materials in relation to their electronic structure. Solid state devices are electronic components consisting entirely of solids (e.g. semiconductors, transistors, etc.) without heating elements, as in ***thermionic valves***. Recently the term ***condensed-matter physics*** has been introduced to include the study of crystalline solids, amorphous solids and liquids.

2. Semiconductor is a crystalline solid (silicon, germanium, selenium, lead telluride) with an electrical conductivity intermediate between that of a conductor and an insulator. Germanium has a melting point of 937^o C and a boiling point – 2830^o C. It is found in zink sulphide and in certain other sulphide ores, and is mainly obtained as a by-product of zinc smelting. Germanium was predicted in 1871 as ekasilicon by Dmitri Mendeleyev, it was discovered by Winkler in 1886. Selenium has a melting point of 217^o C (grey) and boiling point – 684.9^o C. It occurs in sulphide ores of other metals and is obtained as a by-product (e.g. from the anode sludge in electrolytic refining). The grey allotrope is light sensitive and is used in photocells, zerography and similar applications. Selenium was discovered in 1817 by Jöns Berzelius. Silicon has a melting point of 1410^o C and boiling point – 2355^o C. It occurs in various forms of silicon oxide (quarts) and in silicate minerals. It has a diamond – like crystal

structure; an amorphous form also exists. Silicon was identified by Antoine Lavoisier in 1787 and first isolated in 1823 by Jöns Berzelius.

3. Semiconductor devices have virtually replaced thermionic devices, because they are several orders of magnitude smaller, cheaper in energy consumption and more reliable. The basic structure for electronic semiconductor devices is the semiconductor diode. Transistor is also a semiconductor device capable of amplification in addition to rectification. It is the basic ***unit*** in radio, television and computer circuits, having almost completely replaced the thermionic valve.

Notes:
1. thermionic valve – (электродная) лампа с териокатодом
2. condensed-matter physics – физика конденсированного вещества
3. unit – устройство, прибор, компонент

V. Find Russian equivalents for:

solid-state physics, electrical properties of semiconducting materials, semi-conductor, without heating elements, crystalline solid, liquid silicon, germanium, selenium, lead telluride, intermediate, conductor and an insulator, a melting point, a boiling point, sulphide ore, zinc smelting, light sensitive, photocell, silicon oxide, a diamond – like crystal structure, magnitude, energy consumption, amplification and rectification

VI. Find English equivalents for:

изучать физические свойства, особое внимание, относительно их электронной структуры, твердотелый (полупроводниковый) прибор, состоять из, вводить (представлять), включать в себя, электрическая проводимость, получать как побочный продукт, электролитическая очистка, использовать, сходное применение, замещать, дешевле, более надёжный, кроме, компьютерные схемы

VII. Read and translate text 10.2. Identify, define or explain each of the following:

1. Solid-state physics
2. Solid-state devices
3. Condensed-matter physics
4. Semiconductor
5. Germanium
6. Selenium
7. Silicon
8. Semiconductor devices
9. Transistor

TEXT 10.3. DIFFRACTION

1. Diffraction is the spreading or bending of waves as they pass through an ***aperture*** or round the edge of a ***barrier***. The diffracted waves subsequently interfere with each other (interference) producing regions of reinforcement or weakening. It was noteced first by Franceasco Grimaldi (1618-63) as accurring with light. This phenomenon gave considerable support to the wave theory of light. Diffraction also occurs with streams of particles such as electrons because of the quantum-mechanical wave nature of such particles.

2. X-ray diffraction is the diffraction of X-rays by a crystal. The ***wavelengths*** of X-rays are comparable in size to the distances between atoms in most crystals, and the repeated ***pattern*** of the crystal lattice acts like a ***diffraction grating*** for X-rays. Thus, a crystal of suitable type can be used to disperse X-rays in a spectrometer. X-ray diffraction is also the basis of X-ray crystallography. Max Theodor Felix von Laue (1879-1960) discovered in 1912 the phenomenon of X-ray diffraction, for which he was awarded the 1914 Nobel Prize for physics.

Notes:
1. aperture – апертура, отверстие
2. barrier – преграда, препятствие
3. wavelength – длина волны
4. pattern – картина, схема, структура
5. diffraction grating – дифракционная решётка

VII. Read and translate text 10.3. Identify, define or explain each of the following:

1. Diffraction
2. Discovery of diffraction
3. X-ray diffraction
4. Discovery of X-ray diffraction

VIII. Make up the abstracts of texts 10.1– 10.3 (in English or in Russian).

IX. Comment on the following quotation. Do you agree or disagree with it?

1. To determine a crystal structure on the atomic scale, one must know the phase difference between the different interference spots on the photo-

graphic plate, and this task may certainly prove to be rather difficult. (Max von Laue 1879–1960, – German physicist)

SECTION 11

TEXT 11.1. MIKHAIL LOMONOSOV

1. Mikhail Vasilyevich Lomonosov (1711-1765) was a Russian scientist, poet and grammarian who is often considered the first great Russian linguistic reformer. He also made substantial contributions to the natural sciences, reorganized the St. Petersburg Imperial Academy of Sciences, established in Moscow the university that today bears his name and created the first coloured glass mosaics in Russia.

2. Lomonosov was the son of a poor fisherman. In December 1730 he left his native village for Moscow, without money and on foot. His aim was to educate himself to join the learned men on whom the tzar Peter I the Great was calling to transform Russia into a modern nation. In order to be admitted to the Slavonic-Greek-Latin Academy he had to conceal his humble origin, and he had scarcely enough money for food and clothes. But his robust health and exceptional intelligence enabled him in five years to assimilate the eight-year course of study. During this time he taught himself Greek and read the philosophical works of antiquity.

3. In January 1736 Lomonosov became a student at the St. Petersburg Academy. Seven months later he left for Germany to study at the University of Marburg. For three years he had surveyed the Western philosophy and science. In dissertations sent to St. Petersburg, he attacked the problem of the structure of matter. In 1739, in Freiberg, Lomonosov studied the technologies of mining, metallurgy and glassmaking. Lomonosov returned in July 1741 to St. Petersburg. In 1743 he worked out the plan of work that he had already developed in Marburg. '276 Notes on Corpuscular Philosophy and Physics' set forth the dominant ideas of his scientific work.

4. Appointed a professor by the Academy in 1745, he translated Christian Wolf's 'Studies in Experimental Philosophy' into Russian and wrote in Latin important works on 'Cause of Heat and Cold' (1747), 'Elastic Force of Air' (1748) and "Theory of Elasticity' (1756). In 1748 the laboratory was granted to him. He carried out many tests and more than 4,000 experiments, the results of which enabled him to set up a colored glass works and to make mosaics with these glasses. 'Discourse on the Usefulness of Chemistry' (1751), 'Letters to I.I. Shuvalov Concerning

the Usefulness of glass” (1752) and the “Ode dedicated to the Empress Elizabeth”, celebrated his fruitful union of abstract and applied science.

5. Anxious to train students, he wrote in 1752 an introduction to the physical chemistry course. The theories on the unity of natural phenomena and the structure of matter that he set forth in the discussion on ‘Origin of Light and Colours’ (1756) and his theoretical works on electricity in 1753 and 1756 also matured in his laboratory. The universal law of nature (the law of conservation of matter and energy) with the corpuscular theory, constitutes the dominant thread in all his research. To these achievements were added the composition of ‘Russian Grammar’ and ‘Short Russian Chronicle’, and all the work of reorganizing education, to which Lomonosov accorded much importance.

6. From 1755 he followed very closely the development of Moscow University, for which he had drawn up the plans. Appointed a ***councillor*** by the Academy in 1757, he undertook reforms to make the University an intellectual centre closely linked with the life of the country. ***To that end***, he wrote several scholarly works including ‘Discussion of the Great Accuracy of the Maritime Route’ (1759), ‘Discussion of the Formation of Icebergs in the Northern Seas’ (1760), ‘A Short Account of the Various Voyages in the Northern Seas (1762-63), ‘Of the Terrestrial Strata’ (1763), which constituted an important contribution both to science and to the development of commerce and the exploitation of mineral wealth (mining).

7. Despite the honours that came to him, he continued to lead a simple and industrious life, surrounded by his family and a few friends. His prestige was considerable in Russia, and his scientific works and his role in the Academy were known abroad. He was a member of the Royal Swedish Academy of Sciences and of that of Bologna. His ‘Complete Works’ were published in Russia in 1950-83.

Notes:

1. councillor – член совета, советник
2. to that end – с этой целью

I. Find Russian equivalents for:

scientist, grammarian, natural sciences, coloured glass mosaics, to transform Russia into a modern nation, be admitted to the Academy, exceptional intelligence, to study at University, to survey the Western philosophy and science, structure of matter; technology of mining, metallurgy and steelmaking; scientific work, translate into Russian, to carry out tests and experiments, to train students, natural phenomena, carpuscular theory, development of Moscow University, lead a simple and industrious life, abroad, publish

II. Find English equivalents for:

считать (полагать), внести существенный вклад, основать университет, его цель, скрыть свое простое происхождение, крепкое здоровье, разработать план работы, назначить профессором, завод по выпуску цветного стекла, прикладная наука, написать введение, закон сохранения материи и энергии, достижения,составлять план, научные работы, разработка минеральных ресурсов, несмотря на награды (почести), значительный (большой) престиж

III. Read and translate text 6.3. Answer the following questions:

1. What was Mikhail Lomonosov?
2. What was he famous for?
3. Why did Lomonosov leave his village?
4. Where did he study?
5. Why did Lomonosov go abroad?
6. What theory was dominant in his research?
7. How did Lomonosov develop Moscow University?

IV. What do the following dates refer to:

1711, 1730, 1736, 1741, 1745, 1752, 1753-1756, 1755, 1765, 1950-83

V. Find in the text 11.1 the information to prove that:

1. M. Lomonosov was born in a poor family.
2. He studied well at Slavonic-Greek-Latin Academy.
3. M. Lomonosov studied many technologies abroad.
4. He wrote many works on heat, electricity, chemistry, light, grammar.
5. M. Lomonosov was the founder of Moscow University.
6. He wrote many scientific works.
7. His prestige and role was great in Russia and abroad.

TEXT 11.2. THE LAW OF CONSERVATION OF MASS

1. The Law of Conservation of Mass is one of the most important concepts in chemistry. The law states that matter can neither be created nor

destroyed. This means that in any chemical reaction, the mass of the reacting substances at the start of the reaction will be the same as the mass of the products at the end of the reaction. Matter can change its form in a reaction, for example from a liquid state to a gas, but the mass will remain the same.

2. The Law of Conservation of Mass is also known as the Lomonosov-Lavoisier Law because both of these scientists contributed to its development. Lomonosov first described the law in a letter to a friend and then published his ideas in a dissertation dated 1760. Lavoisier reached the same conclusions much later, in 1789, and was first to formulate the law in clear scientific terms. For this reason the law takes its name from both these brilliant men. Both men were interested in the nature of combustion – what happens when things burn – and this was the first breakthrough in our understanding of chemistry.

3. The idea of conservation of mass, however, can be traced back as far as ancient Greece. In the 5^{th} century B.C., Anaxagoras, a philosopher and scientist, said that nothing comes into existence or is destroyed and that everything is a mixture of pre-existing things. Over the course of history, many other distinguished scientists also expressed their views on the conservation of mass.

4. The dominant theory in the 18^{th} century was the phlogiston theory. According to this theory, all flammable materials (that is, materials that can burn) contain a substance called phlogiston, which is released during the burning process. That means that flammable materials burn, the new substance, without phlogiston, should weigh less than the original substance. But this theory was wrong. Experiments showed that some metals actually increased in weight when they burnt. Lomonosov's experiment in 1756 demonstrated that the increase in weight was due to air. Many years later, Lavoisier proved that oxygen was required for combustion (burning); without it, the mass of burnt matter remained the same.

5. The fact that the total amount of matter in chemical reactions is always conserved and never disappears even though the matter may be in an altered form, is not only important for science, but also for the other fields of human knowledge, particularly philosophy. It has led us to think about the nature of existence, and where we truly come from.

VI. Read and translate text 11.2. Answer the following questions:

1. What is the Law of Conservation of Mass?

2. Who is the law named after?
3. How long ago had other philosophers thought about it?
4. Which theory did it replace?
5. How was it discovered?
6. Can we create or destroy matter?

TEXT 11.3. HISTORY OF MOSCOW STATE UNIVERSITY

1. One of the oldest Russian institutions of higher education, Moscow University was established in 1755. In 1940 it was named after Academician Mikhail Lomonosov (1711-1765), an outstanding Russian scientist, who greatly contributed to the establishment of the university in Moscow.

2. Mikhail Lomonosov was one of the intellectual titans of XVIII century. The great Russian poet Alexander Pushkin described him as a person of formidable willpower and keen scientific mind, whose lifelong passion was learning. Lomonosov's interests ranged from history, rhetoric, art and poetry to mechanics, chemistry, mineralogy. His activity is a manifestation of the enormous potential of the Russian scientific ***community*** whose representatives occupied the leading positions in the world at the time. Peter I reformed Russia, which allowed the country reach the standard of the contemporary European powers in many spheres. Great importance was given to education. In 1724 the St. Petersburg Academy of Sciences, founded by Peter I, established a university and a grammar school to educate intellectuals and researchers the country needed; however, these educational establishments did not fulfill the task they took on. It was Michail Lomonosov who suggested, in his letter to Count Shuvalov, the idea of establishing a university in Moscow. An influential courtier and the favourite of Empress Elizaveta Petrovna, Count Shuvalov was the patron of the arts and science; he supported Lomonosov's plans for a new university and presented them to the Empress.

3. In 1755, on 25 January, St. Tatiana's Day according to the Russian Orthodox Church calendar, Empress Elizaveta Petrovna signed the decree that a university should be founded in Moscow. The opening ceremony took place on 26 April, when Elizaveta Petrovna's coronation day was celebrated. Since 1755, 25 January and 26 April are marked by special events and festivities at Moscow University; the annual conference where students present the results of their research work is traditionally held in April.

4. According to Lomonosov's plan, there were originally three faculties. First, all the students acquired a comprehensive knowledge in the field of science and humanities at the Faculty of Philosophy; then they could specialize and continue at the faculty of philosophy or join either the Law Faculty or the Faculty of Medicine. Lectures were delivered either in Latin, the language of educated people at the time, or in Russian. Unlike European Universities, Moscow University did not have the Faculty of Theology, since in Russia there were special theological education establishments.

5. From the very beginning elitism was alien to the very spirit of the University community, which determined Moscow University's long-standing democratic tradition. The Decree Elizaveta Petrovna signed stated in its preamble that the university was to educate commoners; only serfs were not admitted. Lomonosov himself pointed out that in European universities it was the academic achievements of a student that mattered, not his social position or family background. In the late part of XVIII century there were only three noblemen among the 26 professors at Moscow University, most of the students were commoners too. The best students were sent abroad to continue their education, establishing the contacts with the international scientific community.

6. Originally tuition at Moscow University was free for all students, later only poor students were exempt from tuition fees. The state funding did not cover all the University expenses; thus the administration had to find ways to raise additional funds. The University was partly funded by its patrons, such as the rich merchants of the Demidov and Stroganov families and some others, who donated laboratory equipment, books, various collections and established scholarships for University students. University ***alumni*** supported their alma mater through hard times raising money by public ***subscriptions***. University professors traditionally bequeathed to the University library their private book collections, the largest among them were those collected by I.M. Snegirev, P.Ya. Petrov, T.N. Granovsky, S.M. Soloviev, F.I. Buslaev, N.K. Gudzy, I.G. Petrovsky and some others.

7. Moscow University played an outstanding role in popularizing science and learning in Russia making the lectures of its professors open to the public. Book publishing in Russia started in 1756, when a printing house and a bookshop were opened in campus; printing one of the first Russian newspapers "Moskovskie Vedomosti" (Moscow Gazette) started there. The first literary periodical in Moscow "Poleznoe Uveselenie"

(Useful Entertainment) was also printed at the University printing house since 1760. N.I. Novikov, one of the outstanding figures of the Enlightenment in Russia, was at the head of the University publishers from 1779 to 1789. For over a century, since 1756, the University library was the only one opened for the general public in Moscow.

8. Professors of Moscow University greatly contributed to establishing new cultural centres in Moscow and Russia, the grammar school and later a university in Kazan. The Academy of the Fine Arts in St. Petersburg, the Maly Theatre in Moscow, to name just a few. In XIX century the first scientific societies appeared at the University, those uniting naturalists, historians and philologists.

9. XVIII century saw a number of outstanding figures among the students and professors of Moscow University: philosophers N.N. Popovsky, D.S. Anichkov, mathematicians V.K. Arshenevsky, M.I. Pankevitch, medical doctor S.Z. Zybelin, botanist P.D. Veniaminov, physicist P.I. Strakhov, soil scientists M.I. Afonin and N.E. Cherepanov; H.A. Chebotarev, historian and geographer, historian N.N. Bantysh-Kamenetsky; A.A. Barsov, S. Khalfin and E.I. Kostrov who were philologists and translators; lawyers S.E. Desnitsky and I.A.Tretiakov, well-known authors D.I. Fonvisin, M.M. Kheraskov, and N.I. Novikov, architects V.I. Bazhenov and I.E. Starov. Their works greatly contributed to Moscow University's becoming the educational, scientific and cultural centre of Russia.

Notes:

1. community – сообщество
2. alumni – бывшие питомцы (университета или школы)
3. subscription – пожертвование, взнос

VII. Read and translate text 11.3. Explain each of the following:

1. Role of Mikhail Lomonosov
2. Decree on foundation Moscow University
3. Faculties of Moscow University
4. Spirit of the University community
5. Tuition and founding
6. Role of Moscow University in popularizing science and learning in Russia
7. Role of professors of Moscow University
8. Outstanding students and professors

TEXT 11.4. PERIOD OF REFORMS AT MSU

1. Initially governed according to “The Imperial Decree on the Establishment of Moscow University”, in 1804 Moscow University was granted a ***charter*** and thus considerable independence. According to the Charter the Rector and Deans of the faculties were elected by the professors; the first Rector-elect became H.A. Chebotarev, Professor of History and Philology. The University governing body was the Board of Professors; they also awarded the academic degrees. The publications approved by the Board and printed by the University publishing house were exempt from censorship. There were four divisions within Moscow University in the early XIX century: the Department of Moral and Political Science, the Department of Physics and Mathematics, the Department of Medicine, the Department of Philology. The course of university education took three years, after final examinations the best graduates were awarded candidate’s degrees. According to the 1804 Charter the University controlled the secondary and elementary schools in the central provinces of Russia, which contributed to continuity in the programmes of educational establishments at all levels.

2. The invasion of the French Army led by Napoleon caused a wave of patriotism among the University students, many of them joined the volunteer corps in 1812. M.I. Kutuzov, who led the Russian Army, specially mentioned selfless work of the University medical professors and students. The University buildings were burned down during the French occupation, the library, archives, museum and all the equipment were destroyed. After the war it was the joint effort of all educated people in Russia that made the restoration of the University possible: books, ancient manuscripts, all kinds of collections, equipment and financial aid came from research laboratories and scientists, there were donations from private citizens too. Thus 7,500 books had been collected for the University library by 1815. In spite of the difficult conditions, the academic year at Moscow University started on 1 September, 1813; in 1820s the total number of students exceeded 500.

3. In the early XIX century Moscow University attracted free-thinking people who discussed the future of Russia. It was often a real battle of wits between the supporters of Western ideas and those who thought Russia had its own unique way of development. In 1840s public lectures, delivered by T.N. Granovsky, were attended by all Moscow intellectuals. Moscow University was a melting pot, where young people

from the various strata of the society met and overcame their social prejudices; it was at the University that the traditions of fraternity were supported and cultivated. University alumni brought the most advanced ideas with them when they left their alma mater. The work of the University publishers was not limited to only scientific publications, they were the first to publish “Sonnets” by A. Mitskevich and I.C. Turgenev’s prose.

4. Abolishing serfdom in Russia in 1861 was a turning point in the history of the country. In the history of Moscow University a period of reforms started too. The 1863 University Charter set new standards and requirements: the demand for highly qualified specialists in the field of industry, agriculture, commerce was growing; the country needed well-educated government officials, lawyers and military men. The new Charter widened the range of the subjects in the curriculum, which included more seminars and laboratory experiments. The number of professors and instructors increased. There were four divisions at the University: the Faculty of History and Philology, the Faculty of Physics and Mathematics, the Law Faculty, the Faculty of Medicine. The total number of students was commoners.

5. Professors of Moscow University greatly contributed to the development of secondary education in Russia. New textbooks for secondary schools were compiled by the University professors. University alumni very often taught at secondary schools, introducing the most advanced ideas and methods in their work. In the late XIX century Moscow University contributed to the establishment of a number of museums in Moscow, such as the Polytechnic Museum, the Historical Museum, The Zoological Museum, The Anthropological Museum, The Museum of Fine Arts, the Botanical Gardens and the Zoological Gardens.

6. The 1863 Charter of Moscow University promoted learning and facilitated the development of education in Russia. But after the assassination of Alexander II in 1881 the government restricted the rights of universities, trying to put the curriculum under their own control, nevertheless, Moscow University remained the centre of science and culture, uniting in the early XIX century such outstanding thinkers and philosophers as V.S. Soloviev, V.V. Rozanov, the Trubetskoi brothers, S.N. Bulgakov, P.A. Florensky. The democratic spirit and traditions of Moscow University manifested themselves during the first Russian revolution, in 1905-1907. The students were against the monarchy, they

demanded a republican system of government; many of them joined the fighters in the streets.

7. During the first 150 years of its history Moscow University played the leading role in the development of science and humanities in Russia, being the centre of learning and research. In the late XIX century and early XX century quite a number of Russian scientists and scholars worked there, among them *mathematicians*: N.D. Brashman, N.E. Zhukovsky, N.V. Bugaev, C.A. Chaplygin; *physicists and astronomers:* A.G. Stoletov, F.A. Bredikhin, A.A. Belopolsky, N.A. Umov, P.N. Lebedev, P.K. Sternberg; *chemists*: V.V. Markovnikov, V.F. Luginin, I.A. Kablukov, N.D. Zelinsky, *biologists and soil scientists:* K.F. Rulie, A.I. Filomafitsky, I.M. Setchenov, K.A. Timiryazev, A.N. Severtsov, M.A. Menzbir, A.N. Sabanin, D.N. Pryanishnikov; *medical doctors*: M.Ya. Mudrov, F.I. Inozemtsev, N.V. Sklifosovsky, G.A. Zakharin, A.A. Ostroumov, N.V. Filatov, F.F. Erisman, V.F. Snegirev; *georgapher and anthropologist* D.N. Anutchin; *geologists:* G.Ye. Schurovsky, V.O. Kovalevsky, A.P. Pavlov; *geochemist:* V.I. Vernadsky; *historians:* T.G. Granovsky, N.I. Nadezhdin, M.T. Kachenovsky, M.P. Pogodin, I.D.Belyaev, S.M. Soloviev, V.O. Klyuchevsky, V.I.Gerie, N.A. Rozhkov, M.N. Pokrovsky, Yu.V. Gotie; *philologists:* N.S. Tikhonravov, F.I. Buslaev, N.I. Storozhenko, F.F. Fortunatov, F.Ye. Korsh, V.F. Miller, S.K. Shambinago, M.N. Speransky, M.M. Pokrovsky, V.N. Schepkin; *lawyers:* B.N. Chicherin, K.D. Kavelin, M.M. Kovalevsky, P.I. Novgorodtsev; *economists*: I.K. Babst, A.I. Chuprov, I.I. Yanzhul; *philosophers*: Ye.N. and C.N. Trubetskoi and many others.

Notes:

1. charter – хартия, грамота, устав

VIII. Read and translate text 11.4. Explain each of the following:

1. The Charter of Moscow University
2. Patriotism of professors and students
3. Free-thinking people
4. New standards and requirements in University Charter
5. Contribution to the development of secondary education in Russia
6. Russian scientists and scholars

TEXT 11.5. MSU AFTER 1917

1. The Russian revolution of 1917 changed the whole system of higher education. On the one hand, it became more democratic, in the sense that students did not have to pay tuition fees and all of them received grants. In 1919 a preparatory department for young people from the working class was opened at Moscow University. Since 1919 the University was fully financed by the state. Quite a number of well-known scientists worked at the University; at the same time, many others found it difficult to accept the new situation and left. A destructive effect was produced by the attempts to reorganize the University, making some faculties or departments into separate educational institutions for the sake of training more students. University professors compiled new secondary school textbooks and manuals for university students. In 1934 doctoral dissertations were defended at Moscow University for the first time after 1917. By 1941 the total number of full-time students at Moscow University had grown to 5000. Over 30 professors became full members of the Academy of Sciences of the USSR.

2. The political repressions of the 1930s and 1950s negatively affected the development of scientific ideas, as Soviet scientists had virtually no contacts with their colleagues abroad, while certain branches of science were condemned as based on the ideology alien to Communist ideas, and a number of scientists and scholars were sentenced for life imprisonment. The Great Patriotic War against Fascism was one of the most difficult periods in the history of Russia. The first group of University students and staff joined the army on the third day of fighting. One of the divisions formed out of University volunteers fought heroically defending Moscow.

3. Moscow University professors, students and staff were evacuated during the war first to Ashkhabad (Turkmenia) then to Sverdlovsk, returning to Moscow in 1943, after the German troops were defeated near the capital. During the war over 3000 specialists were trained at the University; the University scientists continued their research; their contributions to ***applied science*** allowed improvements in aircraft development, in the accuracy of artillery fire etc. New explosives were invented, a study of uranium was carried out, a preparation causing blood ***coagulation*** was introduced into practice; University geologists discovered a tungsten deposit in Central Asia and new oil wells, University geographers supplied the Red Army with maps and charts. University scholars popularized the ideas of patriotism, and University lawyers made their contribution during

the Nurenberg and Tokyo trials. Over 5000 University students, instructors, professors and staff fought in the war, over 1000 were decorated for their heroism, seven became Heroes of the Soviet Union. In 1975 a memorial was erected in campus to honour over 3000 people Moscow University lost during the war.

4. During the post-war period the leading role of Moscow University in the restoration and further development of the country was fully recognized. There was a fivefold increase in the state funding, the new University campus was built on Vorobievy Gory (Sparrow Hills), where all the lecture halls and laboratories had the latest equipment available at the time. Newly established University divisions included the Institute of Asian and African Languages, the Faculty of Psychology, the Faculty of Computing, Mathematics and Cybernetics and the Faculty of ***Soil Science***. A few problem-dedicated scientific laboratories and a computer centre appeared during the same period. The total number of full-time students was constantly growing; thus, it rose from 13,000 in 1953 to 31,000 in 2001. At the same time Moscow University became an international educational centre, with the Faculty of the Russian Language which has been teaching international students since 1959.

5. In XX century quite a number of renowned scientists and scholars worked at Moscow University, among them *mathematicians:* P.S. Alexandrov, V.V. Golubev, D.F. Yegorov, M.V. Keldysh, A.N. Kolmogorov, N.N.Luzin, I.G. Petrovsky, I.I. Privalov, V.V. Stepanov, O.Yu. Shmidt; *physicists*: V.K. Arkadiev, L.A. Artsimovitch, N.N. Bogoliubov, S.I.Vavilov, V.I.Vexler, A.A.Vlasov, P.L. Kapitsa, I.V. Kurchatov, L.D. Landau, G.S. Landsberg, Ya.B. Zeldovitch, A.S. Predvoditelev, D.V. Skobeltsin, I.E. Tamm, R.V. Khokhlov; *chemists*: A.A. Balandin, I.V. Berezin, S.I. Volfkovitch, Ya.I. Gerasimov, B.A. Kazansky, V.A. Kargin, A.N. Nesmeyanov, A.V. Novoselova, P.I. Rebinder, N.N. Semenov, A.N. Frumkin, N.M. Emanuel; *geographers*: N.N. Baransky, A.A. Borzov, K.K. Markov, V.N. Sukachev, I.S. Schukin; *geologists*: A.D. Arkhangelsky, N.V. Belov, A.A. Bogdanov, A.P. Vinogradov, Yu.A. Oriole, M.M. Flattop, *biologists* and *soil scientists:* A.N. Belozersky, D.G. Vilensky, L.A. Zenkevitch, N.K. Koltsov, G.V. Nikolsky, A.I. Oparin, N.P. Remezov; *historians*: A.V. Artsikhovsky, B.D. Grekov, A.A. Guber, N.M. Druzhinin, N.I. Konrad, M.V. Netchkina, A.M. Pankratova, S.D. Skazkin, M.N. Tikhomirov, L.V.Cherepnin; *art critics:* V.N. Lazarev, A.A. Fedorov - Davidov; *philologists*: D.D. Blagoi, S.M. Bondi, V.V. Vinogradov, N.K. Gudzi, R.M.Samarin, D.N.Ushakov; *philosophers:* V.F. Asmus, V.P. Vol-

gin, G.Ye. Glezerman, E.B. Ilienkov, B.M. Kedrov; *lawyers*: M.N. Gernet, P.Ye. Orlovsky, A.N. Trainin, *psychologists*: A.N. Leontiev, A.R. Luria, S.L. Rubinshtein; *economists*: L.Ya. Berri, A.Ya. Boyarsky, V.S. Nemchinov, K.V. Ostrovitianov, S.K. Tatur, N.A. Tsagolov and many others.

6. Since 1917 over 180,000 specialists have graduated from Moscow University and about 35,000 have been awarded doctoral degrees, which confirms the position of Moscow University as a leading centre of learning and science in this country. In June 1992 the President of the Russian Federation issued a decree, which established the status of Moscow University as a self-governing institution of higher education. In November 1998, after a wide-ranging discussion, the Charter of Moscow University was approved. The Charter proclaims democracy, openness and self-government to be the main principles in the life of Moscow University; the main goal is freedom to teach and to study as well as to develop oneself as a personality. The basic division within the University is a department (laboratory) whose professors, instructors and staff make decisions collectively.

Notes:

1. applied science – прикладная наука
2. coagulation – коагуляция, свёртывание
3. soil science – почвоведение

IX. Read and translate text 11.5. Characterize the following:

1. Changing of system of higher education in Russia
2. Negative effect of political repressions
3. Moscow University during the Great Patriotic War (1941)
4. Role of Moscow University in restoration and further development of Russia
5. Well-known scientists and scholars
6. Status and Charter of Moscow State University

TEXT 11.6. MODERN ACHIEVEMENTS OF MSU

1. Moscow State University is a major traditional educational institution in Russia, it offers training in almost all branches of modern science and humanities. Its undergraduates may choose one of 57 qualifications, while doctoral students may specialize in 168 different areas. The total number of MSU students exceeds 40,000; besides, about

10,000 high school students attend various clubs and courses at MSU. MSU is a centre of research science famous for its major scientific schools. There have been 11 Nobel Prize winners among its professors and alumni, out of 18 Russians who have received the prestigious prize so far. Many MSU scientists have been awarded various Soviet and Russian prizes for their achievements, among them 60 Lenin Prizes and 120 State Prizes. Among those who teach at MSU there are higher doctoral degree holders, full professors and associate professors, full members and correspondent members of the Russian Academy of Sciences. Scientists and scholars are involved in research projects in various fields.

2. Moscow State University comprises 29 faculties and over 350 departments, 15 research institutes, 4 museums, the Science Park, the Botanical Gardens, The Library, the University Publishing House and printing shop, a recreational centre and a boarding school for talented children. 9 faculties have been recently established, along with 47 new departments and 22 research laboratories. Research has recently started in 30 new interdisciplinary areas. The University Computer Centre represents more computing power than any other educational institution in Russia. There have been major changes in the curricula, with over 200 new academic programmes added. The first Russian Science Park appeared at MSU and it unites about 2,000 scientists who work to make scientific achievements into technological innovations.

3. From the engineering and operational point of view Moscow University campus, with its 1,000 buildings and structures, 8 dormitories and 300 km of utility lines, is an extremely complex system. Nevertheless, this system is being modernized and developed. According to the plan, approved by the government, a number of new buildings are to be erected in the area adjacent to the campus on Vorobievy Gory. There will be new blocks for a few faculties and research laboratories, a library, a swimming pool, a stadium, a recreation centre, some services. The University clinic and the Main Library Building were built and opened in January, 2005.

4. The University’s scientific potential creates a unique opportunity for interdisciplinary research and pioneering work in various branches of science. The recent years have been marked by achievements in the fields of high-energy physics, superconductivity, laser technology, mathematics and mechanics, renewable energy sources, biochemistry and biotechnology. In humanities new problems arise while studying various aspects of sociology, economics, history, psychology, philosophy and the history

of culture. On average 800 doctoral and 200 higher doctoral degrees in various fields of science and humanities are awarded at MSU every year.

5. As training highly qualified specialists has always been the main goal, the faculties and departments constantly revise their curricula and introduce new programmes. The stress is on student’s ability to work independently and meet employer’s requirements. In the curricula for science faculties more classes in the humanities have been included. The University offers individual programmes combining classes at different faculties.

6. The curricula of all MSU faculties are based on the combination of academic instruction with students’ research work and the combination of thorough theoretical knowledge with special skills. Having acquired theoretical knowledge in the first and the second year, undergraduates choose an area to specialize in. At the same time they choose a field for their independent research work, joining special seminars; the results of research are usually presented at the meetings of students’ scientific societies or at scientific conferences, the most interesting results are published. At the end of the final semester the results of each student's independent research are submitted in the form of final paper, which is publicly presented by the student at the meeting of the department.

7. According to the MSU Charter, The MSU Student Board is a form of student government, coordinating various aspects of campus life and activities.MSU has a long-standing tradition as a centre of retraining admitting up to 5,000 students a year. Highly-qualified professionals update themselves on the latest achievements in various fields of science and humanities, choosing special programmes at one of MSU faculties.

8. MSU collaborates with the International Association of Universities and has links with about 60 educational institutions, centres and unions in Europe, the USA, Japan, China and some other Asian countries, in Australia, Latin America, Arab countries. Since 1946, when the first international students were admitted, over 11,000 highly qualified specialists from 150 countries have graduated from MSU.

Moscow University has well-established contacts with the most distinguished universities in the world, exchanging students and lecturers with the leading universities abroad. Moscow University houses the UNESCO Hydrology Courses, the International Biotechnology Centre, the International LASER Centre, courses and seminars on Russian as a foreign language. In 1991 the French University College, the Russian-American University, the Institute of German Science and Culture were opened. In

January 2010 Lomonosov Moscow State University celebrated its 255th anniversary.

X. Read and translate text 11.6. Explain each of the following:

1. MSU is a centre of education and research
2. Structure of MSU (faculties, departments, etc)
3. University campus
4. Scientific potential in interdisciplinary research
5. Curricula and new programmes
6. International links and contacts

XIII. Make up the abstracts of texts 11.1– 11.6 (in English or in Russian).

IX. Comment on the following quotations. Do you agree or disagree with them?

1. Nature uncovers the inner secrets of nature in two ways: one by the force of bodies operating it, the others by the very movements of its innards. The external actions are strong winds, rains, river currents, sea waves, ice, forest fires, floods; there is only one internal force – earthquake. (Mikhail Vasilievich Lomonosov, 1711–1765. – Russian chemist, physicist and poet)
2. Science is public, not private, knowledge. (Robert King Merton, 1910–2003. – American sociologist)
3. Ask not what your country can do for you – ask what you can do for your country. (John Fitzgerad Kennedy, 1917-1963. – American President)

SECTION 12

TEXT 12.1. HENDRIK LORENTZ

1. Hendrik Lorentz (1853-1922) was a Dutch physicist and joint winner (with Pieter Zeeman) of the Nobel Prize for Physics in 1902 for his theory of electromagnetic radiation, which confirmed by findings of Zeeman, gave rise to Albert Einstein's special theory of relativity.

2. Lorentz was appointed professor of mathematical physics at Leaden University in 1878. In his doctoral thesis (1875) he refined the electromagnetic theory of James C. Maxwell of England so that it more satisfactorily explained the reflection and refraction of light. Although his

work in physics was wide in scope, his central aim was to construct a single theory to explain the relationship of electricity, magnetism and light. According to Maxwell's theory, electromagnetic radiation is produced by the ***oscillation*** of electric charges, the charges that produce light were unknown. Lorentz later theorized that the atoms of matter might also consist of charged particles and suggested that the oscillations of these charged particles inside the atom were the source of light. If this were true, then a strong magnetic field ought to have an effect on the oscillations and therefore on the wavelength of the light thus produced.

3. In 1896 Zeeman, a pupil of Lorentz, demonstrated this phenomenon, known as the Zeeman effect, and in 1902 they were awarded the Nobel Prize for their efforts. Lorents introduced in 1895 the idea of local time (different time rates in different locations). Influenced by the proposal of George F. Fitzgerald of Ireland that moving bodies approaching the velocity of light contract in the direction of motion, Lorentz extended his idea in 1904 and arrived at the Lorentz transformations. These transformations are mathematical formulas that describe the increase of mass, shortening of length and ***dilation*** of time that are characteristic of a moving body and form the basis of Einstein's special theory of relatively.

4. In 1912 Lorentz became director of research at the Teyler Institute (Haarlem) though he remained honorary professor at Leiden, where he gave weekly lectures.

Notes:
1. oscillation – колебание, осцилляция
2. dilation – расширение

I. Find Russian equivalents for:

Dutch physicist, the Nobel Prize for Physics, theory of electromagnetic radiation, special theory of relativity, mathematical physics, doctoral thesis, reflection and refraction of light, his central aim, oscillation of electric charges, atoms of matter, charged particles, source of light, strong magnetic field, wavelength of the light, demonstrated this phenomenon, local time, velocity of light, transformations, describe, moving body

II. Find English equivalents for:

подтверждать (подкреплять) полученными данными, вызывать (приводить к), назначать профессором, доработать электромагнитную теорию, объяснять взаимосвязь (зависимость) электричества, магнетизма и света; состоять из, представлять идею, направление движения, увеличение массы, расширение времени, научное исследование

III. Read and translate text 12.1. Answer the following questions:

1. What was Hendrik Lorents?
2. What was he famous for?
3. Where did he work?
4. What was his central aim of research?
5. What did Lorents theorize?
6. What effect did his pupil demonstrate?
7. What are Lorents transformations?

IV. What do the following dates refer to:

1853, 1875, 1878, 1895, 1896, 1902, 1904, 1912, 1922

TEXT 12.2. PIETER ZEEMAN

1. Pieter Zeeman (1865-1943) was a Dutch physicist, joint winner, with Hendrik A. Lorentz, also of the Netherlands, of the Nobel Prize for physics in 1902 for his discovery of the Zeeman effect.

2. Zeeman, who had been a student of Lorentz at the University of Leiden, began lecturing at Leiden in 1890. Six years later, at the suggestion of Lorentz, he investigated the effect of magnetic fields on a source of light and found that each of the lines in the spectrum emitted light into several lines, this became known as the Zeeman effect. Zeeman was appointed professor of physics at the University of Amsterdam in 1900 and director of its Physical Institute in 1908. Remaining there until his death, he conducted research on the propagation of light in moving media, such as water, quartz, and light.

V. Read and translate text 12.2. Answer the following questions:

1. What was P. Zeeman?
2. What was he famous for?
3. Where did he study?
4. What did Zeeman investigate?
5. What did he find?
6. Where did he work?
7. What research did he conduct?

TEXT 12.2. ZEEMAN EFFECT

1. Zeeman effect, in physics and astronomy, is the splitting of a spectral line into two or more components of slightly different frequency when the light source is placed in a magnetic field. It was first observed in 1896 by the Dutch physicist Pieter Zeeman as a broadening of the yellow D-line of sodium in a flame held between strong magnetic poles. Later the broadening was found to be a distinct splitting of spectral lines into as many as 15 components.

2. Zeeman's discovery earned him 1902 Nobel Prize for Physics, which he shared with a former teacher, Hendrik Lorentz, another Dutch physicist. Lorentz, who had earlier developed a theory concerning the effect of magnetism on light, hypothesized that the oscillations of electrons inside an atom produce light and that a magnetic field would affect oscillations and thereby the frequency of the light emitted. This theory was confirmed by Zeeman's research and later modified by quantum mechanics, according to which spectral lines of light are emitted when electrons change from one discrete energy level to another. Each of the levels, characterized by an angular momentum (quantity related to mass and ***spin***), is split in a magnetic field into substrates of equal energy. These substrates of energy are revealed by the resulting ***patterns*** of spectral line components.

3. The Zeeman effect has helped physicists determine the energy levels in atom and identify them in terms of angular moment. It also provides an effective means of studying atomic nuclei and such phenomena as electron paramagnetic resonance. In astronomy, the Zeeman effect is used in measuring the magnetic field of the Sun and of other stars.

Notes:
1. spin – спин, вращение
2. pattern – рисунок, картина, характеристика, структура

X. Read and translate text 12.3. Identify, define or explain each of the following:

1. Zeeman effect 2. Its discovery 3. Application of Zeeman effect

TEXT 12.4. ELECTROMAGNETIC RADIATION

1. Electromagnetic radiation is energy resulting from the acceleration of electric charge and ***associated*** electric fields and magnetic fields. The

energy can be regarded as waves propagated through space (requiring no supporting medium) involving oscillating electric and magnetic fields at right angles to each other and to the direction of propagation. In a vacuum the waves travel with a constant speed (the speed of light) of 2.9979 x 10^9 metres per second, if material is present they are slower.

2. Alternatively, the energy can be regarded as a stream of photons travelling at the speed of light, each photon having an energy hc/λ, where h is the Planck constant, c is the speed of light, and λ is the wavelength of the associated wave. The characteristics of the radiation depend on its wavelength.

3. Electromagnetic spectrum is the range of wavelengths over which electromagnetic radiation extends. The longest are infrared waves (10^{-3}-10^{-6} m), then comes the narrow band (4^{-7} x 10^{-7} m) of visible light, followed by ultraviolet waves (10^{-7}-10^{-9} m), X-rays (10^{-9}-10^{-11} m) and gamma rays (10^{-11}-10^{-14} m).

Notes:

1. associated – взаимодействующий, связанный

VII. Read and translate text 12.4. Identify, define or explain each of the following:

1. Electromagnetic radiation
2. Energy
3. Speed of waves
4. Electromagnetic spectrum
5. Wavelength

XIII. Make up the abstracts of texts 12.1–12.4 (in English or in Russian).

IX. Comment on the following quotation. Do you agree or disagree with it?

1. Science contributes to our culture in many ways, as a creative intellectual activity in its own right, as the light which has served to illuminate man's place in the Universe, and as the source of understanding of man's own nature. (John Fitzgerald Kennedy 1917–1963, – American President)

SECTION 13

TEXT 13.1. ERNST MACH

1. Ernst Mach (1838-1916) was an Austrian physicist and philosopher who established important principles of optics, mechanics and wave dynamics and who supported the view that all knowledge is a conceptual organization of the data of ***sensory experience*** (or observation).

2. Mach was educated at home until the age of 14, then went briefly to gymnasium (high school) before entering the University of Vienna at 17. He received his doctorate in physics in 1860 and taught mechanics and physics in Vienna until 1864, when he became professor of mathematics at the University of Graz. Mach's interests had already begun to turn to the physiology and physiology of sensation, although he continued to identify himself as a physicist and conduct physical research throughout his career.

3. Mach left Graz to become professor of experimental physics at the Charles University in Prague in 1867, remaining there for the next 28 years. There he conducted studies on kinesthetic sensation, the feeling associated with movement and acceleration. Between 1873 and 1893 he developed optical and photographic techniques for the measurement of sound waves and wave propagation. In 1887 he established the principles of supersonics and the ***Mach number*** – the ratio of the velocity of an object to the velocity of sound.

4. In 'Contributions to the Analysis of the Sensations' (1897), Mach advanced the concept that all knowledge is derived from sensation, thus, phenomena under scientific investigation can be understood only in terms of experiences, or 'sensations', present in the observation of the phenomena. This view leads to the position that no statement in natural science is admissible unless it is empirically ***verifiable***. Mach's exceptionally rigorous criteria of verifiability led him to reject such metaphysical concepts as absolute time and space, and prepared the way for the Einstein relativity theory.

5. Mach also proposed the physical principle, known as Mach's principle, that inertia results from a relationship of that object with all the rest of the matter in the universe. Inertia, Match argued, applies only as a function of the interaction between the body and other bodies in the universe, even at enormous distances. Mach returned to the University of Vienna as professor of inductive philosophy in 1895, but he suffered a stroke two years later and retired from active research in 1901, when he was appointed to the Austrian parliament. He continued to lecture and

write in retirement, publishing 'Knowledge and Error' in 1905 and autobiography in 1910.

Notes:

1. sensory experience – чувственный опыт
2. Mach number – число Маха
3. verifiable – поддающийся проверке, неголословный

I. Find Russian equivalents for:

Austrian physicist and philosopher, optics, mechanics, wave dynamics, knowledge, data, observation, teach mechanics and physics, to conduct physical research, professor of experimental physics, movement and acceleration, develop optical and photographic techniques, measurement of sound waves, natural science, velocity of sound, interaction

II. Find English equivalents for:

создавать важные принципы, поддерживать точку зрения, поступить в университет, оставаться, распространение волны, принципы сверхзвуковых перемещений, исследуемые явления, допустимый, отношение (состояние), отставка, публиковать

III. Read and translate text 13.1. Answer the following questions:

1. What was Ernst Mach?
2. What was he famous for?
3. Where did E. Mach study?
4. Where did he work?
5. What techniques did Mach develop?
6. What principle did he propose?
7. Why did Mach retire from active research?

IV. What do the following dates refer to:

1838, 1860, 1864, 1867, 1873-1893, 1887, 1895, 1901,1905, 1910, 1916

TEXT 13.2. MACH NUMBER

1. Mach number in ***fluid mechanics*** is ratio of the velocity of a fluid to the velocity of sound in that ***fluid***, named after Ernst Mach (1838-1916), an Austrian physicist and philosopher. In the case of an object moving through a fluid, such as an aircraft in flight, the Mach number is equal to the velocity of the object relative to the fluid divided by the velocity of sound in that fluid.

2. If the Mach number is below 1, then the speed is ***subsonic***; above 1 is ***supersonic***, and as an aircraft increases its speed to go over Mach 1, it is said to break the sound barrier. ***Hypersonic*** is when speeds are in excess of Mach 5. Most airliners travel subsonically but Concorde flies at Mach 2. Certain military planes reach over Mach 3.

3. Fluid flow, in addition, is classified as compressible or incompressible on the basis of the Mach number. For example, gas flowing with a Mach number of less than three-tenths may be considered incompressible, or constant density. For higher Mach numbers, compressibility must be considered, as in aircraft flight, spacecraft reentry, and ***jet***-and rocket-***propulsion*** systems.

4. The noise associated with breaking the sound barrier is a sonic boom. A subsonic aircraft produces pressure waves in front of itself and these waves travel at the speed of sound. A supersonic aircraft overtakes the pressure waves, creating a shock waves like a cone with the print of the cone at the noise of the aircraft. The shock wave creates a typical ***double bang*** that can be strong enough to damage buildings.

Notes:
1. fluid mechanics – механика жидкостей и газов
2. fluid – жидкость, газ
3. subsonic – дозвуковой
4. supersonic – сверхзвуковой
5. hypersonic – сверхзвуковой
6. jet propulsion – реактивное движение, реактивный двигатель
7. double bang – двойной звук (шум)

V. Read and translate text 13.2. Identify, define or explain each of the following:

1. Mach number
2. Subsonic speed
3. Supersonic speed
4. Hypersonic speed
5. Speed of airliners and military planes
6. Fluid flow
7. Sonic boom
8. Pressure waves
9. Shock waves

TEXT 13.3. LAWS, THEORIES AND HYPOTHESES

1. In science, a law is a descriptive principle of nature that holds in all circumstances covered by the ***wording*** of the law. ***Eponimous*** laws are

named after their discoveries (Bole's law); some laws, however, are known by their subject matter (the law of conservation of mass), while other laws use both the name of the discoverer and the ***subject matter*** describe them (Newton's law of gravitation).

2. A description of nature that encompasses more than one law but has not achieved the ***uncontrovertible*** status of a law is sometimes called a theory. Theories are often both eponymous and descriptive of the subject matter (Einstein's theory of relativity).

3. A hypothesis is a theory or law that ***retains the suggestion*** that it may not be universally true. However, some hypotheses about which no doubt still lingers have remained hypotheses (Avogadro's hypotheses), for no clear reason. Clearly there is a degree of overlap between the three concepts.

Notes:
1. wording – текст, сообщение, формулировка
2. eponimous – дающий чему-либо свое имя
3. subject matter – сущность, содержание
4. uncontrovertible – неоспоримый
5. retain the suggestion – поддерживать (сохранять) предположение (намёк)

VI. Read and translate text 13.3. Characterize the following:

1. Law
2. Eponimous laws
3. Theory
4. Hypotheses
5. Importance of laws, theories and hypotheses

VII. Make up the abstracts of texts 13.1–13.3 (in English or in Russian).

VIII. Comment on the following quotations. Do you agree or disagree with them?

1. Physics is experience, arranged in economical order. (Ernst Mach 1838 – 1916, – German physicist, physiologist and psychologist)
2. Thought experiment is in any case a necessary precondition for physical experiment. Every experimenter and inventor must have the planned arrangement in his head before translating it into fact. (Ernst Mach 1838 –1916)

SECTION 14

TEXT 14.1. GUGLIELMO MARCONI

1. Guglielmo Marconi (1874-1937) was Italian physicist and inventor of a successful system of radio telegraphy (1896). In 1909 he received the Nobel Prize for Physics. He later worked on the development of shortwave wireless communication, which constitutes the basis of nearly all modern long-distance radio.

2. Marconi's father was Italian and his mother – Irish. Educated first in Bologna later in Florence, Marconi then went to the technical school in Leghorn, where, in studying physics, he had every opportunity for investigating electromagnetic wave technique, following the earlier mathematical work of James Clerk Maxwell and the experiments of Heinrich Hertz, who first produced and transmitted radio waves, and Sir Oliver Lodge, who conducted research on lightning and electricity.

3. In 1894 Marconi began experimenting at his father's estate near Bologna, using comparatively ***crude*** apparatus: an induction coil for increasing voltages, with a ***spark discharger*** controlled by a ***Morse key*** at the sending end and a simple ***coherer*** (a device designed to detect radio waves) at the receiver. After preliminary experiments over a short distance, he first improved the coherer; then, by systematic tests, he showed that the range of signaling was increased by using a vertical aerial with a metal plate or cylinder at the top of a pole connected to a similar plate on the ground. The range of signaling was thus increased to about 2.4 km (1.5 miles), enough to convince Marconi of the potentialities of this new system of communication. During this period, he also conducted simple experiments with reflectors around the aerial to concentrate the radiated electrical energy into a beam instead of spreading it in all directions.

4. Receiving little encouragement to continue his experiments in Italy, he went, in 1896, to London, where he was soon assisted by Sir William Preece, the chief engineer of the post office. Marconi filed his first patent in England in June 1896 and, during that and the following year, gave a series of successful demonstrations, in some of which he used balloons and kites to obtain greater height for his aerials. He was able to send signals over distances of up to 6.4 km on the Salisbury Plain and to nearly 14.5 km across the Bristol Channel. These tests, together with Preece's lectures on them, attracted considerable publicity both in England and abroad, and in June 1897 Marconi went to La Spezia, where a land

station was erected and communication was established with Italian warships at distances of up to 19 km.

5. There remained much skepticism about the useful application of this means of communication and a lack of interest in its exploitation. But Marconi's cousin Jameson Davis, a practicing engineer, financed his patent and helped in the formation of the Wireless Telegraph and Signal Company, Ltd. (changed in 1900 to Marconi's Wireless Telegraph Company, Ltd). During the first years, the company's efforts were devoted chiefly to showing the full possibilities of radiotelegraph. A further step was taken in 1899 when a wireless station was established at South Foreland (England) for communicating with Wimereux in France, a distance of 50 km; in the same year British battleships exchanged at 121 km.

6. In September 1899, Marconi equipped two U.S. ships to report to newspapers in New York City the progress of the yacht race for the America's Cup. The success of this demonstration aroused worldwide excitement and led to the formation of the American Marconi Company. The following year the Marconi International Marine Communication Company, Ltd., was established for the purpose of installing and operating services between ships and land stations. In 1900 Marconi filed his famous patent No.7777 for Improvements in Apparatus for Wireless Telegraphy. The patent, based in part on earlier work in wireless telegraphy by Sir Oliver Lodge, enabled several stations to operate on different wave lengths without interference. (In 1943 the U.S. Supreme Court overturned patent No.7777, indicating that Lodge, Nikola Tesla and John Stone appeared to have priority in the development of radio-tuning apparatus).

Notes:

1. crude – неразработанный, непродуманный, предварительный
2. spark discharger – искровой разрядник
3. Morse key – ключ Морзе
4. coherer – соединитель, когéрер

I. Find Russian equivalents for:

Italian physicist and inventor, system of radio telegraphy, receive the Nobel Prize for Physics, shortwave wireless communication, long-distance radio, to study physics, transmit radio waves, induction coil for increasing voltage, design, experiments over a short distance, vertical aerial, beam, to assist, to obtain greater height, up to, abroad, useful application, to equip, formation of company, Improvements in Apparatus for Wireless Telegraphy, priority in the development

II. Find English equivalents for:

развитие, возможность для исследования, метод (способ), проводить исследования, прибор для обнаружения радио волн, усовершенствовать, диапазон, распространять во всех направлениях, ободрение (поощрение), зарегистрировать патент, посылать сигналы на расстояние, установить связь с военным кораблем, с целью установки, работать без помех, радиоуправляемые приборы

III. Read and translate text 14.1. Answer the following questions:

1. What was G. Marconi?
2. What was he famous for?
3. What can you say about his parents?
4. Where did he study?
5. Why did Marconi go to England?
6. Why did his cousin finance his patent?
7. What helped Marconi attract interest to his work?
8. What famous patent did he file?

IV. What do the following dates refer to:

1874, 1894, 1896, 1897, 1899, 1900

V. Find in text 14.1 the information to prove that:

1. Marconi was acquanted with works of English and German scientists.
2. Marconi filed his first patent abroad.
3. Marconi's work failed to interest the public.
4. The Marconi International Marine Communication Company was established for a definite purpose.
5. Marconi's priority of radio-tuning apparatus was disputed.

TEXT 14.2. MARCONI'S MAJOR DISCOVERIES AND INNOVATIONS

1. Marconi's great triumph was, however, yet to come. In spite of the opinion expressed by some distinguished mathematicians that the curvature of the Earth would limit practical communication by means of electric waves to a distance of 161-322 km, Marconi succeeded in December 1901

in receiving at St. John's (Newfoundland) signals transmitted across the Atlantic Ocean from Poldhu in Cornwall, England. This achievement created an immense sensation in every part of the civilized world, and it was the starting point of the vast development of radio communications, broadcasting and navigation services that took place in the next 50 years, in much of which Marconi himself continued to play an important part.

2. During a voyage on the U.S. liner Philadelphia in 1902, Marconi received messages from distances of 1,125 km (700 miles) by day and 3,200 km (2,000 miles) by night. He thus was the first to discover that, because some radio waves travel by reflection from the upper regions of the atmosphere, transmission conditions are sometimes more favourable at night than during the day. This circumstance is due to the fact that the upward travel of these waves is limited in the daytime by absorption in the lower atmosphere, which becomes ionized – and so electrically conducting – under the influence of sunlight.

3. In 1902 also, Marconi patented the magnetic detector in which the magnetization in a moving ***band*** of iron wires is changed by the arrival of a signal causing a click in the telephone receiver connected to it. During the ensuing three years he also developed and patented the horizontal directional aerial. Both of these devices improved the efficiency of the communication system. In 1910 he received messages at Buenos Aires from Clifden in Ireland over a distance of approximately 9,650 km (6,000 miles), using a wavelength of about 8,000 m (about 5 miles). Two years later, Marconi introduced further innovations that so improved transmission and reception that important long-distance stations could be established. This increased efficiency allowed Marconi to send the first radio message from England to Australia in September 1918.

4. In 1916, during World War I, Marconi saw the possible advantages of shorter wavelengths that would permit the use of reflectors around the aerial, thus minimizing the ***interception*** of transmitted signals by the enemy and also effecting an increase in signal strength. After tests in Italy, Marconi continued the work in Great Britain and, a wavelength of 15 m (49 feet), received signals over a range of 30-160 km (200-100 miles). In 1923 the experiments were continued on board his steam yacht 'Electra', which had been specially equipped. From a transmitter of 1 kilowatt at Poldhu, Cornwall, signals were received at a distance of 2.250 km (1,400 miles). These signals were much louder and with 100 times the power at the transmitter.

5. Thus began the development of shortwave wireless communications that, with the use of the ***beam aerial*** system for concentrating the energy in the desired direction, is the basis of most modern long-distance radio communication. In 1924 the Marconi company obtained a contract from the post office to establish shortwave communication between England and the countries of the British Commonwealth.

6. A few years later Marconi returned to the study of still shorter waves of about 0.5 m (1.6 feet). At these very short wavelengths a parabolic reflector of moderate size gives a considerable increase in power in the desired direction. Experiments conducted off the coast of Italy on the yacht Electra soon showed that useful ranges of communication could be achieved with low-powered transmitters. In 1932, using very short wave-lengths, Marconi installed a radiotelephone system between Vatican City and the pope's palace at Castel Gandolfo. In later work Marconi once more demonstrated that even radio waves as short as 55 cm (22 inches) are not limited in range to the horizon or to optical distance between transmitter and receiver.

7. Marconi received many honours and several honorary degrees. He was awarded the Nobel Prize for Physics (1909) for the development of wireless telegraphy; sent as ***plenipotentiary*** delegate to the peace conference in Paris (1919), in which capacity he signed the peace treaties with Austria and with Bulgaria; created marches and nominated to the Italian senate (1929); and chosen president of the Italian Academy (1930).

Notes:
1. band – полоска-указатель
2. interception – перехват, преграда
3. beam aerial – лучевая антенна (остронаправленная)
4. plenipotentiary – полномочный

VI. Find Russian equivalents for:

curvature of the Earth, distance, transmit, vast development of radio communication, play an important part, upper regions of atmosphere, upward travel of waves, magnitization, a click in telephone receiver, horizontal directional aerial, introduce further innovations, increase in signal strength, short wavelength, obtain a contract, low-powered transmitters, install, peace conference

VII. Find English equivalents for:

получать сигналы, ограничивать осуществимую связь, достижения, происходить (иметь место), получать сообщения, условия передачи благоприятные ночью, благодаря тому факту, поглощение в нижней части атмосферы, под влиянием солнечного света, железная проволока, улучшать эффективность (к.п.д.) системы связи, приблизительно, улучшенная передача и приём, преимущества, оборудовать, получать много наград

VIII. Read and translate text 14.2. Answer the following questions:

1. What achievement created a sensation in civilized world?
2. What was Marconi the first to discover?
3. What devices did he patent?
4. What work did Marconi continue in England?
5. What is the basis of modern long-distance radio communication?
6. What experiments did Marconi conduct on very short wavelengths?
7. What can you say about his honorary degrees?

IX. What do the following dates refer to:

1901, 1902, 1909, 1910, 1916, 1919, 1924, 1929, 1930, 1932, 1937

TEXT 14.3. ALEKSANDR POPOV

1. Aleksandr Stepanovich Popov (1859-1906) was a Russian physicist, electrical engineer and the inventor of radio. He built his first primitive radio receiver, a lightning detector (1896), without knowledge of the contemporary work of the Italian inventor Guglielmo Marconi. The genuineness and the value of Popov's successful experiments are not seriously doubted, but Marconi's priority is conceded outside Russia.

2. Popov was the son of a village priest. He received his early education in an ***ecclesiastical seminary*** school and planned to enter the priesthood. But in 1877 his interests changed to mathematics, and he entered the University of St. Petersburg, from which he was graduated with distinction in 1883. Joining the teaching faculty of the University, he lectured in mathematics and physics in preparation for a professoship.

3. Popov's main interest soon changed to the ***electrical engineering***, and, because Russia in that period lacked colleges that taught the subject, he became an instructor at the Russian Navy's Torpedo School at Kronstadt, near St. Petersburg, where students were trained to ***take charge*** of electrical equipment of Russian warships. Popov took advantage of the school's library, which was stocked with foreign books and periodicals, and also of its well-equipped laboratory to follow scientific developments abroad and carry out experiments. Recognizing the importance of German physicist Heinrich Hertz's discovery of electromagnetic waves, Popov began to work on methods of receiving them over long distances.

4. Popov constructed an apparatus that could register atmospheric electrical ***disturbances*** and, in July 1895, installed it at the meteorological observatory of the Institute of Forestry in St. Petersburg. In a paper published a few months later, Popov suggested that such an apparatus could be used for the reception of signals from a man-made source of oscillations, provided a sufficient power source became available. In March 1896, he appeared before the St. Petersburg Physical Society and demonstrated the transmission of Hertzian waves – as they were then termed – between different parts of the University of St. Petersburg buildings. On that occasion the words 'Heinrich Hertz' were transmitted in Morse code and the aural signals received were transcribed on a blackboard by the society's president, who was the chairman of the meeting.

5. During the academic year 1895-96 at the Torpedo School, however, Popov became interested in setting up experiments on Röntgen rays (X-rays), which had just been discovered. Therefore, he discontinued for a time the further development of his lightning, or thunderstorm, detector. He then read the first newspaper accounts of Marconi's demonstrations in September 1896. It seems clear that neither Marconi nor Popov was aware of the close similarity between their experiments.

6. The news of Marconi's work, as disclose in his patent of June 1896, aroused Popov fresh activity. Working in conjunction with the Russian navy, he effected ship-to-shore communication over a distance of 6 miles (10 km) by 1898. The distance was increased to about 30 miles (50 km) by the end of the following year, during which he had also visited wireless stations in operation in France and Germany.

7. Although it is agreed that Popov's experimental work in connection with Hertzian waves is deserving recognition, it has not been generally accepted that radio communication was actually invented by Popov. But in Russia the 7th of May is celebrated as the radio invented by

A. Popov. Thus, while it is true that historical research was brought to light indirect evidence that Popov demonstrated the transmission of intelligible signals in March 1896, there is comparable evidence that Marconi demonstrated the transmission of these signals at an even earlier date, though not before an audience of scientists. In 1901 A. Popov returned to St. Petersburg as a professor at the electrochemical institute, of which he was later elected director. He died five years later.

Notes:
1. ecclesiastical seminary – духовная семинария
2. electrical engineering – электротехника
3. take charge – возглавлять, взять на себя руководство
4. disturbances – помехи

X. Find Russian equivalents for:

inventor, radio receiver, lightning detector, outside Russia, enter the University, electrical engineering, foreign books and periodicals, scientific developments abroad, construct an apparatus, man-made source of oscillations, before St. Petersburg Physical Society, Russian navy, effect ship-to-shore communication, visit wireless stations in operation, celebrate

XI. Find English equivalents for:

инженер-электрик, гениальность и значение, признавать приоритет, воспользоваться библиотекой школы, хорошо оборудованная лаборатория, проводить эксперименты, устанавливать в обсерватрии, использовать для приема сигналов, источник энергии, близкое сходство, заслуживать признания, закончить университет с отличием

XII. Read and translate text 14.3. Answer the following questions:

1. What was A. Popov?
2. What was he famous for?
3. Where is Marconi's priority conceded?
4. Where did A. Popov study?
5. Where did he work?
6. What was A. Popov's main interest?
7. On what method did he begin to work?
8. What apparatus did A. Popov construct?
9. Was it generally accepted that Popov invented radio?

XIII. What do the following dates refer to:

1859, 1877, 1883, 1895, 1896, 1898, 1901, 1906

XIV. Read and translate text 14.3. Find the information to prove that:

1. A. Popov did not know about the work of another inventor.
2. His parents were not rich.
3. His interests changed.
4. A. Popov worked as a teacher.
5. He demonstrated the transmission of waves before the scientists.
6. Day of radio is celebrated in Russia.

TEXT 14.4. RADIO

1. Radio is the transmission and detection of communication signals consisting of electromagnetic waves that travel through the air in a straight line or by reflection from the ionosphere or from a communication satellite.

2. Radio first became a possibility when the English physicist Michael Faraday demonstrated that an electrical current could produce a magnetic field. In 1864 James Clerk Maxwell, a professor of experimental physics at Cambridge, proved mathematically that these electrical distributions could be detected at considerable distances. Maxwell predicted that the electromagnetic energy could move outward in waves travelling at the speed of light. In 1888 Heinrich Hertz demonstrated that Maxwell's prediction was true for transmissions over short distances. The Italian physicist Guglielmo Marconi then perfected a radio system that in 1901 transmitted Morse code over the Atlantic Ocean.

3. Radio is the use of electromagnetic waves to send and receive information without wires (hence the former term 'wireless' for the radio). It includes, in its widest sense, radio, television and radar. Radiowaves are created in an antenna or aerial by making electrons oscillate. Aerial (antenna) is the part of a radio or television system from which radio waves are transmitted into the atmosphere or space (transmitting aerial) or by which they are received (receiving aerial). A ***directional*** or directive aerial is one in which energy is transmitted or received more effectively from some directions than others, whereas an ***omnidirectional aerial*** transmits and receives equally well in all directions.

4. Long and medium waves are sent around the world by bouncing them off the ionosphere (a layer of charged particles in the upper atmosphere), but VHF (very high frequency) and UHF (ultrahigh frequency waves for television) waves require a straighter path between the receiver and the transmitting aerial because these waves are not reflected by the ionosphere. Similarly the longer waves can diffract around hills and other obstacles, unlike the short-wavelength VHF and UHF waves. When a receiver is tuned to the frequency of the appropriate wave sent from the transmitter, it can amplify and rectify the signal to produce a varying current that matches the frequency of the sound wave at the microphone. This current is then used to work a loudspeaker, thus reproducing the original sound.

Notes:
1. directional aerial – направленная атненна
2. omnidirectional aerial – ненаправленная антенна

XV. Read and translate text 14.4. Identify, define or explain each of the following:

1. Radio 2. Scientists contributed to the study of wave communication
3. Wireless communication 4. Arial
5. Types of waves 6. Work of receiver

XVI. Make up the abstracts of texts 14.1– 14.4 (in English or in Russian).

XVII. Comment on the following quotation. Do you agree or disagree with it?

1. Most institutions demand unqualified faith, but the institution of science makes skepticism a virtue. (Robert King Merton 1910–2003)

SECTION 15

TEXT 15.1. JAMES MAXWELL

1. James Clerk Maxwell (1831-1879) was a Scottish physicist best known for his formulation of electromagnetic theory. He is often ranked with Sir Isaac Newton for the fundamental nature of his contributions to

science. The concept of electromagnetic radiation originated with Maxwell, and his field equations, based on Michael Faraday's observation of the electric and magnetic lines of force, paved the way for Einstein's special theory of relatively. Maxwell's ideas also ushered in the other major innovation of 20th century physics, the quantum theory.

2. Maxwell came from a middle-class background. James, an only child, was born on June 13, 1831, in Edinburgh, where his father was a laywer. His parents had married late in life, and his mother was 40 years old at his birth. He displayed a lively curiosity at an early age and had a phenominal memory. His mother died in 1839 from abdominal cancer. Fortunately he was rescued by his aunt Jane Cay and from 1841 was sent to school at the Edinburgh Academy. Maxwell's interests ranged far beyond the school syllabus. His first scientific paper 'On the Description of Oval Curves', was published when he was only 14 years. This fascination with geometry and with mechanical models continued throughout his career and was of great help in his subsequent research.

3. At the age of 16 he entered the University of Edinburgh, which he attended for three years, but in 1850 he went to the University of Cambridge, where he obtained a mathematics degree from Trinity College in 1854. Maxwell was second ***wrangler*** (a wrangler is one who takes first class honours in the mathematics examinations at Cambridge) and first Smith's prizeman (the Smith's prize is a prestigious competitive award for an essay that incorporates original research). In 1856, he became professor of natural philosophy at Marischal College, Aberdeen, Scotland. In 1858 Maxwell married Ketherine Mary Dewar, daughter of the principal of Marischal College, the union was childless.

4. In 1860 he was appointed to the professorship of natural philosophy at King's College (London). The next five years were the most fruitful of his career. During this period his two classic papers on the elecromagnetic field were published, and his demonstration of colour photography took place. He was elected to the Royal Society in 1861. His theoretical and experimental work on the viscosity of gases also was undertaken during these years and culminated in a lecture to the Royal Society in 1866. He supervised the experimental determination of electrical units for the British Association for the Advancement of Science, and this work in measurement and standardization led to the establishment of the National Physical Laboratory. He also measured the ratio of electromagnetic and electrostatic units of electricity and confirmed that it was in satisfactory ***agreement*** with the velocity of light as predicted by theory.

5. In 1865 Maxwell resigned his professorship at King's College and retired to the family estate in Glenlair. He continued to visit London every spring and served as external examiner for the Mathematical Tripos (exams) at Cambridge. In the spring and early summer of 1867 he toured to Italy. But most of his energy during this period was devoted to writing his famous treatise on electricity and magnetism. In 1871 Maxwell was elected the first Cavendish professor of Physics at Cambridge. In spring 1879 Maxwell took ill on several occasions. He died after a short illness on November 5, 1879. Maxwell received no public honours and was buried quietly in a small churchyard in the village of Parton, Scotland.

Notes:
1. wrangler – студент, особо отличившийся на экзамене по математике в Кембридском университете
2. agreement – соответствие

I. Find Russian equivalents for:

Scottish physicist, formulation of electromagnetic theory, observation of the electric and magnetic lines of force, quantum theory, a lawyer, phenominal memory, scientific paper, publish, research, enter University, become professor of natural philosophy, colour photography, theoretical and experimental work, viscosity, work in measurement and standardization, ratio, velocity of light, elect, public honours

II. Find English equivalents for:

его вклад в науку, понятие (концепция) электромагнитного излучения, уравнение поля, возвещать о другом главном новшестве, происхождение, живое любопытство, спасать, школьная программа, очарование геометрией, получать научную степень, плодотворный, руководить экспериментальным анализом (измерением) единиц электричества, создание лаборатории, уходить в отставку, научный труд по электричеству и магнетизму

III. Read and translate text 15.1. Answer the following questions:

1. What was J. Maxwell?
2. What was he famous for?
3. Why was he ranked with I. Newton?

4. What can you say about Maxwell's family?
5. Where did he study?
6. Where did Maxwell work?
7. What can you say about the most fruitful years of his career?
8. What did Maxwell do after resignation?

IV. What do the following dates refer to:

1831, 1839, 1841, 1850, 1854, 1856, 1858, 1860, 1861, 1865, 1866, 1871, 1879

V. Find in text 15.1 the information to prove that:

1. Maxwell's work influenced the development of new branch of physics.
2. He displayed extraodinary qualities in his childhood.
3. Maxwell published his first scientific paper when he was very young.
4. He was fascinated with science.
5. Maxwell studied well.
6. He remained active after retirement.

TEXT 15.2. RESEARCH OF J.C. MAXWELL

1. It was Maxwell's research on electromagnetism that established him among the great scientists of history. In the preface to his 'Treatise on Electricity and Magnetism (1873), the best exposition of his theory, Maxwell stated that his major task was to convert Faraday's physical ideas into mathematical form. In attempting to illustrate Faraday's law of induction (that a changing magnetic field gives rise to an induced electromagnetic field), Maxwell constructed a mechanical model. On calculating the velocity of transverse waves in the model, he found that they were very close to the velocity of light.

2. Maxwell's theory suggested that electromagnetic waves could be generated in a laboratory, a possibility first demonstrated by Heinrich Hertz in 1887, eight years after Maxwell's death. The resulting radio industry with its many applications thus has its origin in Maxwell's publications. In addition to his electromagnetic theory, Maxwell made major contributions to other areas of physics. Maxwell's interests ranged from colour vision (he produced one of the first colour photographs) and the nature of Saturn's rings to mechanics and the kinetic theory of gases.

3. While still in his 20s, Maxwell demonstrated his mastery of classical physics by writing a prizewinning essay on Saturn's rings, in which

he concluded that the rings must consist of masses of matter not mutually ***coherent*** – a conclusion that was corroborated more than 100 years later by the first Voyager ***space probe*** to reach Saturn. The Maxwell's relations of ***quality*** between different ***partial derivatives*** of thermodynamic functions are included in every standard texbook on thermodynamics.

4. Though Maxwell did not originate the modern kinetic theory of gases, he was the first to apply the methods of probability and statistics in describing the properties of an assembly of molecules. Thus he was able to demonstrate that the velocities of molecules in a gas, previously assumed to be equal, must follow ***a statistical distribution law***). In later papers Maxwell investigated the transport properties of gases – i.e., the effect of change in temperature and pressure on velocity, thermal conductivity and diffusion.

5. Maxwell was far from being an abstruse theoretician. He was skillful in the design of experimental apparatus. He devised a colour top with adjustable sectors of ***tinted paper*** to test the three-colour hypothesis of Thomas Young and later invented a colour ***box*** that made it possible to conduct experiments with spectral colours rather than pigments. His investigations of the colour theory led him to conclude that a colour photography could be produced by photographing through filters of the three primary colours and then recombining the images. He demonstrated his supposition in a lecture to the Royal Institution of Great Britain in 1861 by projecting through filters a colour photograph of a tartan ribbon that had been taken by this method.

6. In addition to these well-known contributions, a number of ideas that Maxwell put forward quite casually have since led to the developments of great significance. The hypothetical intelligent being known as Maxwell's demon was a factor in the development of information theory. Maxwell's analytic treatment of ***speed governors*** is generally regarded as the founding paper on cybernetics, and his 'equal areas' construction provided as essential constituent of the theory of fluids developed by Johannes van der Waals. His work in geometrical optics led to the discovery of the ***fish-eye lens***. He also was a contributor to the ninth edition of Encyclopedia Britannica. His publications include 'Theory of Heat' (1870) and 'Treatise on Electricity and Magnetism' (1873). The electromagnetic unit of magnetic flux in the centimetre-gram-second system of units was named maxwell in his honour.

Notes:
1. coherent – когерентный, связанный
2. space probe – беспилотная исследовательская космическая ракета
3. quality – характеристика, свойство
4. partial derivative – частная производная
5. a statistical distribution law – закон статистического распределения
6. tinted paper – тоновáя окрашенная бумага
7. box – камера
8. speed governor – регулятор скорости
9. fish-eye lens – линза Максвелла (с угловым полем около 180^{o} и более)

VI. Find Russian equivalents for:

electromagnetism, major task, illustrate, a changing magnetic field, construct a mechanical model, transverse waves, velocity of light, application, colour photograph, mechanics and kinetic theory of gases, essay, conclusion, describe the properties, effect of change in temperature and pressure, thermal conductivity and diffusion, design of experimental apparatus, theory of fluids, discovery, name in his honour

VII. Find English equivalents for:

преобразовать, вызывать индуцированное электромагнитное поле, подсчитывать скорость, получать в лаборатории, начало (возникновение), делать вклад в другие области физики, природа планеты Сатурн, состоять из масс вещества (материи), применять методы вероятности и статистики, исследовать, малопонятный теоретик, придумывать (изобретать), важная составная часть, единица магнитного потока

VIII. Read and translate text 15.2. Answer the following questions:

1. What was Maxwell's major research?
2. What did he suggest concerning electromagnetic waves?
3. What essay did Maxwell write?
4. What was he first to apply?
5. Was Maxwell a pure theoretician?
6. What did his ideas develop to?
7. What was Maxwell's contribution to Encyslopedia Britannica?
8. What was named in his honour?

TEXT 15.3. MAXWELL'S EQUATIONS

1. Maxwell's equations are four equations that, together, form a complete description of the production and interrelation of electric and magnetic fields, space and time dependence of the electromagnetic field. They are the basis of classical electrodynamics. These equations were proposed in 1864 by James Clerk Maxwell and express experimental laws.

2. The statements of these four equations are, respectively:

a) electric field ***diverges*** from electric charge (an expression of the Coulomb force),
b) there are no isolated magnetic poles, but the Coulomb force acts between the poles of a magnet,
c) electric fields are produced by changing magnetic fields (an expression of Faraday's law of induction) and
d) circulating magnetic fields are produced by changing electric fields and by electric currents (Maxwell's ***extension*** of Ampere's law to include the interaction of changing fields).

The most compact way of writing these equations in the metre-kilogram-second (inks) system is ***in terms*** of the vector operators, divergence and ***curl***.

Notes:

1. diverge – расходиться
2. extension – расширение, увеличение
3. in terms – на основе, через, в терминах
4. curl – спираль, вихрь, ротор (векторного поля)

IX. Read and translate text 15.3. Identify, define and enumerate:

1. Maxwell's equations
2. Statements of the equations

TEXT 15.4. MAGNETISM

1. Magnetism is a group of phenomena associated with magnetic fields. A magnetic field is a field of force that exists around a magnetic body or a current-carrying conductor. Whenever an electric current flows a magnetic field is produced. As the orbital motion and the spin of atomic electrons are equivalent to tiny current loops, individual atoms create magnetic fields around them.

2. The magnetic properties of the black metallic mineral magnetite, an oxide of iron found in ***igneous rocks***, were known to the ancient Greeks. The principle application of those properties in the magnetic compass was accomplished possibly as early as the 26th century BC by the Chinese. The first serious study of magnetism was made by Petrus Peregrinus de Maricourt in the late 1260s. He established the existence of magnetic poles and stated that like poles repel and unlike attract; he also ***specified*** the construction of a mariner's compass in detail. William Gilbert, physician to Queen Elizabeth I, observed that the Earth is a huge magnet and thus explained why a magnetic needle tends to dip it's north-pointing end downward in the Northern Hemisphere.

3. The forces between the poles of magnets were first investigated experimentally by the French physicist Charles-Augustin de Coulomb in 1785 and were found to follow an ***inverse square law***. (Coulomb's finding corroborated the observation made by the English physicist Joseph Priestly some years earlier). In 1824 Simeon-Denis Poisson, a French mathematician, presented a mathematical model of magnetism which still provides a ***sound basis*** for the calculation of the forces between permanent magnets.

4. A connection between electricity and magnetism had long been suspected, and in 1820 the Danish physicist Hans Christian Ørsted showed that an electric current flowing in a wire produces its own magnetic field. Andre-Marie Ampere of France immediately repeated Ørsted's experiments and within weeks was able to express the magnetic forces between current-carrying conductors in a simple and elegant mathematical form. He also demonstrated that a current flowing in a loop of wire produces a magnetic dipole indistinguishable at a distance from that produced by a small permanent magnet, this led Ampere to suggest that magnetism is caused by currents circulating on a molecular scale, an idea remarkably near the modern understanding.

5. The English chemist and physicist Michael Faraday demonstrated the 'motor' action of a current-carrying conductor in a magnetic field in 1821 and the induction of a current in a moving conductor in a magnetic field – the dynamo effect – in 1831; he coined the term magnetic field in 1845. The electromagnet, in which an iron core enhances the field generated by a current flowing through a coil, was invented by William Sturgeon in England during the mid-1820s. It later became a vital component of both motors and generators.

6. The ***unification*** of electric and magnetic phenomena in a complete mathematical theory was the achievement of the Scottish physicist James Clerk Maxwell. Maxwell's field equations, published in 1864, predicted the existence of electromagnetic waves, subsequently verified by Heinrich Hertz of Germany, and showed that light was also such a wave. Today magnetism finds many technical applications, from the humble magnetic door catch to medical imaging devices and superconducting magnets for use high-energy particle accelerators.

Notes:
1. igneous rock – магматическая (изверженная) порода
2. specify – конкретизировать, указывать, точно устанавливать
3. inverse square law – закон обратных квадратов
4. sound basis – прочная (логическая) основа
5. unification – объединение, унификация

X. Read and translate text 15.4. Discuss in brief:

1. Magnetism 2. Magnetic field 3. Magnetite (properties and application)
4. Contributors to the study of magnetism
5. Contributors to the study of electricity and magnetism

XI. Make up the abstracts of texts 15.1– 15.4 (in English or in Russian).

XII. Comment on the following quotations. Do you agree or disagree with them?

1. It was a great step in science when men became convinced that, in order to understand the nature of thing, they must begin by asking, not whether a thing is good or bad, noxious or beneficial, but of what kind it is? And how much is there of it? Quality and quantity were then first recognized as the primary features to be discovered in scientific inquiry. (James Clerk Maxwell 1831–1879, – British physicist)
2. An experiment, like every other event which takes place, is a natural phenomenon; but in a Scientific Experiment the circumstances are so arranged that the relations between a particular set of phenomena may be studied to the best advantage. (James Clerk Maxwell 1831– 1879)

SECTION 16

TEXT 16.1. ALBERT MICHELSON

1. Albert Abraham Michelson (1852-1931) was German-born U.S. physicist who established the speed of light as a fundamental constant and pursued other spectroscopic and meteorological investigations. He received the 1907 Nobel Prize for Physics.

2. Michelson came to the United States with his parents when he was two years old. From New York, the family made its way to Virginia City (Nevada) and San Francisco, where the elder Michelson prospered as a merchant.

3. At 17, Michelson entered the United States Naval Academy at Annapolis (Maryland), where he did well in science but was rather below average in ***seamanship***. He was graduated in 1873, then served as science instructor at the Academy from 1875 until 1879. In 1878 Michelson began work on the accurate measurement of the speed of light. He was able to get useful value with homemade apparatus. To study optics he travelled to Europe in 1880 and spent two years in Berlin, Heidelberg and Paris, resigning from the navy in 1881. Upon his return to the United States, he determined the velocity of light to be 299,853 kilometres (186,329 miles) per second.

4. While in Europe, Michelson began constructing an interferometer, a device designed to split a beam of light into two, send the parts along perpendicular paths, then bring them back together. If the light waves had, ***in the interim***, fallen out of step, ***interference fringes*** of alternating light and dark ***bands*** would be obtained. From the width and number of those fringes, unprecedently delicate measurements could be made, comparing the velocity of light rays travelling at right angles to each other.

Notes:

1. seamanship – морская практика
2. in the interim – тем временем, в это время
3. interference fringe – интерференционная полоса
4. band – диапазон, зона, полоса

I. Find Russian equivalents for:

establish the speed of light, enter the Naval Academy, seamanship, serve as science instructor, study optics, device designed to split a beam of light into two, light waves, dark band, width and number, velocity of light

II. Find English equivalents for:

проводить исследования, торговец (купец), хорошо успевать по наукам, точное измерение, получить практическое значение (величину), определять, строить (конструировать), интерферометр, чередующийся световые полосы, получать, проводить точные измерения, проходить под прямым углом

III. Read and translate text 16.1. Answer the following questions:

1. What was A. Michelson?
2. What was he famous for?
3. Where did his family live in the United States?
4. Where did Michelson study?
5. Where did he work?
6. Why did Michelson go to Europe?
7. What did he determine?
8. What did he begin to construct?

IV. What do the following dates refer to:

1852,1854,1873, 1875-1879, 1878, 1880-1882

TEXT 16.2. MICHELSON'S NEGATIVE EXPERIMENT

1. It was Michelson's intention to use the interferometer to measure the Earth's velocity against the 'ether' that was then taught to make up the basic substratum of the universe. If the Earth were travelling through the light-conducting ether, then the speed of the light travelling in the same direction would be expected to be equal to the velocity of light plus the velocity of the Earth, whereas the speed of light travelling at right angles to the Earth's path would be expected to travel only at the velocity of light. His earliest experiments in Berlin showed no interference fringes, however, which seemed to signify that there was no difference in the speed of the light rays, and, therefore, no Earth motion relative to the ether.

2. In 1883 he accepted a position as professor of physics at the Case School of Applied Science in Cleveland and there concentrated his efforts on improving the delicacy of this interferometer experiment. By 1887, with the help of his colleage, American chemist Adward Williams Morley, he was ready to announce the results of the Michelson-Morley experi-

ment. Those results were still negative, there were no interference fringes and apparently no motion of the Earth relative to the ether.

3. It was perhaps the most significant negative experiment in the history of science. In terms of classical Newtonian physics, the results were paradoxical. Evidently, the speed of light plus any other added velocity was still equal only to the speed of light. To explain the result of the Michelson-Morley experiment, physics had to ***be recast*** on a new and more refined foundation, something that resulted, eventually, in Albert Einstein's formulation of the theory of relativity in 1905.

Notes:

1. be recast – исправлять

V. Read and translate text 16.2. Answer the following questions:

1. For what purpose did Michelson use the interferometer?
2. What were his first results?
3. Who helped Michelson in his work?
4. What was the result of the Michelson-Morley experiment?

TEXT 16.3. MICHELSON'S CAREER AND RESEARCH

1. In 1892 Michelson, after serving as professor of physics at Clark University at Worcester (Massachusetts) from 1889, was appointed professor and the first head of the department of physics at the newly organized University of Chicago, a position he held until his retirement in 1929. From 1923 to 1927 he served as president of the National Academy of Sciences. In 1907 he became the first American ever to receive a Nobel Prize in the sciences, for his spectroscopic and meteorological investigations, the first of many honours he was to receive.

2. Michelson ***advocated*** using some particular wavelength of light as a standard of distance (a suggestion generally accepted in 1960) and in 1893, measured the standard metre in terms of the red light emitted by heated cadmium. His interferometer made it possible for him to determine the width of heavenly objects by matching the light rays from the two sides and noting the interference fringes that resulted. In 1920, using a 6-metre interferometer attached to a 254-centimetre (100-inch) telescope, he succeeded in measuring the diameter of the star Alpha Orionis as 386,160,000 km (300 times the diameter of the Sun). This was the first substantially accurate determination of the size of a star.

3. In 1923 Michelson returned to the problem of the accurate measurement of the velocity of light. In the California mountains he surveyed a 35-km pathway between two mountain peaks, determining the distance to an accuracy of less than 2,5 cm. He used a special eight-sided revolving mirror and obtained a ***value*** of 299,798 km/sec for the velocity of light. To refine matters further, he used a long, evacuated tube through which a light beam was reflected back and forth until it had travelled 16 km through a vacuum. Michelson died before the results of his final tests could be evaluated, but in 1933 the final figure was announced as 299,774 km/sec higher than the value accepted in the 1970s.

Notes:
1. advocate – отстаивать, поддерживать, пропагандировать
2. value – величина, значение

VI. Read and translate text 16.3. Discuss in brief:

1. Michelson's work at Massachusetts and Chicago
2. His work in the National Academy of Science
3. Michelson received the Nobel Prize
4. His measurement the standard metre
5. With his interferometer Michelson determined the width of stars
6. He measured accurately the speed of light

TEXT 16.4. INTERFEROMETER

1. Interferometer is an instrument designed to produce optical interference fringes for measuring wavelengths, testing flat surfaces, measuring small distances, etc.

2. ***Echelon*** is a form of interferometer consisting of a stack of glass plates arranged stepwise with a constant ***offset***. It gives a high resolution and is used in spectroscopy to study hyperfine line structure. In the transmission echelon the plates are made equal in optical thickness to introduce a constant delay between adjacent parts of the wavefront. The reflecting echelon has the exposed steps metallized and acts like an exaggerated ***diffraction grating.***

3. Fabry-Perot interferometer is a type of interferometer in which monochromatic light is passed through a pair of parallel half-silvered glass plates producing circular interference fringes. One of the glass plates is adjustable, enabling the separation of the plates to be varied. The wave-

length of the light can be determined by observing the fringes while adjusting the separation. This type of instrument is used in spectroscopy.

Notes:

1. echelon – ступень, уровень
2. offset – сдвиг, смещение
3. diffraction grating – дифракционная решетка

VII. Read and translate text 16.4. Identify, define or explain each of the following:

1. Interferometer
2. Echelon
3. Transmission echelon
4. Reflecting echelon
5. Fabry-Perot interferometer

TEXT 16.5. SPEED OF LIGHT

The speed of light is the speed at which electromagnetic radiation travels. The speed of light in vacuum is 2.997.924.58 X 10^8m s^{-1}. When light passes through any material medium its speed is reduced. The speed of light in vacuum is the highest speed attainable in the universe. It is taught to be a universal constant and is independent of the speed of the observer. Since October 1983 it has formed the basis of the definition of the metre.

XIII. Characterize the speed of light:

(In vacuum; as a constant; through material medium)

IX. Make up the abstracts of texts 16.1–16.5 (in English or in Russian).

X. Comment on the following quotation. Do you agree or disagree with it?

1. Theoretical and experimental physicists are now studying nothing at all – the vacuum. But that nothingness contains all of being. (Heinz R. Pagels 1939–1988, – American physicist and science writer)

SECTION 17

TEXT 17.1. LOUIS NEEL

1. Louis-Eugene-Felix Neel (1904-2000) was a French physicist, corecipient, with the Swedish astrophysicist Hannes Alfven, of the Nobel Prize for Physics in 1970 for his pioneering studies of the magnetic properties of solids. His contributions to ***solid-state physics*** have found numerous useful applications, particularly in the development of improved computer memory units.

2. Neel was professor at the Universities of Strasbourg (1937) and Grenoble (1946-76). During the early 1930s he studied, on the molecular level, forms of magnetism that differ from ferromagnetism. In ferromagnetism, the most common variety of magnetism, the electrons line up (or spin) in the same direction at low temperatures. Neel discovered that in some substances the alternating groups of atoms align their electrons in opposite directions (much like placing together two identical magnets with opposite poles aligned), thus neutralizing the ***net*** magnetic ***effect***. This magnetic property is called antiferromagnetism.

3. Neel's studies of ***fine-grain*** ferromagnetics provided an exploration for the unusual magnetic memory of certain mineral deposits that has provided information on changes in the direction and strength of the Earth's magnetic field. Neel was director of the Polytechnic Institute (Grenoble) from 1971 to 1976 and also of the Center for Nuclear Studies (Grenoble) from 1956 to 1971. Neel wrote over 200 works on various aspects of magnetism. Mainly because of his contributions, ferromagnetic materials can be manufactured to almost any ***specifications*** for technical applications, and a flood of new synthetic ferrite materials has revolutionized microwave electronics.

Notes:

1. solid-state physics – физика твердого тела
2. net magnetic effect – суммарное воздействие; результирующий эффект
3. fine-grain – мелкозернистый
4. specifications – технические характеристики; технические условия (требования)

I. Find Russian equivalents for:

French physicist, magnetic properties of solids, solid-state physics, development, at low temperature, discover, in opposite direction, opposite poles, neutralize, changes in strength of the Earth's magnetic field, ferromagnetic materials can be manufactured, technical applications, microwave electronics

II. Find English equivalents for:

вклад, находить многочисленное практическое (полезное) применение, блоки компьютерной памяти, отличаться, наиболее распространенная разновидность магнетизма, выстраиваться (в линию) в одном направлении, в некоторых веществах, чередующиеся группы, называть, исследования, месторождение минералов, обеспечивать информацию, из-за его вклада (научного), технические характеристики

III. Read and translate text 7.1. Answer the following questions:

1. What was L-E-F Neel?
2. What was he famous for?
3. Where did Neel work?
4. What did he study?
5. Where did Neel work in Grenoble?
6. What became possible due to his studies?

IV. What do the following dates refer to:

1904, 1937, 1946-1976, 1956-1971, 1971-1976

TEXT 17.2. FERROMAGNETISM

1. In ferromagnetic materials the electron spins are magnetically coupled by either ***exchange*** or super-exchange quantium-mechanical ***forces***. Such materials can acquire a ***spontaneous magnetization*** which is much greater than either diamagnetism or paramagnetism. There are three types of ferromagnetism: ferromagnetism, ferrimagnetism and antiferromagnetism.

2. In ferromagnetic substances, within a certain temperature range, there are ***net*** atomic magnetic moments, which line up in such a way that magnetization persists after the removal of the ***applied*** magnetic ***field***. Below a certain temperature, called the Curie point, an increasing magnetic field applied to a ferromagnetic substance will cause increasing magnetization to a high value, called the ***saturation magnetization***. This is because a ferromagnetic substance consists of small (1-0,1 mm across) magnetized regions called ***domains***. The total magnetic moments of a ***sample*** of the substance is the vector sum of the magnetic moments of the compo-

nent domains. Within each domain the individual atomic magnetic moments are spontaneously aligned by exchange forces, related to whether or not the atomic electron spins are parallel or antiparallel.

3. However, in an unmagnetized piece of ferromagnetic material the magnetic moments of the domains themselves are not aligned; when an external field is applied those domains that are aligned with the field increase in size ***at the expense of*** the others. In a very strong field all the domains are lined up in the direction of the field and provide the high observed magnetization. Iron, nickel, cobalt and their alloys are ferromagnetic. Above the Curie point, ferromagnetic materials become paramagnetic.

4. Some metals, alloys and transition-element salts exhibit another form of magnetism called antiferromagnetism. This occurs below a certain temperature, called the Neel temperature, above which an antiferromagnetic substance becomes paramagnetic. The susceptibility increases with temperature, reaching a maximum at the Neel temperature, after which it abruptly declines. The phenomenon was discovered around 1930 by L.E.F. Neel.

5. A special form of antiferromagnetism is ferrimagnetism, a type of magnetism exhibited by the ferrites. The ferrites are ceramic materials that show either ferrimagnetism or ferromagnetism, but are not electrical conductors. For this reason they are used in high-frequency circuits as magnetic cores. In ferrites the magnetic moments of adjacent ions are antiparallel and of unequal strength, or the number of magnetic moments in one direction is greater than those in the apposite direction. By suitable choice of rare-earth ions in the ferrite lattices it is possible to design ferrimagnetic substances with specific magnetizations for use in electronic components.

Notes:
1. exchange forces – силы взаимодействия, обменные силы
2. spontaneous magnetization – самопроизвольное (спонтанное) намагничивание
3. net – сеть, чистый, общий, конечный
4. applied field – внешнее (приложенное) поле
5. saturation magnetization – намагниченность насыщения
6. domain – домен, область, сфера
7. sample – образец
8. at the expense of – за счет чего-либо

V. Find Russian equivalents for:

ferromagnetic substance, line up in such a way, below, Curie point, an increasing magnetic field, high value, magnetized regions, unmagnetized piece, external field, direction, iron, nickel, cobalt and their alloys, above, ferrites are ceramic materials, electrical conductor, to use, high-frequency circuits, adjacent ions, in opposite direction, it is possible to design, electronic components

VI. Find English equivalents for:

приобретать самопроизвольное намагничивание, в пределах определенного температурного диапазона, намагничивание сохраняется, вызывать, состоять из, увеличиваться в размерах, обеспечивать, становиться, проявлять (показывать) другой вид магнетизма, чувствительность (восприимчивость) возрастает вместе с температурой, по этой причине, магнитный сердечник, неодинаковая прочность, кристаллическая решётка

VII. Read and translate text 17.2. Identify, define or explain each of the following:

1. Ferromagnetic materials 2. Curie point 3. Domains
4. Antiferromagnetism 5. Paramagnetic substance
6. Ferrimagnetism 7. Ferrites and their application

TEXT 17.3. BOOKS IN OUR LIFE

1. All great people liked to read much. Nowadays it’s almost impossible to imagine our life without books. There are more books on our planet then men alive. Long before the invention of printing people valued books as treasure troves of the human knowledge and experience. Handwritten manuscripts took months of writing and were collected by and kept in monasteries with utmost care. We can put books into three classes. Firstly, books on different branches of knowledge, works by brilliant minds of mankind. Secondly, textbooks, reference books and numerous dictionaries. And lastly, books of all kinds and genres to read in leisure.

2. Classics should be taken a little at a time. One’s understanding of books by Tolstoy and Dostoevsky, Maupassant and Balzac depend on one’s age and experience. Serious books are to be read conscientiously and

may be more than once. To a thinking reader they will provide new food for thought every time he reads it. Many people indulge in reading science fiction, fantasy or detective stories. Of course, there are some advantages and disadvantages of this kind of literature, often referred to us “easy reading”. Good science fiction and fantasy develop imagination, logical thinking and broaden one’s outlook. Detective stories reveal minute details of everyday life in different countries, show the depths of psychological analysis and insight into human nature.

3. As an old saying goes, man cannot live on bread alone. Books are the source of knowledge and the means of selfperfection. Sometimes it is difficult to solve some problems in life. Books can help us. Books must be our friends during all our life. Books teach people to be real friends, honest, kind, brave and clever. They teach us to understand people, to help them in difficult situations, to fight with evil, to feel responsibility for somebody or something. As people prefer watching TV and video and play computer games, so they begin to read less. In 20th century people used books to get information, to think over them, to relax; but today people prefer to use net. But in spite of all this, people go on reading books. And if each person finds something for himself in a book, this book will be popular with the reading public and will teach the readers good things, help self-education as books are the source of knowledge.

VIII. Read and translate text 17.3. Answer the following questions:

1. Why did great people read much?
2. Do you think that books have an influence on the way you behave or think?
3. What is your main reason for reading books?
4. Tell about the last book you read?
5. What is your idea of a private collection of books?
6. What materials were books made of? Books of Past, Present, Future: (carving on stones, papyrus, clay, tree bark, animal skin).
7. What do you consider the aim of a good book?
8. What do you think about people’s likes and dislikes in reading?
9. What books will you buy as a present to your friend?

IX. Comment on the proverbs. What do they mean?

1. Bad books are worse than useless, they are harmful.

2. The person who doesn't read has no advantage over the person who can not.
3. There is no friend so faithful as a good book.
4. Choose an author as you choose a friend.
5. Don't judge a book by its cover.
6. A room without books is like a body without soul.
7. Reading is to the mind what exercise is to the body.
8. We are what we read.
9. Tell me what you read and I will tell you what you are.
10. Books are a great thing as long as you know how to use them.

X. Make up the abstracts of texts 17.1–17.3 (in English or in Russian).

XI. Comment on the following quotation. Do you agree or disagree with it?

1. The language of science is universal, and perhaps scientists have been the most international of all professions in their outlook. (John Fitzgerald Kennedy 1917-1963, – American President)

SECTION 18

TEXT 18.1. ISSAAC NEWTON

1. Sir Isaac Newton (1642-1727) was English physicist and mathematician, who laid foundation of ***calculus,*** extended the understanding of colour and light and examined the mechanics of planetary motion. In optics, his discovery of the composition of white light integrated the phenomena of colours into the science of light and laid the foundation for modern physical optics. In mechanics, his three laws of motion, the basic principles of modern physics, resulted in the formulation of the law of universal gravitation. In mathematics, he was the original discoverer of the ***infinitesimal*** calculus. Newton's 'Mathematical Principles of Natural Philosophy (1687) was one of the most important works in the history of modern science.

2. Newton was born on December 25, 1642 in the hamlet of Woolsthorpe (Lincolnshire). He was the only son of a local yeoman, also Isaac Newton, who had died three months before, and of Hannah Ayscough. For nine years Newton lived with his grandmother. He attended the village school and then the grammar school in Grathan. At the school he gained a

first command of Latin. He entered the Trinity College (Cambridge), in 1660 somewhat older than the other undergraduates because of his interrupted education. Newton received a bachelor's degree at the Trinity College, Cambridge in 1665. During the plague (1665-1666) University was closed, Newton returned home and formulated most of his major discoveries. He discovered the binomal theorem, and he developed the calculus, a more powerful form of analysis that employs infinitesimal considerations in finding the slopes of curves and areas under curves.

3. Newton was elected to a fellowship in Trinity College in 1667, after the university reopened, where he became Lucasian professor of mathematics in 1669 and delivered lectures on colours and optics. He concluded that rays refract at distinct angles – hence, the prismatic spectrum, a beam of ***heterogeneous*** rays, i.e. alike incident on one face of a prism, separated or analyzed by the refraction into its component parts and that phenomena such as the rainbow are produced by refractive analysis. Newton constructed the first reflecting telescope.

4. In mechanics of 'Mathematical Principles of Natural Philosophy' he described the motion of visible bodies in three laws of motion. Newton put forward the law of universal gravitation in 1687. The law of universal gravitation states that every particle of matter in the universe attracts every other with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them. In 1696 he was appointed warden of the mint, and then the master of the mint, although he did not resign his Cambridge appointments until 1701. In 1703 he was elected President of the Royal Society. Four years earlier, the French Academy of Sciences had named him one of eight foreign associates. In 1705 Queen Anne knighted him, the first occasion on which a scientist was so honoured.

5. Newton had a long career: as a scientist he discovered the composition of white light and formulated the three fundamental laws of mechanics, leading to the law of gravitation; as a mathematician he invented the infinitesimal calculus; and as a civil servant he was warden of the mint. Other works by Newton include 'Optics' (1704), 'Universal Arithmetics' (1707), 'The Chronology of Ancient Kingdoms Amended' (1728) and 'Observations upon the Prophecies of Daniel and the Apocalypse of St. John' (1733).

Notes:

1. calculus – дифференциальное исчисление

2. infinitesimal calculus – исчисление бесконечно малых величин
3. heterogeneous – гетерогенный, неоднородный

I. Find Russian equivalents for:

English physicist and mathematician, colour and light, mechanics of planetary motion, major discoveries, composition of white light, modern physical optics, laws of motion, formulation of the law of universal gravitation, the most important works, attend the village school, enter the college, the binomal theorem, elect, deliver lectures on, a beam of heterogeneous rays, refraction, rainbow, describe, particles of matter, scientist, invent

I. Find English equivalents for:

заложить основу дифференциального исчисления, расширить понимание, исследовать, явления, приводить к, деревушка, единственный сын, получить степень бакалавра, угол наклона кривой, падающий (луч) на грань призмы, построить отражающий телескоп, движение видимых тел, выдвигать закон, притягивать с силой, обратно пропорциональный, квадрат расстояния, произведение их масс, монетный двор

III. Read and translate text 18.1. Answer the following questions:

1. What was Sir Isaac Newton?
2. What was he famous for?
3. What can you say about his family?
4. Where did Newton study?
5. What degree did he receive?
6. Why did Newton return home?
7. Where did he work?
8. What did Newton construct?
9. What does the law of Universal gravitation state?
10. What Newton's book was the most important?

IV. What do the following dates refer to:

1642,1660, 1665, 1665-1666, 1667, 1668, 1687, 1696, 1703, 1705, 1727

V. Find in text 18.1 the information about Newton's discoveries in:

1. Mathematics 2. Optics 3. Mechanics

VI. Characterize Newton's long scientific career as:

1. Scientist 2. Mathematician 3. Civil servant

TEXT 18.2. NEWTONIAN MECHANICS

1. Newtonian mechanics is the system of mechanics that relies on Newton's laws of motion. Newtonian mechanics is ***applicable*** to bodies moving at speeds relative to the observer that are small compared to the speed of light. Bodies moving at speeds comparable to the speed of light require an ***approach*** based on relativistic mechanics, in which the mass of a body changes with its speed.

2. Newton's laws of motion are the three laws of motion on which Newtonian mechanics is based. Newton's first law states that, if a body is at rest or moving at a constant speed in a straight line, it will remain at rest or keep moving in a straight line at a constant speed unless it is acted upon by a force. This postulate is known as the law of inertia, and it is basically a description of one of the properties of a force: its ability to change rest into motion or motion into rest or one kind of motion into another kind.

3. Newton's second law is a quantitative description of the changes that a force can produce in the motion of a body. It states that ***the time rate of change*** of the ***velocity*** (directed speed), or acceleration, is directly proportional to the force and inversely proportional to the mass of the body. The larger the force, the larger the acceleration (rate of change of velocity); the larger the mass, the smaller the acceleration. The acceleration produced by a force is in the same direction as the force; if several forces act on a body, it is their ***resultant*** (sum), obtained by adding the vectors tail-to-tip, that produces the acceleration.

4. The second law is the most important, and from it all of the basic equations of dynamics can be derived by procedures developed in the calculus. A simple case is a freely falling body. Neglecting air resistance, the only force acting on the body is its weight acting down, and it produces a downward acceleration equal to the acceleration of gravity, which has an average value of 9.8 metres (32.2 feet) per second near the surface of the Earth.

5. Newton's third law states that if one body exerts a force on another, there is an equal and opposite force, called a reaction, exerted on the first body by the second, i.e. reaction is always equal and opposite to action. The third law is important in statics (bodies at rest) because it permits the separation of complex structures and machines into simple

units that can be analyzed individually with the least number of unknown forces. At the connections between the units, the force in one member is equal and opposite to the force in the other member. The third law may not hold for electromagnetic forces when the bodies are far apart.

Notes:

1. applicable – применимый, пригодный
2. approach – принцип, метод, подход
3. time rate of change – ускорение при разгоне или замедлении
4. velocity – вектор скорости
5. resultant – результирующий вектор, векторная сумма

VII. Find Russian equivalents for:

Newtonian mechanics, Newton’s laws of motion, speed of light, a body at rest, move in a straight line, a force, law of inertia, description of properties, ability, velocity, acceleration, in the same direction, the most important law, derive the basic equations, a freely falling body, the only force acting on the body, weight, near the surface of the Earth, equal and opposite force

VIII. Find English equivalents for:

тела, движущиеся со скоростью наблюдателя, по сравнению с, констатировать (утверждать), двигаться с постоянной скоростью, оставаться в покое, количественное описание изменений, обратно пропорциональна, полученный путем сложения векторов, простой пример, пренебрегая сопротивлением воздуха, среднее значение (величина), прилагать силу, простые блоки

IX. Read and translate text 18.2. Identify, define or explain each of the following:

1. Newtonian mechanics
2. Application of Newtonian mechanics
3. Newton’s first law
4. Newton’s second law
5. Newton’s third law

TEXT 18.3. DEVELOPMENT OF TELESCOPE

1. Telescope is an instrument for magnifying an image of a distant object. Optical astronomical telescopes fall into main classes: ***refracting***

telescopes (or refractors) which use lenses to form the primary image, and ***reflecting telescopes*** (or reflectors), which use mirrors.

2. The name refractor is derived from the term ***refraction***, which is the bending of light when it passes from one medium to another of different density – e.g. from air to glass, the glass is referred to as a lens, which may be convex, concave or ***plane-parallel***. The name reflector is derived from the fact that the primary mirror reflects the light back to a focus instead of refracting it. The primary mirror usually has a concave spherical or parabolic shape, and, as it reflects the light, it inverts the image at the ***focal plane***.

3. Refracting telescopes use a ***converging lens*** to collect the light and the resulting image is magnified by the ***eyepiece***. This types of instrument was first constructed in 1608 by the Dutch optician (Holland) Hans Lippershey (1587-1619) and developed as an astronomical instrument by Galileo (1564-1642) in 1609, who used a ***diverging lens*** as eyepiece. The Galilean telescope was improved in 1611 by the German astronomer Johannes Kepler (1571-1630), who substituted a converging eyepiece lens. This form is still in use for small astronomical telescopes (the Keplerian telescope).

4. The first reflecting telescope was produced by Newton (1642-1727) in 1668. This used a concave mirror to collect and focus the light and a small secondary mirror at an angle of 45^{o} to the main beam to reflect the light into the magnifying eyepiece. This design is known as the Newtonian telescope. The Gregorian telescope, designed by James Gregory (1638-1675) in 1663, and the Cassegrainian telescope, invented by N. Cassegrain in 1672, use different secondary optical systems. The Herschelian reflector was invented by the British astronomer Sir William Herschel in 1780.His great telescope, built in 1789, had a mirror 48 inches in diameter and a tube 40 feet in length.

5. Another type of optical system, a catadioptic telescope, which combines both a lens and a mirror, was invented in 1930 by Estonian instrument maker Bernard Schmidt (1879-1935). It produces very sharp photographic images of celestial objects over very wide angle of sky. The telescope giving the minimum power is the ***opera glass***, usually magnifying two and one-half or three diameters, which is sufficient for indoor use, while for outdoor use the Galilean binocular has a power of four or five diameters, and the prism binocular of six, eight, ten or even twelve diameters.

6. The important features of telescope are ***magnifying power, light-gathering power***, ***resolving power*** and the stability of the telescope mounting. Telescope ***apertures*** range from 25 mm for the smallest refractors up to many metres for the largest reflectors. In 1750, the English optician John Dollond (1706-1761), invented the achromatic objective. The new objectives are made of several thin lenses ***cemented*** together, usually four in number and alternatively ***crown*** and ***flint glass***. Professor George Airy (1801-1892), astronomer Royal at Greenwich, designed and constructed a vertical telescope, he named it 'Reflex Zenith Tube'.

Notes:
1. refracting telescope – рефрактор, линзовый телескоп
2. reflecting telescope – рефлектор, зеркальный телескоп
3. refraction – рефракция, преломление
4. plane-parallel lens – плоско-параллельная линза
5. focal plane – фокальная плоскость
6. converging lens – собирающая (положительная) линза
7. eyepiece – окуляр
8. diverging lens – рассеивающая (отрицательная) линза
9. opera glass – театральный бинокль
10. magnifying power – оптическое увеличение
11. light-gathering power – светосила
12. resolving power – разрешающая способность
13. aperture – апертура, отверстие
14. cement – склеивать
15. crown glass – крон (оптическое стекло)
16. flight glass – флинт (оптическое стекло)

XI. Read and translate text 18.3. Identify, define or explain each of the following:

1. Telescope
2. Refractor
3. Reflector
4. Catadioptric telescope
5. Opera glass
6. Features of telescope

XII. Enumerate the main events of telescope development in chronological order. Be ready to say a few words about them.

Scientist / inventor	Type of Telescope	Date	Lens / mirror

XIII. Make up the abstracts of texts 18.1–18.3 (in English or in Russian).

XIV. Comment on the following quotations. Do you agree or disagree with them?

1. If I have seen further it is by standing on the shoulders of Giants. (Isaac Newton 1642–1727, – English natural philosopher, astronomer and mathematician)
2. I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me. (Isaac Newton)
3. It is good to recall that three centuries ago, around the year 1660, two of the greatest monuments of modern history were erected, one in the West and one in the East; St. Paul's Cathedral in London and the Taj Mahal in Agra. Between them, the two symbolize, perhaps better than words can describe, the comparative level of architectural technology, the comparative level of craftsmanship and the comparative level of affluence and sophistication the two cultures had attained at that epoch of history. But about the same time there was created – and this time only in the West – a third monument, a monument still greater in its eventual importance for humanity. This was Newton's Principia (Mathematical Principles of Natural Philosophy), published in 1687. Newton's work had no counterpart in the India if the Moguls. (Abdul Salam 1926 –1996, – Pakistan nuclear physicist)
4. Here lies Sir Isaac Newton, Knight, who by vigour of mind almost supernatural, first demonstrated, the motions and figures of the planets, the paths of the comets, and the tides of the oceans… Let mortals rejoice that there has existed such and so great an ornament of Nature (Epitaph of Isaac Newton on his tomb at Westminster Abbey)

SECTION 19

TEXT 19.1. KONSTANTIN NOVOSELOV

1. Konstantin Sergeevich Novoselov (1974) is a Russian and British physicist, who jointly with his supervisor Andre Geim, was awarded the

Nobel Prize for Physics (2010) for groundbreaking experiments regarding the two-dimensional material graphene at the University of Manchester.

2. Konstantin Novoselov was born in Nizhny Tagil, a middle-sized industrial city in the Ural Mountains in Russia. His father, Sergey Victorovich was an engineer at the local factory which produced railway carriages and tanks. His mother, Tatiana Novoselova, was an English teacher at school where he studied. His hobbies were rather technical: cross-country skiing, carting and many parts of the cars were produced or modified by his and his father's hands. Through this hobby he learned bits of ***lathing***, ***milling*** and welding, skills which he used widely.

3. When his sister Elena was in the nursery, he used to do 'research' in the kitchen such as looking for gunpowder recipes or casting materials. His passion for such experiments was supported by his physics teacher, Ljudmila Rastorgueva, who allowed him to work with the equipment in the school physics laboratory. She also, together with his math's teachers Valentina Filippova and Ljudmila Bashmakova, introduced him to the Distance Learning School of the Moscow Institute of Physics and Technology (Phystech) in 1988–1991, as well as pushed him to participate in physics and math's Olympiads at various levels (1986 – the first place in the Regional Olympiad in Physics; in All-Union Olympiad of pupils he was one of the top ten).

4. When at school the other great sources of information and encouragement for him at that time were the monthly journal 'Quant', and a series of fantastic books and translated texts by Martin Gardner. He was not limited to physics and math's literature; his school-time favourites included Pasternak, Pushkin, Jack London, Jerome K. Jerome, Lewis Carroll and Mark Twain.

5. His participation in the Distance Learning School and Olympiads made entering Phystech fairly straightforward. In 1991 he entered Moscow Institute of Physics and Technology. He chose the Faculty of Physics and Quantum Electronics and experienced an amazing and bizarre combination of the highest standards of education and rather tough living conditions. The curriculum was also quite intense, especially during the third year when one could easily spend ten straight hours a day at the lectures, tutorials and research labs. But with the courses given by the leading actively-working scientists, he felt extremely proud to study there.

6. Phystech was rather different from other Russian universities. Science in Russia was traditionally concentrated in research institutes and Phystech used these so-called 'bases' where students could follow specia-

lized courses and get involved in research projects. Typically students spent a day a week at a ‘base’, during their third year, with the proportion reaching 100% by the sixth year. Konstantin graduated from the Institute with Honors in 1997. His first base was Astrophysics, the State Research Center originally focused on research into powerful laser systems and their use in military applications, but within a year he moved to the Institute of Microelectronics Technology in Chernogolovka.

7. Chernogolovka is a very small town in the middle of forest about 60 km east of Moscow, with 20,000 people and a dozen research institutes. The people were enthusiastic and passionate about science and the range of courses offered was excellent. In addition, the lectures were given by the leading scientists at the Institute of Solid State Physics, the Landau Institute for Theoretical Physics and the Institute of Microelectronics Technology: Vsevolod Gantmakher, Vladislav Timofeev, Mikhail Trunin and others.

Notes:
1. lathing – обработка на токарном станке
2. milling – обработка на фрезерном станке

I. Find Russian equivalents for:

Russian and British physicist, award the Nobel Prize for Physics, two-dimensional material, participate in physics and mathematics Olympiads, enter the Institute, faculty of physics and quantum electronics, the highest standards of education, intense curriculum, research institute, poweful laser systems, leading scientists

I. Find English equivalents for:

вместе с, сварка, поддерживать, работать на оборудовании физической лаборатории, источники информации, жесткие условия жизни, гордиться учебой в институте, закончить институт с отличием, сосредоточиться на исследовании, читать лекции

III. Read and translate text 19.1. Answer the following questions:

1. What is Konstantin Novoselov?
2. What is he famous for?
3. Where was K. Novoselov born?

4. What can you say about his family?
5. Why did his hobbies help him in work?
6. How did his teachers influence his future career?
7. Where did Novoselov study?
8. Why was Phystech rather different from other universities?
9. Where did he work?

TEXT 19.2. RESEARCH OF K. NOVOSELOV

1. In Chernogolovka Novoselov started to learn microelectronics technology (nanotechnology) from Sergey Dubonos and worked with Evgeny Vdovin, Yuri Khanin and Sergey Morozov in tunneling spectroscopy in the laboratory of Yuri Dubrovskii (who was his scientific supervisor). He learned much from these people, from basic human communication skills to the most complicated experimental techniques.

2. In 1997 when he was doing his Ph.D. in the same lab, he got an opportunity to go to Nijmegen in the Netherlands to work with Andre Geim. Andre had already had a reputation of being innovative and creative experimentalist. During spring of 1999 K. Novoselov spent a couple of months in Nijmegen as a probation period. In 1999 he moved to the Netherlands where he started working with Andre Geim at Nijmegen University. He started his Ph.D. with Andre at Professor Jan Kees Maan's high magnetic field laboratory in August 1999. The laboratory was large, international and had a huge variety of projects running simultaneously.

3. In 2001 Andre Geim moved to Manchester and invited K. Novoselov to join him. He started to work in the laboratory of the University of Manchester. The team of Andre Geim was involved in several projects, including magnetic water, mesoscopic superconductivity, gesko tape, scanning tunneling microscopy (STM) with ***gate electrode***, etc. In 2001 Novoselov married Irina Barbolova (born in Vologda), (with a Ph.D. in microbiology received in St. Petersburg) and she joined their group. In 2003 K. Novoselov received Ph.D. In 2009 their two daughters (twins) Sophia and Victoria were born.

4. One of their projects initiated by Andre, was an attempt to make a metallic ***field effect transistor***. They started to examine graphite, mostly due to its low ***carrier concentration***. They cleaned graphite by ***cleaving*** it with Scotch tape (with residual flakes on it). In 2004 they got graphene. Konstantin Novoselov says that "it is impossible to learn the spirit of science from a textbook or article. They may be able to teach us physics

and chemistry and many other disciplines at university, but it is up to us to develop a good feeling of how best to do science. I am extremely lucky to have worked with and leaned from Andre Geim, who is highly innovative and broad in his perspective but, at the same time, very truthful and critical of himself, with manic attention to details. Andre is a master of finding the narrow path between extremes (details, theory and facts), and, if there is one thing I am proud in my life, it is that I have learned a little of this style".

5. K. Novoselov received many honours: Nicolas Kurti European Prize (2007), Technology Review – 35 Young Innovator (2008), Applied Science Young Scientist Prize (2008).

6. A. Geim together with K. Novoselov received the 2008 Euro-Physics Prize for discovering and ***isolating*** a single free-standing atomic layer of carbon (graphene) and elucidating its remarkable electronic properties. The Queen Elizabeth II awarded him the title of knight-bachelor for contribution to science (2011) with the right to be called "*Sir*". K. Novoselov was elected *Honorary Fellow of the Royal Society of Chemistry (2010), Honorary Fellow of the Institute of Physics (2011), Fellow of the Royal Society of London (2011)*. He published more than 60 scientific papers, including papers in journals 'Nature' and 'Science'.

Notes:
1. gate electrode – электрод затвора (полевого транзистора), управляющий электрод
2. field effect transistor – полевой транзистор
3. carrier concentration – концентрация носителей (заряд)
4. cleaving – расщепление, расслоение
5. isolating – выделение

IV. Read and translate text 19.2. Find in the text the information to prove that:

1. In Chernogolovka K. Novoselov got an opportunity to go abroad.
2. Novoselov moved to England.
3. He received Ph. D.
4. Geim's group discovered the two dimensional material.
5. K. Novoselov was lucky to work with A. Geim.
6. K. Novoselov received many honours.
7. Geim together with Novoselov received a Prize.

TEXT 19.3. ANDRE GEIM

1. Andre Geim (Andrey Konstantinovich Geim –1958), is a Soviet and Dutch physicist, who was awarded the Nobel Prize for Physics 2010 (jointly with Konstantin Novoselov) for groundbreaking experiments regarding the two-dimensional material – graphene.

2. Andre Geim was born in 1958 in the Black Sea resort of Sochi, the second son of Nina Bayer and Konstantin Geim, the family of engineers. His father came from so-called Volga Germans, descendants of colonists from Germany who settled on the Volga River banks in the 18th century. In 1964 A. Geim with his parents and his elder brother Vladislav went to live to Nalchik, where they worked.

3. His grandfather Nikolai Bayer was a professor at Kharkov University who specialized in aerial cartography. When Andre was born, his father was forty-eight years old. Before the Second World War he was a young professor at State University of Saratov, lecturing in physics and maths. However, when the war broke out in Europe, being ethnic German he was sent to a Gulag camp (forced labour camp) in Siberia, where he spent many years building a hydroelectric power station and a railway. In 1949 he was allowed to join his family, who had been deported to Novosibirsk. In the 19th century his grandmother's family lived in Poland (then a part of Russian Empire), where they took part in the 1863 uprising and consequently were deported to Siberia.

4. His grandmother Maria was a meteorologist and A. Geim spent his first years of life on the beach, around the weather station where she worked. His mother was a head of quality control (chief-technologist) and his father was an engineer-in-chief at a large vacuum-electronics factory. His father was a hard-working person. Perseverance and hard work were the qualities Andre inherited from him. A. Geim studied at a specialized English language school. Mathematics was taught at an extremely high level, physics and chemistry were taught at good level too. He was a disciplined Soviet pupil. In 1975 Andre finished a secondary school with a gold medal. His decision was to study physics. In 1976 he entered the Moscow Institute of Physics and Technology (Phystech). But before it, his tutor was a physics professor from Nalchik's University, Valery Petrosian. He taught Andre to deal with physics problem:"it is much easier to solve a problem if you first guess possible answers". Most problems at Phystech level require understanding of more than one area of physics and usually involve several logical steps. For example, in the case of a five-step

solution, if you try to solve the problem from both ends, guessing two or three plausible answers, the space of possibilities and logical steps is much reduced. This is the way A. Geim learned to think then and is still using it in his research every day trying to build all the logical steps between what he had and what he thought might be the end result of a particular project.

5. His tutor in Russian literature gave him an important lesson: in writing essays try to explain your own opinions and ideas and use authoritative phrases (literature critics and famous writers) only occasionally, to support and strengthen your writing. Her advice was crucial and it changed the way he wrote, so Andre was better at explaining his thoughts in writing than his fellow students. He studied at the Faculty of General and Applied Physics. All special and some general courses were taught by practising scientists from the Academy Institutes from all over the Moscow region. Active researchers gave undergraduate courses. Phystech students were forced to think and find logic in everything they studied, as opposed to just memorizing facts and formulas.

6. From the moment of its establishment Phystech was led by prominent Soviet scientists such as Kapitsa, Landau and many others. Among his lecturers and examiners were many eminent scientists as Emmanuel Rashba, Vladimir Pokrovskii, Victor Lidovskii, Spartak Belyaev, Lev Pitaevskii, Isaak Khalatnikov and Lev Gorkov.

7. The work load at Phystech was heavy and the courses – extremely challenging. The standard textbooks for quantum mechanics, statistical physics, electrodynamics and classical mechanics were from the Landau – Lifshitz Theoretical Physics Course. From the third year students started attending lectures at the so-called base institutes of the Academy of Sciences. A. Geim attended the Institute of Solid State Physics in Chernogolovka. From the fifth year students started working in research labs on real ongoing projects, where they worked as member of an academic research team. The sixth year was a Master's year and 100% research based. He graduated from Phystech (1982) with honours. Out of 50 final exam marks he got only two "good" (on political economy of socialism and superconductivity). The topic of his Master's project was electronic properties of metals which he studied by exciting electromagnetic waves (helicons) in spherical samples of ultrapure indium. After finishing the post-graduate course he received a Ph. D. (1987). He worked as staff scientist at the Institute of Solid State Physics (the USSR Academy of Science) in Chernogolovka and at the Institute of Problems of Microelectronics Technology.

V. Read and translate text 19.3. Answer the following questions:

1. What is Andre Geim?
2. What is he famous for?
3. What can you say about his family?
4. What can you say about his grand-parents?
5. Where did A. Geim study?
6. How did his teachers influence his future career?
7. Why did A. Geim work in Chernogolovka?

TEXT 19.4. RESEARCH OF A. GEIM

1. In 1990 Geim received a scholarship from Royal Society of England and moved to Europe. He worked at the Universities of Nottingham and Bath (England), the University of Copenhagen (Denmark), the University of Nijmegen (the Netherlands) and from 2001 at the University of Manchester (England). Now he is Director of Mesoscience and Nanotechnology Center in Manchester and also the head of Condensed State Physics Department.

2. Geim is a subject of the Kingdom of Netherlands. His wife is Irina Grigorieva (graduate of Moscow Steel and Alloys Institute, Ph.D.), she worked as well as A. Geim at the Institute of Solid State Physics in the USSR, and now she works together with her husband in the laboratory of the University of Manchester. They have a daughter Alexandra (2002).

3. One of the Geim's achievements is gesko tape (biomimetic adhesive or glue). He carried out experiments (jointly with mathematician and theoretician Sir Mikhail Berry) on diamagnetic levitation. The fields of his research were: semiconductor physics, mesoscopic superconductivity, magnetic field water, high magnetic fields and diamagnetism, metallic electronics (transistors, semiconductors, ultra-thin material carbon, and monotube transistors), thin films of graphene, and etc. In 2004 Andre Geim, together with his post-graduate and follower Konstantin Novoselov, invented the technology of producing graphene – the material of monoatom carbon layer. It was found in the course of their experiments that graphene has a number of unique properties: it possesses extreme strength, it conducts electricity as well as copper, it surpasses all materials in heat conductivity, and it is transparent for light but dense enough not to transmit even a helium molecule, the smallest of known molecules. These properties make graphene the perspective material for many applications such as production of sensor screens, light panels and solar batteries.

4. Geim has received several awards for his research on graphene, including the Mott medal (2007) for the discovery of a new class of materials – free-standing two dimensional crystals, in particular, graphene, the 2008 Euro Physics Prize (together with Novoselov) for discovering and isolating a single free-standing atomic layer of carbon (graphene) and elucidating its remarkable electronic properties, the 2009 Körber Prize for development the first two-dimensional crystals made of carbon atoms, Hughes Medal (2010), John J. Carty Award (2011). On October 5, 2010 the Nobel Prize in Physics was awarded to Andre Geim and Konstantin Novoselov from the University of Manchester for their work on graphene.

5. Geim is an honorary doctor of the Technical University of Delft, (Netherlands), High Technical School in Zurich (Switzerland), and the University of Antwerp. He has a title of Langworthy Professor of the University of Manchester (among the others were Ernest Rutherford, Lawrence Bragg and Patrick Blakett). He is also the Royal Society Research Professor (UK).

VI. Read and translate text 19.4. Find in the text the information to prove that:

1. A. Geim moved abroad.
2. His family lives with him.
3. He was involved in different fields of research.
4. A. Geim together with A. Novoselov invented a new technology.
5. He received many awards.
6. A. Geim has a high title in science.

TEXT 19.5. GRAPHENE

1. Graphene is an allotrope of carbon. Its structure is one-atom thick planar sheets of carbon atoms that are densely packed in a honeycomb crystal lattice. The term graphene was coined as a combination of graphite and the suffix – ene by Hannson-Peter Boehm who described single-layer carbon foils in 1962. Graphene is most easily visualized as an atomic-scale wire made of carbon atoms and their bonds. The crystalline or "***flake***" form of graphite consists of many graphene sheets ***stacked*** together.

2. The carbon-carbon ***bond length*** in graphene is about 0,142 nanometers. Graphene sheets stack to form graphite with an ***interplanar spacing*** 0,335 nm, one sheet of graphene is only one atom thick, which means that a stack of three million sheets would be only one millimeter thick

(approximately three quarters of the thickness of a US dime coin). Graphene is the basic structural element of some allotropes including graphite, charcoal, carbon nanotubes and fullerenes.

3. Graphene has been known since the invention of X-ray crystallography. Graphene planes become even better separated in ***intercalated*** graphite compounds. In 2004 physicists at the University of Manchester and the Institute for Microelectronics Technology in Chernogolovka (Russia) first isolated individual graphene planes by using adhesive tape. They also measured electronic properties of the obtained flakes and showed their unique properties. In 2005 the same Manchester Geim group together with the Philip Kim group from Columbia University demonstrated that quasiparticles in graphene were massless Dirac fermions. These discoveries led to an explosion of interest in graphene.

4. Graphene or ultra-thin graphitic layers were epitaxially grown on various substrates. Intercalated graphite compounds were studied in a transmission electron microscope (TEM). An early detailed study on few-layer graphene dates back to 1962. The earliest TEM images of few-layer graphene were published by G. Ruess and F. Vogt in 1948. However, already D.C. Brodie was aware of the highly ***lamellar*** structure of thermally reduced graphite oxide in 1859. It was studied in detail by V. Kohlschütter and P. Haenni in 1918, who also described the properties of graphite oxide paper.

5. The theory of graphene was first explored by P. R. Wallace in 1947 as a starting point for understanding the electronic properties of more complex 3D graphite. The emergent massless Dirac equation was first pointed out by Gordon Walter Semenoff and David P. DeVincenzo and Eugene J. Mele. Semenoff emphasized the occurrence in a magnetic field of an electronic Landau level precisely at the Dirac point. This level is responsible for the anomalous integer quantum Hall effect. More recently, graphene samples prepared on nickel films, and on both the silicon face and carbon face of silicon carbide, have shown the anomalous quantum Hall effect directly in electrical measurements. Even though graphene on nickel and on silicon carbide have both existed in the laboratory for decades, it was graphene mechanically ***exfoliated*** on SiO_2 that provided the first proof of the Dirac fermion nature of electrons in graphene.

Notes:

1. flake – чешуйка, пластинка
2. stack – укладывать в пачку, стопу

3. bond length – длина связи
4. interplanar spacing – расстояние между плоскостями
5. intercalated – слоистый, с прослойками
6. lamellar – пластинчатый
7. exfoliate – расслаивать, отслаивать

VII. Read and translate text 19.5. Explain each of the following:

1. Structure of graphene
2. Graphene as a structural element
3. Bond length and interplanar spacing
4. Crystalline form of graphene
5. Scientists who contributed to graphene investigation

19.6. PROPERTIES OF GRAPHENE

1. Graphene differs from most conventional three-dimensional materials. Intrinsic graphene is a semimetal or zero-gap-semiconductor. Graphene has a remarkably high electron mobility at room temperature. It may be a suitable material for the construction of quantum computers using anionic circuits. Graphene's unique optical properties produce an unexpec-tedly high opacity for an atomic monolayer. Graphene/graphene oxide system exhibits electrochromatic behavior, allowing ***tuning*** of both linear and ultrafast optical properties.

2. Graphene appears to be one of the strongest materials, because graphene has a ***breaking strength*** 200 times greater than steel. Graphene has the ideal properties to be an excellent component of integrated circuits. Graphene's high electrical conductivity and high optical transparency make it a candidate for transparent conducting electrodes, required for such applications as touchscreens, liquid crystal displays, organic photovoltaic cells, and organic light-emitting diodes. In particular, graphene's mechanical strength and flexibility are advantageous compared to indium tin oxide, which is brittle, and graphene films may be deposited from solution over large areas.

3. Due to the extremely high ***surface area*** to mass ratio of graphene, one potential application is in the conductive plates of ***ultracapacitors***. It is believed that graphene could be used to produce ultracapacitors with a greater energy storage density. Graphene's modifiable chemistry, large surface area, atomic thickness and molecularly-gatable structure make antibody-functionalized graphene sheets excellent candidates for mammalian and microbial detection and diagnosis devices. Integration of graphene (thickness of 0,34 nm) layers as nanoelectrodes into a nanopore can solve

one of the important issues of nanopore-based single-molecule DNA ***sequencing***.

4. Sheets of graphene oxide are highly effective at killing bacteria, this means that graphene could be useful in applications such as hygiene products or packaging that will help keep food fresh for longer periods of time.

Notes:

1. tuning – регулировка
2. breaking strength – сопротивление разрушению
3. surface area – площадь поверхности
4. ultracapacitor – ультраконденсатор
5. sequencing – расшифровка последовательности

VIII. Read and translate text 19.6. Enumerate the main properties of graphine.

TEXT 19.7. MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY

1. Moscow Institute of Physics and Technology (State University) (abbreviated MIPT, MIPT (SU) or informally Phystech (alternative transliterations: MFT Fiztech,) is a leading Russian university, originally established in the Soviet Union. It trains specialists in theoretical and applied physics, applied mathematics, and ***related*** disciplines. MIPT has its motto – 'Sapere aude (Dare to know; Dare to be wise)'. Moscow Institute of Physics and Technology was established in 1946 by a group of leading Soviet scientists including among others the Nobel Prize laureates P. Kapitsa, L. Landau and N. Semyonov. It is sometimes referred to as "the Russian MIT" (Massachusetts Institute of Technology).

2. MIPT is famous in the countries of the former Soviet Union. With its emphasis on practical research in the educational process, MIPT "***outsources***" education and research beyond the first two or three years to institutions of the Russian Academy of Sciences. MIPT's own faculty is relatively small, and many of its distinguished lecturers are ***visiting professors*** from those institutions. Student research is typically performed outside of MIPT. The main MIPT campus is located in Dolgoprudny, a northern suburb of Moscow. However the Aeromechanics Department is based in Zhukovsky, a suburb south-east of Moscow.

3. The following is a summary of the key principles of the Phystech

System, as outlined by Kapitsa in his 1946 letter arguing for the founding of MIPT:

- Rigorous selection of gifted and creative young individuals
- Involving leading scientists in student education, in close contact with them in their creative environment
- An individualized approach to encourage the cultivation of students' creative ***drive***, and to avoid overloading them with unnecessary subjects and rote learning common in other schools and necessitated by mass education
- Conducting their education in an atmosphere of research and creative engineering, using the best existing laboratories in the country

4. In its implementation, the Phystech System combines highly competitive admissions, extensive fundamental education in mathematics, as well as theoretical and experimental physics in the undergraduate years, and immersion in research work at leading research institutions of the Russian Academy of Sciences starting as early as the second or third year.

5. Apart from Kapitsa, other prominent scientists who taught at MIPT in the years that followed included the Nobel prize winners Nikolay Semyonov, Lev Landau, Alexandr Prokhorov, Vitaly Ginzburg and Academy of Sciences members Sergey Khristianovich, Mikhail Lavrentiev, Mstislav Keldysh, Sergey Korolyov, and Boris Rauschenbach. MIPT alumni include Andre Geim and Konstantin Novoselov, the 2010 winners of the Nobel Prize for Physics.

Notes:
1. related – связанный, родственный
2. outsource – организовывать … (на базе институтов)
3. visiting professor – специалист, приглашаемый для чтения цикла лекций в университет
4. drive – побуждение, стимул

XI. Read and translate text 19.7. Answer the following questions:

1. What is MIPT?
2. What specialists does it train?
3. What is its motto?
4. When was MIPT established?
5. Who helped in its foundation?
6. What is the emphasis in education?
7. Where is the main campus located?
8. What are the key principles of the Phystech System?
9. What does the Phystech System combine?
10. What prominent scientists worked at MIPT??

TEXT 19.8. DEPARTMENTS AND ADMISSION (MIPT)

1. The institute has eleven departments (with an average of 80 students admitted annually into each): Radio Engineering and Cybernetics, General and Applied Physics, Aerophysics and Space Research, Molecular and Biological Physics, Physical and Quantum Electronics, Aeromechanics and Flight Engineering, Applied Mathematics and Management, Problems of Physics and Power Engineering, Innovation and High Technology, Nano-, Bio-, Information and Cognitive Technologies, Information Business Systems.

2. Traditionally, applicants were required to take written and oral exams in both mathematics and physics, write an essay, and have an interview with the faculty. The interview has always been an important part of the selection process. Sometimes an applicant with lower exam grades could be admitted, and one with higher grades rejected, based solely on the interview results, but the interview remains an important part of the selection process.

3. The strongest performers in national physics and mathematics competitions and IMO/IPhO (Mathematics and Physics Olimpiads) participants are granted admission without exams, subject only to the interview. Students receive small scholarships and free housing in campus, which allows them to study full time.

XII. Read and translate text 19.8. What information have you learned about:

1. Departments of MIPT
2. Necessary exams for applicants
3. The important part of selection process
4. Admission without exams
5. Scholarship and housing

TEXT 19.9. EDUCATION AND BASE ORGANIZATIONS (MIPT)

1. It normally takes six years for a student to graduate from MIPT. The curriculum of the first three years consists exclusively of required courses, with emphasis on mathematics, physics, and English. There are no significant curriculum differences between the departments in the first three years. A typical course load during the first and second years can be over 48 hours a week, not including homework. Classes are taught five days a week, beginning at 9:00 am or 10:30 am, and continuing until 5:00 pm, 6:30 pm, or 8:00 pm. Most subjects include a combination of lectures

and seminars (problem-solving study sessions in smaller groups) or laboratory experiments. Lecture attendance is optional, while seminar and lab attendance affects grades.

2. Starting with the third year, the curriculum matches each student's area of specialization, and also includes more elective courses. Most importantly, starting with the third year, students begin work at base institutes (or "base organizations", usually simply called bases). The bases are the core of the Phystech system. Most of them are research institutes, usually belonging to the Russian Academy of Sciences. At the time of enrollment, each student is assigned to a base that matches his or her interests. Starting with the third year, a student begins to commute to their base regularly, becoming essentially a part-time employee. During the last two years, a student spends 4-5 days a week at their base institute, and only one day at MIPT.

3. In other words, a base organization is an extension of MIPT, specializing in each particular student's area of interests. While working at the base organization, a student prepares a thesis based on his or her research work and presents ("defends") it before the Qualification Committee consisting of both MIPT faculty and the base organization staff. Defending the thesis is a requirement for graduation.

4. Some years ago MIPT had 103 base organizations: Institute for Information Transmission Problems of RAS, Institute for Nuclear Research (RAS), Institute for Physical Problems, Institute for Problems in Mechanics (RAS), Institute for Spectroscopy (Russian Academy of Sciences), Institute for Theoretical and Experimental Physics, Institute of Biochemical Physics (RAS), Engelhardt Institute of Molecular Biology (RAS), Shirshov Institute of Oceanology, Institute of Molecular Genetics (RAS), Institute of Numerical Mathematics (RAS), Institute of Problems of Chemical Physics (RAS), Institute of Radio Engineering and Electronics of RAS, Institute of Solid State Physics (RAS), Joint Institute for Nuclear Research, Institute of Synthetic Polymer Materials (RAS), Institute for High Energy Physics, Kurchatov Institute (formerly Kurchatov Institute of Atomic Energy) etc.

5. In addition, a number of Russian and Western companies act as base organizations of MIPT. These include: 1C Company, ABBYY, Competentum Group or Physicon, NPMP "Concept Consulting", Intel, IPG Photonics, Kraftway, MetaSythesis, Paragon Software Group, S.P. Korolev Rocket and Space Corporation Energia, SWsoft; Yandex.

XIII. Read and translate text 19.9. Characterize in brief:

1. Course of education at MIPT
2. Carriculum and course load
3. Specialization and elective course
4. Base institutes
5. Defending the thesis
6. Base organizations (Russian and Western)

TEXT 19.10. DEGREES AND REPUTATION (MIPT)

1. Since 1998, students have been awarded a Bachelor's degree diploma after four years of study and the defense of a Bachelor's "qualification work" (effectively a smaller and less involved version of the Master's thesis). An estimated 90% of students continue their education after receiving this diploma to complete the full six-year curriculum and receive the Master's degree.

2. The complete course of education at MIPT takes six years to complete, just like an American Bachelor's degree followed by a Master's degree. However, MIPT graduates usually view their training as effectively higher than an American M.S. in Physics. The MIPT curriculum is, indeed, considerably more extensive compared to an average American college. In addition, American M.S. programs usually focus more on classroom education and less on research. There is an opinion that an MIPT specialist / Master's diploma may be roughly equivalent to an American Ph.D. in physics possibly an undue generalization which, however, may be true in some cases.

3. Many distinguished professors teaching at MIPT are officially on staff at the base institutes rather than MIPT itself. Student research work is also typically carried out outside of MIPT, and published research results do not mention MIPT.

4. About 30% of all students are residents of Moscow and Moscow region, the rest come from all over the former Soviet Union. Most out-of-town students live in the dormitory on campus for at least the first 4 years. Many senior students move to another dormitory in Moscow, while some either move to base institute dormitories or rent apartments. The student population is almost exclusively male, with the female/male ratio in a department rarely exceeding 15% (seeing 2-3 women in a class of 80 is not uncommon).

5. Most MIPT graduates continued research at their base institutes or found jobs in OKBs. Nowadays, many graduates become business people or software engineers. Some, especially high-performing students of

prestigious departments (e.g. DGAP, DCAM), go on to get post-graduate degrees from foreign universities. In the past some students were known to have been admitted into Ph.D. programs of American universities as early as after their 3rd year of education. Many MIPT alumni hold faculty positions in the world's top Universities, including Harvard, Princeton University, MIT, Columbia, Stanford, Brown, and University of Chicago.

XIV. Read and translate text 19.10. Discuss in brief:

1. Bachelor's and Master's degree
2. Differences in MIPT curriculum and American M.S. programs
3. Student's research work and publication
4. Out-of-town students   5. Student population (female / male ratio)
6. MIPT graduates

TEXT 19.11. CHERNOGOLOVKA

1. Chernogolovka is a town in Moscow Region (Russia) located 43 kilometers northeast from Moscow border. Its population is 20,986 people. Chernogolovka for the first time has been officially mentioned in 1710.

2. In 1956, Chernogolovka grew into a scientific center with the help of the Nobel Prize winner Nikolay Semyonov. Semyonov started the experimental branch of Moscow Institute of Chemical Physics, which in the 1960s–1970s grew into a scientific center. In 2001, Chernogolovka was granted a town status and given the further status as a naukograd or science city in 2008.

3. Administratively, Chernogolovka Town Under Region Jurisdiction is incorporated as Chernogolovka Urban Okrug. Chernogolovka does not have a rail link but ***long distance buses*** link the town to Moscow, Noginsk and Fryanovo.

4. Chernogolovka is a major Russian center of scientific research. It is home for a number of research institutions of the Russian Academy of Sciences: Institute of Problems of Chemical Physics, Institute of Solid State Physics, Institute of Physiologically Active Compounds, Institute of Microelectronics Technology and High Purity Materials, Landau Institute for Theoretical Physics, Institute of Energy Problems for Chemical Physics, Institute of Experimental Mineralogy, Institute of Structural Macrokinetics and Materials Science.

Notes:

1. long distance bus – междугородний автобус

XV. Read and translate text 19.11. Answer the following questions:

1. What is Chernogolovka?
2. Where is it located?
3. What did Chernogolovka grow into?
4. What was Chernogolovka granted?
5. What research institutions of RAS are there in Chernogolovka?

TEXT 19.12. INSTITUTE OF PROBLEMS OF CHEMICAL PHYSICS

1. The Institute of Problems of Chemical Physics (IPCP) of the Russian Academy of Sciences (RAS) is the largest Institute of the research center in Chernogolovka. The Institute consists of 10 scientific departments, about 100 laboratories and independent research groups. The staff of the Institute is 1500 people, among them more than 100 Professors and 350 PhD.

2. IPCP was established in 1956 as branch of the Moscow Institute of Chemical Physics of RAS. It was reorganized as an independent Institute of Chemical Physics of RAS in Chernogolovka (1991-1997) and as Institute of Problems of Chemical Physics (since 1997).

3. IPCP carries out investigations in the following fields: general problems of chemical physics, structure of molecules and solids, kinetics and mechanisms of complex chemical reactions, chemical physics of explosion and combustion, chemical physics of polymer synthesis and modification, chemical physics of biological processes and systems, chemical materials science.

4. In IPCP of RAS a unique experimental base, a testing area and specialized premises allowing large-scale investigations of rapid processes, combustion and explosion, chemical-technological and micro-biological installations, vivarium and a modern computer center have been established.

5. The Institute is the basis of a Branch of the Moscow State University, a chair of Moscow Physical Technical Institute and other high schools. Many students of different high schools of the former USSR and Russia were professionally trained in the IPCP RAS: more than a thousand PhD and ***SciD*** thesises were defended here. Specialists trained at the Institute work in the RAS organisations and collaborate with numerous foreign Universities and Institutes.

Notes:
1. SciD – учёная степень ‘доктор технических наук’

XV. Read and translate text 19.12. What information have you learned about:

1. IPCP (departments, laboratories, staff)
2. Foundation of IPCP
3. Investigations of IPCP
4. IPCP as a branch of MSU
5. Work of specialists trained at IPCP

XVI. Make up the abstracts of texts 19.1–19.12 (in English or in Russian).

XVII. Comment on the following quotation. Do you agree or disagree with it?

1. Creativity is a type of learning process where the teacher and pupil are located in the same individual. – (Arthur Koestler)

SECTION 20

TEXT 20.1. GEORG OHM

1. Georg Simon Ohm (1789-1854) was a German physicist who discovered the law (in 1827), named after him, which states that the current flow through a conductor is directly proportional to the ***potential difference*** (voltage) and inversely proportional to the resistance.

2. Ohm became professor of mathematics at the Jesuits’ College at Cologne in 1817. He accepted a position at the Polytechnic School of Nürnberg in 1833. In 1841 he was awarded the Copley Medal of the Royal Society of London and was made a foreign member a year later. The physical unit measuring electrical resistance was given his name. Ohm is a unit of electrical resistance in the metre-kilogram-second system. It is equal to the resistance of a circuit in which a potential difference of one volt produces a current of one ampere. Ohm’s law states that resistance equals the ratio of the potential difference to current and the ohm, volt and ampere are the respective fundamental units used universally for expressing ***quantities***.

Notes:
1. potential difference – разность потенциалов, (электрическое) напряжение

2. quantity – величина, параметр

TEXT 20.2. OHM'S LAW

1. Ohm's law (in electricity) is experimentally discovered ***relationship*** that the amount of direct current through a large number of materials is directly proportional to the potential difference (or voltage) ***across*** the materials. Ohm's law may be expressed mathematically as R = V/I. Resistance is the ratio of voltage to current for all or part of an electric circuit at a fixed temperature and is generally constant.

2. Ohmmeter is instrument for measuring electrical resistance, which is expressed in ohms. In the simplest ohmmeters, the resistance to be measured may be connected to the instrument in parallel or in series. ***Ratio meters*** measure the ratio of the voltage across the resistance to the current flowing through it. For high resistances, the scale is usually graduated in mega-ohms (10^6 ohms), and the instrument is called a ***megohmeter***, or 'megger'.

Notes:
1. relationship – отношение, связь, зависимость
2. across – сквозь, через
3. ratio meter – измеритель отношений, логометр
4. megohmeter – мегометр, мегаомметр

I. Read and translate text 20.1, 20.2. Find Russian equivalents for:

a German physicist, discover the law, directly proportional, inversely proportional, become professor of mathematics, resistance, the Royal Society of London, physical unit, equal, use universally, constant, connect in parallel, instrument is called, express mathematically, a large number of materials

II. Find English equivalents for:

поток электрического тока через проводник, разность потенциалов, напряжение, занимать должность, измерять, сопротивление в электрической цепи, отношение, для выражения величин, постоянный ток, соединять последовательно; шкала обычно градуируется (калибруется), экспериментально, количество

III. Read and translate texts 20.1 and 20.2. Answer the following questions:

1. What was Georg S. Ohm?
2. What was he famous for?
3. Where did G. Ohm work?
4. What was he awarded?
5. What unit is ohm?
6. What is Ohm's law?
7. What is ohmmeter?
8. What is ratio meter?

TEXT 20.3. ELECTRICAL & ELECTRONICS ENGINEERING

1. ***Electrical engineering*** deals with the practical application of electricity in all forms, including those of the field of electronics. ***Electronics engineering*** is that branch of electrical engineering concerned with the uses of the electromagnetic spectrum and with the application of such electronic devices as integrated circuits, transistor and vacuum tubes. Electrical engineering is the branch dealing with "heavy current" – that is, electric light and power systems and apparatuses, whereas electronic engineering deals with such "light current" applications as wire and radio communication, the stored-program electronic computer, radar and automatic control systems.

2. Electrical phenomena attracted the attention of scientists as early as the 17th century. Beginning as a mathematically oriented science, the field has remained primarily in that form, mathematical ***predication*** often precedes laboratory demonstration. The most noteworthy pioneers include Ludwig Wilhelm Gilbert and Georg Simon Ohm (Germany), Hans Christian Ørsted (Denmark), Andre-Marie Ampere (France), Alessandro Volta (Italy), Joseph Henry (the United States) and Michael Faraday (England). Electrical engineering may be said to have emerged as a discipline in 1864 when the Scottish physicist James Clerk Maxwell summarized the laws of electricity in mathematical form and predicted that radiation of electromagnetic energy would occur in a form that later became known as radio waves.

3. The first practical application of electricity was the telegraph invented by Samuel F. B. Morse in 1837. The telephone was invented by Alexander Bell (1876) and the incandescent lamp by Thomas A. Edison (1878). These devices and Edison's first central ***generating plant*** in New York City (1882) created a large demand for men trained to work with electricity.

4. The discovery of the "Edison effect", a flow of current through the vacuum of one of his lamps, was the first observation of current in space.

Hendrick Anton Lorentz of the Netherlands predicted the electron theory of electrical charge in 1895, and in 1897 J. J. Thomson (England) showed that the Edison effect was indeed caused by negatively charged particles (electrons). This led to the work of Guglielmo Marconi (Italy), A. Popov (Russia), Lee De Forest (the U.S.) and many others, who laid the foundation of radio engineering.

5. In 1930 the term "electronics" was introduced to embrace radio and the industrial applications of electron tubes. Since 1947, when the transistor was invented by John Bardeen, William H. Brattain and William B. Shockley, electronics engineering has been dominated by applications of such ***solid-state*** electronic devices as transistor, semiconductor diode and integrated circuit.

Notes:
1. electrical engineering – электротехника
2. electronics engineering – электронная техника
3. predication – утверждение
4. generating plant – электростанция
5. solid-state – твердотельный прибор, полупроводниковый прибор

IX. Read and translate text 20.3. Identify, define or explain each of the following:

1. Electrical engineering
2. Electronics engineering
3. Pioneers in electrical engineering
4. Practical application of electricity
5. Pioneers in radio engineering
6. Electronics

20.4. ELECTRICAL & ELECTRONICS ENGINEERING FUNCTIONS

1. Research. The functions performed by electrical and electronics engineers include:

- Basic research in physics, other sciences and applied mathematics in order to extend knowledge ***applicable*** to the field of electronics;
- ***Applied research*** based on the findings of ***basic research*** and directed at discovering new applications and principles of operation;
- Development of new materials, devices, assemblies and systems suitable for existing or proposed product lines;
- Design of devices, equipment and systems for manufacture;
- ***Field-testing*** of equipment and systems;

- Establishment of quality control standards to be observed in manufacture;
- ***Supervision*** of manufacture and production testing;
- Postproduction ***assessment*** of ***performance***, maintenance and repair;
- Engineering management or direction of research, development, engineering, manufacture, marketing and sales.

2. Consulting. The rapid proliferation of new discoveries, products and markets in the electrical and electronics industries has made it difficult for workers in the field to maintain the range of skills required to manage their activities. ***Consulting engineers***, specializing in new fields, are employed to study and recommend courses of action.

3. The educational background required for these functions tends to be the highest in basic and applied research. In most major laboratories a doctorate in science or engineering is required to fill leadership roles. Most positions in design, product development and supervision of manufacture and quality control require a master's degree. In the high-technology industries typical of modern electronics, an engineering background at not less than the bachelor's level is required to assess competitive factors in sales engineering to guide marketing strategy.

Notes:
1. applicable – пригодный, применимый
2. applied research – прикладные исследования
3. basic research – фундаментальные исследования
4. field-testing – эксплуатационные (производственные) испытания
5. supervision – надзор, наблюдение
6. assessment – оценка, определение
7. performance – эксплуатационные качества
8. consulting engineer – инженер-консультант

VIII. Read and translate text 20.4. Enumerate the main functions of electrical and electronics engineering.

IX. Make up the abstracts of texts 20.1–20.4 (in English or in Russian).

X. Comment on the following quotation. Do you agree or disagree with it?

1. Every great advance in science has issued from a new audacity of imagination. – (John Dewey)

SECTION 21

TEXT 21.1. HANS OERSTED

1. Hans Christian Oersted (1777-1851) was a Danish physicist and chemist who discovered that electric current in a wire can deflect a magnetized needle of compass, a phenomenon the importance of which was rapidly recognized and which inspired the development of electromagnetic theory.

2. In 1806 Oersted became a professor at the University of Copenhagen, where his first physical researches dealt with electric currents acoustics. During an evening lecture in April 1820, Oersted discovered that a magnetic needle aligns itself perpendicularly to a current-carrying wire, definite experimental evidence of the relationship between electricity and magnetism. This phenomenon had been first discovered by the Italian jurist Gian Domenico Romagnosi in 1802, but his announcement was ignored.

3. Oersted's discovery of piperine (in 1820), one of the pungent components of pepper, was an important contribution to chemistry, as was his preparation of metallic aluminum in 1825. In 1824 he founded a society devoted to the spread of scientific knowledge among the general public. Since 1908 this society has awarded an Oersted Medal for outstanding contributions by Danish physical scientists. In 1932 the name oersted was adopted for the physical unit of magnetic field strength in the c.g.s. system of units (based on the centimetre, gram and second). A field has a strength of one oersted if it exerts a force of one dyne on a unit magnetic pole placed in it.

I. Find Russian equialents for:

Danish physicist and chemist, discover, phenomenon, development of electromagnetic theory, physical researches, during an evening lecture, magnetic needle, relationship between electricity and magnetism, important contribution to chemistry, spread of scientific knowledge, physical unit of magnetic field strength

II. Find English equialents for:

электрический ток в проволоке, отклонять намагниченную стрелку компаса, значение (важность), быстро признавать, воодушевлять, стать профессором, иметь дело с, токонесущий провод, определенное экспериментальное доказательство, основать общество, награждать за выдающийся вклад, воздействовать силой

III. Read and translate text 21.1. Answer the following questions:

1. What was Hans Øersted?
2. What was he famous for?
3. Where did he work?
4. What experimental evidence did Øersted discover?
5. What was his contribution to chemistry?
6. Why did H. Øersted find a society?
7. What for did his name was adopted?

TEX 21.2. ELECTRICITY AND MAGNETISM

1. Electricity is a form of energy resulting from the existence of charged particles (electrons, protons, etc), either statically as an ***accumulation*** of charge or dynamically as a current (i.e. static electricity and ***current electricity***). Current electricity consists of a flow of charges, specifically electrons. Current electricity was first demonstrated by Volta in 1800 and investigated by Ampere during the next 25 years. Oersted's discovery (1820) that a magnetic needle was deflected by an electric current inspired Faraday to a deep investigation of the relationship between electricity and magnetism, which led him to the discovery of electromagnetic induction, the electric generator and the electric motor. The theory of electromagnetism was elucidated by Clerk Maxwell in the mid-1850s.

2. Magnetism is a phenomenon in which one body can exert a force on another body with which it is not in contact (action at a distance). The space in which such a force exists is called a magnetic field. Faraday explained the action-at-a-distance forces produced by a magnet. The magnet is surrounded by a field of force, within which its magnetic properties are effective. The strength and direction of the field is indicated by the lines of force that join the magnets's north and south poles.

Notes:
1. accumulation – аккумулирование, накопление
2. current electricity – электрический ток

IV. Find Russian equialents for:

form of energy, statistically, dynamically, current electricity, flow of charges, demonstrate, discovery of electromagnetic induction, electric generator, electric motor, action at a distance, magnetic field, explain, strength and direction of the field, north and south poles

V. Find English equialents for:

вид энергии, существование заряженных частиц, накопление заряда, состоять из, исследовать, разъяснять теорию, одно тело может оказывать силу на другое тело, окружать, магнитные свойства, показывать (обозначать) силовыми линиями, явление

VI. Read and translate text 20.3. Identify, define or explain each of the following:

1. Electricity
2. Static electricity
3. Current electricity
4. Magnetism
5. Magnetic field
6. Scientists contributed to the study of electricity
7. Strength and direction of magnetic field

TEX 21.3. MAGNET

1. Magnet is a body that has an appreciable external magnetic field. Magnetic field is the ***concept*** devised by Faraday to explain the action-at-a-distance forces produced by a magnet. The magnet is thought of as being surrounded by a field of force, within which its magnetic properties are effective. If two magnets are brought together, the like poles repel each other and the opposite poles attract each other.

2. Ferromagnetic materials (iron, cobalt, nickel, and alloys of this materials) are attracted to magnets because the magnet induces a field in the material ***in line with*** its own field. Permanent magnets are made of ferromagnetic materials and retain their magnetism unless they are heated above a certain temperature or are demagnetized by a strong opposing field.

3. Electromagnetic field is a concept describing electrical and magnetic forces that, like gravitational forces, act without physical contact (action at distance). The interaction of electricity and magnetism was first investigated in the 19^{th} century. Faraday explained the electromagnetic

interaction ***in terms of*** magnetic lines of force, forming a field of force, which is distorted by the presence of a ***current-carrying*** conductor or by another magnet. James Clerk Maxwell developed the theory that electricity and magnetism are different manifestation of the same phenomenon (the electromagnetic field), magnetism being the result of relative motion of electric fields.

4. A wire carrying an electric current is also surrounded by a magnetic field, with concentric lines of force. Electromagnetism is the action of the magnetic forces produced by electricity. An electromagnet usually has a a magnet consisting of a soft ferromagnetic core with a coil of insulated wire wound round it. When a current flows through the wire, the core becomes magnetized; when the current ceases to flow, the core loses its magnetization. The lines of force in an electromagnet run through the centre of the coil and around its circumference. Electromagnets are used in switches, solenoids, electric bells, metal-lifting cranes, and many other applications.

Notes:
1. concept – понятие, концепция
2. in line with – в соответствии с
3. in terms of – на основе, с учётом, в зависимости от, через
4. current-carrying – токонесущий

VIII. Read and translate text 21.3. Identify, define, or explain each of the following:

1. Magnet
2. Magnetic field
3. Like and opposite poles
4. Ferromagnetic materials
5. Electromagnetic field
6. Electromagnetic interaction
7. Maxwell’s development of theory
8. Electromagnet

IX. Make up the abstracts of texts 21.1–21.3 (in English or in Russian).

X. Comment on the following quotation. Do you agree or disagree with it?

1. The human mind once stretched by a new idea never goes back to its original dimensions. – (Oliver Wendell Holmes)

SECTION 22

TEXT 22.1. BLAISE PASCAL

1. Blaise Pascal (1623-1662) was a French physicist, mathematician, and religious philosopher and writer, who laid the foundation for the modern ***theory of probabilities*** and formulated the law of pressure.

2. Pascal was born on June 19, 1623, at Clermont-Ferrand (France), where his father, Etienne Pascal, was presiding judge of the tax court. His mother died in 1626, and in 1631 the family moved to Paris. Etienne, who was respected as a mathematician, devoted himself ***henceforth*** to the education of his children. While his sister Jacqueline (born in 1625) figured as an infant prodigy in literary circles, Blaise proved himself no less precocious in mathematics.

3. In 1640 (at the age of 17) Pascal published an essay on mathematics (***conic sections***) that was highly regarded in the academic community and praised by the mathematician Rene Descartes. Between 1642-1644, Pascal conceived and constructed a calculating device to help his father – who in 1639 had been appointed intendant (local administrator) at Rouen in his tax computations. This machine was the first digital calculator since it operated by ***counting integers***.

4. Further studies in geometry, hydrodynamics, and hydrostatic and atmospheric pressure led him to invent the syringe and to discover Pascal's law of pressure (1647-54), to create the hydraulic press and the principle of the hydraulic press (1650). He composed treatises on the equilibrium of liquid solutions, on the weight and density of air, and on the arithmetic triangle.

5. The two works for which he is chiefly known in religious philosophy are '***Provincial Letters***' were an immediate success due to their form, in which for the first time the bombast and tedious rhetoric of traditional French prose are replaced by variety, brevity, tautness and precision of style; they mark the beginning of modern French prose. 'Throughts' consists of his notes and manuscript fragments of his Christian apologetics.

6. Pascal's major works were in the field of mathematics, physics, logic, the foundations of science, and religious philosophy. Pascal spent his last years in scientific research and good works. Pascal died on August 19, 1662.

Notes:
1. theory of probabilities – теория вероятности
2. henceforth – с этого времени
3. conic section – коническое сечение
4. counting integer – подсчёт целых чисел
5. Provincial Letters – письма к провинциалу

I. Find Russain equialents for:

a French physicist, mathematician, religious philosopher and writer, modern theory of probabilities, education, publish an essay on mathematics, a calculating device, digital calculator, hydrodynamics, hydrostatic and atmospheric pressure, principle of hydraulic press, weight and density of air, major works, field, scientific research

II. Find English equialents for:

заложить основы, сформулировать закон давления, ребёнок-вундеркинд, не по годам развитый в математике, академическое сообщество, подсчёты налогов, изобретать шприц, писать трактаты о равновесии жидких растворов, арифметический треугольник, благодаря (из-за), разнообразие, краткость, чёткость и точность стиля, основы наук

III. Read and translate text 22.1. Answer the following questions:

1. What was B. Pascal?
2. What was he famous for?
3. What can you say about his family?
4. What fields did he study?
5. What device did Pascal construct?
6. What did Pascal discover and create?
7. Why was he praised by the mathematician?
8. Why was he known in religious phylosophy?

IV. What do the following dates refer to:

1623, 1621, 1625, 1631, 1639, 1640, 1642-1644, 1647-1654, 1650, 1662

TEXT 22.2. PASCAL'S LAW

1. Pascal's law (or principle) in ***fluid*** (gas or liquid) ***mechanics*** is a statement that in a confined fluid, externally applied pressure is transmit-

ted ***uniformly*** in all directions. In a closed container a pressure change in one part is transmitted without loss to every portion of the fluid and to the walls of the container. The law was discovered in 1647 by Blaise Pascal.

2. Pressure is equal to the ***face*** divided by the area on which it acts. According to Pascal's principle, in a hydraulic system a pressure exerted on a ***piston*** produces an equal increase in pressure on another piston in the system. If the second piston has an area ten times that of the first, the force on the second piston is ten times greater, though the pressure is the same as that on the first piston. This effect is exemplified by the hydraulic press, based on Pascal's principle, which is seen in such applications as hydraulic brakes, the pneumatic tyre, etc.

3. Pascal (Pa) is unit of pressure in the metre-kilogram-second (SI) system. A pascal is a pressure of one Newton's per square metre (N/m^2). This unit is inconveniently small for many purposes, and the kilopascal (kPa) of 1000 newtons per square metre is more commonly used in ***engineering*** work (one pound per square inch equals 6.895 kPa).

Notes:
1. fluid mechanics – механика жидкостей и газов, гидромеханика
2. fluid – текучая среда, жидкость, газ
3. uniformly – равномерно
4. face – поверхность
5. piston – поршень, плунжер
6. engineering – машиностроение, строительство

V. Read and translate text 22.2. Identify, define or explain each of the following:

1. Pascal's law
2. Discovery of law
3. Pressure in hydraulic system
4. Pascal as unit

TEXT 22.3. PASCALINE

1. Somewhere around 3000 BC the Chinese developed a frame and bead device, called the abacus, for adding large sets of numbers. It is believed that this device grew out of a calculating method developed in ancient Babylon. The abacus became popular because it did not require an educated operator. You don't need to be able to read and write or have a great deal of knowledge about a numbering system to calculate with an abacus. In early Babylon and China, as well as in the rest of the ancient

world, most people were uneducated, and the abacus proved to be a most useful calculating device.

2. The abacus remained the primary device for calculating throughout much of early human history. Although there were other devices for measuring and predicting the motion of stars and planets, the first mechanical calculating device was not invented until the 17th century. For hundred of years, scholars have credited Blaise Pascal with the invention of the first mechanical calculating machine in about 1642.

3. When Blaise Pascal was a young man, he worked for his father, a French tax official. Pascal's father had to prepare documents that contained several columns of numbers. Blaise thought there must be a better and easier way handle the tedious work of adding and balancing figures. In 1642, at the age of 19, Blaise Pascal invented a calculating device using ***levers and gears*** to add and subtract numbers mechanically. He called this mechanical device the pascaline, which proved to be a rather remarkable and accurate machine for the limited tasks of adding and subtracting.

4. The pascaline could do the work of many clerks with amazing speed and accuracy. However, many people were afraid of the pascaline. Some felt it was too complex and difficult to use. Some bookkeepers were afraid that such an efficient machine would eventually cause them to lose their jobs. For these reasons, Pascal was able to build and distribute only about 50 working models of the pascaline.

5. Later in the 17th century, a German philosopher and mathematician, Gottfried Wilhelm von Leibnitz, further enhanced the pascaline. Leibnitz developed a machine that could multiply, divide and calculate numerical roots. This machine was the forerunner of modern hand-held calculators.

Notes:

1. levers and gears – рычажки и шестерёнки

VI. Read and translate text 22.3. Tell your partner about the history of invention of pascaline (abacus, a calculating device, its characteristics, G. Leibnitz's machine).

TEXT 22.4. PROGRAMMING LANGUAGE

1. Pascal (named after Blaise Pascal) is a programming language developed in the late 1960s specifically as a teaching ***tool*** to assist the teaching of programming as a systematic discipline. It incorporates the

control structures of ***structured programming*** – sequence, selection and repetition – and data structures – arrays, records, files, sets, and user – defined types. It is an ***austere*** language, with a minimum of facilities. Pascal was relatively easy to implement on a variety of machines since the Pascal compile was written in Pascal. Used first as an education tool, Pascal became a more-or-less standard language for the teaching of ***computer science***. Standard Pascal is used on mainframes and minicomputers; the microcomputer programming field is dominated by Turbo Pascal for both DOS and Windows and Think Pascal for the Macintosh.

2. Turbo languages are ***implementations*** of popular programming language by Borland (a major US-based producer of tools to support software development, it was founded in 1983) for the IBM PC and equivalents. They include Turbo C^{++} and Turbo Pascal. They were characterized by extremely fast compile speed and an integrated environment comprising editor, compiler and debugger.

Notes:

1. tool – средство, приспособление, инструмент, орудие
2. structured programming – структурное программирование
3. austere – простой
4. computer science – информатика
5. implementation – реализация, внедрение

VII. Read and translate text 22.3. Tell your partner about the Pascal (date of development, structure, application, Turbo labguages).

VIII. Make up the abstracts of texts 22.1-22.4 (in English or in Russian)

IX. Comment on the following quotation. Do you agree or disagree with it?

1. Man is but a reed, the weakest thing in nature; but a thinking reed. (Blaise Pascal 1632– 662, – French mathematician and philosopher)

SECTION 23

TEXT 23.1. MAX PLANCK

1. Max (Karl Ernst Ludwig) Planck (1858-1947) was a German theoretical physicist who originated quantum theory. For that achievement

he was awarded the Nobel Prize for Physics in 1918. Quantum theory revolutionized our understanding of atomic and subatomic processes.

2. Max Planck was born in April 23, 1858, in Kiel (Germany) and was the sixth child of a distinguished jurist and professor of law at the University of Kiel. The long family tradition of devotion to church and state, excellent in scholarship, incorruptibility, conservatism, idealism, reliability and generosity became deeply ingrained in Planck's own life and work.

3. When Planck was nine years old, his father received an appoinment at the University of Munich, and Plank entered the city's renowned Maximilian Gymnasium, where a teacher stimulated his interest in physics and mathematics. But Planck excelled in all subjects, and after graduation he ultimately chose physics over classical philology or music. Music, nevertheless, remained an integral part of his life, he was an excellent pianist, enjoying especially the works of Schubert and Brahms. He also loved the outdoors, taking long walks each day and hiking and climbing in the mountains on vacations, even in advanced old age.

4. Planck entered the University of Munich in 1874, and studied also at the University of Berlin (1877-78). He received his doctoral degree on the second law of thermodynamics in 1879 at the unusually young age of 21. In 1880 he completed his qualifying dissertation at Munich and became a Privatdozent (lecturer). In 1885 he was appointed ***associate professor*** at the University of Kiel. In 1889 Planck received an appointment to the University of Berlin, where he was promoted to ***full professor*** in 1892. His Berlin lectures on all branches of theoretical physics went through many editions and exerted great influence. He remained in Berlin for the rest of his active life.

Notes:

1. associate professor – доцент
2. full professor – профессор

I. Find Russian equialents for:

a German theoretical physicist, quantum theory, to award the Nobel Prize for Physics, atomic and subatomic processes, reliability and generosity, interest in physics and mathematics, after graduation, an excellent pianist, enter the University at young age, for the rest of his active life, study at University

II. Find English equialents for:

создавать, достижение, производить коренной перелом в понимании, преданность церкви и государству, получать назначение (должность), получать степень доктора наук, оказывать большое влияние, завершить написание диссертации, продвигать, оставаться неотъемлемой частью его жизни

III. Read and translate text 23.1. Answer the following questions:

1. What was Max Planck?
2. What was he famous for?
3. What can you say about his family?
4. Where did M. Planck study?
5. What were his hobbies?
6. Where did he work?
7. What can you say about his lectures?

IV. What do the following dates refer to?

1867, 1874, 1877-78, 1879, 1885, 1889, 1892

TEXT 23.2. RESEARCH OF M. PLANCK

1. He deliberately decided to become a theoretical physicist at a time when theoretical physics was not yet recognized as a discipline. The entropy law, the second law of thermodynamics, became the subject of his doctoral dissertation and it lay at the core of the researches that led him to discover the quantum of action, now known as Planck's constant ***h***, in 1900. Planck was 42 years old in 1900 when he made the famous discovery (energy quanta), that brought him many honours. Planck formulated the correct mathematical description of thermal radiation from a perfect absorber (***blackbody***) and showed that the formulation required a discontinuous process of emission or absorption involving discrete quantities of energy. Those discoveries initiated the field of quantum physics.

2. Nevertheless, he continued to contribute at a high level to various branches of objects, thermodynamics and statistical mechanics, physical chemistry and other fields. In his later years, Planck devoted more of his writings to philosophical, aesthetic and religious questions. Planck became permanent secretary of the mathematics and physics sections of the Prussian Academy of Sciences in 1912 and held that position until 1932. He was also president of the Kaiser Wilhelm Society (now the Max Planck Society) from 1930 to 1937. These offices and others placed Planck in a

position of great authority, especially among German physicists. His authority stemmed fundamentally from his personal moral force. His fairness, integrity and wisdom were ***beyond question***. He remained in Germany during the Nazi period to try to preserve what he could of German physics.

3. Planck was a man of indomitable will. He had to withstand the tragedies that entered his life after age 50. In 1909, his first wife, Mary Merck, the daughter of a Munich banker, died after 22 years of happy marriage, leaving Planck with two sons and twin daughters. The elder son, Karl, was killed in action in 1916. His daughter, Margarete, died in childbirth in 1917, and in 1919 the same fate befell Emma, his other daughter. The younger son, Erwin, died a horrible death at the hands of the Gestapo in 1945. Planck's house in Berlin was completely destroyed by bombs in 1944. Planck and his second wife, Margarete von Hoesslin, whom he had married in 1910 and by whom he had one son, went to Göttingen. There, on October 4, 1947, in his 89th year, he died. Planck described his life and work in his 'Scientific Autobiography, and Other Papers' (1949).

Notes:

1. blackbody – полный (идеальный) излучатель, излучатель Планка
2. beyond question – вне всякого сомнения

V. Find Russian equialents for:

subject of his doctoral dissertation, to discover the quantum of action, Planck's constant, thermal radiation, discrete quantities of energy, to initiate the field of quantum physics, thermodynamics and statistical mechanics, physical chemistry, become permanent secretary, a position of great authority, elder son, younger son, describe his life

VI. Find English equialents for:

признавать, в центре его исследований, сделать известное открытие, сформулировать правильное математическое описание, непрерывный процесс выделения и поглощения, вносить вклад; посвящать бóльшую часть своих произведений философским, эстетическим и религиозным вопросам; его личная нравственная сила; честность, целостность и мудрость, человек упорной воли, выдерживать (противостоять) трагедии, разрушать

VII. Read and translate text 23.2. Answer the following questions:

1. When did M. Planck decide to become a theoretical physicist?
2. What did he discover?
3. What discoveries initiated the field of quantum physics?
4. What fields did M. Planck also contribute?
5. What can you say about his career?
6. What can you say about Planck's personal qualities?
7. What tragedies had he experienced?
8. Where did Planck describe his life and work?

VIII. What do the following dates refer to?

1900, 1912-1932, 1930-1937, 1909, 1917, 1919, 1944, 1945, 1947, 1949

TEXT 23.3. PLANCK'S RADIATION LAW

1. Planck's radiation law is a mathematical relationship formulated in 1900 by Max Planck to explain the spectral-energy distribution of radiation emitted by a blackbody (a hypothetical body that completely absorbs all radiant energy falling upon it, reaches some equilibrium temperature, and then reemits that energy as quickly as it absorbs it). Planck assumed that the sources of radiation are atoms in a state of oscillation and that the vibrational energy of each oscillator may have any of a series of discrete values but never any value between.

2. Planck further assumed that when an oscillator changes from a state of energy to a state of lower energy, the discrete amount of energy is emitted as a photon, or quantum of radiation. The energy of this quantum is equal to the product of the frequency of the radiation, symbolized by the Greek letter nu, υ, and a constant, h**,** now called Planck's constant; i.e. $E_1 – E_2 = H\upsilon$. The dimension of Planck's constant is the product of energy multiplied by time, a quantity called action. Planck's constant is often defined, therefore, as the elementary ***quantum of action***. Its ***value*** in metre-kilogram-second units is $6.6260755 \times 10^{-34}$ joule-second. Planck's constant describes the behaviour of particles and waves on the atomic scale, including the particle aspect of light.

3. For a blackbody at temperatures up to several hundred degrees, the majority of the radiation is in the infrared region of the electromagnetic spectrum. At increasingly higher temperatures, the total radiated energy

increases, and the intensity peak of the emitted spectrum shifts to shorter wavelengths so that a significant portion is radiated as visible light.

Notes:
1. quantum of action – квант действия
2. value – значение, величина

IX. Read and translate text 23.3. Identify, define or explain each of the following:

1. Planck's radiation	3. Planck's constant
2. Photon	4. Processes at higher temperatures

X. Make up the abstracts of texts 23.1-23.3 (in English or in Russian)

XI. Comment on the following quotation. Do you agree or disagree with it?

1. The goal is nothing other than the coherence and completeness of the system not only in respect of all details, but also in respect of all physicists of all places, all times, all peoples and all cultures. (Max Ernst Ludwig Planck 1858–1947, – German physicist)

SECTION 24

TEXT 24.1. ALEKSANDR PROKHOROV

1. Aleksandr Mikhaylovich Prokhorov (1916-2000) was a Russian physicist who received, jointly with Nikolay Gennadiyevich Basov of Russia and Charles H. Townes of the United States, the Nobel Prize for Physics in 1964 for fundamental research in quantum electronics that led to the development of the maser and laser.

2. Prokhorov joined the P.N. Lebedev Physical Institute (Moscow) as a senior associate in 1946. He and Basov jointly suggested the maser principle of amplifying and emitting parallel electromagnetic waves that are all in phase and all of the same wavelength. In 1954 Prokhorov became head of the Institute's ***Oscillation*** Laboratory and later professor at M.V. Lomonosov Moscow State University.

3. He received the Lenin Prize in 1959 and later two Orders of Lenin and various medals. In 1971 he was elected corresponding member of the American Academy of Arts and Sciences. Prokhorov has written a number of fundamental works on the construction of infrared and visible light lasers and on non-linear optics.

4. Basov N.G. (1922-2001) was a Russian physicist best known for the development of the maser, the precursor of the laser. In 1955, working as a research student with Aleksandr Prokhorov at Russian Academy of Sciences, he devised a microwave amplifier based on ammonia molecules.

Notes:

1. oscillation – колебание, осцилляция, генерация

I. Find Russian equialents for:

Russian physicist, receive the Nobel Prize for Physics, fundamental research in quantum electronics, principle of amplifying and emitting parallel electromagnetic waves, oscillation, elect, infrared and visible light lasers, microwave amplifier

II. Find English equialents for:

вместе с, разработка (развитие), предлагать, одинаковая длина волны, стать руководителем лаборатории, член-корреспондент американской академии искусств и наук, нелинейная оптика, предшественник (предтеча), аммиак, придумывать (изобретать)

III. Read and translate text 24.1. Answer the following questions:

1. What was A. Prokhorov?
2. What was he famous for?
3. Where did A. Prokhorov work?
4. What principle did he and N. Basov suggest?
5. What awards did A. Prokhorov receive?
6. What works did A. Prokhorov write?
7. What device did N. Basov invent?

TEXT 24.2. CHARLES TOWNES

1. Charles Townes (1915 –) is American physicist, who independently developed a maser. Townes studied at Furman University (B.A., B.S., 1935), Duke University (V.F., 1937) and the California Institute of Technology (Ph.D., 1939). In 1939 he joined the technical staff of Bell Telephone Laboratories, Inc., where he worked until 1948, then he joined the faculty of Columbia University. Three years later he had the idea that culminated in construction of the maser, in December 1953.

2. From 1959 to 1961 Townes served as vice president and director of research of the Institute for Defense Analyses, Washington, D.C. He then was appointed ***provost*** and professor of physics at Massachusetts Institute of Technology (Cambridge). In 1967 he became a professor at the University of California, Berkeley, where he initiated a program of radio and infrared astronomy leading to the discovery of complex molecules (ammonia and water) in the interstellar medium. He became ***professor emeritus*** in 1986.

3. In addition to the Nobel Prize (1964), Townes received the NASA distinguished Public Service Medal in 1969, was named to the National Inventors Hall of Fame in 1976, and was awarded the Niels Bohr International Gold Medal in 1979.

Notes:

1. provost – ректор
2. professor emeritus – заслуженный профессор в отставке

IV. Read and translate text 24.2. Answer the following questions:

1. What was Charles Townes?
2. What was he famous for?
3. Where did Townes study?
4. Where did he work?
5. What did he construct?
6. What did Townes discover?
7. What awards did he receive?

TEXT 24.3. MASERS AND LASERS

1. ***Maser*** (***microwave amplification by stimulated emission of radiation***) is a device for amplifying or generating microwaves by means of stimulated emission. Stimulated emission (or induced emission) is the emission of a photon by an atom in the presence of electromagnetic radiation. The atom can become excited by the absorption of a photon of

the right energy and, having become excited, the atom can emit a photon. The rate of absorption is equal to the rate of induced emission, both rates being proportional to the density of photons of the electromagnetic radiation. The process of induced emission is essential for the operation of masers and lasers. As ***oscillators***, masers are used in atomic clocks, while they are used as amplifiers in radio astronomy, being especially suitable for amplifying feeble signals from space. There are two types of masers: the ammonia gas and the solid-state maser.

2. ***Laser*** (***light amplification by stimulated emission of radiation***) is a light amplifier usually used to produce monochromatic coherent radiation in the infrared, visible, and ultraviolet regions of the electromagnetic spectrum. Lasers that operate in the X-ray region of the spectrum are also developed. Some lasers are solid, others are liquid or gas devices. Lasers have found many uses since their invention in 1960, including laser welding, surgery, holography, printing, optical communications, and the reading of digital information. In chemistry, their main use has been in the study of photochemical reactions and in the spectroscopic investigation of molecules.

Notes:

1. maser – мазер, квантовый усилитель и генератор СВЧ-диапазона
2. microwave amplification by stimulated emission of radiation – усиление микроволн (СВЧ) в результате вынужденного излучения
3. oscillator – генератор
4. laser – оптический квантовый генератор
5. light amplification by stimulated emission of radiation – усиление света в результате вынужденного излучения

V. Read and translate text 24.3. Identify, define or explain each of the following:

1. Maser
2. Stimulated emmision
3. Types of masers
4. Application of masers
5. Laser
6. Types of lasers
7. Application of lasers

TEXT 24.4. QUANTUM THEORY OF RADIATION

1. Quantum theory of radiation is the study of the emission and absorption of photons of electromagnetic radiation by atomic systems

using quantum mechanics. Photon is a particle with zero ***rest mass*** consisting of a quantum of electromagnetic radiation. Protons travel at the speed of light. They are required to explain the photoelectric effect and other phenomena that require light to have particle character.

2. Photons are emitted by atoms when a transition occurs from an excited state to the ***ground state***. If an atom is exposed to external electromagnetic radiation a transition can occur from the ground state to an excited state by absorption of a photon. An excited atom can loose the energy it has gained by ***stimulated emission***. However, an atom can also emit a photon in the absence of external electromagnetic radiation, a process called spontaneous emission.

3. The quantum theory of radiation was initiated by Einstein in 1916-17, as an extension of Planck's radiation law. The theory is ***quantified*** by the Einstein coefficients. The quantum theory of radiation is the basis of the theory behind the operation of lasers and masers. Quantum electronics is the application of quantum optics and the specially quantum-mechanical properties of electrons to the design of electronic devices.

Notes:
1. rest mass – масса покоя
2. ground state – основное (квантовое) состояние
3. stimulated emission – вынужденное (индуцированное) излучение
4. quantify – определять, уточнять

VI. Read and translate text 24.3. Identify, define or explain each of the following:

1. Quntum theory of radiation
2. Photon (mass, speed)
3. Photon emission
4. Quantum theory founders
5. Quantum theory application
6. Quantum electronics

VII. Make up the abstracts of texts 24.1-24.4 (in English or in Russian)

VIII. Comment on the following quotation. Do you agree or disagree with it?

1. An experiment is a question which science poses to Nature, and a measurement is the recording of Nature's answer. (Max Ernst Ludwig Planck 1858–1947)

SECTION 25

TEXT 25.1. CHANDRASEKHARA RAMAN

1. Sir Chandrasekhara Venkata Raman (1882-1970) was an Indian physicist whose work was influential in the growth of science in India. He was the recipient of the Nobel Prize for Physics in 1930 for the discovery that when light ***traverses*** a transparent material, some of the light changes in wavelength.

2. Raman became professor of physics at the University of Calcutta in 1917. Studying the scattering of light in various substances, in 1922 he found that when a substance is illuminated by a beam of light of one frequency, the beam emerging ***at right angles*** to the original direction contains other frequencies that ***are characteristic of*** the material. These so-called Raman frequencies are equal to the infrared frequences for the material and are caused by the exchange of energy between the light and the material.

3. Raman was knighted in 1929, and in 1933 he moved to the Indian Institute of Science, at Bangalore, as head of the department of physics. In 1947 he was named director of the Raman Research Institute there and in 1961 became a member of the Pontifical Academy of Science. He contributed to the building up of nearly every Indian research institution in his time, founded the 'Indian Journal of Physics' and the Indian Academy of Sciences, and trained hundreds of students who found important posts in universities and government in India and Burma.

Notes:
1. traverse – пересекать, проходить
2. at right angle – под прямым углом
3. to be characteristic of – быть характерным для

I. Find Russian equialents for:

an Indian physicist, growth of science, light changes in wavelength, frequency, exchange of energy, head of the department of physics, found the Indian Academy of Sciences, train hundreds of students

II. Find English equialents for:

работа которого, важная (влиятельная) работа, когда свет проходит через прозрачный материал, стать профессором физики, рассеивание света в разных веществах, содержать, характерный для, вызывать, присваивать ненаследственное дворянское звание (Knight, рыцарь) и титул ‘Sir’, содействовать (вносить вклад)

III. Read and translate text 25.1. Answer the following questions:

1. What was Ch. Raman?
2. What was he famous for?
3. Where did Raman work?
4. What did he study and find?
5. Why did Raman move to Bangalore?
6. What did he contribute?

TEXT 25.2. RAMAN EFFECT

1. ***Raman effect*** is a change in the wavelength of light that occurs when a light beam is deflected by molecules. The phenomenon is named for Sir Chandrasekhara Venkata Raman, who discovered it in 1928. Raman effect is a type of ***inelastic*** scattering of light and ultraviolet radiation. If a beam of monochromatic light is passed through a transparent substance some of the radiation will be scattered. Although most of the scattered radiation will be the same as the incident frequency, some will have frequencies above and below that of the ***incident beam***. This effect is known as ***Raman scattering*** and is due to inelastic collisions between photons and molecules leading to changes in the vibrational and rotational energy levels of the molecules.

2. An increase in frequency represents a loss in molecular energy; a decrease represents ***a gain*** in molecular energy. The ***frequency shifts*** are thus measures of the amounts of energy involved in the transition between initial and final states of the scattering molecule. Raman effect is used in ***Raman spectroscopy*** for investigating the vibrational and rotational energy levels of molecules. Because the scattering intensity is low, a laser source is used. Raman spectra are used in qualitative and quantitative analysis. Gases have low molecular concentration at ordinary pressures and therefore produce very faint Raman effects; thus liquids and solids are more frequently studied.

3. In Raman effect, light suffers a change of frequency and a change in phase as it passes through a material medium. In Raman spectroscopy, light from a laser is passed through a substance and the scattering is analysed spectroscopically. The new frequences in the Raman spectrum of monochromatic light scattered by a substance are characteristic of the substance. Both inelastic and superelastic scattering occurs. The technique

is used as a means of determining molecular structure and as a tool in chemical analysis. The effect was predicted theoretically by H.A. Kramer and Werner Heisenberg in 1925.

Notes:
1. Raman effect – комбинационное рассеяние света, эффект Рамана
2. inelastic – неупругий
3. incident beam – падающий луч (пучок)
4. Raman scattering – комбинационное рассеяние (света)
5. gain – увеличение, усиление
6. frequency shift – сдвиг частоты, уход частоты
7. Raman spectroscopy – спектроскопия комбинационного рассеяния

IV. Read and translate text 25.2. Identify, define or explain each of the following:

1. Raman effect
2. Raman scattering
3. Frequency shift
4. Application of Raman effect
5. Prediction of the effect

TEXT 25.3. SCATTERING OF ELECTROMAGNEIC RADIATION

1. Light is the form of electromagnetic radiation to which the human eye is sensitive. Electromagnetic radiation is energy resulting from the acceleration of electric charge and the associated electric and magnetic fields. The energy can be regarded as waves propagated through space.

2. Scattering of electromagnetic radiation is the process in which electromagnetic radiation is deflected by particles in the matter through which it passes. In ***elastic scattering*** the protons of the radiation are reflected, i.e. they bounce off the atoms and molecules without any change of energy. In this type of scattering, known as Rayleigh scattering (after Lord Rayleigh), there is a change of phase but no frequency change.

3. In inelastic scattering and ***superelastic scattering***, there is inter-change of energy between the photons and the particles. Consequently, the scattered photons have a different wavelength as well as a different phase. Examples include the Raman effect and the Compton effect [16, p.728].

Notes:

1. elastic scattering – упругое рассеяние
2. superelestic scattering – сверхупругое рассеяние

V. Read and translate text 25.3. Identify, define or explain each of the following:

1. Light
2. Electromagnetic radiation
3. Scattering of electromagnetic radiation
4. Elastic scattering
5. Inelastic scattering and superelastic scattering

VI. Make up the abstracts of texts 25.1-25.3 (in English or in Russian)

VII. Comment on the following quotation. Do you agree or disagree with it?

1. The acquisition and systematization of positive knowledge is only human activity which is truly cumulative and progressive. Our civilization is essentially different from earlier ones, because our knowledge of the world and of ourselves is deeper, more precise, and more certain, because we have gradually learned to disentangle the forces of nature, and because we have contrived, by strict obedience to their laws, to capture them and to divert them to the gratification of our needs. (George Alfred Leon Sarton 1884–1956, – Belgian-born American historian of science)

SECTION 26

TEXT 26.1. BARON RAYLEIGH

1. John William Strutt, 3rd Baron Rayleigh (1842-1919) was an English physical scientist who made fundamental discoveries in the fields of acoustics and optics that are basic to the theory of wave propagation in fluids. He received the Nobel Prize for Physics in 1904 for his successful isolation of argon, an inert atmospheric gas.

2. Strutt suffered from poor health throughout his childhood and youth, and it was necessary for him to be withdrawn from both Eton and Harrow. In 1857 he began four of private study under a tutor. In 1861 Strutt entered Trinity College in Cambridge, from which he was graduated with a B.A. as ***Senior Wrangler*** (highest honour) in the Mathematical

Tripos in 1865. He early developed an absorbing interest in both the experimental and mathematical sides of physical science and in 1868 he purchased an ***outfit*** of scientific apparatus for independent research.

3. He married Evelin Balfour, the sister of Arthur James Balfour, the politician and statesman, in 1871. In his great book ‘The Theory of Sound’, he examined questions of vibrations and the resonance of elastic solids and gases (1877-1878) and concentrated on acoustical propagation in material media. He succeeded to the title of Baron Rayleigh in 1873, on the death of his father. Reyleigh then took up residence at Terling Place, where he built a laboratory adjacent to the manor house. His early papers dealt with such subjects as electromagnetism, colour, acoustics, and ***diffraction gratings***. His most significant early work was his theory explaining the blue colour of the sky as a result of scattering of sunlight by small particles in the atmosphere. The Rayleigh scattering law, which evolved from this theory, has since become classic in the study of all kinds of wave propagation.

Notes:

1. Senior Wrangler – старший ранглер (выпускник, занявший первое место на экзамене по математике)
2. tripos – трайпос (публичный экзамен на степень бакалавра с отличием)
3. outfit – оснащение, оборудование, установка
4. diffraction grating – дифракционная решётка

I. Find Russian equivalents for:

discoveries in the fields of acoustics and optics, theory of wave propagation in fluids, receive the Nobel Prize for Physics, inert atmospheric gas, poor health, necessary, private study, enter, graduate college, independent research, elastic solids and gases, material media, residence, electromagnetism, colour, acoustics, diffraction gratings, significant early work, small particles

II. Find English equivalents for:

сделать фундаментальные открытия, основной, успешное выделение аргона, страдать от плохого здоровья в детстве и юности, уйти из школы, купить оборудование, исследовать вопросы, распространение звука, примыкающий (соседний), первые работы, в результате рассеяния солнечного света, изучение всех видов распространения волн

III. Read and translate text 26.1. Answer the following questions:

1. What was Baron Rayleigh?
2. What was he famous for?
3. Where did he study?
4. What were his interests?
5. What was his great book?

IV. What do the following dates refer to:

1842, 1857, 1861, 1865, 1868, 1871, 1873, 1877-1878

V. Find in the text 26.1 the information to prove that:

1. Rayleigh received the Nobel Prize.
2. His health was not good.
3. Rayleigh graduated from the University with honours.
4. He bought the scientific equipment and built a laboratory.
5. His first papers dealt with various fields of science.
6. Rayleigh's theory and law became classic in science.

TEXT 26.2. RESEARCH OF RAYLEIGH

1. In the period of 1879-84, he served as the second Cavendish professor of experimental physics at Cambridge, in succession to James Clerk Maxwell. Rayleigh took his university duties very seriously with respect both to the instruction of students and to the carrying out a vigorous research program on the precision determination of electrical standards. After a tenure of five years he returned to his laboratory at Terling Place, where he carried out practically all of his scientific investigations. A few months after resigning from Cambridge, Rayleigh became secretary of the ***Royal Society***, an administrative post that, during the next 11 years, allowed considerable freedom for research.

2. Rayleigh's greatest contribution to science is generally considered to have been his discovery and isolation of argon, one of the rare gases of the atmosphere. Precision measurements of the density of gases conducted by him led to the discovery of argon (1895), which he named from Greek word meaning 'inactive'. Rayleigh shared the priority of the discovery with the chemist William Ramsay, who also isolated the new gas. In 1904 Rayleigh was awarded the Nobel Prize for Physics; Ramsay received the award in chemistry for his work on argon and other inert

elements. The next year Rayleigh was elected president of the Royal Society.

3. Rayleigh investigated a wide variety of topics, such as optics, acoustics, electricity, and fluid mechanics. He preferred to work on several research projects at once, his work was consistently of high quality throughout his career, both in the brilliance and thoroughness of experimental execution and in the lucidity and precision of his writings. He not only expanded and consolidated existing knowledge in important branches of the physical sciences, but he also opened up important new research frontiers, especially in acoustics and fluid dynamics (hydrodynamics).

4. In his later years, when he was the foremost leader in British physics, Rayleigh gave freely all his time and helpful counsel by serving in influential advisory capacities in education and government. In 1908 he accepted the post of chancellor of Cambridge University, retaining this position until his death. He was also associated with the National Physical Laboratory and government committees on aviation and the treasury. Retaining his mental powers until the end, he worked on scientific papers till his death, on June 30, 1919.

Notes:

1. Royal Society – Королевское общество (ведущий научный центр, выполняющий функции национальной академии наук; самое старое научное общество Великобритании, учрежденное в 1660 г.)

VI. Find Russian equivalents for:

serve as, university duties, carrying out a vigorous research program, scientific investigations, secretary of the Royal Society, discovery and isolation of argon, precision measurements of the density of gases, electricity, to work on several research projects at once, high quality, expand and consolidate existing knowledge, the foremost leader in British physics, retain his mental powers, work on scientific papers

VII. Find English equivalents for:

в качестве преемника Д.К. Максвелла, в отношении (что касается) обучения студентов, точное определение стандартов электричества, после пятилетнего срока пребывания в должности, административная должность, величайший вклад в науку, разделить приоритет открытия, исследовать разнообразные темы, предпочитать; как по яркости (великолепию) и основательности (тщательности) выполнения экспериментов так и по ясности (понятности) и точности его письменных работ, в важных отраслях физических наук, открыть новые важные границы исследования, влиятельные должности советника в образовании и правительстве

VIII. Read and translate text 26.2. Answer the following questions:

1. What can you say about Rayleigh's university duties?
2. What allowed him freedom for research?
3. What was Rayleigh's greatest contribution to science?
4. What Prize was he awarded?
5. What branches of physics did Rayleigh investigate?
6. Why was his work of high quality?
7. What did Rayleigh do in physical sciences?
8. Where did he work in his later years?

TEXT 26.3. ARGON

1. Argon (Ar) is a monoatomic noble gas present in air (0.93%). This inert gas (noble gas) belongs to group 0 of the periodic table. The group includes helium, neon, argon, krypton, xenon and radon, and they make up approximately 1 per cent of air by volume, with argon the most abundant. As their name suggests, these elements are chemically unreactive because of their stable electronic configuration. They can be extracted from liquid air by fractional distillation.

2. Argon has melting point of -189^{o} C and its boiling point is -185^{o} C. It is slightly soluble in water, colourless and has no smell. Because it is chemically inert, it is used to fill fluorescent lamps (when mixed with 20% nitrogen) and as an inert gas ***blanket*** (inert atmosphere) for welding reactive metals and in special-metal manufacture (Ti and Zr). Lord Rayleigh and Sir William Ramsay identified argon in 1894.

Notes:

1. blanket – защитный слой

IX. Describe the properties of the noble gas argon:

(group in periodic table, its extraction, melting and boiling point, solubility, colour, its discovery and application)

X. Make up the abstracts of texts 26.1-26.3 (in English or in Russian).

XI. Comment on the following quotation. Do you agree or disagree with it?

1. Experience teaches slowly and at the cost of mistakes. (James A. Froude)

SECTION 27

TEXT 27.1. OWEN RICHARDSON

1. Sir Owen Willans Richardson (1879-1959) was English physicist, winner of the Nobel Prize for Physics in 1928 for his work on electron emission by hot metals, the basic principle used ***in vacuum tubes***.

2. Richardson, a graduate (1900) of Trinity College (Cambridge) and a student of J.J. Thomson at the Cavendish Laboratory, was appointed professor of physics at Princeton University (1906-13). In 1911 he proved that electrons are emitted from metal and not from the surrounding air, as some had thought. That same year he proposed a mathematical equation that relates the rate of electron emission to the absolute temperature of the metal. This equation, called Richardson's law or the Richardson-Dushmann equation, because it is an important aid in electron-tube research and technology.

3. In 1914 Richardson became professor of physics and, 10 years later (1924), director of research at King's College of the University of London, retiring in 1844. He was knighted in 1939.

Notes:

1. vacuum tube – электровакуумный прибор

I. Find Russian equivalents for:

English physicist, electron emission by hot metals, vacuum tubes, graduate, to emit, a mathematical equation, rate, called Richardson's law, electron-tube research and technology

II. Find English equivalents for:

лауреат Нобелевской премии по физике, основной принцип, назначать, доказывать, окружающий воздух (атмосфера), предложить, устанавливать связь, важная помощь (содействие), уходить в отставку (на пенсию)

III. Read and translate text 27.1. Answer the following questions:

1. What was O. Richardson?
2. What was he famous for?
3. Where did Richardson study?
4. Where did he work?
5. What did Richardson prove?
6. What did he propose?
7. Where did he work in London?

TEXT 27.2. THERMIONIC EMISSION

1. ***Thermionic emission*** (also called the Edison effect), a discharge of electrons from heated materials, is widely used as a source of electrons in conventional electron tubes (***television picture tubes***) in the fields of electronics and communications. The phenomenon was first observed (1883) by Thomas A. Edison as a passage of electricity from a filament to a plate of metal inside an incandescent lamp.

3. In thermionic emission, the heat supplies some electrons with at least the minimal energy required to overcome the attractive force holding them in the structure of the metal. This minimal energy, called ***the work function***, is characteristic of the emitting material and the state of contamination of its surface. Thermionic emission is the emission of electrons, usually into a vacuum, from a heated conductor. The emitted current density is given by the Richardson (of Richardson-Dushmann) equation. Thermionic emission is the basis of the thermionic valve and the ***electron gun*** in cathode-ray tubes.

Notes:
1. thermionic emission – термоэлектронная эмиссия
2. television picture tube – кинескоп
3. work function – работа выхода
4. thermionic valve – (электронная) лампа с термокатодом
5. electron gun – электронная пушка

IV. Read and translate text 27.2. Identify, define or explain:

1. Thermionic emission
2. Discovery of this phenomena
3. Work function
4. Richardson equation
5. Application of thermionic emission

TEXT 27.3. THERMIONICS

1. ***Thermionics*** is the branch of electronics concerned with the study and design of devices based on the emission of electrons from metal or metal-oxide surfaces as a result of high temperatures. The primary concern of thermionics is the design of thermionic valves and the electron guns of cathode-ray tubes and other devices.

2. Thermionic valve is a device consisting of an evacuated glass or metal tube, into which two or more electrodes are inserted. One heated electrode, the cathode, emits electrons, which are attracted to the positively charged anode, forming an ***electric current***. Thus current flows in one direction only and can be controlled by the applied at one or more other electrodes (called ***grids***).

3. The diode valve was invented in 1904 by Sir John Ambrose Fleming. The triode valve with one grid was invented in 1910 by Lee Forest, it was the first to function as an amplifier. The weak signal ***fed*** to the grid produces a stronger signal in the anode circuit. Diode and triode valves made possible the development of radio transmitters and receivers, although now semiconductor diodes and transistors have replaced them.

4. Semiconductor diode is a ***solid state*** electronic device with two electrodes. It consists of a single ***p-n junction***. When the p-region is at a more positive voltage than the n-region (***forward bias***), the current flow increases exponentially as the voltage rises. In ***reverse bias***, very little current flows until a sufficiently high reverse voltage has built up to cause breakdown, the current then increases sharply. The diode is, therefore, commonly used as a rectifier. Semiconductor diodes are used to general microwaves by the Gunn effect, to detect light in photocells and to emit light in low-voltage displays (light-emitting diodes, LED).

5. Light-emitting diode (LED) is a semiconductor device that converts electrical energy into light or infrared radiation in the range 550 nm (green light) to 1300 nm (infrared radiation). The most commonly used LED emits red light and consists of gallium arsenide-phosphide on a gallium arsenide substrate, light being emitted at a p-n junction, when electrons and holes recombine. LEDs are extensively used for displaying

letters and numbers in digital instruments in which a self-luminous display is required.

Notes:
1. thermionics – физика термоэлектронных процессов
2. electric current – электрический ток
3. grid – сетка
4. feed – подавать, питать, подводить
5. solid state – твердотельный (полупроводниковый)
6. p-n junction – p-n переход, электронно-дырочный переход
7. forward bias – напряжение прямого смещения, прямое смещение
8. reverse bias – напряжение обратного смещения, обратное смещение

V. Read and translate text 27.3. Tell about the history of thermionics development:

1. Thermionics and its primary concern
2. Thermionic valve
3. Diode valve
4. Triode valve
5. Semiconductor diode, its application and function
6. Light emitting diode, its application and function

VI. Make up the abstracts of texts 27.1-27.3 (in English or in Russian)

VII. Comment on the following quotation. Do you agree or disagree with it?

1. A successful man is he who receives a great deal from his fellow men, usually incomparably, or than corresponds to his service to them. The value of a man, however, should be seen in what he gives and not in what he is able to receive. (Albert Einstein …. 1879-1955)

SECTION 28

TEXT 28.1. CHARLES RICHTER

1. Charles Francis Richter (1900-1985) was American physicist and seismologist who helped develop the Richter scale for measuring the ***magnitude*** of earthquakes.

2. Born on an Ohio farm, Richter and his mother moved to Los Angeles in 1916. He attended the University of Southern California (1916-17) and then studied physics at Stanford University (A.B., 1920) and the California Institute of Technology (Ph.D., 1928). Richter was on the staff of the Seismological Laboratory of the Carnegie Institution of Washington, Pasadena, California (1927-36), and then both taught physics and seismology at the California Institute of Technology (1937-70) and worked at its Seismological Laboratory (found in 1936).

3. With Beno Gutenberg (1889-1960), a German-born Caltech professor, he developed in 1935 the scale that came to be associated with his name, replacing the older 'Mercalli Scale', which unreliably measured an earthquake's intensity at the seismic measuring station rather than at the epicentre of the earthquake. Richter also mapped out quakeprone areas in the United States but tended to disparage attempts at earthquake prediction. He wrote (with Beno Gutenberg) 'Seismicity of the Earth and Associated Phenomena' (1949) and 'Elementary Seismology' (1958).

Notes:

1. magnitude – величина, амплитуда, магнитуда (о землетрясении)

I. Find Russian equivalents for:

physicist and seismologist, the Richter scale, attend the University, study physics, be on the staff of the Seismological Laboratory, earthquake prediction

II. Find English equivalents for:

измерение магнитуды землетрясений, переезжать, Калифорнийский технологический институт, разработать шкалу, заменять, наносить на карту области, склонные к землетрясению районы (участки)

III. Read and translate text 28.1. Answer the following questions:

1. What was Charles Richter?
2. What was he famous for?
3. Where did he study?
4. Where did he work?
5. What scale did he develop?
6. What did he write?

TEXT 28.2. RICHTER SCALE

1. Earthquake is a convulsion of the Earth's crust due to the release of accumulated stress as a result of ***faults*** in strata or volcanic action. It is a movement of the earth, which is often violent, caused by the sudden release of stress that may have accumulated over a long period. Waves of ***disturbance*** – seismic waves – spread out from the origin, or focus of the earthquake.

2. Earthquakes are classified by their depth of focus as shallow (less than 70 km/44 miles), intermediate (70-300 km/44-187 miles), deep (more than 300 km/187 miles). The effects of earthquakes are naturally very alarming and can be quite catastrophic. Near the focus, ground waves actually throw the land surface about. Surface effects may include the opening of ***fissures*** (large cracks), the breaking of roads and pipes, buckling and twisting of railroad lines, and the ***collapse*** of bridges and buildings. Secondary effects can be equally destructive if the ground vibrations initiate ***landslides***, ***avalanches*** and tsunami or cause fires.

3. Richter scale is a widely used quantitative measure of the magnitude of an earthquake, introduced in 1935 by the seismologists Beno Gutenberg and Charles Francis Richter. The scale was originally devised to measure the magnitude of local earthquakes in southern California as ***recorded*** by a certain kind of seismograph. Richter scale is the measurement of the intensity of an earthquake using the amplitude of seismic waves. The amplitude depends on the depth of the earthquake focus, the distance of the recording station from the focus, the travel path and local geology at both the source and receiver.

4. The Richer Scale is:

Rating	**Identifying features**
1 – instrumental	detected only by seismograps
2 – feeble	noticed by sensitive people
3 – slight	similar to a passing truck
4 – moderate	loose objects are rocked
5 – rather strong	felt generally
6 – strong	trees sway; loose objects fall
7 – very strong	walls crack
8 – destructive	chimneys fall, masonry cracks
9 – ruinous	houses collapse where ground starts to crack

10 – disastrous	ground badly cracked, buildings destroyed
11 – very disastrous	bridges and most buildings destroyed, landslides
12 – catastrophic	ground moves in waves, total destruction

5. The scale was arranged so that each increase of one unit represents a 10-fold increase in the magnitude of an earthquake (i.e., the numbers of the Richter scale are proportional to the common [base 10] logarithms of the magnitude). Later and more sensitive seismographs can detect earthquakes even fainter than the ones that were originally chosen to determine magnitude zero; their magnitudes are accomodated on the Richter scale by the use of negative numbers.

6. Seismology is the branch of geology concerned with the study of earthquakes. Seismograph is an instrument that records ground oscillations (those caused by earthquakes, volcanic activity and explosions). The record made by a seismograph is known as a seismogram. Seismic wave is a vibration propagated within the earth or along its surface as a result of an earthquake or explosion. Earthquakes generate two types of body waves that travel within the earth and two types of surface waves. The ***body waves*** consist of primary (or longitudinal) waves that impart a back-and-forth motion to rock particles along their parth. They travel at speeds between 6 km per second in surface rock and 10.4 km per second near the earth's core. Secondary (or transverse or chear) waves cause rock particles to move back and forth perpendicularly to their direction of propagation. They travel at between 3.4 km per second in surface rock and 7.2 km per second near the core.

Notes:
1. fault – сдвиг (горной породы)
2. disturbance – возмущение
3. fissure – трещина
4. collapse – разрушение, обрушение
5. landslide – оползень
6. avalanch – лавина
7. record – регистрировать, записывать
8. body wave – объёмная волна

IV. Find Russian equivalents for:

convulsion of the Earth's crust, as a result of faults in strata, movement, seismic waves, depth of focus, shallow, intermediate, deep, surface effects, secondary effects, ground vibrations initiate landslides, introduced by seismologists, distance of the recording station, sensitive seismograph, seismology is the branch of geology, seismogram, generate, longitudinal waves, transverse waves, rock particles

V. Find English equivalents for:

из-за выброса (высвобождения) накопленного напряжения, вызванный, распространяться от источника землетрясения, образование трещин, разрушительный, количественный критерий (метод измерения) магнитуды, амплитуда зависит от, путь прохождения, десятикратное увеличение магнитуды, определять (обнаруживать); прибор, который регистрирует вибрацию земли, распространять, проходить со скоростью, направление распространения

VI. Read and translate text 28.2. Characterize in brief:

1. Earthquake
2. Classification of earthquakes
3. Effects of earthquakes
4. Introduction of Richter scale
5. Arrangement of Richter scale
6. Seismology
7. Seismograph
8. Seismogram
9. Seismic waves

TEXT 28.3. DEVELOPMENT OF THE SEISMOGRAPH

1. Seismograph is an instrument that records ground ***oscillations*** caused by an earthquake, explosion or other Earth-shaking phenomenon. Although originally designed to record natural earthquakes, it has many other uses. Most modern seismographs are based on the inertia of a delicately suspended mass and depend on the measurement of the displacement between the mass and a point fixed to the earth. Others measure the relative displacement between two points on earth. The record made by a seismograph is known as a seismogram.

2. An earlier seismic instrument called the seismoscope made no record of the ground oscillations but simply indicated that shaking had occurred. The term seismometer originally referred to an instrument that measures the amount of ground motion. Some seismographs are equipped with an electromagnetic device called a ***sensor*** that translates ground motions into electrical changes.

3. A Chinese scholar, Chang Heng, invented a seismoscope that registered the occurrence of an earthquake as early as AD 132. It was cylindrical in shape with eight dragon heads arranged around its upper-circumference, each with a ball in its mouth. Around the lower circumference were eight frogs, each directly under a dragon head. When an earthquake occurred, one of the balls dropped from a dragon's mouth and was caught by the frog's mouth, generating a sound. A device involving water spillage was developed in 17th century Italy. Later, a water-filled bowl and still later a cup filled with mercury were used for detecting earthquakes and tremors.

4. In 1855 Luigi Palmieri of Italy designed a seismometer that consisted of several U-shaped tubes filled with mercury and oriented toward the different points of the compass. When the ground shook, the motion of the mercury made an electrical contract that stopped a clock and simultaneously started a recording drum on which the motion of a ***float*** on the surface of mercury was registered. This device thus indicated time of occurrence and the relative intensity and duration of the ground motion.

5. In 1840 a seismometer based on the common ***pendulum*** was installed near Comrie in Perthshire, Scotland. In 1841 a seismometer based on the invented pendulum was installed at six places near Comrie to register local shocks. Seismograph developments occurred rapidly in 1880 when Sir James Alfred Ewing, Thomas Gray and John Milne, British scientists working in Japan, began to study earthquakes. Following a severe earthquake that occurred at Yokohama near Tokyo in that year, they organized the Seismological Society of Japan. Under its auspices, various devices, forerunners of today's seismograph, were invented.

6. Among the instruments constructed in this period was Milne's horizontal pendulum seismograph. It was improved greatly after World War II. The Press-Ewing seismograph, developed in the United States for recording long-period waves, was widely used throughout the world. This device employs a Milne-type pendulum, but the ***pivot*** supporting the pendulum is replaced by an elastic wire to avoid friction.

Notes:

1. oscillation – колебание, вибрация
2. sensor – чувствительный элемент, датчик
3. float – поплавок
4. pendulum – маятник
5. pivot – ось, цапфа

VII. Read and translate text 28.3. What information have you learned about:

1. Seismograph 2. Seismoscope 3. Chinese seismoscope
4. Italian seismometer 5. Scottish seismometer 6. British scientists
7. Milne's seismograph 8. Press-Ewig seismograph

TEXT 28.4. APPLICATIONS OF THE SEISMOGRAPH

1. The eruption of a volcano is commonly accompanied by many small earthquakes, especially when a volcano resumes activity after a long dormant period. Observation with sensitive seismographs therefore plays an important role in the prediction of volcanic activity. Often a strong earthquake is preceded by small earthquakes. Observation of very small tremors with sensitive seismographs is helpful in predicting disastrous earthquakes. Seismographs sometimes detect small and long-continuing oscillations of the ground, called microseisms, that do not originate in earthquakes. The occurrence of some ***microseisms*** is related to storms at sea.

2. Seismographs can be used for detecting remote nuclear underground tests. In this activity, the relatively faint seismic waves generated by an underground explosion must be distinguished by natural tremors. In one American installation, the Large Aperture Seismic Array, established in Montana in 1965, 525 seismometers were spread over an area of 30-100 square km (11,600 square miles). Their signals are combined to attain a high degree of sensitivity to seismic events.

3. Depth of underground layers, their angle of inclination and the speed of seismic waves in each layer can be determined. Since the discovery of a large oil field in the United States by this method in 1923, seismic prospecting (surveying) has made rapid progress and is now used for oil, gas and ore exploration. The improvement in the instruments and techniques achieved after World War II made it possible to determine the structure of the Earth's crust to a depth of 40 to 50 km by detonation of small amount of explosive.

4. Ground shocks caused by dynamite blasts in mines, quarries and public works also can be measured by the seismograph. Preliminary examinations based on seismographic measurements make it possible to estimate the intensity of shocks and, thus, evaluate the possibilities of damage caused by a given amount of dynamite. ***Rock bursts***, in which rocks are ejected suddenly in deep pits or tunnels, are caused by increase

of stress in the surrounding rocks. Experience in mines shows that an increase of small shocks detectable by highly sensitive ***geophones***-portable seismometers for field use – generally indicates a rock burst hazard.

5. A strong motion seismograph is designed particularly to register intense movements of the ground for engineering purposes (antiseismic construction in earthquake-prone areas such as Japan). Detection of vibrations on the lunar surface by use of seismographs is of fundamental importance in determining the internal structure, physical state, tectonic (crustal) activity and composition of the Moon, and other planets.

Notes:
1. microseisms – микросейсмы
2. rock burst – внезапное обрушение породы
3. geophone – сейсмоприемник

VIII. Read and translate text 28.4. Tell about spheres of seismograph's application.

IX. Make up the abstracts of texts 28.1–28.4 (in English or in Russian).

X Comment on the following quotations. Do you agree or disagree with them?

1. Every man is a consumer and ought to be a producer. (Ralf Waldo Emerson 1803-1882)
2. Everything comes to him who hustles while he waits. (Thomas Alva Edison 1847-1931).

SECTION 29

TEXT 29.1. HEINRICH ROHER

1. Heinrich Roher (1933) was a Swiss physicist who, with Gerd Binning (1947), received half of the 1986 Nobel Prize for Physics for their joint invention of the ***scanning tunneling microscope.*** (German engineer Ernst Ruska (1906-1988), who developed the electron microscope in 1938, received the other half of the Prize). Gerd Binning also invented the ***atomic force microscope*** in 1985.

2. Roher was educated at the Swiss Federal Institute of Technology in Zürich and received his Ph.D. there in 1960. In 1963 he joined the IBM Research Laboratory in Zürich, where he remained. Binning also joined the laboratory, and it was there that the two men designed and built the first scanning tunneling microscope (1981). This instrument is equipped with a thin tungsten ***probe*** whose tip, only about one or two atoms wide, is brought to within 5 to 10 atoms' distance of the surface of a conducting or semiconducting material. (An atom is equal to about one angstrom, or one ten-billionth of a metre).

3. When the electric potential of the tip is made to differ by a few volts from that of the surface, quantum mechanical effects cause a measurable electric current to cross the gap. The strength of this current is extremely sensitive to the distance between the probe and the surface, and as the probe's tip scans the surface, it can be kept a fixed distance away by raising and lowering it so as to hold the current constant. A record of the elevation of the probe is a topographical map of the surface under study, on which the contour intervals are so small that the individual atoms making up the surface are clearly recognizable.

Notes:
1. scanning tunneling microscope – растровый (сканирующий) микроскоп
2. atomic force microscope – атомносиловой микроскоп
3. probe – щуп, контактный датчик

I. Find Russian equivalents for:

a Swiss physicist, receive half of the Nobel Prize for Physics, scanning tunneling microscope, electron microscope, get education, research laboratory, instrument, thin tungsten probe, one or two atoms wide, equal, electric current, scan the surface, constant, contour intervals

II. Find English equivalents for:

совместное изобретение, разработать, получить степень доктора наук, проектировать (конструировать) и строить, оборудовать, наконечник, расстояние от поверхности, отличаться, сила тока, поднимая и опуская наконечник, регистрация (запись) подъёма наконечника, чётко управляемый

III. Read and translate text 29.1. Answer the following questions:

1. What was Heinrich Roher?
2. What was he famous for?
3. Where did Roher study?
4. Where did he work?
5. What is the principle of work of scanning tunneling microscope?

TEXT 29.2. G. BINNIG

1. Gerd Binnig (1947) is a German-born physicist who shared with Heinrich Rohrer half of the 1986 Nobel Prize for Physics for their invention of the scanning tunneling microscope. (Ernst Ruska won the other half of the prize).

2. Binnig graduated from Johann Wolfgang Goethe University in Frankfurt and received a Ph.D. from the University of Frankfurt in 1978. He then joined the IBM Research Laboratory in Zürich, where he and Rohrer designed and built the first scanning tunneling microscope (STM). This instrument produces images of the surfaces of conducting or semiconducting materials in such fine detail that individual atoms can be clearly identified.

3. Quantum mechanical effects cause an electric current to pass between the extremely ***fine*** tip of the STM's tungsten probe and the surface being studied, and the distance between the probe and the surface is kept constantly by measuring the current produced and ***adjusting*** the probe's height accordingly. By recording the varying elevation of the probe, a topographical map of the surface is obtained on which contour intervals are so small that individual atoms are clearly recognizable. The tip of the STM's probe is only about one angstrom wide (one ten-billionth of a meter, or about the width of an atom), and the distance between it and the surface being studied is only about 5 or 10 angstroms.

Notes:

1. fine – тонкий, острый, мелкий
2. adjusting – регулирование, регулировка

IV. Read and translate text 29.2. Find in the text the information to prove:

1. G. Binnig was not the single winner of the Nobel Prize.
2. He got education in Germany.
3. Binnig worked in research laboratory.

4. He was one of the designers of STM.
5. Quantum mechanical effects cause the definite actions.
6. Topographical map of the surface can be obtained.
7. Tip of the probe is very fine and the distance to the surface is small.

TEXT 29.3. E. RUSKA

1. Ernst Ruska (1906–1988) was a German electrical engineer who invented the electron microscope. He was awarded half of the Nobel Prize for Physics in 1986 (the other half was divided between Heinrich Rohrer and Gerd Binnig).

2. Ruska studied at the Technical University of Munich during 1925–27 and then was enrolled to the Technical University of Berlin. Around this time he began the studies that led to his invention of the electron microscope. The extent to which an optical microscope could resolve the detail of a highly magnified object was limited by the wave lengths of the light beams used to view the object. Since it had been established in 1920s that electrons have the properties of waves about 100 000 times shorter than those of light, Ruska posited that if electrons could be focused on an object the same way light is, at extremely high magnifications the electrons would yield greater detail (have a greater ***resolving power***) than would conventional microscopes.

3. In 1931 he built the first electron lens, an electromagnet that could focus a beam of electrons just as a lens focuses a beam of light. By using several such lenses ***in series***, he invented the first electron microscope in 1933. In this instrument, electrons were passed through a very thin slice of the object ***under study*** and were then ***deflected*** onto photographic film or onto a fluorescent screen, producing an image that could be greatly magnified.

4. Ruska joined Siemens-Reiniger Plant as a research engineer in 1937 and in 1939 the company brought its first commercial electron microscope, which was based on his inventions. Ruska did research at Siemens until 1955 and then served as director of the Institute for Electron Microscopy of the Fritz Haber Institute from 1955 to 1972. He was also a longtime professor at the Technical University of West Berlin.

Notes:
1. resolving power – разрешающая способность
2. in series – последовательно
3. under study – изучаемый, рассматриваемый

4. deflect – отклонять, преломлять

IV. Read and translate text 29.3. Answer the following questions:

1. What was E. Ruska? 2. What was he famous for?
3. Where did Ruska study? 4. Where did he work?
5. What can you say about the resolving power and lenses of his electron microscope?

TEXT 29.4. ELECTRON MICROSCOPE

1. Electron microscope (EM) is a form of microscope that uses a beam of electrons instead of a beam of light (as in the optical microscope) to form a large ***image*** of a very small object. In optical microscopes the ***resolution*** is limited by the wavelength of the light. High-energy electrons, however, can be associated with a considerably shorter wavelength than light; for example, electrons accelerated to an energy of 10^5 electronvolts have a wavelength of 0.004 nanometre enabling a resolution of 0.2-0.5 nm to be achieved. Magnification above 1,500 can be achieved with EM.

2. The ***transmission electron microscope*** (TEM) has an electron beam sharply focused by electron lenses, passing through a very thin metallized specimen (less than 50 nanometres thick) onto a fluorescent screen, where a visual image is formed. This image can be photographed. Magnification up to 200,000 can be achieved with TEM.

3. Scanning is the process of repeatedly crossing a surface or volume with a beam, aerial, or moving detector in order to bring about some change to the surface or volume, to measure some activity, or to detect some object. The ***scanning electron microscope (SEM)*** can be used with thicker specimens and forms a perspective image, although the resolution and magnification are lower. In this type of instrument a beam of primary electrons scans the specimen and those that are reflected, together with any secondary electrons emitted, are collected. This current is used to modulate a separate electron beam in a TV monitor, which scans the screen at the same frequency, consequently building up a picture of the specimen. The resolution is limited to above 10-20 nm. Scanning does not magnify the object as much as transmission electron microscopy, but the image is three-dimensional.

4. ***Scanning tunneling microscope*** (STM) is a type of microscope in which a fine conducting probe is held close to the surface of a sample. Electrons ***tunnel*** between the sample and the probe, producing an

electrical signal. The probe is slowly moved across the surface and raised and lowered so as to keep the signal constant. A profile of the surface is produced, and a computer-generated contour map of the surface is produced. The technique is capable of resolving individual atoms, but works better with conducting materials.

5. Microscopes are used in science and engineering, often with modifications to fulfil a particular role. They are used for studing samples of plant and animal tissue, rock samples to determine minerals and structures present, metals and non-metals to determine crystal structure, separate atomic planes, dislocation patterns in metals and alloys, etc.

Notes:

1. image – изображение
2. resolution – разрешающая способность, разрешение
3. transmission electron microscope – просвечивающий электронный микроскоп (TEM)
4. scanning electron microscope – растровый (сканирующий) электронный микроскоп (SEM)
5. tunnel – туннелировать, совершать туннельный переход
6. scanning tunneling microscope – растровый (сканирующий) микроскоп

VI. Read and translate text 29.4. Identify, define or explain:

1. Electron microscope and its features
2. Transmission electron microscope
3. Scanning and its purpose
4. Scanning electron microscope
5. Scanning tunneling microscope
6. Application of microscope

VII. Make up the abstracts of texts 29.1–29.4 (in English or in Russian).

VIII. Comment on the following quotation. Do you agree or disagree with it?

1. Let me tell you the secrete that has led me to my goal. My strength lies solely in my tenacity. (Louis Pasteur 1822-1895)

SECTION 30

TEXT 30.1. WILHELM RÖNTGEN

1. Wilhelm Conrad Röntgen (1845-1923) was a German physicist who was a recipient of the first Nobel Prize for Physics, in 1901, for his discovery of X-rays, which heralded the age of modern physics and revolutionized diagnostic medicine.

2. Röntgen studied at the Polytechnic Institute in Zürich and then was professor of physics at the universities of Strasbourg (1876-79), Giessen (1879-88), Würzburg (1888-1900), Munich (1900-20). His research also included work on elasticity, capillary action of fluids, specific heat of gases, conduction of heat in crystals, absorption of heat by gases, and piezoelectricity.

3. In 1895, while experimenting with electric current flow in a partially evacuated glass tube (***cathode-ray tube***), Röntgen observed that a nearly piece of barium platinocyanids gave off light when the tube was in operation. He theorized that when the cathode rays (electrons) struck the glass wall of the tube, some unknown radiation was formed that travelled across the room, struck the chemical, and caused the fluorescence. Futher investigation revealed that paper, wood and aluminium, among other materials, are transparent to this new form of radiation.

4. He found that the radiation affected photographic plates, and, since it did not noticeably exhibit any proper ties of light, such as reflection or refraction, he was mistaken by thought the rays were unrelated to light. ***In view of*** its uncertain nature, he called the phenomenon X-radiation, though it also became known as Röntgen radiation. He took the first X-ray photographs of the metal objects and of the bones in his wife’s hand.

Notes:
1. cathode-ray tube – электронно-лучевая трубка (ЭЛТ)
2. in view of – ввиду, с учётом, в связи

I. Find Russian equivalents for:

a German physicist, discovery of X-rays, study at the Institute, elasticity, capillary action of fluids, conduction of heat in crystals, absorption of heat by gases, piezoelectricity, glass tube, observe, theorize, further investigation, transparent, exhibit, to call the phenomenon X-radiation, metal objects

II. Find English equivalents for:

предвещать эпоху современной физики, лауреат первой Нобелевской премии, производить переворот в диагностической медицине, научно-исследовательская работа, включать, удельная теплоёмкость газов, поток электрического тока, испускать свет, ударяться, вызывать свечение, обнаруживать, излучение воздействовало на фотографические пластины, так как, сделать фотографии

III. Read and translate text 30.1. Answer the following questions:

1. Who was W. Röntgen?
2. What was he famous for?
3. Where did Röntgen study?
4. What did he investigate?
5. What did Röntgen observe?
6. What did he find?
7. Why did he call the phenomenon X-radiation?

TEXT 30.2. X-RAYS

1. X-rays are electromagnetic waves with a short wavelength (approximately 10^{-10} -10^{-8} m) produced when electrons moving at high speed strike a ***target*** and are stopped very quickly and X-rays are emitted. They were discovered in 1895 by the German scientist Wilhelm Röntgen. He found that wrapped photographic plates left near a working cathode-ray tube became fogged, as if they had been exposed to light, and he called this unknown radiation X-rays. In fact X-rays were being emitted as electrons hit the anode and walls of the cathode-ray tube.

2. Atoms of all elements give off characteristic X-rays when hit by electrons. The stream of electrons colliding with the atom displaces electrons from inner orbitals and vacant places are then filled by electrons from the outer orbital, which give out energy as they move down. X-rays have the properties of electromagnetic radiation and also penetrate solid matter, cause ionisation (by removal of electrons from atoms), make some materials fluorescent and they affect photographic film.

3. These properties render X-rays both useful and hazardous. Their ionisation effect damages living tissue, but by using very small doses, they can be used in medicine to take X-ray photographs of the body. The extent to which the rays are absorbed depends on the density and the atomic

weight of the material; the lower these factors, the more easily will the rays penetrate. The greater density of bone means it is possible to take an X-ray photograph because the flesh appears transparent while the bones are opaque.

4. X-rays are used in industry for checking joints in metal and examining ***flaws***. They are also used in X-ray diffraction (or X-ray crystallography), which is analytical ***tool*** in geology, crystallography and biophysics. X-rays directed at the sample are diffracted off the planes of atoms in the crystal. By repeating the procedure and then calculating the spacing between atomic planes, a representation of the crystal's structure can be determined. In this way the structure of some protein and nucleic acids has been analysed.

Notes:

1. target – мишень, цель
2. flaw – трещина, дефект
3. tool – средство, приспособление, инструмент

IV. Find Russian equivalents for:

electromagnetic waves, short wavelength, strike a target, unknown radiation, stream of electrons, displace electrons from inner orbitals, fill, properties, cause ionisation, fluorescent, to take X-ray photographs of the body, absorb, density and the atomic weight of the material, transparent, in industry, for examining flaws, analytical tool, calculate the spacing between atomic planes, nucleic acids

V. Find English equivalents for:

электроны, движущиеся с высокой скоростью; подвергаться воздействию света, выделять (испускать лучи), сталкиваться, электроны с внешней орбиты, проникать в твердое вещество, воздействовать на фотопленку, делать рентгеновские лучи и полезными и опасными, разрушать живую ткань, степень, зависеть от, чем ниже … тем легче... , кости (тела) светонепроницаемые (непрозрачные), для проверки швов (соединений) в металле, образец (для испытаний), исследовать (изучать)

VI. Read and translate text 30.2. What information have you learned about:

1. X-rays wavelength	4. Useful effect of X-rays
2. Discovery of X-rays	5. Dangerous effect of X-rays
3. Properties of X-rays	6. Use in industry and other fields

TEXT 30.3. APPLICATION OF X-RAYS

1. Due to the many varied properties of X-rays, they have been applied to a wide range of medical, industrial and scientific problems. Some of these are ***differential absorption***, quantitative measurement of absorption, ***diffraction*** by crystals, fluorescence of characteristic radiation and biological effects produced by X-rays.

2. One of the earliest applications of X-rays was to medicine, being used in both diagnosis and therapy. Diagnostics include the detection of bone fractures, ***foreign objects*** in the body, dental cavities, and diseased conditions such as cancer, whereas, in therapeutic treatment, X-rays are used to stop the spread of ***malignant tumours.***

3. In industry, ***X-ray radiographs*** are used to detect flaws nondestructively in castings that are inaccessible to direct observation and to measure the thickness of materials. X-rays have been applied to a wide range of quantitative materials characterization problems. By measuring quantitatively the amount of absorption in a sample of known composition, the thickness can be determined. If the thickness of a sample is known, the absorption can be used to measure accurately its composition even if it contains two elements.

4. The fluorescence of X-rays from a sample is used in many instruments for the qualitative and quantitative analysis of materials. The primary beam may be X-rays, gamma rays, electrons or other charged particles. The energy of the fluorescence of X-rays is characteristic of the materials contained in the sample. By using suitable standards, quantitative determinations can be made. This principle is used in the ***electron microprobe*** in which a narrow electron beam (about 0.0001cm in diameter) is used to determine the constituents of a given area of a sample.

5. X-rays are used in scanning electron microscopy to obtain ‘a picture’ of an elemental distribution in a sample. Also, Si (Li) detectors may be combined with a fluorescence source as energy analysis detectors for rapid material identification. X-rays are used in study of crystal structure (X-ray diffraction). X-ray diffraction is the diffraction of X-rays

when they strike a crystal. The angle through which the X-rays are diffracted depends on the spacing between the different planes in the crystal in a manner given by Bragg's law.

Notes:
1. differential absorption – дифференциальное поглощение
2. diffraction – дифракция, преломление (лучей)
3. characteristic radiaton – характеристическое (рентгеновское) излучение
4. foreign objects – инородные предметы
5. malignant tumour – злокачественная опухоль
6. X-ray radiograph – рентгенограмма
7. electron microprobe – электронный микрозонд

VII. Read and translate text 30.3. With your partner, discuss the application of X-rays in:

1. Medicine (diagnostics and therapy)
2. Industry
3. Qualitative and quantitative analysis of materials
4. Scanning electron microscopy

VIII. Make up the abstracts of texts 30.1–30.3 (in English or in Russian).

IX. Comment on the following quotations. Do you agree or disagree with them?

1. Very simple ideas lie within the reach only of complex minds. (Remy de Gourmont 1858-1915)
2. Success is that old ABC – ability, breaks and courage. (Charles Luckman)

SECTION 31

TEXT 31.1. ERNEST RUTHERFORD

1. Ernest Rutherford, Baron Rutherford of Nelson (1871-1937) was New Zealand-born British physicist and Nobel Prize winner to be ranked in fame with Sir Isaac Newton and Michael Faraday. He made fundamental discoveries concerning the nature of radioactivity, distinguishing between the three types of radiation, which he named alpha, beta and

gamma rays. Working with Hans Geiger (1882-1945) he discovered that alpha radiation consisted of positively charged helium atoms. In 1906, he ***deduced*** the existence of a positively charged core in the atom, which he called the nucleus. In 1908, Rutherford received the Nobel Prize for Chemistry.

2. Rutherford was born in Spring Grove (New Zealand). He was the fourth of the 12 children of James, a ***wheelwright*** at Brightwater near Nelson on South Island, and Martha Rutherford. His parents, who had emigrated from Great Britain, denied themselves many comfort so that their children might be well educated. In 1887 Ernest won a scholarship to Nelson College, a secondary school – similar to a public (private) school in England – where he was a popular boy, clever with his hands, and a keen football player. He won prizes in history and languages as well as mathematics. Another scholarship allowed him to enroll in Canterbury College, Christchurch, from where he graduated with the B.A. in 1892 and the M.A. in 1893 with first class honours in mathematics and physics.

3. Financing himself by part-time teaching, he stayed for a fifth year to do research work in physics, studying the properties of iron in high-frequency alternating magnetic fields. He could detect the electromagnetic waves – wireless waves – newly discovered by the German physicist Heinrich Hertz, even after they had passed through brick walls. Two substantial scientific papers on this work won for him an'1851 Exhibition' scholarship, which provided for further education in England.

Notes:

1. deduce – выводить (заключение, следствие, формулу)
2. wheelwright – колёсный мастер

I. Find Russian equivalents for:

New Zealand-born British physicist, make fundamental discoveries; alfa, beta and gamma rays; nucleus, emigrate from Great Britain, scholarship, clever, to graduate from the College, detect the electromagnetic waves, substantial scientific papers

II. Find English equivalents for:

открытия, касающиеся природы радиоактивности, распознавать три вида излучения, положительно заряженные атомы гелия, отказывать себе во многом, изучать свойства железа в высокочастотных переменных магнитных полях радио-волны, проходить через кирпичные стены, обеспечить дальнейшее обучение в Англии

III. Read and translate text 31.1. Answer the following questions:

1. What was Ernest Rutherford?
2. What was he famous for?
3. Who is E. Rutherford ranked in fame with?
4. Where was he born?
5. What can you say about his family?
6. Where did Rutherford study and how?
7. Why did he finace himself?
8. What helped Rutherford continue education in England?

TEXT 31.2. E. RUTHERFORD'S WORK IN CAMBRIDGE AND ABROAD

1. On his arrival in Cambridge in 1895, Rutherford began to work under J.J. Thomson, professor of experimental physics at the university's Cavendish Laboratory. Continuing his work on the detection of Hertzian waves over a distance of two miles, he gave an experimental lecture on his results before the Cambridge Physical Society and his paper was published in the 'Philosophical ***Transactions***' of the Royal Society of London, a signal honour for so young an investigator. Rutherford made a great impression on colleagues in the Cavendish Laboratory.

2. In December 1895, when Röntgen discovered X-rays, Thomson asked Rutherford to join him in a study of the effects of passing a beam of X-rays through a gas. They discovered that the X-rays produced large quantities of electrically charged particles, or carriers of positive and negative electricity, and that these carriers, or ionized atoms, recombined to form neutral molecules. Working on his own, Rutherford then devised a technique for measuring the velocity and rate of recombination of these positive and negative ions. The published papers on this subject remain classics to the present day.

3. In 1896 the French physicist Henry Becquerel discovered that uranium emitted rays. Rutherford soon showed that they also ionized air but that they were different from X-rays, consisting of two distinct types of radiation. He named them alpha rays, highly powerful in producing ionization but easily absorbed, and beta rays, which produced less radiation but had more penetrating ability. In 1898 Rutherford was

appointed to the chair of physics at McGill University in Montreal (Canada). In the summer of 1900 he travelled to New Zealand to visit his parents and get married Mary Newton, a daughter of his landlady in Christchurch. They had a daughter, the only child, Eileen.

4. Within three years Rutherford succeeded in ***marking out*** an entirely new branch of physics called radioactivity. Rutherford and a young chemist, Frederick Soddy, then investigated three groups of radioactive elements – radium, thorium and actinium. They concluded in 1902 that radioactivity was a process in which atoms of one element spontaneously disintegrated into atoms of an entirely different element, which also remained radioactive. Rutherford's outstanding work won him recognition by the Royal Society, which elected him a fellow in 1903 and awarded him the Rumford medal in 1904. In his book 'Radioactivity' he summerized in 1904 the results of research in that subject.

5. Rutherford, a prodigious worker with tremendous powers of concentration, showed (1903) that alpha rays can be deflected by electric and magnetic fields, the direction of the deflection proving that the rays are particles of positive charge: he determined their velocity and the ratio of their charge to their mass.

Notes:

1. transactions – труды (научного общества)
2. mark out – выделять

IV. Find Russian equivalents for:

on his arrival in Cambridge, young investigator, electrically charged particles, carriers of positive and negative electricity, recombine, measuring the velocity and rate, the published papers on this subject, consist of two distinct types of radiation, more penetrating ability, to visit his parents, to win him recognition by the Royal Society, outstanding work, to award a medal, ratio of charge to mass

V. Find English equivalents for:

работать под руководством профессора, прочитать лекцию о результатах, произвел большое впечатление на коллег, присоединиться, большое количество, изобретать (придумывать) метод (способ), уран испускает (излучает) лучи, легко поглощаемые лучи, был назначен на кафедру физики; новая область (отрасль) физики, называемая радиоактивностью, самопроизвольно распадаться, избирать членом научного общества, огромная способность к концентрации

VI. Read and translate text 31.2. Find in the text the information to prove that:

1. In Cambridge E. Rutherford worked under well-known professor.
2. His paper was published in a scientific journal.
3. Rutherford studied also the effects of X-rays.
4. He devised a technique.
5. Rutherford discovered and named several types of radiation.
6. He worked in Canada.
7. E. Rutherford with a young chemist investigated radioactive elements.
8. He won recognition by his colleagues.

TEXT 31.3. RUTHERFORD'S CONTRIBUTION TO SCIENCE

1. Rutherford wrote 80 scientific papers during his seven years at McGill, made many public appearances, among them the Silliman Memorial Lectures at Yale University in 1905, and received offers of Chairs at other universities. In 1907 he returned to England to accept a Chair at the University of Manchester, where he continued his research on the alpha particles. With the ingenious apparatus that he and his research assistant, Hans Geiger, had invented they counted the particles as they were emitted one by one from a known amount of radium; and they also measured the total charge collected from which the charge on each particle could be detected.

2. With his student, Thomas D. Royds, he proved in 1908 that the alpha particle really is a helium atom. In 1908 Rutherford received the Nobel Prize for Chemistry for his investigations concerning the disintegration of elements. In 1911 Rutherford made his greatest contribution to science with his nuclear theory of the atom according to which almost all the mass is concentrated on a very small central nucleus some 10,000 times smaller in diameter than that of the entire atom. The positive charge on the nucleus is balanced by an equal charge on all the electrons distributed around the nucleus.

3. Rutherford had been knighted in 1914. During World War I he worked on the practical problem of submarine detection by ***underwater acoustics***. He produced the first ***artificial disintegration*** of an element (1912), when he found that on collision with an alpha particle an atom of

nitrogen was converted into an atom of oxygen and atom of hydrogen. In 1919 Rutherford was invited to succeed Thomson in the Cavendish chair at Cambridge. After moving to Cambridge in 1919 he achieved the artificial splitting of light atoms. The Copley Medal of the Royal Society was bestowed on him in 1922. He served as president of the British Association for the Advancement of Science in 1923 and as president of the Royal Society (1925-30).

4. In 1925 he was appointed to the ***Order of Merit***. In 1931 he was created Baron Rutherford of Nelson. Rutherford, together with J. Chadwick and C. Ellis, wrote 'Radiation from Radioactive Substances' (1930). His other books include 'Radio-Activity" (1904), 'Radioactive Transformation' (1906), 'Radioactive Substances and Their Radiations' (1913), and 'The newer Alchemy' (1937). Rutherford read widely and enjoyed good heath, the game of golf, his home life, and hard work. He could listen to the views of others, his judgments were fair, and from his many students he earned affection and asteem. In 1931 he was made a ***peer***. He died in Cambridge on October 19, 1937, following a short illness, and was buried in Westminster Abbey.

Notes:

1. underwater acoustics – гидроакустика
2. artificial disintegration – искусственное расщепление (распад)
3. Order of Merit – орден "За заслуги" (одна из высших наград, которая присуждается монархам за выдающиеся заслуги в разных областях)
4. peer – пэр (титулованный дворянин, принадлежащий к одной из пяти степеней сословия наследственных пэров [герцог, маркиз, граф, виконт и барон], имеет право быть членом палаты лордов)

VII. Read and translate text 31.3. Find in the text the information to prove that:

1. In Canada E. Rutherford wrote many scientific papers and gave many lectures.
2. He returned to England.
3. He and his assistant invented the apparatus.
4. Rutherford received the Nobel Prize.
5. Rutherford had many awards and titles.
6. He made the greatest contribution to science.
7. His students liked him.

8. He wrote many important books

TEXT 31.4. RUTHERFORD ATOMIC MODEL

1. Rutherford atomic model is the discription of the structure of atoms, proposed (1911) by the British physicist Ernest Rutherford, as a tiny, dense, positively charged core called a nucleus, in which nearly all the mass is concentrated, around which the light, negative ***constituents***, called electrons, ***circulate*** at some distance, much like planets revolving around the Sun. The Rutherford atomic model has been alternatively called the nuclear atom or the planetary model of the atom.

2. The nucleus was ***postulated*** as small and dense to account for the scattering of alpha particles from thin gold foil. Alpha particles, ejected at high speeds from some radioactive materials, are positively charged particles more than 7,000 times as massive as electrons. Most alpha particles were observed to pass straight through the gold foil. A few, however, scattered at large angles, and some even ***bounced*** back toward the source. Only positively charged and relatively heavy target particles, such as the proposed nucleus, could account for such strong repulsion. The negative electrons that balanced electrically the positive nuclear charge were regarded as travelling in circular orbits about the nucleus.

3. The electrostatic force of attraction between the electrons and the nucleus was likened to the gravitational force of attraction between the revolving planets and the Sun. Most of this planetary atom was open space and offered no resistance to the passage of the alpha particles. The Rutherford model, based wholly on classical physics, was superseded in a few years by the Bohr atomic model, which incorporated some early quantum theory.

Notes:
1. constituent – составная часть, компонент, структурная составная
2. circulate – иметь круговое движение
3. postulate – постулировать, теоретически допускать
4. bounce – отскакивать

VIII. Read and translate text 31.4. Identify, define or explain:

1. Rutherford atomic model, its alternative name
2. Positively charged particles and negative electrons
3. Electrostatic force of attraction

4. Space and resistance of planetary atom
5. A new atomic model

IX. Make up the abstracts of texts 31.1– 31.4 (in English or in Russian).

X. Comment on the following quotations. Do you agree or disagree with them?

1. All science is either physics or stamp collecting. (Ernest Rutherford 1871–1937, – New Zealand-born British physicist)
2. Should a young scientist working with me come to me after two years of such work and ask me what to do next, I would advise him to get out of science. After two years of work, if a man does not know what to do next, he will never make a real scientist. (Ernest Rutherford 1871–1937)

SECTION 32

TEXT 32.1. THOMAS SEEBECK

1. Thomas Johann Seebeck (1770-1831) was Estonia-born German physicist who discovered (1821) that an electric current flows between different conductive materials that are kept at different temperatures, known as the Seebeck effect.

2. Seebeck studied medicine at Berlin and at the University of Göttingen, where he acquired an M.D. in 1802. However, he abandoned medical practice for scientific research. He was chosen (1814) as a member of the Berlin Academy and was awarded (1816) the academy's annual prize for his investigation of polarization in stressed glass.

3. In numerous experiments on the magnetizability of various metals, he observed the anomalous reaction of magnetized red-hot iron, which eventually resulted in the phenomenon now known as ***hysteresis***. Hysteresis is a phenomenon in which two physical quantities are related in a manner that depends on whether one is increasing or decreasing in relation to the other. The repeated measurement of ***stress*** against ***strain***, with the stress first increasing and then decreasing, will produce for some specimens a ***graph*** that has the shape of a ***closed loop***. This is known as a hysteresis cycle. The most familiar hysteresis cycle, however, is produced by ***plotting*** the magnetic flux density within a ferromagnetic material ***against*** the applied magnetic field strength.

4. Continued experiments with different metal pairs and a variety of conductors revealed that it was possible to place the many conducting materials in a ***thermoelectric series***. His most important contribution, however, was the Seebeck effect. He discovered that a copper strip was joined to a strip of bismuth to form a closed circuit, heating the junction induced a current of electricity to flow around the circuit as long as the difference in temperature existed. This remained true of any pair of metals.

Notes:

1. hysteresis – гистерезис, запаздывание
2. stress – напряжение
3. strain – деформация, напряжение
4. graph – график, диаграмма, кривая
5. closed loop – замкнутая петля, замкнутый контур
6. plotting – построение графика (диаграммы, кривой)
7. against – в зависимости от, относительно, по отношению
8. thermoelectric series – термоэлектрический ряд напряжений

I. Find Russian equivalents for:

physicist, discover, different conductive materials, study medicine, scientific research, investigation of polarization in stressed glass, observe, phenomenon, physical quantities, depend on, increasing or decreasing, stress against strain, graph, shape, magnetic flux density, applied magnetic field strength, possible, copper strip, heating the junction, to flow around the circuit, his most important contribution

II. Find English equivalents for:

электрический ток протекает (проходит), хранить (содержать) при разных температурах, получить степень магистра, отказаться (оставлять) от медицинской практики, награждать ежегодной премией, намагничиваемость различных металлов, раскалённое до красна железо, приводить к, повторное измерение, образец (экземпляр), ряд проводников, обнаруживать, соединять, образовывать, замкнутая цепь (контур), побуждать (стимулировать) поток электричества, пока

III. Read and translate text 32.1. Answer the following questions:

1. What was Thomas Seebeck? 2. What was he famous for?

3. Where did Seebeck study?
4. What did he observe?
5. What is hesteresis?
6. What was his most important contribution?

TEXT 31.2. SEEBECK EFFECT

1. Thermoelectric effects are the effects of changes of temperature on electric circuits or devices. The Seebeck effect, named after J. Seebeck (1770-1831), provides the basis for the thermocouple; it occurs when a circuit has two junctions between dissimilar metals. If the junctions are maintained at different temperatures, a voltage is generated between them. A Peltier effect, named after Jean Peltier (1785-1845), is the converse of this. One junction heats up and the other cools down when a steady current flows through such a circuit. In the Thomson (or Kelvin) effect, named after Lord Kelvin, a temperature gradient along a single metal conductor causes a current to flow through it.

2. Seebeck effect (thermoelectric effect) is production of an electromotive force (emf) and consequently an electric current in a loop of at least two dissimilar conductors when two junctions are maintained at different temperatures. The magnitude of the e.m.f. depends on the nature of the metals and the difference in temperature. The conductors are commonly metals. The Seebeck effect is used to measure temperature with great sensitivity and accuracy and to generate electric power for special applications. The Seebeck effect is the basis of the thermocouple.

3. Thermocouple is a device (a type of thermometer) consisting of two dissimilar metal wires or semiconducting rods joined (welded together) at their ends. A thermoelectric e.m.f. is generated in the device when the ends are maintained at different temperatures, the magnitude of the e.m.f. being related to the temperature difference. This enables a thermocouple to be used as a thermometer over a limited temperature range. One of the two junctions, called the ***hot or measuring junction***, is exposed to the temperature to be measured. The other, the ***cold or reference junction***, is maintained at a known ***reference temperature***. The output is usually displayed on a galvanometer. Copper-constant junctions are used up to 500^{o} C and platinum-rhodium alloy up to 1500^{o} C. A ***thermopile*** consists of several thermocouples connected in series.

4. Thermopile is a device used to detect and measure the intensity of radiant energy. It consists of a number of thermocouples connected together ***in series*** to achieve greater sensitivity. The hot junctions of the

thermocouples are blackened and exposed to the radiation to be detected or measured, while the cold junctions are shielded from the radiation. The thermoelectric e.m.f. generated enables the hot junction excess temperature to be calculated and the radiant intensity to be deduced. They are used in various applications, from a safety device that ceases to produce an electric current if a ***pilot light*** blows out to an instrument to measure the heat radiation received from the sun.

Notes:
1. hot (measuring) junction – горячий (рабочий) спай (термопары)
2. cold (reference) junction – холодный (свободный) спай (термопары)
3. reference temperature – опорная (исходная) температура
4. thermopile – термобатарея
5. in series – последовательно
6. pilot light – буферный фонарь, сигнальная (контрольная) лампа включения

I. Find Russian equivalents for:

electric circuits, device, two junctions between dissimilar metals, to heat up, to cool down, electromotive force, electric current in a loop, conductors, difference in temperature, to generate electric power for special applications, metal wires or semiconducting rods, a limited temperature range, output, platinum-rhodium alloy, to detect and measure, to achieve greater sensitivity, to calculate, instrument

II. Find English equivalents for:

влияние изменений температуры, обеспечивать основу для термопары, происходить, генерировать (создавать) напряжение, обратное утверждение (положение), величина э.д.с. зависит от, измерять температуру с большой чувствительностью и точностью, состоять из, использовать в качестве термометра, показывать, соединять последовательно, ряд (несколько) термопар, защищать (прикрывать) от радиации защитное устройство (предохранитель), измерять тепловое излучение

III. Read and translate text 32.2. What have you learned about:

1. Thermoelectric effect   2. Seebeck effect

3. Peltier effect
4. Kelvin effect
5. Magnitude of e.m.f.
6. Thermocouple
7. Two junctions of thermocouple
8. Thermopile (construction, junctions, application)

TEXT 32.3. JEAN PELTIER

1. Jean-Charles-Athanase Peltier (1785-1845) was a French physicist who discovered (1834) that at the junction of two dissimilar metals an electric current will produce heat or cold, depending on the direction of current flow. The effect, known by his name, is used in devices for measuring temperature and, with the discovery of new conducting materials, in refrigeration units.

2. A clockmaker, Peltier retired when he was 30 years old to devote his time to scientific investigations. In 1840 he introduced the concept of electrostatic induction, a method of charging a conductor by closely juxtaposing another charged object to attract all charges of one sign and then grounding the conductor to ***bleed off*** the other group of charges, leaving a ***net charge*** behind. He wrote numerous papers on atmospheric electricity, ***waterspouts*** and the boiling point at high elevations.

3. Peltier effect is the change in temperature produced at a junction between two dissimilar metals or semiconductors when an electric current passes through the junction. The direction of the current determines whether the temperature rises or falls. The first metals to be investigated were bismuth and copper. In a circuit consisting of a battery joined by two pieces of copper wire to a length of bismuth wire, a temperature rise occurs at the junction where the current passes from copper to bismuth, and a temperature drop occurs at the junction where the current passes from bismuth to copper.

Notes:
1. bleed off – спускать, скачивать
2. net charge – результирующий (полный, общий) заряд
3. waterspout – водосточная труба

VII. Read and translate text 32.3. Answer the following questions:

1. What was J. Pieltier?
2. What was he famous for?
3. Where is Pieltier effect used?
4. Why did he retire?
5. What concept did Pieltier introduce?
6. What is Pieltier effect?

7. What does the direction of current determine?

VIII. Make up the abstracts of texts 32.1–32.3 (in English or in Russian).

IX. Comment on the following quotations. Do you agree or disagree with them?

1. The progress of science has always been the result of a close interplay between our concept of the universe and our observations of nature. The former can only evolve out the latter and yet the latter is also conditioned greately by the former. Thus in our exploration of nature, the interplay between our concepts and our observations may sometimes lead to totally unexpected aspects among already familiar phenomena. (Tsung-Dao Lee 1926), – Chinese-born American scientist)

SECTION 33

TEXT 33.1. NIKOLAY SEMYONOV

1. Nikolay Semyonov (1896-1986) was a Russian physicist and chemist, and a leader of the Soviet nuclear weapons programme. His main scientific contributions are related to the quantitative theory of chemical chain reactions, the theory of thermal explosion and the burning of gaseous mixtures.

2. He was a Physics graduate of Petrograd (St. Petersburg) University, and in 1920 he was put in charge of the electron phenomena laboratory of the Physico-Technical Institute in Petrograd. While working with Pyotr KapItsa he discovered a way to measure the magnetic field of atomic nucleus. In 1931 he became Director of the Institute of Chemical Physics of the USSR Academy of Sciences, and from 1944 he was a professor at the Moscow State University.

3. For his work of the mechanism of chemical transformation he was awarded the 1956 Nobel Prize for Chemistry. Semyonov’s work on the mechanism of chemical transformation includes an important analysis of the application of the chain theory (a sequence of reactions where a reactive ***product*** or ***by-product*** causes additional reactions) to different reactions, particularly combustion processes.

4. In chemistry and physics, a chain reaction is a reaction that, once started, continues without further outside influence. Proper conditions for a

chain reaction depend not only on various external factors, such as temperature, but also on the quantity and shape of the substance in the reaction. A chain reaction can be of various types, but nuclear chain reactions are the best known and in this area Semyonov contributed his expertise to the nuclear weapons programme. He also made valuable contributions to the field of molecular physics and electron phenomena.

5. Semyonov published his work in three important books: ‘Chemistry of the Electron’ (1927), ‘Chemical Kinetics and Chain Reactions’ (1934) and ‘Some Problems of Chemical Kinetics and Reactivity’ (1954), which was translated into many languages.

6. Semyonov received many awards and honours in his lifetime, including five Orders of Lenin. He was a member of the Chemical Society in London, Foreign Member of the Royal Society and Foreign Member of the American, Indian, German and Hungarian Academies of Sciences. He held honorary doctorates from the University of Oxford and Brussels University [19].

Notes:
1. product – продукт, произведение
2. by-product – побочный продукт

I. Find Russian equivalents for:

physicist and chemist, Soviet nuclear weapons programme, quantitative theory of chemical chain reactions, burning of gaseous mixtures, to graduate from the University, the electron phenomena laboratory, to measure the magnetic field of atomic nucleus, mechanism of chemical transformation, important analysis, sequence of reactions, various external factors, publish his work

II. Find English equivalents for:

основной научный вклад, теория теплового взрыва, поставить во главе, открыть способ, быть награжденным Нобелевской премией по химии, включать, применение теории ядерной цепной реакции, вызывать дополнительные реакции, процессы горения, продолжаться без дальнейшего влияния извне, подходящие (надлежащие) условия, область молекулярной физики, переводить на многие языки, получать много наград и почестей

III. Read and translate text 33.1. Answer the following questions:

1. What was N. Semyonov?
2. What was he famous for?
3. Where did Semyonov study?
4. What did he work?
5. What did he discover?
6. What Prize was Semyonov awarded?
7. What is chain reaction?
8. What books did he publish?
9. Did Semyonov receive many awards?

TEXT 33.2. CHEMICAL KINETICS

1. Chemical kinetics is the study of rates of chemical reactions. It attempts to understand the factors that control the rates of chemical reactions. These factors are concentration, pressure, surface area, nature of reacting substances, temperature and catalysts.

2. Concentration is the quantity of dissolved substance per unit quantity of ***solvent*** in a solution. Increasing the concentration of the reacting substances increases the reaction rate, because molecules must collide in order to react. The more concentrated the reacting substances, the more molecules there will be in any given volume, and therefore, the greater the number of molecular collisions.

3. If the substances involved in the reaction are gases, pressure will have an effect on reaction rate. Solids and liquids cannot be compressed, but gases can, so pressure acts as a kind of concentration for gases. The volume of a gas decreases as the pressure increases. For a given amount of gas, increasing the pressure means we are forcing the same number of gas molecules to occupy a smaller volume. In the smaller volume, the molecules will collide more often, which means there will be a greater number of successful collision in a given period of time. Reaction rate increases with pressure.

4. If a chemical reaction takes place at a ***boundary*** between two states (gas, liquid or solid), the surface area will affect the reaction rate. Only the molecules at the surface area are available to react. Thus, increasing the surface area increases the number of molecules that are able to react, and this leads to a higher reaction rate.

5. Some substances are naturally more reactive than others. For example, if the metals – magnesium, zinc and copper – are dropped into ***hydrochloric acid*** in separate test tubes, three very different results are obtained. Magnesium is consumed within seconds, zinc is consumed but takes much longer, and copper shows no reaction. Therefore, magnesium is more reactive than zinc and copper.

6. Temperature affects the rate of a chemical reactions in two ways. Firstly, molecules move faster in a hot system than in a cold one, so they will collide more often if they are moving faster. Secondly, increasing the temperature increases reaction rate through its effect on the collision energy (activation energy) of the molecules. Molecules must collide with sufficient force in order to combine and produce a chemical reaction. Higher temperatures give molecules the energy to collide forcefully. If they collide with less than a certain amount of energy, they simply bounce off each other unchanged.

7. Finally, a catalyst is a substance that increases the rate of a chemical reaction without being consumed in the reaction. It increases the reaction rate by reducing the activation energy, that is, the minimum amount of energy that the reducing molecules must have in order to react [19].

Notes:
1. solvent – растворитель
2. boundary – граница
3. hydrochloric acid – соляная (хлористо-водородная) кислота

IV. Find Russian equivalents for:

chemical kinetics, rate of chemical reactions, concentration, surface area, temperature and catalyst, solvent, increase, volume, number, solids and liquids, decrease, to mean, to take place at a boundary, some substances, magnesium, zinc, copper, different results, move faster, hot and cold, collision energy, collide with sufficient force, unchanged

V. Find English equivalents for:

изучение (исследование), давление, природа (свойства) реагирующих веществ, количество растворенного вещества, раствор, сталкиваться, влиять (воздействовать) на, сжимать, для данного количества газа, занимать меньший объем, имеющий силу (доступный), в отдельную пробирку, получать, расходовать, отскакивать друг от друга

VI. Read and translate text 33.2. Discuss the factors affecting chemical reaction rates.

TEXT 33.3. ATOMIC AND NUCLEAR ENERGY

1. Atomic and nuclear power can be very destructive (remember Hiroshima and Nagasaki). This kind of power involves the forces that hold the nucleus of an atom together. These forces contain incredible amounts of energy, and there are two basic ways that nuclear energy can be released from an atom. The first one is ***nuclear fission*** – fission means separating. In this process a neutron splits the nucleus of an uranium atom into two smaller fragments. The other method is ***nuclear fusion***, which involves bringing atoms together. Two smaller atoms, usually hydrogen, are brought together to form a larger one such as helium; in fact, this is how the sun produces energy. In both processes, ***fission bomb*** uses such an element like uranium to create a nuclear explosion.

2. Uranium is one of the few materials that can become unstable and split immediately when it absorbs a neutron. As soon as the uranium nucleus captures the neutron, it splits into two lighter atoms and also throws off two or three new neutrons. These then emit gamma radiation. The neutrons that are released during the reaction can, in turn, cause another fission reaction. This is what is called a chain reaction – it continues by ***setting off*** more reactions. In this way, an incredible amount of energy is released when an atom splits.

3. This process can cause total destruction. In the 1980s, scientists considered the possible effects of a nuclear war and proposed the theory that ‘a nuclear winter’ could occur. The explosion of many bombs would raise huge clouds of dust and radioactive material that would travel high into the Earth’s atmosphere. These clouds would block out sunlight. Without sunlight, plants would not survive, and this would disrupt the ***food chain***, resulting in the end of all life on the planet.

Notes:

1. nuclear fission – деление ядра
2. nuclear fusion – ядерный синтез
3. fission bomb – ядерная бомба
4. set off – стимулировать, побудить
5. food chain – пищевая цепь, трофическая связь

VII. Read and translate text 33.3. Answer the following questions:

1. Where is energy contained?
2. What is nuclear fission?

3. What is used to split an atom? 4. What is nuclear fusion?
5. What particles are released in uranium splitting?
6. How could a nuclear winter affect life on Earth?

TEXT 33.4. CHAIN REACTIONS

1. Chain reaction is a series of reactions in which the product of each reaction sets off further reactions. In a nuclear chain reaction each nuclear fission is induced by a neutron ejected by a previous fission. For example, the fission of uranium-235 nucleus produces either two or three neutrons each of which can induce the fission of another uranium-235 nucleus. Chain reactions are used as a source of energy in nuclear reactors and nuclear weapons.

2. Nuclear reactor is a device for producing nuclear energy in a usable form. There are several types of nuclear reactors: ***fast reactor***, ***thermal reactor,*** thermonuclear reactor. Fast reactor is a nuclear reactor in which natural uranium enriched with uranium-235 or plutonium-239 is used without a ***moderator***, the chain reaction being ***sustained*** by fast neutrons. In these reactors the ***core*** is surrounded by a ***blanket*** of natural uranium into which neutrons escape. These neutrons collide with U-238 nuclei to form U-239 nuclei, which decay to the fissionable isotope Pu-239. By suitable design, more Pu-239 can be produced in the blanket than is required to enrich the fuel in the core. These reactors are therefore called ***breeder reactors***. They are 50 times more economical in uranium usage than thermal reactors. The temperature is so high that a liquid metal (usually sodium) has to be used as coolant.

3. Thermal reactor is a nuclear reactor in which natural or enriched uranium is used with a moderator so that the velocities of the emitted neutrons are comparable to the velocities of gas molecules (‘thermal’ velocities). The reactor core consists of ***fuel rods*** made of uranium metal or oxide surrounded by a moderator, the heat of the reaction being removed by a coolant. After leaving the core, the coolant passes to a heat exchanger in which steam is raised. The rate of reaction is controlled by a series of control rods, which can move in and out of the core: the rods contain a neutron – absorbing element, such as boron. Early British reactors used natural uranium; the next generation (advanced ***gas-cooled reactor*** –AGR) used enriched uranium dioxide and CO_2 as a coolant. The US – designed ***pressurized-water reactors*** (PWR), using ordinary water as both moderator and coolant are now widely used.

4. Thermonuclear reactor is a reactor in which a fusion reaction takes place with the controlled release of energy. The most readily achieved fusion reaction is the combination of deuterium and tritium to form helium. To overcome the electrostatic repulation between nuclei a temperature of about 40 mln^{o} C is needed. Containing the plasma (high-temperature ionized gas) is a central problem. To produce useful power gain at this temperature, the product of the plasma density and the containment time must exceed 10^{14} particle seconds per cm^{3}. Toroidal ***tokamak*** devices, which originated in the Soviet Union, have approached this figure.

5. Nuclear weapons are missiles, bombs or mines that use nuclear fission or fusion yielding enormous quantities of heat, light, blast and radiation. The first atomic bomb (or fission bomb), manufactured by the USA in World War II, was dropped on Hiroshima in 1945. The bomb had an explosive power equivalent to 20 000 tons of ***TNT***. The hydrogen bomb (fusion bomb or thermonuclear bomb) consists of atom bomb surrounded by a layer of hydrogeneous material, such as lithium deuteride. The atom bomb creates the necessary temperature (about 100 000 000^{o} C) needed to ignite the fusion reaction. Hydrogen bombs have an explosive power measured in tens of megatons (millions of tons) of TNT. The first hydrogen bomb was exploded by US scientists on Eniwetok Atoll in 1952. The neutron bomb (or enhanced radiation bomb) is designed to maximize neutron radiation. It is lethal to all forms of life but, having reduced blast, leaves buildings, etc., relatively unchanged.

Notes:

1. fast reactor – ядерный реактор на быстрых нейтронах, быстрый ядерный реактор
2. thermal reactor – ядерный реактор на тепловых нейтронах
3. moderator – замедлитель (нейтронов)
4. sustain – поддерживать
5. core – активная зона ядерного реактора
6. blanket – зона воспроизводства (ядерного реактора), защитный слой
7. breeder reactor – ядерный реактор-размножитель, бридер
8. fuel rod – топливный стержень
9. gas-cooled reactor – ядерный реактор с газовым охлаждением
10. pressurized-water reactor – ядерный реактор с водой под давлением
11. tokamak – сокр. тороидальная камера с магнитным полем (тип тороидальной магнитной ловушки для управляемого термоядерного синтеза)

12. TNT (trinitrotoluene) – тринитротолуол, тротил

VIII. Read and translate text 33.4. Identify, define or explain:

1. Chain reaction
2. Nuclear reaction
3. Types of nuclear reactors
4. Fast reactor
5. Thermal reactor
6. Thermonuclear reactor
7. Nuclear weapons
8. Types of nuclear bombs

IX. With your partner, discuss the danger of nuclear weapons.

TEXT 33.5. THE RUSSIAN ACADEMY OF SCIENCES (RAS)

1. In 1724, Peter the Great established the Academy of Sciences as part of his push for reform to strengthen Russia. He wished to make the country as economically and politically independent as possible and he was aware of how important scientific thought, along with education and culture, was to this. However, unlike other foreign organizations at that time, the Academy was a state institution, which Peter intended should offer scientists from any country the opportunity to do their research in complete freedom, as well as providing the opportunity for students to study under these famous people. The Academy officially opened in 1725.

2. Over the next three decades, work was done in many fields, among them, work on electricity and magnetism theory. Research enabled the development of mining, metallurgy and other branches of Russian industry. Work was done in geodesy and cartography and 1745 saw the first atlas of Russia created. From its earliest days, the Academy carried out mathematical research, which added greatly to the development of calculus, hydrodynamics, mechanics, optics, astronomy and made discoveries in various fields, such as chemistry, physics and geology. In addition, expeditions in 1733-1742 and 1760-1770 helped contribute to the discovery of Russia's natural resources.

3. The 19th century was a time of many more contributions from the Academy. The Academy's naturalists were involved in voyages of discovery, including that of F.F. Bellingshausen and M.P. Lazarev in 1820, when Antarctica was discovered. In the fields of mathematics and physics, progress was furthered by N.I. Lobachevsky and his theory of non-Euclidean geometry as well as by P.L. Chebyshev who made progress in the field of probability, statistics and number theory. Other notable achievements were the invention of the radio, the creation of the periodic

table of the chemical elements, the discoveries of viruses and the cell mechanism of immunity. In the 1090s and early 1900s, I.P. Pavlov carried out experiments which resulted in the discovery of classical conditioning or conditioned reflexes. Clearly, throughout the 18^{th} and 19^{th} centuries and into the 20^{th} century, the Russian Academy led the way in Russian science.

4. In 1925, the name of the Academy changed to the Academy of Sciences of the USSR. One of the achievements of the Academy was to help set up scientific research centres in all Soviet republics. The Academy also gave scientists the opportunity to work and study in different parts of the USSR and abroad. In 1934, its ***headquarters*** were moved to Moscow. At that time, it had 25 member institutions. The Academy continued to grow, reaching a high point of 260 members institutions. In 1991, after the breakup of the USSR, the Academy's name was changed to the Russian Academy of Sciences (RAS).

5. Today, the RAS supervises the research of a large group of institutions within Russia which focus on different research areas, including philosophy, botany, anthropology, paleontology and archaeology as well as nuclear physics, astrophysics, mathematics, computer engineering and many others. A special Internet system, called the Russian Space Science Internet (RSSI), which links over 3000 members, has also been set up.

6. Becoming a member of the RAS is not easy. Only scientific researchers who have done outstanding work or who have great potential are chosen to become members. The RAS gives awards to members who have made significant discoveries. Its highest award is the Lomonosov Medal, named after the outstanding Russian scientist, writer and polymath of the 18^{th} century. Many RAS award winners have later gone on to be awarded prestigious Nobel Prizes [19].

Notes:

1. headquarters – главное управление

X. Read a nd translate text 33.5. Characterize in brief:

1. Establishment of the Academy of Sciences
2. Work done in many fields
3. The 19^{th} century achievements
4. The Academy of Sciences of the USSR
5. The RAS and RSSI
6. Membership of the RAS and its highest award

TEXT 33.6. RUSSIAN NOBEL PRIZE WINNERS IN PHYSICS AND CHEMISTRY

Because of its long history of supporting scientific research and education, Russia has produced a number of internationally recognised leaders in physics and chemistry. The Russian Academy of Sciences or RAS (or the USSR Academy of Sciences, as it was called before 1991), played a major part in all their careers. With one exception, all were members of the Academy, carrying out their research and publishing their findings with the Academy ***support***.

1956 In 1956, Nikolay Semyonov was the first Russian to receive Nobel Prize for Chemistry for his research into the mechanism of chemical reactions. He was trained as a physicist and chemist. During his career, working alone or with other distinguished scientists like Pyotr L. Kapitsa, he made many important discoveries and contributions to chemistry and physics. In 1931, Semyonov became the first director of the Institute of Chemical Physics of the Academy and was also one of the founder of the Moscow Institute of Physics and Technology (MIPT).

1958 The collaboration of Pavel A. Cherenkov, Igor Y. Tamm and Ilya M. Frank resulted in the discovery and description of the Cherenkov-Vavilov effect, a phenomenon which is very important in nuclear physics. For their work they received the Nobel Prize in 1958. All three of the scientists were professors at universities and the Academy’s institutes and greatly influenced future generations of scientists.

1962 After receiving his doctoral degree from Leningrad University at the exceptionally young age Lev D. Landau went on to study abroad. When he returned to Russia, he became head of two of the Academy’s institutes. Like Semyonov, he was also involved in founding the MIPT. He received the Nobel Prize for Physics in 1962, for his phenomenological theory of ***superfluidity*** in helium.

1964 Nikolay G. Basov and Aleksandr M. Prokhorov worked together on a project which led to the development of laser and their receiving the 1964 Nobel Prize. Both worked at the Lebedev Institute of Physics (Basov was the Director from 1973-1988) and also taught at universities. Even though Prokhorov never became a member of the Academy, the Academy’s ***General Physics Institute*** was renamed the A.M. Prokhorov General Physics Institute in his name.

1978 Pyotr L. Kapitsa went to England after he had completed his studies at Petrograd Polytechnic Institute. He studied at Cambridge and also worked at various projects there. He returned to Russia in 1934 and continued his career there. He was also one of the founders of the MIPT. In addition, Kapitsa was a member of the Soviet National Committee of the Pugwash movement, a group of international scientists who wanted to use science for the good of mankind and not for violence and war. Kapitsa won the Nobel Prize for Physics in 1978, for his work on low-temperature physics.

2000 Zhores I. Alfyorov has been active in physics since graduating from the Electrotechnical Institute in Leningrad. He received the Nobel Prize for Physics in 2000, for the development of the semiconductor heterostructures used in high-speed electronics and optoelectronics.

2003 More recently, Russian Nobel Prize winners in 2003 were Vitaly L. Ginzburg and Alexei A. Abrikosov. Ginzburg, who holds a doctoral degree from Moscow State University, became the director of the Academy's Physics Institute after Igor Tamm. Ginzburg was influenced by Landau, with whom he had worked, and by Tamm, who had been his teacher. Alexei Abrikosov was educated at Moscow State University. He worked at the Landau Institute for Theoretical Physics for over 20 years (1965-1988) and also taught at Moscow State university during that time. They received the Nobel Prize for Physics for pioneering contributions to the theory of superconductors and superfluids.

2010 Konstantin S. Novoselov and his supervisor Andrei K. Geim, working at University of Manchester (United Kingdom) were awarded the Nobel Prize for Physics in 2010 for ***groundbreaking*** experiments regarding the two-dimentional material graphene [19].

Notes:
1. support – поддержка, опора
2. superfluidity – сверхтекучесть
3. General Physics Institute – институт общей физики
4. groundbreaking – новаторские

XI. Read and translate text 33.6. Find additional information about the Russian Nobel Prize winners and tell your groupmates about them.

XII. Make up the abstracts of texts 33.1– 33.6 (in English or in Russian).

XIII. Comment on the following quotation. Do you agree or disagree with it?

1. To be somebody you must last. (Ruth Gordon)

SECTION 34

TEXT 34.1. IGOR TAMM

1. Igor Yevgenyevich Tamm (1895-1971) was a Russian physicist who shared the 1958 Nobel Prize for Physics with Pavel A. Cherenkov (1904-1990) and Ilya M. Frank (1908-1990) for their efforts in ***interpreting*** the Cherenkov effect (the emission of light waves by electrically charged atomic particles moving in a medium faster than the speed of light for the same medium).

2. A professor at Moscow University, he studied the quantum theory of diffused light in solid bodies before he worked with Frank in deriving the theory of Cherenkov radiation (1937). His ***technique*** of interpreting the interaction of elementary nuclear particles is known as the Tamm method. Interest in the peaceful uses of nuclear energy led him to work on methods for the control of thermonuclear reactions. He appeared on U.S. television (1963) with an appeal for international disarmament.

Notes:
1. interpret – объяснять, толковать
2. technique – метод, способ

I. Find Russian equivalents for:

a Russian physicist, electrically charged atomic particles, faster than the speed of light, solid body, technique, Tamm method, peaceful use of nuclear energy, appeal for international disarmament

II. Find English equivalents for:

объяснение эффекта Черенкова, выделение световых волн, движущихся в среде, изучать квантовую теорию рассеянного света, выводить (получать) теорию, взаимодействие элементарных ядерных частиц, контроль (управление) термоядерными реакциями

III. Read and translate text 34.1. Answer the following questions:

1. What was Igor Tamm?
2. What was he famous for?
3. What is Cherenkov effect?
4. Where did he work?
5. What did Tamm study?
6. What is Tamm method?
7. What was he interested in?

TEXT 34.2. PAVEL CHERENKOV

1. Pavel Alekseyevich Cherenkov (1904-1990) was a Soviet physicist, corecipient of the Nobel Prize for Physics in 1958 with Igor Y. Tamm and Ilya M. Frank, for their investigation and interpretation of the phenomenon called Cherenkov radiation.

2. Cherenkov graduated from Voronezh State University in 1928. In 1934, while observing radioactive radiation underwater, he discovered Cherenkov radiation when he was a research student at the Lebedev Institute of Physics of the Academy of Sciences of the Soviet Union in Moscow, where he remained as a member and, from 1959, full professor. The explanation of Cherenkov radiation was provided by Igor Tamm (1895-1971) and Ilya Frank (1908-1990).

3. Cherenkov radiation is electromagnetic radiation, usually bluish light, emitted by a beam of high-energy charged particles passing through a transparent medium (water) at a speed greater than the speed of light in that medium. The effect is similar to that of a sonic ***boom*** when an object moves faster than the speed of sound; in this case the radiation is a shock wave ***set up*** in the electromagnetic field. Cherenkov radiation is used in the Cherenkov counter.

4. Cherenkov counter (Cherenkov detector) is a type of counter for detecting and counting high-energy charged particles. The particles pass through a liquid and the light emitted as Cherenkov radiation is registered by a ***photomultiplier tube***.

Notes:
1. boom – гул
2. set up – поднимать, воздвигать
3. photomultiplier tube – фотоэлектронный умножитель (ФЭУ)

IV. Read and translate text 34.2. Answer the following questions:

1. What was Pavel Cherenkov?
2. What was he famous for?
3. Where did Cherenkov study?
4. Where did he work?
5. What did Cherenkov discover?
6. What is Cherenkov radiation?
7. What is Cherenkov counter?

TEXT 34.3. ANDREI SAKHAROV

1. Andrei Dmitrievich Sakharov (1921-1989) was a Soviet physicist and public figure, an outspoken advocate of human rights, civil liberties and reform in the Soviet Union. In 1975 he was awarded the Nobel Prize for Peace.

2. His parents were teachers, and his exceptional scientific promise was recognized early. He graduated from Moscow University in 1942. He defended his thesis for the degree of Candidate of Science (1947) at the age of 26. He defended his Doctorate thesis (1953) at the age of 32 and was admitted as a full member of the Academy of Sciences.

3. When he was a graduate student Sakharov began to work on the Soviet nuclear weapons programme. He had worked for several years with Igor Tamm as a theoretical physicist to develop the Soviet Union's first hydrogen bomb and suggested a totally new idea for a hydrogen bomb design. He had also devised, with Tamm, the theoretical basis for controlled thermonuclear fusion. He understood better than anybody else what nuclear weapons meant and he stated about his own responsibility and about the responsibility of the states which possessed such weapons.

4. In 1968 Sakharov wrote an article attacking Soviet political system. He wrote that people needed a democratic society, free of dogmatism. He published in the West his assay 'Progress, Coexistence and Intellectual Freedom', in which he called for nuclear arms reduction, predicted the eventual integration of communist and capitalist systems in a form of democratic socialism and criticized repressions of Soviet dissidents. In 1966 he took part in his first human rights demonstration, a one-minute silent protest in Pushkin Square. A year later, he wrote a letter to Communist Party leader Leonid Brezhnev defending imprisoned dissidents.

5. In 1971 he married the human-right activist Yelena G. Bonner. Sakharov is often called the father of the Soviet hydrogen bomb, but he became more known as a champion for human rights and freedom. For this

work the Nobel Committee awarded him the Prize for Peace and called him 'the conscience of mankind'. The Soviet authorities, however, did not allow him to go to Norway to receive the award. In 1979 with his denunciation of the Soviet invasion in Afganistan, he was deprived of all his titles and orders and exiled with his wife to the city of Gorky (now Nizhny Novgorod).

6. In 1986 the Soviet government under Mikhail S. Gorbachev released Sakharov and Bonner from their exile and permitted them to return to Moscow. Elected to the Congress of People's Deputies in April 1989, Sakharov had his honours restored. Andrei Sakharov died in December 1989. Sakharov's memoirs were published in 1990. He is remembered by everybody as an outstanding humanist, who could teach and inspire, who foresaw the changes that are taking place now.

V. Read and translate text 34.3. Answer the following questions:

1. What was Andrei Sakharov?
2. What was he famous for?
3. Where did Sakharov study?
4. What programme did he work on?
5. What did Sakharov suggest and divise?
6. What did he understand?
7. Why was Sakharov exiled?

VI. How can you characterize A. Sakharov and some other scientists in connection with the following:

1. Mankind must put an end to war or war will put an end to mankind. (John Kennedy 1917-1963)
2. Moral courage is more rare commodity than bravery in battle or great intelligence. (Robert F. Kennedy 1925-1968)
3. Today the real test of power is not capacity to make war but capacity to prevent it. (Anne McCormick 1954)
4. Man armed with science is like a baby with a box of matches. (John Burden Sanderson Haldane 1892–1964, –British geneticist, physiologist and biochemist)
5. Liberty means responsibility. That is why most men dread it. (G.D. Shaw 1856-1950)

TEXT 34.4. NUCLEAR PHYSICS

1. Nuclear physics is the physics of atomic nuclei and their interactions, with particular reference to the generation of nuclear energy. Nuclear energy is obtained as a result of ***nuclear fission*** or ***nuclear fusion***. Nuclear fission is a nuclear reaction in which a heavy nucleus (such as uranium) splits into two parts (fission products), which subsequently emit two or three neutrons, releasing a quantity of energy equivalent to the difference between the rest mass of the neutrons and the fission products and that of the original nucleus. Fission may occur spontaneously or as a result of irradiation by neutrons.

2. Nuclear fusion is a nuclear reaction in which atomic nuclei of low atomic number fuse to form a heavier nucleus with the release of large amounts of energy. In nuclear fission reactions a neutron is used to break up a large nucleus, but in nuclear fusion the two reacting nuclei themselves have to be brought into collision. The reacting nuclei have very high kinetic energies. These high kinetic energies imply temperatures of the order of 10^8 K.

3. The nuclear fission of one uranium atom yields about $3.2x10^{-11}$ joule, whereas the combustion of one carbon atom yields about $6.4x10^{-19}$ joule. Mass for mass, uranium yields about 250 000 times more energy by fission than carbon does by combustion. The nuclear fusion of deuterium to form helium releases about 400 times as much energy as fission of uranium (on a mass basis).

Notes:

1. nuclear fission – деление ядра
2. nuclear fusion – ядерный синтез

VII. Read and translate text 34.4. Identify, define or explaine:

1. Nuclear physics
2. Nuclear fission
3. Nuclear fusion
4. Amount of energy released in nuclear fission / fusion

VIII. Make up the abstracts of texts 34.1–34.4 (in English or in Russian).

SECTION 35

TEXT 35.1. ALBERT TAYLOR

1. Albert Hoyt Taylor (1874-1961) was American physicist and radio engineer whose work ***underlay*** the development of radar in the United States.

2. Taylor was trained at Northwestern University in Evanston (Illinois) and the University of Göttingen (Germany). He taught at Michigan State College in East Lansing and at the universities of Wisconsin at Madison and North Dakota at Grant Forks. He supervised the radio division of the U.S. Naval Research Laboratory from 1923 until 1945.

3. Taylor's studies in electromagnetic radiation concentrated on shortwaves, examining their polarization and refraction; his research confirmed the Heaviside 'radio roof' theory in 1925. His work in the 1920s and '30s on radio echoes and the upper atmosphere contributed to the development of radar. In 1938 Taylor installed the first ***combat*** radar unit, on the battleship 'New York', and by 1939 radar equipment was being ***commercially*** manufactured in the United States.

Notes:
1. underlie – лежать в основе
2. combat – боевой, подходный
3. commercially – в промышленном масштабе

I. Find Russian equivalents for:

American physicist and radio engineer, to be trained, U.S. Naval Research Laboratory, to examine polarization and refraction of shortwaves, to install the first combat radar unit, radar equipment

II. Find English equivalents for:

работа которого лежала в основе разработки радара, руководить отделом по радио разработкам, исследование электромагнитного излучения, его исследование подтвердило теорию, вносить вклад в разработку радара, линкор, производить в промышленном масштабе

III. Read and translate text 35.1. Answer the following questions:

1. What was A. Taylor?
2. What was he famous for?
3. Where was Taylor trained?
4. Where did he work?
5. What did Taylor study?
6. What did he install on the battleship?
7. How was radar equipment manufactured?

TEXT 35.2. ROBERT WATSON-WATT

1. Sir Robert Alexander Watson-Watt (1892-1973) was Scottish physicist credited with the development of radar in England.

2. Watson-Watt attended the University of St. Andrews and later taught at University College, Dundee. From 1915 to 1952 he held a number of government positions, beginning as a meteorologist working on devices for locating thunderstorms. In 1935, while heading the radio department of the National Physical Laboratory, he began to work on aircraft radio-location. By late 1935 he was able to locate planes at a distance of 110 km (70 miles) by beaming radio waves at them, receiving their reflections from the airplanes and calculating distance by elapsed time. This work led to the design of the world's first ***practical*** radar systems, which was a vital element in the defense of British against German air raids in 1940. He was knighted in 1942.

3. Watson-Watt's other contributions include a cathode-ray ***direction finder*** used to study atmospheric phenomena, research in electromagnetic radiation and inventions used for flight safety.

Notes:
1. practical – осуществимый, реальный
2. direction finder – радиопеленгатор

IV. Read and translate text 35.2. Answer the following questions:

1. What was Sir Watson-Watt?
2. What was he famous for?
3. Where did Watson-Watt study?
4. Where did he work?
5. What was Watson-Watt able to do?
6. What did he design?
7. What were other Watson-Watt's contributions?

TEXT 35.3. RADAR DEVELOPMENT

1. Radar (from ***radio detecting and ranging***) is electromagnetic device used to detect and locate objects at distances and under conditions of lighting or ***obscuration*** that would render the unaided eye useless. It also provides a means for measuring precisely the distance, or range, to an object and the speed at which the object is moving toward or away from the observing unit. This method of locating distant objects (such as ships and aircraft, cars) is used in military ***surveillance***, air traffic control, navigation and ***guidance***. It was developed before World War II by a British team led by Sir Robert Watson-Watt.

2. High-frequency (300 to 30000 megahertz) radio waves are sent out in ***pulses*** from a powerful rotating transmitter and are reflected back by any object they encounter. The reflected signal is picked up by a receiver antenna and is used to deflect the electron beam in a ***cathode-ray tube***. The beam scans the screen of the tube by rotating at the same speed as the antenna, so that its angular position indicates the direction of the located object. The distance from the centre of the screen shows the distance away of the object.

3. The most widely used types of radar are pulse radar, ***continuous wave*** (CW) radar, frequency-modulated radar, laser radar or lidar, etc. The development of radar can be traced to the experimental work of the German physicist Heinrich Hertz. During the late 1880s Hertz proved the existence of radio waves and demonstrated that they behave much like light waves (they can be reflected by objects; just as light is reflected by a mirror). Christian Hülsmeyer, a German engineer, was one of the first to apply Hertz's findings. He developed a simple radio echo device for use in navigation and obtained a patent for it in 1904. His primitive radar like system, however, failed to attract interest because of its severe technical limitations.

4. The possibility of using the radio reflection phenomenon for detection purpose was further explored after the Italian engineer Guglielmo Marconi elaborated its principles in 1922. Soon afterwards, the United States Naval Research Laboratory tested his proposal, employing continuous-waved radiation to detect a ship passing between a radio transmitter and receiver. The operating principle of pulse ranging was developed in 1925 by two American physicists, Gregory Breit and Merle A. Tuve, while engaged in ionospheric research. They succeeded in measuring the height of the Earth's ionosphere by bouncing radio pulses

off the ionized layer of air and determining the amount of time taken by the echoes to return.

5. During the 1930s several countries, including Great Britain, France, the United States, Germany and Japan, initiated research on radar systems capable of detecting aircraft and surface vessels at long range and under conditions of poor visibility. Before the outset of World War II, Britain had constructed a network of radar stations designed to provide early warning against approaching enemy aircraft. By late 1939 Germany had begun production of similar ground-based aircraft warning units called Freya.

6. Within a few years the British developed an aircraft-intercept radar set small enough to be installed on fighters, and the United States introduced radar equipment that could be used to direct gunfire. Moreover, cooperative efforts by British and American researchers over the war resulted in the development of a reliable high-power microwave radar system particularly suited for automatic fire control and long-distance aircraft ***interception***.

Notes:

1. radio detecting and ranging (radar) – радиообнаружение и измерение расстояния радиодальномером
2. obscuration – затмение, затемнение
3. surveillance – наблюдение, контроль, обзор
4. guidance – наведение, управление
5. pulse – импульс
6. cathode-ray tube – электронно-лучевая трубка
7. interception – перехват
8. continuous wave radar – радиолокационная станция (РЛС) непрерывного излучения

V. Read and translate text 35.3. Characterize in brief:

1. Radar (as device and means of measurement)
2. High-frequency radio waves
3. Types of radars
4. Heinrich Hertz and Christian Hülsmeyer
5. G. Marconi and Gregory Breit and Merle Tuve
6. Network of radar stations
7. Intercept radar set and radar equipment

TEXT 35.4. RADAR APPLICATIONS

1. Since the late 1940s radar development has included improvements of components and circuitry, with an increasing use of solid-state electronic devices from transistors to very-large-scale integrated (VLSI) circuits. The introduction of new scanning methods and the adoption of high-speed digital computers for ***signal processing*** have also contributed significantly to the efficiency and reliability of radar equipment.

2. Many technological advances have given rise to a wide variety of new radar applications. In military uses, the networks of extremely long-range radars for early warning of intercontinental ballistic missiles were made possible. In the late 20^{th} century the United States and Canada jointly operated a radar network known as Space Detection and ***Tracking*** System (SPADATS) for identifying and monitoring artificial satellites launched into Earth orbit. Other modern-day military applications include the use of radar for missile guidance and for surveillance (***mapping radar*** – carried out by reconnaissance planes).

3. Radar has found numerous and varied civilian applications as well. It has become an important navigational aid for commercial airplanes and marine vessels. Virtually all major airports have surveillance and ***precision–approach*** radar systems, which enable air-traffic controllers to monitor and direct the movements of approaching and departing aircraft so as to prevent collision. With these systems, controllers also are able to help guide pilots to safe landings when visibility is poor. More and more ships, small and large, are equipped with simple radar units suitable for coastline navigation. The radar operator observing ship movements in the ***confined waters*** (the harbour) advises pilots of harbour traffic conditions from moment to moment via radiotelephone.

4. Radar also serves as a valuable ***tool*** in astronomical studies. Radar techniques not only permit more accurate measurement of distances than optical methods do but also make possible the study of planetary and satellite surface features. So far, astronomers have employed radar to map the surfaces of the Moon, Mars and Venus in considerable detail.

5. Another field of science that has benefited from radar is meteorology. Ground-based and ***airborne radars*** are used to aid weather forecasters in making short-range predictions. Such equipment can locate and track approaching storms for several hundred kilometres because strong radar echoes are reflected from cloud droplets, ice crystals, raindrops, and hailstones. Other kinds of meteorological observations,

such as those of atmospheric aerosols, dust and molecules, are commonly conducted with laser radar.

6. The handheld continuous-wave radar gun employed by the police for detecting speeding vehicles is a notable example of small portable radar units. An even smaller, lightweight unit is a laser-radar sensory device developed for use in canes for the blind.

Notes:
1. signal processing – обработка сигнала
2. tracking – слежение, сопровождение
3. mapping radar – картографическая радиолокационная станция (РЛС)
4. precision–approach – точный заход на посадку
5. confined waters – в ограниченных водах
6. tool – инструмент, средство
7. airborne radar (aircraft radar) – бортовая самолетная РЛС

VI. Read and translate text 35.4. Discuss in brief:

1. Radar development
2. Networks of long-range radars
3. SPADATS
4. Navigational aid
5. Astronomical studies
6. Meteorological aid
7. Police equipment

VII. Discuss with your groupmates the radar applications (military and civil).

TEXT 35.5. SONAR

1. ***Echo sounding*** is the use of sound waves to measure the depth of the sea below a vessel or to detect other vessels or obstacles. The device used consists of a source of ultrasonic pulses and an electronic circuit to measure the time taken for the pulse to reach the target and its echo to return to the ***transducer***. The device was developed originally by the Allied Submarine Detection Investigation Committee (ASDIC) in 1918 and was formerly known by this acronym. The name was changed to sonar in 1963.

2. Sonar (from '***sound navigation ranging***') is a technique for detecting and determining the distance and direction of underwater objects by acoustic means. Sound waves emitted by or reflected from the object

are detected by sonar apparatus and analyzed for the information they contain.

3. ***Sonar*** systems may be divided into three categories. In active sonar systems an ***acoustic projector*** generates a sound wave that spreads outward and is reflected back by a target object. A receiver picks up and analyzes the reflected signal and may determine the ***range, bearing*** and relative motion of the target. Passive systems consist of receiving sensors that pick up the noise produced by the target (such as a ship, submarine or torpedo). Waveforms thus detected may be analyzed for identifying characteristics as well as direction and distance. The third category of sonar devices is acoustic communication systems, which require a projector and receiver at both of the acoustic path.

4. Sonar was first proposed as a means of detecting icebergs. Interest in sonar was heightened by the threat posed by submarine warfare in World War II. An early passive system consisting of towed lines of microphones, was used to detect submarines by 1916, and by 1918 an operational active system had been built by British and U.S. scientists. Subsequent developments included the echo sounder, or depth detector, rapid-***scanning sonar***, ***side-scan sonar***, and WPESS (within-pulse electronic-***sector-scanning***) sonar.

5. Sonar has different applications. In the military field are a large number of systems that detect, identify and locate submarines. Sonar is also used in acoustic homing torpedoes, in acoustic mines, and in mine detection. Nonmilitary uses of sonar include fish finding, depth sounding, mapping of the sea bottom, Doppler navigation, and acoustic location for divers.

6. The acoustic transducers and acoustic projectors utilize piezo-electric crystals (quartz or tourmaline), magnetostrictive materials (iron or nickel), or electrostrictive crystals (barium titanate). These materials change shape when subjected to electric or magnetic fields, thus converting electrical energy to acoustic energy. Suitably mounted in an oil-filled ***housing***, they produce beams of acoustic energy over a wide range of frequencies.

Notes:

1. echo sounding – акустическое зондирование, измерение глубины эхолотом
2. transducer – датчик, измерительный преобразователь
3. sound navigation ranging – акустическая навигационная дальнометрия

4. sonar – гидролокатор
5. acoustic projector – гидроакустический излучатель
6. range – дальность
7. bearing – пеленг
8. scanning sonar – гидролокационная станция
9. side-scan sonar – гидролокатор бокового обзора
10. sector-scanning sonar – гидролокатор секторного обзора
11. housing – корпус, кожух

VIII. Read and translate text 35.5. Characterize in brief:

1. Echo sounding
2. Sonar
3. Types of sonar systems
4. Sonar application (military and civil)
5. Materials of acoustic transducers and projectors

IX. Make up the abstracts of texts 35.1– 35.5 (in English or in Russian).

X. Comment on the following quotation. Do you agree or disagree with it?

1. Remember that happiness is a way of travel – not a destination. (Roy M. Goodman)

SECTION 36

TEXT 36.1. NIKOLA TESLA

1. Nikola Tesla (1856-1943) was Serbian-American inventor, mechanical and electrical engineer, researcher and futurist, who discovered the rotating magnetic field, the basis of most alternating-current machinery. His many revolutionary developments in the field of electromagnetism in the late 19th and early 20th centuries were based on the theories of electromagnetic technology discovered by Michael Faraday. He emigrated to the United States in 1884 and sold the patent rights to his system of alternating-current dynamos, transformers and motors to George Westinghouse the following year. In 1891 he invented the ***Tesla coil***, an induction coil widely used in radio technology. Tesla’s patents and theoretical work formed the basis of wireless communication and radio.

2. Tesla was born in a family of Serbian origin in the village of Smiljan (present day Croatia) and was a subject of the Austrian Empire by

birth. Nicola was the fourth of five children, having one older brother (Danilo, who was killed in a horse-riding accident when Nikola was five) and three sisters (Milka, Angelina and Marica). His father was an Orthodox priest, his mother was unschooled but highly intelligent. Tesla attended school at Higher Real Gymnasium in Karlovac. He finished a four-year term in three years. A dreamer with a poetic touch, as he matured, Tesla added to these earlier qualities those of self-discipline and a desire for precision. Training for an engineering career, he attended the Technical University at Gratz (Austria) and Charles-Ferdinand University of Prague. At Gratz he first saw the Gramme dynamo, which operated as a generator and when reversed, became an electric motor, and he conceived a way to use alternating current ***to advantage***.

3. Later, at Budapest, he visualized the principle of the rotating magnetic field and developed plans for an induction motor that would become his first step toward the successful utilization of alternating current. In 1882 Tesla went to work in Paris for the Continental Edison Company and while on assignment to Strasburg in 1883, he constructed in after-work hours, his first ***induction motor***. Tesla sailed for America in 1884, arriving in New York, with four cents in his pocket, a few of his own poems and calculations for a flying machine. Tesla claimed that one of his life goals was to create a flying machine that would run without the use of an airplane engine, wings, ailerons, propellers or an onboard fuel source. The theorized appearance would typically take the shape of a cigar or saucer. He first found employment with Thomas Edison, but the two inventors were far apart in background and methods, and their separation was inevitable.

4. In May 1885, George Westinghouse, head of the Westinghouse Electric Company in Pittsburg, bought the patent rights to Tesla's polyphase system of alternating-current dynamos, transformers and motors. Tesla soon established his own laboratory, where his inventive mind could be given free rein. He experimented with shadowgraphs similar to those that later were to be used by Wilhelm Rontgen when he discovered X-rays in 1895. Tesla's countless experiments included work on a ***carbon button lamp***, on the power of electrical resonance and on various types of lighting.

5. Tesla gave exhibitions in his laboratory in which he lighted lamps without wire by allowing electricity to flow through his body, to allay fears of alternating current. He was often invited to lecture at home and abroad. The Tesla coil, which he invented in 1891, is widely used today in

radio and television sets and other electronic equipment. That years also marked the date of Tesla's United States citizenship.

6. Possessing a good memory, Nikola Tesla was a polyglot and along with his native language he also spoke Chech, English, French, German, Hungarian, Italian and Latin. He was very proficient at billiard, chess and card playing. Tesla never married. He was a life-long bachelor. Some people described him as attaining 'a distinguished sweetness, sincerity, modesty, refinement, generosity and force'. He was a scientist and engineer 'who was also a poet, a philosopher, an appreciator of fine music, a linguist and a connoisseur of food and drink'. In his later years Tesla became a vegetarian. N. Tesla was a great genius. The Nobel Prize recipients acknowledge him to be "one of the outstanding intellects of the world who paved the way for many of the technological developments of modern times".

Notes:
1. Tesla coil – трансформатор Тесла
2. to advantage – выгодно, с успехом
3. induction motor – асинхронный (электро) двигатель
4. carbon button lamp – кнопочная лампа с угольной нитью накаливания

I. Find Russian equivalents for:

Serbian-American inventor and researcher, to discover, alternating current, transformers and motors, invent, highly intelligent, self-discipline and a desire for precision, attend the Technical University, successful utilization, calculations, inventive mind, include, various types of lightning, to lecture at home and abroad, electronic equipment, a great genius, one of the outstanding intellects of the world

V. Find English equivalents for:

вращающее магнитное поле, продать права на патент, генератор переменного тока, трансформатор Тесла, семья сербского происхождения, православный священник, качества, обучаться для технической карьеры, работать как генератор, найти работу, создать свою собственную лабораторию, устраивать выставки, лампы без проводов, американское гражданство, признавать, который проложил путь (подготовил почву)

IV. Read and translate text 36.1. Answer the following questions:

1. What was N. Tesla?
2. What was he famous for?.
3. What can you say about his family?
4. Where did Tesla study?
5. Where did he work?
6. What did Tesla establish?
7. What do the Nobel Prize recipients acknowledge him to be?

IV. What do the following dates refer to?

1856, 1882, 1883, 1884, 1885, 1891

36.2. TESLA'S INVENTIONS AND IDEAS

1. Tesla would visualize an invention in his mind with extreme precision, including all dimensions, before moving to the construction stage. He typically did not make drawings by hand, instead just conceiving all ideas in his mind. In 1897, Tesla filed the first radio patent. In 1898 Tesla announced his invention of the teleautomatic boat guided by ***remote control***. When skepticism was voiced, Tesla proved his claims for it before a crowd in Madison Square Garden.

2. In Colorado Springs (1899-1900) Tesla made his important discovery – ***terrestrial*** stationary waves. By this discovery he proved that the Earth could be used as a conductor and would be as responsive as a ***tuning fork*** to electrical vibrations of a certain frequency. He also lighted 200 lamps without wires from a distance of 25 miles (40 kilometres) and created man-made lightning, producing flashes measuring 135 feet (41 metres). At one time he was certain, he had received signals from another planet in his Colorado laboratory, a claim that was met with derision in some scientific journals.

3. Returning to New York in 1900, Tesla began construction on Long Island of a wireless world ***broadcasting tower***, with $ 150,000,000 capital from the American financier J. Pierpont Morgan. Tesla claimed he secured the loan by assigning 51 per cent of his patent rights of telephony and telegraphy to Morgan. He expected to provide worldwide communication and to ***furnish facilities*** for sending pictures, messages, weather warnings and stock reports. The project was abandoned because of a financial panic, labour troubles, and Morgan's withdrawal of support. It was Tela's greatest defeat.

4. Tesla's work then shifted to turbines and other projects because of a lack of funds, his ideas remained in his notebooks, which are still examined by engineers for unexploited clues. In 1915 he was severely disappointed when a report that he and Edison were to share the Nobel Prize proved erroneous. Tesla was a recipient of the Edison Medal in 1917, the highest honour that the American Institute of Electrical Engineers could bestow.

5. Tesla had a way of intuitively sensing hidden scientific secrets and employing his inventive talent to prove his hypotheses. His futuristic prophecies were not regarded seriously. His speculations concerning communication with other planets, his assertions that he could split the Earth like an apple, and his claim of having invented a death ray capable of destroying 10,000 airplanes at a distance of 250 miles (400 km) were greeted with caustic criticism.

6. Tesla died in January 1943 at age of 86 from heart thrombus, alone, in room of the New York Hotel. The remains of N. Tesla were taken to Campbell cemetery. The gilded urn with Tesla's ashes in his favourite geometrical object of sphere was placed in the Nikola Tesla Museum in Belgrade. In 2006 the Belgrade Nikola Tesla Airport was named in his honour. The largest power plant in Serbia is called Nikola Tesla TPP. Tesla was inducted into the Inventor's Hall of Fame in 1975. A monument to Tesla was established at Niagara Falls (New York). This monument, portraying Tesla reading a set of notes, was presented to the United States by Yugoslavia in 1976 and is an identical copy of the monument standing in front of the University of Belgrade Faculty of Electrical Engineering.

7. The Tesla is the unit of magnetic induction or magnetic flux density in the metre-kilogram-second system (SI) of physical units. It is named for Nikola Tesla. One tesla equals one weber per square metre, corresponding to 10^4 gauss. It is used in all work involving strong magnetic fields, while the gauss is more useful with small magnets.

8. Tesla coil is a device for producing a high-frequency high-voltage current. It consists of a transformer with a high turns ratio, the ***primary circuit*** of which includes a ***spark gap*** and a ***fixed capacitor***; the secondary circuit is turned by means of a variable capacitor to resonate with the primary. It was devised by Nikola Tesla. Tesla coils are commonly used to excite luminous discharges in glass vacuum apparatus, in order to detect leaks.

Notes:

1. remote control – дистанционное управление
2. terrestrial – земной
3. tuning fork – камертон, эталонный генератор стабильной частоты
4. broadcasting tower – трансляционная (радио) башня
5. furnish facilities – предоставлять оборудование
6. primary circuit – первичная цепь
7. spark gap – искровой промежуток (разрядник)
8. fixed capacitor – постоянный конденсатор (постоянной ёмкости)

V. Find Russian equivalents for:

extreme precision, dimensions, make drawings by hand, teleautomatic boat, conductor, tuning fork, distance, flash, provide worldwide communication, construction, the highest honour, prove his hypotheses, the largest power plant, monument, Faculty of Electrical Engineering, unit of magnetic induction, equal, strong magnetic field, device, discharges, in order to detect leaks

VI. Find English equivalents for:

задумывая все идеи в своем уме, управляемая дистанционным управлением, вибрации определенной частоты, искусственная молния, научный журнал, радио башня, представлять оборудование, от проекта отказались, обеспечивать заем путём передачи 51 процента своих прав на патент, из-за недостатка денежных средств, интуитивно чувствовать скрытые научные тайны, предположения, плотность магнитного потока, состоять из

VII. Read and translate text 36.2. Characterize in brief:

1. Tesla’s visualization an invention	2. Teleautomatic boat
3. Terrestrial stationary waves	7. Tesla’s intuitive sensing
4. Man-made lightning	8. Objects named in Tesla’s honour
5.Wireless world broadcasting tower	9. Tesla as physical unit
6. Awards	10. Tesla coil

TEXT 36.3. ELECTRIC MOTOR

1. Electric motor is a machine for converting electrical energy into mechanical energy. They are quiet, clean and have a high ***efficiency*** (75-

95%). They work on the principle that a current passing through a coil within a magnetic field will experience forces that can be used to rotate the coil.

2. In the ***induction motor***, alternating current is fed to a stationary coil (the stator), which creates both the magnetic field and induces the current in the rotating coil (rotor), which it surrounds. The advantage of this kind of motor is that current does not have to be fed through a commutator to a moving part.

3. In the synchronous motor, alternating current fed to the stator produces a magnetic field that rotates and locks with the field of the rotor, in this case an independent magnet, causing the rotor to rotate at the same speed as the stator field rotates. The rotor is either a permanent magnet or an electromagnet fed by a direct current through ***slip rings***.

4. In the universal motor, current is fed to the stator and, through a commutator to the rotor. In the ***series-wound motor*** the two are is series, in the ***shunt-wound motor*** they are in parallel. These motors can be used with either a.c. or d.c. but some small motors use a permanent magnet as the stator and require d.c. for the rotor (via the commutator).

Notes:

1. efficiency – кпд (коэффициент полезного действия), эффективность, производительность
2. induction motor – асинхронный (электро) двигатель
3. slip ring – токособирательное (контактное) кольцо
4. series-wound motor – (электро) двигатель с последовательным возбуждением
5. shunt-wound motor – (электро) двигатель параллельного возбуждения

VIII. Read and translate text 36.3. Discuss in brief:

1. Electric motor (machine, efficiency, principle) 2. Induction motor
3. Universal motor (series and shunt-wound motor) 4. Synhronous motor

TEXT 36.4. GEORGE WESTINGHOUSE

1. George Westinghouse (1846-1914) was U.S. inventor and industrialist who was chiefly responsible for the adoption of alternating current for electric power transmission in the United States.

2. After serving in both the army and the navy in the Civil War, Westinghouse received his first patent in late 1865 for a rotary ***steam***

engine. Though the engine proved impractical, he later applied the same principle to develop a water meter. In that same year he invented a device for placing derailed ***freight cars*** back on their tracks.

3. Westinghouse's interest in railroads in general led to his first major invention, an ***air brake***, which he patented in 1869 (eventually he received more then 100 patents), in the same year he organized the Westinghouse Air Brake Company. With additional automatic features incorporated into its design, the air brake became widely accepted, and the Railroad Safety Appliance Act of 1893 made air brakes compulsory on all U.S. trains. As the use of his automatic air brake spread to Europe, Westinghouse saw the advantages of standardizing all air-brake equipment so that the apparatus on cars of different lines would work together and improved designs could be used on earlier models. He thus became one of the first to adopt the modern practice of standardization.

4. Westinghouse then turned his attention to the problems of railroad signalling. By purchasing patents to combine with own inventions, he was able to develop a complete electrical and compressed-air signal system. In 1883 he began to apply his special knowledge of air brakes to the problem of safety ***piping*** the natural gas, and within two years he obtained 38 patents for piping equipment.

5. Although the electrical system being developed in the United States in the 1880s used direct current (d.c.), in Europe several alternating-current (a.c.) systems were being developed. One of the most successful, first demonstrated in 1881 in London, was devised by Lucien Gaulard of France and John Gibbs of England. Four years later, Westinghouse imported a set of Gaularg-Gibbs transformers and a Siemens ac generators and set up an electrical system in Pittsburg. With the help of three U.S. electrical engineers, he altered and perfected the transformer and developed a constant voltage ac generator.

6. In 1886 he incorporated the Westinghouse Electric Company which three years later was renamed Westinghouse Electric and Manufacturing Company. He purchased the patents of Nikola Tesla's ac motor and hired Tesla to improve and modify the motor for use in his power system. Westinghouse used Tesla's system to light the World's Columbian Exposition at Chicago in 1893. His success was a factor in winning him the contract to install the first power machinery – AC generators at Niagara Falls, which bore Tesla's name and patent numbers. The project carried power to Buffalo by 1896.

7. His business flourished until 1907, when a financial panic resulted in his losing control of the company. By 1911 he had severed all connections with his companies. His health failed soon there after.

Notes:

1. steam engine – паровой двигатель
2. freight car – грузовой вагон
3. air brake – пневматический тормоз
4. piping – система трубопроводов, прокладка трубопровода, транспортировка по трубопроводу

IX. Read and translate text 36.4. Enumerate the most important inventions and business activities of G. Westinghouse.

TEXT 36.5. PATENT

1. Patent is a device to encourage and reward invention by giving exclusive rights to inventors. Invention is the idea of new product, or a new method of producing an existing product. This is distinguished from an innovation, which is the development of an invention to the stage where its use becomes economically viable. Innovation is the economic application of a new or modified product; process of innovation involves a new or modified way of making a product.

2. In many countries the inventor of a new product or process can apply for a patent, giving the ***holder*** the exclusive right for a number of years to produce the good or use the process. This right can be used either through their own business, or by charging a license fee to other users. This provides an incentive to create inventions.

3. Patent is a grant of ownership rights by the government to a person or ***business*** in respect of the invention of an entirely new product or manufacturing process or a significant development of an existing product or process. In the UK, under the ***Copyright***, designs and ***patents Act*** (1988), the ***patent office*** can ***grant a patentee*** a monopoly to make, use or sell the invention for a maximum of twenty years from the date on which the patent was first ***filed***. Patent Office is a UK body which is responsible for the administration of various aspects of ‘intellectual property rights’ ***legislation***. The Patent Office is the sole authority for the granting of patent rights on product and process inventions and for the registration of industrial designs and trademarks.

4. In order to obtain patent ***approval***, inventors are required to supply full details of the invention to the Patent Office and satisfy that body that the invention contains original features and that it has a ***demonstrable*** industrial application. Patent registered in one country may be valid in other countries if filed in a country which is party to a ***reciprocal treaty***. The UK, for example, is the member of the 13 – country European Patent Convention which allows inventors to obtain patent rights in the EPC countries by filing a single European ***patent application***.

5. Globally, patent applications are administered by the ***World Intellectual Property Organization (WIPO)*** under the Patent Cooperation Treaty which enables investors to apply for registration in member countries with a single registration. However, under ***a GATT (General Agreement on Tariffs and Trade***) accord it was agreed to give investors a minimum patent term of 20 years in all member countries with members being obliged to enforce patent protection on patent recognized by each other national authorities.

Notes:

1. holder – владелец, держатель
2. business – предприятие, компания
3. copyright – авторское право
4. patents Act – закон о патенте
5. patent office – патентное бюро (ведомство)
6. grant – предоставлять
7. patentee – владелец патента, патентовладелец
8. to file – подавать заявку на
9. legislation – законодательство, закон
10. approval – одобрение, подтверждение, разрешение
11. demonstrable – доказуемый
12. reciprocal treaty – договор на основе взаимности
13. application for patent – патентная заявка
14. World Intellectual Property Organization (WIPO) – Всемирная организация интеллектуальной собственности (ВОИС)
15. GATT – General Agreement on Tariffs and Trade – общее соглашение о торговле и тарифах (ГАТТ)

X. Read and translate text 36.5. Identify, define or explaine each of the following:

1. Patent
2. Invention

3. Innovation	7. Patent approval
4. Types of innovation	8. European Patent Convention
5. Exclusive right of patent	9. WIPO
6. Patent office	10. GATT

XI. Make up the abstracts of texts 36.1–36.5 (in English or in Russian).

XII. Comment on the following quotations. Do you agree or disagree with them?

1. The practical success of an idea, irrespective of its inherent merit, is dependent on the attitude of the contemporaries. If timely, it is quickly adopted; if not, it is apt to fare like a sprout lured out of the ground by warm sunshine, only to be injured and retarded in its growth by the succeeding frost. (Nikola Tesla 1856-1943, Serbian inventor and engineer)
2. I do not think there is any thrill that can go through the human heart like that felt by the inventor as he sees some creation of the brain unfolding to success. Such emotions make a man forget food, sleep, friends, love, everything. (Nikola Tesla)
3. My method is different. I do not rush into actual work. When I get a new idea, I start at once building it up in my imagination, and make improvements and operate device in my mind. When I have gone so far as to embody everything in my invention, every possible improvement I can think of, and when I see no fault anywhere, I put into concrete form the final product of my brain. (Nokola Tesla)
4. Before I put a sketch on paper, the whole idea is worked out mentally. In my mind I change the construction, make improvements, and even operate the device. Without ever having drawn a sketch I can give the measurements of all parts to workmen, and when completed all these parts will fit, just as certainly as though I had made the actual drawings. It is immaterial to me whether I run my machine in my mind or test it in my shop. The inventions I have conceived in this way have always worked. In thirty years there has not been a single exception. My first electric motor, the vacuum wireless light, my turbine engine and many other devices have all been developed in exactly this way. (Nikola Tesla)

SECTION 37

TEXT 37.1. JOSEPH THOMSON

1. Sir Joseph John Thomson (1856-1940) was English physicist who helped revolutionize the knowledge of atomic structure by his discovery of the electron (1897). He received the Nobel Prize for Physics in 1906 ‘in recognition of the great merits of his theoretical and experimental investigations on the conduction of electricity by gases’ and was knighted in 1908.

2. Thomson was the son of a bookseller in a suburb of Manchester. When he was only 14, he entered Owens College, now Victoria University of Manchester. In contrast with most colleges at that time, Ownes provided some courses in experimental physics. In 1876 he obtained a scholarship at Trinity College in Cambridge where he remained for the rest of his life. After taking his B.A. degree in mathematics in 1880 (Second Wrangler and 2nd Smith’s prize) and MA (with Adams Prize) in 1883, in 1884 he became Cavendish Professor of Physics. The opportunity of doing experimental research drew him to the Cavendish Laboratory which was under direction of Lord Rayleigh. He began also to develop the theory of electromagnetism. As set forth by James Clerk Maxwell, electricity and magnetism were interrelated; quantitative changes in one produced corresponding changes in the other.

3. Prompt recognition of Thomson’s achievement by the scientific community came in 1884, with his election as a Fellow of the Royal Society of London at 27 and appointment to the chair of physics at the Cavendish Laboratory. In 1890 he married Rose Elisabeth Paget. They had a son, George Paget Thomson, and a daughter, Joan Paget Thomson. In 1896 he delivered lectures at Princeton University. In 1897 he discovered electrons which he originally called corpuscles. He succeeded in deflecting cathode rays by an electric field, thus showing that they consisted of negatively charged particles. He also measured the ratio of their charge to mass and deduced that electrons were about 2000 times lighter than the hydrogen atom. Thomson thought that atoms consisted of electrons embedded in a positively charged sphere, a concept that was superseded by Rutherford’s model. In 1903 J.J. Thomson suggested a discontinuous theory of light, foreshadowing Albert Einstein’s later theory of photons. He later discovered isotopes and invented mass spectrometry. He made the first version of a mass spectrometer (a device that separates ions by mass) and used it to find two isotopes of neon. In 1906 he received the Nobel

Prize for Physics for his researches into the electrical conductivity of gases. He was knighted in 1908. He was president of the British Association for the Advancement of Science in 1909. He received the ***Order of Merit*** in 1912. He was President of the Royal Society (1915-1920).

4. During his most fruitful years as a scientist, he was administrative head of the highly successful Cavendish Laboratory. For the first quarter of the 20th century the Cavendish Laboratory, where Thomson insisted that theory should be considered ‘a policy, not a creed’, was the world center for particle research. Thomson was, moreover, an outstanding teacher. The group of men (students) he gathered around him between 1895 and 1914 came from all over the world, and after working under him many accepted professorships abroad. His notable students were: Charles Glover Barkla, Charles T.R. Wilson, Ernest Rutherford, Frencis William Aston, John Townsend, J. Robert Oppenheimer, Owen Richardson, William Henry Bragg, H. Stenley Allen, John Zeleny, Daniel Frost Comstock, Max Born, T.H. Laby, Paul Langevin, Balthasar van der Pol, Geoffrey Ingram Taylor, etc. Seven Nobel Prizes were awarded to those who worked under him. Thomson took his teaching duties very seriously: he lectured regularly to elementary classes in the morning and to postgraduates in the afternoon. He considered teaching to be helpful for a researcher, since it required him to reconsider basic ideas that otherwise might have ***taken for granted***. He never advised a man entering a new research field to begin by reading the work already done. Rather, Thomson thought it wise that he first clarify his own ideas. Then he could safely read the reports of others without having his own views influenced by assumptions that he might find difficult to throw off.

5. J.J. Thomson received many awards: Royal Medal (1894), Hughes Medal (1902), Nobel Prize for Physics (1906), Eliott Cresson Medal (1910), Copley Medal (1914), Franklin Medal (1922). Thomson demonstrated his wide range of interests outside science by his interest in politics, current fiction, drama, university sports (he was enthusiastic fan of the Cambridge cricket and rugby teams) and the nontechnical aspects of science. But his greatest interest outside physics was in plants. He enjoyed long walks in the countryside, in hilly regions near Cambridge, where he searched for rare botanical specimens for his elaborate garden. In 1918 Thomson was made master of Trinity College, the position in which he remained until his death. To a large extent, it was Thomson who made atomic physics a modern science.

Notes:

1. Order of Merit – орден ‘За заслуги’
2. take for granted – считать само собой разумеющимся, принимать на веру

I. Find Russian equivalents for:

English physicist, discovery of the electron, receive the Nobel Prize for Physics, provide some courses in experimental physics, doing experimental research, quantitative changes, scientific community, a Fellow of the Royal Society of London, negatively charged particles, measure the ratio of charge to mass, consist of, researches into the electrical conductivity of gases, scientist, clarify ideas, atomic physics

II. Find English equivalents for:

знания структуры (строения) атома, пригород Манчестера, получить стипендию, развивать (разрабатывать) теорию магнетизма, после получения степени бакалавра, соответствующие изменения, быстрое признание достижений Томсона, назначение на кафедру физики, отклонение катодных лучей электрическим полем, в две тысячи раз легче атома водорода, заменять (вытеснять), выдающийся преподаватель, широкий диапазон интересов, искал редкие ботанические образцы, современная наука,

III. Read and translate text 37.1. Answer the following questions:

1. What was Joseph Thomson?
2. What was he famous for?
3. Where did J.Thomson study?
4. Where did he work?
5. What can you say about his family?
6. What Prize did he receive?
7. Why was he an outstanding teacher?
8. What interests did Thomson demonstrate outside science?
9. How were Thomson’s achievements recognized?

IV. What do the following dates refer to:

1856, 1876, 1880, 1884, 1890, 1897, 1895-1914, 1906, 1909, 1912, 1918

TEXT 37.2. MASS SPECTROMETRY

1. Mass spectrometry (also called mass spectroscopy) is analytical technique by which chemical substances are identified by the ***sorting*** of gaseous ions in electric and magnetic fields. A device that performs this operation and uses electrical means to detect the sorted ions is called a ***mass spectrometer***; one that uses photographic or other nonelectrical means is called a ***mass spectrograph*** or a mass spectroscope.

2. Using mass spectrometry with a suitable choice of experimental conditions, it is possible to measure precisely the mass of ions, to show the presence of different isotopes and to measure the relative ***abundance*** of ions in a mixture. Organic chemicals can be made to produce a spectrum of ions from the ***fragmenting*** of the ***parent*** molecule; by identifying the fragments according to their masses and relative abundances, the structure of the original molecule can be established.

3. Mass spectrometry developed from experiments conducted by J.J. Thomson and others on the behaviour of charged particles in electrical and magnetic fields. Thomson built a form of mass spectrometer known as a parabola spectrograph in 1913. With such a device F.W. Aston demonstrated in 1919 the existence of isotopes by showing that ions of mass 22 found in samples of air were in fact a heavy form of neon (thitherto thought of as mass 20).

4. Mass spectrometers, which operate under high vacuum, consist of four basic parts: a handling system to introduce the unknown sample into the equipment; an ion source, in which a beam of particles characteristic of the sample is produced; an analyzer, in which the particles in the beam are separated according to mass; and a detector, in which the separated ion components are collected and characterized. The most widely used ionization method is electron bombardment, in which electrons striking the sample molecules supply the energy needed to convert them to ions.

5. Mass spectrometry is widely used to measure the masses and relative abundances of different isotopes and to determine their relative abundances in various natural or enriched samples. Mass spectroscopy is also used in gas analysis. In particular, the method is widely used for hydrocarbon gases; with the addition of atomic recording, continuous gas analysis is possible for process control in chemical plants.

6. Mass spectrometry can be used as a sensitive method of testing vacuum tightness in high-vacuum equipment. Apparatus under test is connected to a mass spectrometer tuned to detect a particular ***tracer gas***,

and this gas (usually helium) is then applied to the apparatus; the spectrometer reading shows where leakages occur. Another mass spectroscopic technique can be used to measure the geologic age of minerals. Since radioactive disintegration of uranium and thorium results in the formation of different lead isotopes, analysis of the proportions of the latter makes possible accurate estimates of the age of the minerals in which they occur. In accelerator mass spectrometry, high-energy particle accelerators are coupled with electrostatic and magnetic mass analyzers to measure rare, low-abundance isotopes.

Notes:
1. sorting – сортировка
2. mass spectrometer – масс-спектрометр
3. mass spectrograph – масс-спектрограф
4. abundance – распространенность
5. fragmenting – разделение на части, дробление
6. parent – исходный (элемент), родительский (порождающий)
7. tracer gas – незначительная газовая примесь

V. Read and translate text 37.2. Discuss in brief:

1. Mass spectrometry as a technique
2. Mass spectrometer and mass spectrograph
3. Precise measurement of the mass of ions, isotopes
4. Development of mass spectrometry
5. Basic parts of mass spectrometers
6. Application of mass spectrometry

TEXT 37.3. CAVENDISH LABORATORY

The Cavendish Laboratory is the ***Department*** of Physics at the University of Cambridge (UK), and is part of the university's School of Physical Sciences. It was opened in 1874 as a teaching laboratory. The Department is named after William Cavendish, 7th Duke of Devonshire, who was Chancellor of the University and donated money for the construction of the laboratory. Professor James Clerk Maxwell, the developer of electromagnetic theory, was a founder of the lab and became the first Cavendish Professor of Physics.

2. The Cavendish Laboratory was initially located in the centre of Cambridge. Then it moved to its present site in West Cambridge in the

early 1970s. The Department of Physical Chemistry merged with the Department of Chemistry in the new chemistry building. The current head of the Cavendish is James Stirling. The Cavendish Professorship of Physics is currently held by Sir Richard Friend.

3. During World War II the laboratory carried out research in nuclear physics for the MAUD Committee, part of the British Tube Alloys project of research into the Atomic Bomb. Researchers included Nicholas Kemmer, Allan Nunn May, Anthony French, Samuel Curran and the French scientists including Lew Kowarski and Hans von Halban. Several transferred to Canada in 1943; the Montreal Laboratory and some later to the Chalk River Laboratories.

4. The production of plutonium and neptunium by bombarding uranium-238 with neutrons was predicted in 1940 by two teams working independently: Egon Bretscher and Norman Feather at the Cavendish and Edwin M. McMillan and Philip Abelson at Berkeley Radiation Laboratory at the University of California, Berkeley.

5. The Cavendish Laboratory has had an important influence on biology, mainly through the application of X-ray crystallography to the study of structures of biological molecules. Francis Crick already worked in the Medical Research Council Unit, headed by Max Perutz and housed in the Cavendish Laboratory, when James Watson came from the United States and they made a breakthrough in discovering the structure of ***DNA***. For their work while in the Cavendish Laboratory, they were jointly awarded the Nobel Prize in Physiology or Medicine in 1962, together with Maurice Wilkins of King's College, London, a graduate of St. John's College, Cambridge.

6. Areas in which the Laboratory has been very influential since 1950 include: Shoenberg Laboratory for Quantum Matter, Superconductivity Josephson junction, Theory of Condensed Matter, Electron Microscopy, Radio Astronomy and Semiconductor Physics Group.

Nobel Prize winners – Cavendish researchers:

Lord Rayleigh (Physics, 1904), Sir J.J. Thomson (Physics, 1906), Lord Rutherford (Ernest Rutherford) (Chemistry,1908), Sir Lawrence Bragg (Physics, 1915), Charles Barkla (Physics, 1917), Francis Aston (Chemistry, 1922), C.T.R. Wilson (Physics, 1927), Arthur Compton (Physics, 1927), Sir Owen Richardson (Physics, 1928), Sir James Chadwick (Physics, 1935), Sir George Thomson (Physics, 1937), Sir Edward Appleton (Physics, 1947), Lord Blackett (Patrick Blackett)

(Physics, 1948), Sir John Cockcroft (Physics, 1951), Ernest Walton (Physics, 1951), Francis Crick (Physiology or Medicine, 1962), James Watson (Physiology or Medicine, 1962), Max Perutz (Chemistry, 1962), Sir John Kendrew (Chemistry, 1962), Dorothy Hodgkin (Chemistry, 1964), Brian Josephson (Physics, 1973), Sir Martin Ryle (Physics, 1974), Antony Hewish (Physics, 1974), Sir Nevill Mott (Physics, 1977), Philip Anderson (Physics, 1977), Pyotr Kapitsa (Physics, 1978), Allan Cormack (Physiology or Medicine, 1979), Sir Aaron Klug (Chemistry, 1982)

Cavendish professors of physics

The Cavendish Professors were the Heads of the Department up to Professor Pippard, when the roles were made separate. Among them there were: James Clerk Maxwell 1871–1879, Lord Rayleigh 1879–1884, J. J. Thomson 1884–1919, Ernest Rutherford 1919–1937, William Lawrence Bragg 1938–1953, Nevill Mott 1954–1971, Brian Pippard 1971–1984, Sam Edwards 1984–1995, Richard Friend 1995 – present.

Notes:

1. department – отделение
2. DNA – deoxyribonucleic acid – дезоксирибонукдугновая кислота, ДНК

VI. Read and translate text 37.3. Characterize in brief:

1. Cavendish Laboratory as a department
2. Foundation of the laboratory and its founder
3. Name of the laboratory and it's location
4. Nuclear physics research
5. Biological research
6. Important areas of research
7. Nobel Prize winners
8. Cavendish Professoship

TEXT 37.4. ELECTRON

1. Lepton is a class of elementary particles that consists of the electron,muon, tau particles and three types of neutrino. They differ from each other only in mass: the muon is 200 times more massive than the electron and the tau particle is 3500 times more massive than the electron. Leptons interact by the electromagnetic interaction and the weak interaction. Electron is a stable negatively charged elementary particle

with mass 9.10956 x 10^{-31} kilogram, a negative charge of 1.60217733(49) x 10^{-19} coulomb and spin ½.

2. Electrons are present in all atoms in groupings called ***shells*** around the nucleus. Electrons are responsible for almost all commonly observed electrical and magnetic effects and, since they orbit the nucleus in atoms, are also responsible for most chemical processes. A free electron is one that has become detached from an atom. An electric current passing through a metal or low-pressure gas consists of a flow of free electrons. A current of 1 ampere is equivalent to a flow of 6 x 10^{18} electrons per second. The antiparticle of the electron is the position.

Notes:

1. shell – оболочка

VII. Read and translate text 37.4. Describe electron in details:

1. Electron as a particle and a lepton
2. Its mass, charge and spin
3. Electron and electrical and magnetic effects
4. Free electron
5. Electric current
6. Antiparticle
7. Discovery of electron

VIII. Make up the abstracts of texts 37.1–37.4 (in English or in Russian).

IX. Comment on the following quotation. Do you agree or disagree with it?

1. By research in pure science I mean research made without any idea of application to industrial matters but solely with the view of extending our knowledge of the Laws of Nature. (Joseph John Thomson 1856 – 1940, – British physicist)

SECTION 38

TEXT 38.1. EVANGELISTA TORRICELLI

1. Evangelista Torricelli (1608-1647) was Italian physicist and mathematician who invented the barometer and whose work in geometry aided in the eventual development of integral calculus.

2. Inspired by Galileo’s writings, he wrote a treatise on mechanics, ‘Concerning Movement’, which impressed Galilio. In 1641 Torricelli was invited to France, where he served the elderly astronomer as secretary and assistant during the last three months of Galileo’s life. Torricelli was then appointed to succeed him professor of mathematics at the Florentine Academy.

3. Two years later, pursuing a suggestion by Galileo, he filled a glass tube 4 feet (1.2 m) long with mercury and ***inverted*** the tube into a dish. He observed that some of the mercury did not flow out and that the space above the mercury in the tube was a vacuum. Torricelli became the first man to create a man-made vacuum. After much observation, he concluded that the variation of the height of the mercury from day to day was caused by changes in atmospheric pressure. The space above the mercury is still being called a Torricellian vacuum. He invented the mercury barometer in 1644.

4. He never published his findings, however, because he was too deeply involved in the study of pure mathematics – including calculations of the cycloid, a geometric curve described by a point on the ***rim*** of a turning wheel. In his “Geometric Works’ (1644), Torricelli included his findings on ***fluid*** motion and ***projectile*** motion.

Notes:
1. invert – переворачивать
2. rim – обод
3. fluid – жидкость
4. projectile – снаряд, пуля

I. Find Russian equivalents for:

Italian physicist and mathematician, development of integral calculus, a treatise on mechanics, be invited, secretary and assistant, fill a glass tube with mercury, observe, to create a sustained vacuum, height, publish, study of pure mathematics, calculations, fluid motion

II. Find English equivalents for:

изобретать барометр, помогать, воодушевлённый письменными работами Галилея, который поразил Галилея, служил пожилому астроному, быть приемником в качестве профессора математики, перевернуть трубку на блюдце, вытекать, пространство над ртутью, делать заключение, сведения (полученные данные), геометрическая кривая, движение снаряда

III. Read and translate text 38.1. Answer the following questions:

1. What was E. Torricelli?
2. What was he famous for?
3. What did Torricelli write?
4. Where was he invited?
5. Why was he invited there?
6. Where did Torricelli work?
7. How did he invent the barometer?
8. Did he publish his findings?

TEXT 38.2. BAROMETER

1. Barometer is a device for measuring atmospheric pressure. Because atmospheric pressure changes with distance above or below sea level, a barometer can also be used to measure altitude. There are two main types of barometers: mercury and aneroid.

2. The mercury barometer in its simplest form consists of a glass tube about 80 cm long sealed at one end and filled with mercury. The tube is then inverted and the open end is submerged in a reservoir of mercury; the mercury column is held up by the pressure of the atmosphere acting on the surface of mercury in the reservoir. This type of device was invented by the Italian scientist E. Torricelli (1608-47), who first noticed the variation in height from day to day and constructed a barometer in 1644. In such a device, the force exerted by the atmosphere balanced the weight of the mercury column. At standard atmospheric pressure the column is 760 mm high. The pressure is then expressed as 760 mmHg (101325 pascals). Mercury barometers of this type are known as ***cistern barometers***.

3. A nonliquid barometer called the ***aneroid barometer*** is widely used in portable instruments and in aircraft altimeters because of its small size and convenience. In aneroid barometer the cumbersome mercury column is replaced by a metal box with a thin ***corrugated lid***. The air is removed from the box and the lid is supported by a spring. Variation on atmospheric pressure causes the lid to move ***against*** the spring. This movement is magnified by a system of delicate levers and made to move a needle around a scale. The aneroid barometer is less accurate than the mercury type, and the mercury barometer is used to calibrate and check the aneroid barometers. Calibration can be, for example, in terms of atmospheric pressure or altitude above sea level.

4. A barometer that mechanically records the changes in barometric pressure over time is called a barograph. Though mercury barographs have been made, aneroid barographs are much more common. Barograph is a meteorological instrument that records on paper the variations in atmospheric pressure over a period. It often consists of an aneroid barometer operating a pen that rests lightly on a rotating drum to which the recording paper is attached.

Notes:

1. cistern barometer – чашечный барометр
2. aneroid barometer – барометр-анероид
3. corrugated lid – рифлёная крышка
4. against – по, на

IV. Read and translate text 38.2. Describe in brief:

1. Barometer	2. Mercury barometer (design, invention, mercury column)
3. Barograph	4. Aneroid barometer (design, calibration)

TEXT 38.3. TORRICELLIAN VACUUM

1. Torricellian vacuum is the vacuum formed when a long tube, closed at one end and filled with mercury, is inverted into a mercury reservoir so that the open end of the tube is below the surface of the mercury. The pressure inside the Torricellian vacuum is the vapour pressure of mercury, about 10^{-3} torr.

2. Torr is a unit of pressure, used in high-vacuum technology, defined as 1 mmHG. 1 torr is equal to 133,322 pascals. The unit is named after Evangelista Torricelli (1609-47).

V. Read and translate text 38.3. Characterize Torricellian vacuum.

TEXT 38.4. TORRICELLI'S THEOREM

1. Torricelli's theorem (or law) is a ***statement*** that the speed of a liquid flowing under the force of gravity out of an opening in a ***tank*** is proportional jointly to the square root of the vertical distance between the liquid surface and the centre of the opening and to the square root of twice

the acceleration caused by gravity, v = $\sqrt{2gh}$. (The value of the acceleration caused by gravity at the Earth's surface is 9.8 metres per second per second or 32.2 feet per second per second). The theorem is names after Evangelista Torricelli who discovered it in 1643.

2. The speed of a portion of water flowing thought an opening in a tank a given distance below the water surface is the same as the speed that would be attained by a drop of water falling freely under the force of gravity alone (that is, neglecting effects of air) through the same distance. The speed of a ***flux*** is independent of the direction of flow; at the point of the opening the speed is given by this equation, whether the opening is directed upward, downward, or horizontally.

Notes:
1. statement – утверждение
2. tank – цистерна, бак, резервуар
3. flux – плотность потока, поток

VI. Read and translate text 38.4. Describe Torricelli's theorem.

VII. Make up the abstracts of texts 38.1–38.4 (in English or in Russian).

VIII. Comment on the following quotations. Do you agree or disagree with them?

1. Every science has for its basis a system of principles as fixed and unalterable as those by which the universe is regulated and governed. Man cannot make principles – he can only discover them. (Thomas Paine 1737–1809, – English-born American writer)
2. The aim of science is to seek the simplest explanations of complex facts. We are apt to fall into the error of thinking that the facts are simple because simplicity is the goal of our quest. The guiding motto in the life of every natural philosopher should be: seek simplicity and distrust it. (Alfred North Whitehead 1861–1947, – British mathematician and philosopher)

SECTION 39

TEXT 39.1. ALESSANDRO VOLTA

1. Alessandro Giuseppe Antonio Anastasio Volta (1745-1827) was

Italian physicist whose invention of the electric battery provided the first source of ***continuous current***.

2. In 1775 Volta's interest in electricity led him to invent the electrophorus, a device used to generate static electricity. Electrophorus was an early form of electrostatic generator. It consisted of a flat dielectric plate and a metal plate with an insulated handle. The dielectric plate was charged by friction and the metal plate was placed on it and momentarily earthed, which left the metal plate with an induced charge of opposite polarity to that of the dielectric plate. The process could be repeated until all of the original charge had leaked away. He became professor of physics at the Royal School of Como in 1774 and discovered and isolated methane gas in 1778. One year later he was appointed to the chair of physics at the University of Pavia.

3. In 1780 Volta's friend Luigi Galvani discovered that contact of two different metals with the muscle of a frog resulted in electric current. Volta began experimenting in 1794 with metals alone and found that animal tissue was not needed to produce a current. This finding provoked much controversy between the animal electricity adherents and the metallic-electricity advocates, but, with his demonstration of the first electric battery (the ***voltaic pile***) in 1800, victory was assured for Volta.

4. Voltaic cell (galvanic cell) is a device that produces an e.m.f. as a result of chemical reactions that take place within it. These reactions occur at the surfaces of two electrodes, each of which dips into an electrolyte. The first voltaic cell had electrodes of two different metals dipping into ***brine***. Voltaic pile was an early form of a battery, devised by A. Volta, consisting of a number of flat voltaic cells joined in series. The liquid electrolyte was absorbed into paper or leather discs.

5. In 1801 in Paris, he gave a demonstration of his battery's generation of electric current before Napoleon, who made Volta a count and senator of the kingdom of Lombardy. The emperor of Austria made him director of the philosophical faculty at the University of Padua in 1815. The volt, a unit of the electromotive force that drives current, was named in his honour in 1881.

Notes:

1. continuous current – непрерывный ток
2. voltaic pile – выпрямительный столб, батарея
3. brine – соляной раствор, рассол

I. Find Russian equivalents for:

physicist, invention of the electric battery, device, electrostatic generator, flat dielectric plate, to charge by friction, to earth, charge of opposite polarity, repeat, leak away, discover, chair of physics, electric current, demonstration, voltaic pile, galvanic cell, chemical reactions, to dip into electrolyte, unit

II. Find English equivalents for:

источник непрерывного тока, вырабатывать (производить) статическое электричество, состоять из, изолированная ручка, помещать, первоначальный заряд, выделять метан, назначать, создавать (получать) ток, полемика (спор), электродвижущая сила, происходить (иметь место), на поверхности, соединенные последовательно, жидкий электролит

III. Read and translate text 39.1. Answer the following questions:

1. What was Alessandro Volta?
2. What was he famous for?
3. What was electrophorus?
4. Where did A. Volta work?
5. What did he discover and isolate?
6. What was voltaic pile?
7. What was voltaic cell?
8. What did Volta do in Paris?

IV. What do the following dates refer to:

1745, 1774, 1775, 1778, 1780, 1794, 1800, 1801, 1815, 1881

TEXT 39.2. VOLT

1. Volt (V) is the unit of electric potential, potential difference and electromotive force in the metre-kilogram-second system (SI). It is equal to the difference in potential between two points in a conductor carrying one ampere current when the power dissipated between the points is one watt. An equivalent is the potential difference across a resistance of one ohm when one ampere is flowing through it. The volt is named in honour of the Italian physicist Alessandro Volta. These units are defined in accordance with Ohm’s law, that resistance equals the ratio of potential to current, and the respective units of ohm, volt and ampere are used universally for expressing electrical quantities.

2. Electric potential (V) is the energy required to bring unit electric charge from infinity to the point in an electric field at which the potential is being ***specified***. The unit of electric potential is the volt. The potential difference (p.d.) between two points in an electric field or circuit is the difference in the values of the electric potentials at the two points, i.e. it is the work done in moving ***unit charge*** from one point to the other.

3. Electromotive force (e.m.f.) is the greatest potential difference that can be generated by a particular source of electric current. In practice this may be observable only when the source is not supplying current, because of its internal resistance. Internal resistance is the resistance within a source of electric current, such as a cell or generator. It can be calculated as the difference between the e.m.f. and the potential difference between the terminals divided by the current being supplied.

4. Voltage (V) is an e.m.f. or potential difference expressed in volts. The voltage across battery terminals is a measure of the potential energy given to each coulomb of charge, and a potential difference of one volt exists if each coulomb has one joule of potential energy. An instrument used to measure voltage is voltmeter. ***Moving-coil instruments*** are widely used for this purpose.

5. Generally a galvanometer is used in series with a resistor of high values (sometimes called a ***multiplier***). To measure an alternating potential difference a rectifier must be included in the circuit. A ***moving-iron instrument*** can be used for either d.c. or a.c. without a rectifier. ***Cathode-ray oscilloscopes*** are also used as voltmeters. The electronic digital voltmeter displays the value of the voltage in digits. The input is repeatedly sampled by the voltmeter and the instantaneous values are displayed.

Notes:
1. specify – точно определять, устанавливать, указывать
2. unit charge – единичный заряд
3. moving-coil instrument – магнитоэлектрический измерительный прибор
4. multiplier – добавочное сопротивление, умножитель
5. moving-iron instrument – электромагнитный измерительный прибор
6. cathode-ray oscilloscope – электронно-лучевой осциллоскоп

V. Find Russian equivalents for:

unit of electric potential, electromotive force, equal, power resistance, use universally, electric field, value, unit charge, observable, cell, generator, to calculate, voltage, to measure, coulomb, joule, instrument, resistor, d.c. (direct current), a.c. (alternating current), rectifier, electronic digital voltmeter, input

VI. Find English equivalents for:

разность потенциалов, проводник, проходить (протекать) через него, назван в честь, отношение эл. потенциала к электрическому току, для выражения электрических величин, схема (электрическая цепь), фактически (на практике), из-за внутреннего сопротивления, между клеммами, существовать, широко использоваться для этой цели, включать, отображать значение напряжения в цифрах

VII. Read and translate text 39.2. Identify, define or explain:

1. Volt
2. Electric potential
3. Potential difference
4. Electromotive force
5. Voltage
6. Instruments

TEXT 39.3. CELL

1. Cell is a system in which two electrodes are in contact with an electrolyte. The electrodes are metal or carbon plates or rods or, in some cases, liquid metals (e.g. mercury). In ***electrolytic cell*** a current from an outside source is passed through the electrolyte to produce chemical change. In a voltaic cell, spontaneous reactions between the electrodes and electrolyte produce a potential difference between the two electrodes.

2. Voltaic cells can be regarded as made up of two half cells, each composed of an electrode in contact with an electrolyte. Various types of voltaic cell exist, used as sources of current, standards of potential and experimental ***set-ups*** for studying electrochemical reactions.

3. Dry cell is a primary or secondary cell in which the electrolytes are restrained from flowing in some way. Many torch, radio and calculator batteries are ***Leclanche cells*** in which the electrolyte is an ***ammonium chloride*** paste and the container is the negative zinc electrode (with an outer plastic wrapping). Various modifications of the Leclanche cell are used in dry cells.

4. In the zinc chloride cell, the electrolyte is a paste of zinc chloride rather than ammonium chloride. The electrical characteristics are similar to those of the Leclanché cell but the cell works better at low temperatures

and has more efficient depolarization characteristics. A number of alkaline secondary cells can be designed for use as dry cells. In these, the electrolyte is a liquid (***sodium or potassium hydroxide***) held in porous material or in a gel. Alkaline dry cells typically have zinc-manganese dioxide, silver oxide-zinc, nickel-cadmium or nickel-iron electrode systems.

5. For specialized purposes, dry cells and batteries have been produced with solid electrolytes. These may contain a solid crystalline salt, such as ***silver iodide***, an ion-exchange membrane, or an organic wax with a small amount of dissolved ionic material. Such cells deliver low currents. They are used in miniature cells for use in electronic equipment.

Notes:

1. electrolytic cell – химический источник тока, гальванический элемент
2. setup – устройство, установка
3. Leclanché cell – элемент Лекланше, марганцево-цинковый элемент
4. ammonium chloride – хлорид аммония
5. sodium or potassium hydroxide – гидрооксид натрия или калия
6. silver iodide – иодид серебра

VIII. Read and translate text 39.3. Identify, define or explain:

1. Cell	5. Leclanché cell
2. Electrolytic cell	6. Zinc chloride cell
3. Voltaic cell	7. Alkaline cell
4. Dry cell	8. Specialized purpose cell

TEXT 39.4. DEVELOPMENT OF BATTERIES

1. The Italian physicist Alessandro Volta is generally credited with having developed the first ***operable*** battery. Following up on the earlier work of his compatriot Luigi Galvani, Volta performed a series of experiments on electrochemical phenomena during the 1790s. By about 1800 he had built his simple battery, which later came to be known as the 'voltaic pile'. This device consisted of alternating zinc and silver disks separated by layers of paper or cloth soaked in a solution of either ***sodium hydroxide*** or brine. Experiments performed with the voltaic pile eventually led Faraday to derive the quantitative laws of electrochemistry (about 1834). These laws, which established the exact relationship between the

quantity of electrode material and the amount of electric power desired, formed the basis of modern battery technology.

2. Various ***commercially*** significant primary cells were produced on the heels of Faraday's theoretical contribution. In 1836 John Frederic Daniell, a British chemist, introduced an improved form of electric cell consisting of copper and zinc in ***sulfuric acid***. The Daniell cell was able to deliver ***sustained currents*** during continuous operation far more efficiently than Volta's device.

3. Further advances were effected in 1839 by William Robert Grove with his two-***fluid primary cell*** consisting of amalgamated zinc immersed in dilute sulfuric acid, with porous pot separating the sulfuric acid from a strong nitric acid solution containing a platinum cathode. The nitric acid served as an oxidizing ***agent***, which prevented voltage loss resulting from an accumulation by hydrogen at the cathode. The German chemist Robert Wilhelm Bunsen substituted inexpensive carbon for platinum in Grove's cell and thereby helped promote its wide acceptance.

4. In 1859 Gaston Planté of France invented a lead-acid cell, the first ***practical storage battery*** and the forerunner of the modern automobile battery. Planté's device was able to produce a remarkably large current, but it remained a laboratory curiosity for nearly two decades. The Leclanché's prototype of the zinc-manganese dioxide system paved the way for the development of the modern primary cell.

Notes:

1. operable – действующий
2. sodium hydroxide – гидрооксид натрия
3. commercially – в промышленном масштабе, с коммерческой точки зрения
4. sulfuric acid – серная кислота
5. sustained current – установившийся ток
6. fluid (primary) cell – жидкостный (первичный) элемент
7. agent – средство, вещество
8. practical storage battery – осуществимая (реальная, полезная) аккумуляторная батарея

IX. Read and translate text 39.4. Explain in brief:

1. Voltaic pile	2. Quantitative laws of electricity
3. Two-fluid primary cell	4. Lead-acid cell

TEXT 39.5. PRIMARY BATTERIES

1. Primary batteries are the most commonly used world-wide in flashlights, toys, radios, tape recorders and flash cameras. There are three variations: the ***Leclanché cell***, the ***zinc chloride cell*** and the ***alkaline cells***. All provide an initial voltage of 1.58 to 1.7 volts, which declines with use to an end point of about 0.8 volt.

2. The Leclanché cell is the least expensive, traditional general-purpose dry cell available nearly everywhere. Invented by the French engineer Georges Leclaché in 1866, it immediately became a commercial success in large sizes because of its readily available low-cost constituent materials. The original version of the Leclanché cell was ‘wet’, as it had an electrolyte consisting of a solution of ***ammonium chloride***. The idea of employing an immobilized electrolyte was finally introduced in the late 1880s and launched the dry-cell industry that continues to flourish today. The anode of Leclanché primary cell is a zinc alloy sheet or ‘cup’, the alloy containing small amounts of lead, cadmium and mercury. The electrolyte consists of a saturated aqueous solution of ammonium chloride containing roughly 20 percent zinc chloride. The cathode is made of impure ***manganese dioxide*** (usually mined from selected deposits of Africa, Brazil or Mexico). This compound is blended with ***carbon black*** and electrolyte to create a damp, active cathode mixture which is formed around a carbon collector rod (called electrode). All cells of this type are provided with an overwrap structure with metal covers for electrical contact.

4. While first patented in 1899, the zinc chloride cell is really a modern adaptation of the Leclaché cell. Its commercial success is attributed in part to the development of plastic seals that has made it possible to largely dispense with the use of ammonium chloride. The manganese dioxide of the cathode is usually a blend of synthetic manganese dioxide of high purity with natural varieties. The zinc chloride cell is capable of greater continuous service than the Leclanché cell, particularly in motorized devices such as toys. Its use is also increased because it can provide satisfactory performance without mercury in zinc alloy.

5. The invention of alkaline electrolyte batteries (specifically storage batteries of the nickel-cadmium and nickel-iron type) between 1895 and 1905 provided systems that could furnish much-improved cycle life for commercial application. In secondary batteries of this type, electric energy

is derived from the chemical action in an alkaline solution. Nickel (hydroxide)-cadmium systems are the most common small rechargeable battery types for portable appliances. The sealed cells are equipped with ***'jelly roll' electrodes***, which allow high current to be delivered in an efficient way. These batteries are capable of delivering exceptionally high currents, can be rapidly recharged hundreds of times, and are tolerant of abuse such as overdischarging or overcharging. They last longer and perform better if fully discharged each cycle before recharge. Larger nickel-cadmium batteries are used for starting up aircraft engines and in emergency power systems. They also have found application in other backup power systems where very high currents, low temperature conditions and reliability are special factors.

6. ***Nickel-iron batteries*** can provide thousands of cycles but do not recharge with high efficiency, generating heat and consuming more electricity than is generally desirable. They have been used extensively in the European mining industry, however.

Notes:
1. Leclanché cell – элемент Лекланше, марганцево-цинковый элемент
2. zinc chloride cell – элемент с хлоридом цинка
3. alkaline cell – элемент с щелочным электролитом, щелочной элемент
4. ammonium chloride – хлорид аммония
5. manganese dioxide – диоксид марганца
6. carbon black – углеродная сажа
7. jelly roll electrodes – электрод в виде гелевого рулона (валика)
8. nickel-iron battery – батарея железоникелевых аккумуляторов

X. Read and translate text 39.5. Characterize in brief:

1. Leclanché cell 2. Zinc-chloride cell 3. Alkaline electrolyte batteries

XI. Fill in the table concerning the development of batteries:

date	inventor	invention	cell feature	advantages / disadvantages

TEXT 39.6. SCIENCE AND TECHNOLOGY

1. There is a distinction between science and technology. The history

of technology is longer than and distinct from the history of science. Technology is the systematic study of ***techniques*** for making and doing things; science is the systematic attempt to understand and interpret the world. While technology is concerned with the fabrication and use of ***artefacts***, science is devoted to the understanding the environment, and it depends upon the comparatively sophisticated skills of literacy and numeracy. Such skills became available only with the emergence of the great civilizations.

2. Science and technology developed as different and separate activities, the former being for several millennia a field of fairly abstruse ***speculation*** practiced by a class of aristocratic philosophers, while the latter remained a matter of essentially practical concern to craftsmen of many types. There were points of intersection, such as the use of mathematical concepts in building and irrigation work, but for the most part the functions of scientist and technologist remained distinct in the ancient cultures.

3. The situation began to change during the medieval period of development in the West (500-1500 AD), when both technical innovation and scientific understanding interacted with the stimuli of commercial expension and a flourishing urban culture. The robust growth of technology in these centuries could not fail to attract the interest of educated men. Early in the 17^{th} century, the natural philosopher Francis Bacon had recognized three great technological innovations – the magnetic compass, the printing press and gun powder – as the distinguishing achievements of modern man, and he had advocated experimental science as a means of enlarging man's dominion over nature.

4. By emphasizing a practical role for science in this way, Bacon implied a harmonization of science and technology, and he made his intention explicit by urging scientists to study the methods of craftsmen contemporaries, for the first time saw man becoming the master of nature, and a convergence between the traditional pursuits of science and technology was to be the way such mastery could be achieved.

5. Over the next 200 years, carpenters and mechanics – practical men of ***long standing*** – built iron bridges, steam engines and textile machinery without much ***reference*** to scientific principles, while scientists – still amateurs – pursued their investigations in a haphazard matter. But the body of men, inspired by Baconian principles, who formed the Royal Society in London in 1660 represented a determined effort to direct scientific research toward useful ends, by improving navigation and

cartography, and by stimulating industrial innovation and the search for mineral resources. Similar bodies of scholars developed in other European countries, and by the 19^{th} century scientists were moving toward a professionalism in which many of the goals were clearly the same as those of the technologies.

6. Thus Justus von Liebig (Germany) a scientist in organic chemistry and Michael Faraday, the brilliant British experimental scientist in the electro-magnetism, prepared the ground that was exploited by Thomas A. Edison and many others. The role of Edison is particularly significant in the deeping relationship between science and technology, because the prodigious trial-and-error process by which he selected the ***carbon filament*** for his electric light bulb in 1879 resulted in the creation of the world's first genuine industrial research laboratory. From this achievement the application of scientific principles to technology grew rapidly.

7. It led to engineering rationalism applied by F.W. Taylor to the organization of workers in mass production and to the ***time-and-motion studies*** by Frank and Lillian Gilbreth at the beginning of the 20^{th} century. It provided a model that was applied rigorously by Henry Ford in his automobile assembly plant and that was followed by every modern mass-production process. It pointed the way to the development of ***systems engineering***, operation research, ***simulation studies***, mathematical modelling and technological assessment in industrial processes. This was not just a one-way influence of science on technology, because technology created new tools and machines with which the scientists were able to achieve an ever increasing insight into the natural world. Taken together, these developments brought technology to its modern highly efficient level of performance.

Notes:

1. technique – метод, способ, методика, (технологический) приём
2. artefact – артефакт, искусственный объект
3. speculation – предположение, гипотеза, рассуждение, размышление
4. long standing – давний
5. reference – ссылка
6. carbon filament – угольная нить накала
7. time-and-motion study – хронометрирование, изучение (трудовых) движений и затрат времени (при выполнении производственных операций); система нормативов времени на (трудовые) движения
8. systems engineering – системотехника, проектирование систем

9. simulation study – исследование с использованием моделирования (на модели), имитация

XII. Read and translate text 39.6. Characterize in brief:

1. Technology
2. Science
3. Science and technology
4. F. Bacon
5. The Royal Society in London
6. Role of T.A. Edison
7. Application of science to technology
8. Influence of technology on science

TEXT 39.7. TECHNOLOGY AND SOCIETY

1. Techniques are methods of creating new tools and products of tools, and the capacity for constructing such artefacts is a determining characteristic of man. Man has the capacity to think systematically and creatively about techniques. He can innovate and consciously modify his environment. By virtue of his nature as a toolmaker, man is therefore a technologist from the beginning, and the history of technology encompasses the whole evolution of man. The history of technology reveals a profound interaction between the incentives and opportunities of technological innovation, on the one hand and the sociocultural conditions of the human group within which they occur, on the other.

2. Knowledge of social ***involvement*** in technological advances is important in surveying the development of technology through successive civilizations. There are three points at which there must be some social involvement in technological innovation: social need, social resources and a sympathetic social ***ethos***. In default of any of these factors it is unlikely that a technological innovation will be widely adopted or be successful.

3. The sense of social need must be strongly felt, or people will not be prepared to devote resources to a technological innovation. The thing needed may be a more efficient cutting tool, a more powerful lifting device, a labour saving machine or a means of utilizing new fuels or a new source of energy. In modern societies, needs have been generated by advertising. Whatever the source of social need, it is essential that enough people be conscious of it to provide a market for an artefact or commodity that can meet the need.

4. Social resources are similarly an indispensable prerequisite to a successful innovation. Many inventions have foundered because the social resources vital for their realization – the capital, materials and skilled personnel – were not available. The notebooks of Leonardo da Vinci are

full of ideas for helicopters, submarines and airplanes, but few of these reached even the model stage because resources of one sort or another were lacking. The resource of capital involves the existence of surplus productivity and an organization capable of directing the available wealth into channels in which the inventor can use it. The resource of materials involves the availability of appropriate metallurgical, ceramic, plastic or textile substances that can perform whatever functions a new invention requires of them. The resource of skilled personnel implies the presence of technicians capable of constructing new artefacts and devising novel processes. A society has to be well primed with suitable resources in order to ***sustain*** technological innovation.

5. A sympathetic social ethos implies an environment receptive to new ideas, one in which the dominant social groups are prepared to consider innovation seriously. Such receptivity may take the form of a more generalized attitude of inquiry, ***as was the case*** among the industrial middle classes in Britain during the 18th century, who were willing to cultivate new ideas and inventors, the breeders of such ideas. Whatever the psychological basis of inventive genius, there can be no doubt that the existence of socially important groups willing to encourage inventors and to use their ideas has been a crucial factor in the history of technology.

6. Social conditions are thus of the utmost importance in the development of new techniques. Technology involves the application of reason to techniques, and in the 20th century it has come to be regarded as almost ***axiomatic*** that technology is a rational activity stemming from the traditions of modern science. It is impossible to deny that there is a progressive element in technology, as it is clear generation inherits a stock of techniques on which it can build if it chooses and if social conditions permit. Over a long period of time the history of technology inevitably highlights the moments of innovations that show this cumulative quality as some societies advance, stage by stage, from comparatively primitive to more sophisticated techniques.

Notes:

1. involvement – вовлечение, участие
2. ethos – этос, характер явления (или лица)
3. sustain – поддержать
4. as was the case – как это произошло
5. axiomatic – самоочевидный, не требующий доказательств

XIII. Read and translate text 39.7. Explain in brief:

1. Techniques 2. Characteristic of man 3. Social involvement in technological innovation 4. Social need 5. Social resources 6. Sympathetic social ethos 7. Social conditions 8. Cumulative effect of technology

XIV. Make up the abstracts of texts 39.1–39.7 (in English or in Russian).

XV. Comment on the following quotation. Do you agree or disagree with it?

1. A science is not merely knowledge, it is knowledge which has undergone a process of intellectual digestion. It is the grasp of many things brought together in one, and hence is its power; for, properly speaking, it is Science that is power, not Knowledge. (John Henry Newman 1801–1890, – British cardinal and theologian)

SECTION 40

TEXT 40.1. JAMES WATT

1. James Watt (1736-1819) was a Scottish instrument maker and inventor whose steam engine contributed substantially to the Industrial Revolution. He was elected fellow of the Royal Society of London in 1785.

2. Watt's father, the treasurer and magistrate of Greenock, ran a successful ship-and house-building business. A delicate child, Watt was taught for a time at home by his mother, later in the grammar school, he learned Latin, Greek and mathematics. The source for an important part of his education was his father's workshops, where, with his own tools, bench, and forge, he made models (of cranes and barrel organs) and grew familiar with ship's instruments.

3. Deciding at age 17 to be a mathematical instrument maker, Watt first went to Glasgow (1753) and then in 1755 to London, where he found a master to train him. Returning to Glasgow, he opened a shop in 1757 at the University and made mathematical instruments (quadrants, compasses, scales). He met many scientists and became a friend of Joseph Black, who

developed the concept of ***latent heat***. In 1764 he married Margaret Miller, who, before she died nine years later, bore him six children.

4. While repairing a model of Newcomen steam engine in 1764 Watt was impressed by its waste of steam. In May 1765 after wrestling with the problem of improving it, he suddenly came upon a solution – the separate condenser, his first and greatest invention. Watt had realized that the loss of latent heat (the heat involved in changing the state of a substance, solid or liquid) was the worst defect of the Newcomen engine and that therefore condensation must be effected in a chamber distinct from the cylinder but connected to it.

5. Shortly afterward, he met John Roebuck, the founder of the Carron Works, who urged him to make an engine. He entered into partnership with him in 1768, after having made a small test engine with the help of loans from Joseph Black. The following year Watt took out the famous patent for ‘A New Invented Method of Lessening the Consumption of Steam and Fuel in Fire Engines’.

6. Meanwhile, Watt in 1766 became a ***land surveyor***; for the next eight years he was continuously busy making out routes for canals in Scotland. After Roebuck went bankrupt in 1772, Matthew Boulton, the manufacturer of the Soho Works in Birmingham, took over a share in Watt’s patent.

Notes:

1. latent heat – скрытая теплота
2. land surveyor – топограф

I. Find Russian equivalents for:

Scottish instrument maker and inventor, steam engine, successful ship-and house-building business, grammar school, important part of his education, his father’s workshop, tools, ship’s instruments, a mathematical instrument maker, to train, to open a shop, meet many scientists, impress, separate condenser, solid or liquid, connect, to make an engine, land surveyor, manufacturer

II. Find English equivalents for:

делать вклад, быть избранным членом Королевского Общества, казначей и государственный судья, чиновник, источник, тиски и кузнечный горн, решать, найти мастера (учителя), квадранты и весы, ремонтировать модель, потеря пара, придти к решению, изобретение, потеря скрытого тепла, изменение состояния вещества, камера, товарищество (компания), брать патент, прокладывать трассу (маршрут) для канала

III. Read and translate text 40.1. Answer the following questions:

1. What was James Watt?
2. What was he famous for?
3. Where did J. Watt study?
4. What can you say about his family?
5. What was an important part of his education?
6. What did Watt decide to be?
7. What did he open and make at the University?
8. What was Watt's greatest invention?
9. What patent did he take out?

IV. What do the following dates refer to?

1736, 1753, 1755, 1757, 1764, 1765, 1768, 1772

TEXT 40.2. THE WATT ENGINE

1. After Watt's patent was extended by an act of Parliament, he and Boulton in 1775 began a partnership that lasted 25 years. Boulton's financial support made possible rapid progress with the engine. In 1776 two engines were installed, one for pumping water in Staffordshire colliery, the other for blowing air into the furnaces of John Wilkinson, the famous iron master. That year Watt married again – his second wife, Ann MacGregor, bore him two more children.

2. During the next five years, until 1781, Watt spent long period in Cornwall, where he installed and supervised numerous pumping engines for the copper and tin mines, the managers of which wanted to reduce fuel costs. In 1781 Boulton, foreseeing a new market in the corn, malt and cotton mills, urged Watt to invent a rotary motion for the steam engine, to replace the ***reciprocating action*** of the original. He did this in 1781 with his so-called ***sun-and-planet gear***, by means of which a shaft produced two revolutions for each cycle of the engine.

3. In 1782, at the height of his inventive powers, he patented the ***double-acting engine***, in which the piston pushed as well as pulled. The engine required a new method of rigidly connecting the piston to the

beam. He solved this problem in 1784 with his invention of the parallel motion – an arrangement of connected rods that guided the ***piston rod*** a perpendicular motion – which he described as “one of the most ingenious, simple pieces of mechanism I have contrived”. Four years later his application of the ***centrifugal governor*** for automatic control of the speed of the engine, at Boulton’s suggestion, and in 1790 his invention of a ***pressure gauge***, virtually completed the Watt engine.

4. Demands for his engine came quickly from paper mills, cotton mills, iron mills, ***distilleries***, and canals and waterworks. By 1790 Watt was a wealthy man, having received £ 76,00 in royalties on his patents in 11 years. The steam engine did not absorb all his attention, however. He was a member of the Lunar Society in Bermingham, a group of writers and scientists who wished to advance the sciences and the arts. Watt experimented also on the strength of materials. In 1785 he and Boulton were elected fellows of the Royal Society of London. Watt then began to take holidays, bought an estate at Doldowlod (Radnorshire) and from 1795 onward gradually withdrew from business.

5. In 1894 Watt established the new firm of Boulton & Watt, which built the Soho Foundry to manufacture steam engines more competitively. Watt’s son by his first marriage, James, and Boulton’s son, Matthew, took over the management of the new firm.

6. He travelled with his wife to Scotland and to France and Germany when the Piece of Amiens was signed in 1802 and continued to work in the garret of his house, which he had equipped as a workshop. There he invented a sculpturing machine with which he reproduced original busts and figures for his friends. He also acted as consultant to the Glasgow Water Company. His achievements were amply recognized in his lifetime: he was made doctor of laws of the University of Glasgow in 1806 and a foreign associate of the French Academy of Sciences in 1814 and was offered a baronetcy, which he declined.

Notes:
1. reciprocating action – возвратно-поступательное движение
2. sun-and-planet gear – планетарная (зубчатая) передача
3. double-acting engine – двигатель двойного действия
4. beam – балка
5. piston rod – поршневой шток (стержень)
6. centrifugal governor – центробежный регулятор (скорости)
7. pressure gauge – манометр

8. distillery – перегонная установка (завод)

V. Find Russian equivalents for:

financial support, pumping engine, copper and tin mines, rotary motion, require, arrangement, describe, application, automatic control, speed, royalty, to advance sciences and arts, strength of materials, fellow of the Royal Society of London, establish a new firm, to manufacture steam engines; equip as a workshop, recognize his achievements

VI. Find English equivalents for:

продлевать патент, устанавливать двигатели, для вдувания воздуха в печь, снизить стоимость топлива, заменять, вал производил два оборота на каждый цикл, поршень толкал и тянул, жёсткое соединение, спрос на его двигатель, каналы и гидротехнические сооружения, отойти (удалиться) от дела, управление новой фирмой, отклонять (отказаться) предложение

VII. Read and translate text 40.2. Discuss in brief:

1. Extension of Watt's patent
2. Boulton's financial support
3. Piping engine
4. Sun-and-planet gear
5. Double-acting engine
6. Centrifugal governor and pressure gauge
7. Demands for his engine
8. A new firm
9. Work at workshop
10. Recognition of his achievements

TEXT 40.3. MATTHEW BOULTON

1. Matthew Boulton (1728-1809) was English manufacturer and engineer who financed and introduced James Watt's steam engine.

2. After managing his father's hardware business, in 1762 Boulton built the Soho manufactory near Birmingham. The factory produced small metal articles such as gilt and silver buttons and buckles, Sheffield plate, and a variety of other items. In 1768 Boulton made the acquaintance of James Watt. The need for a power source for his factory stirred Boulton's interest in Watt's invention. When the industrialist John Roebuck went bankrupt, Boulton accepted Roebuck's share in Watt's first steam engine patent (1769) as repayment of a debt.

3. In 1775 he and Watt became partners in the steam engine business, obtaining a 25-year extension of the patent. Assisted by the engineer and inventor William Murdock, they established the steam engine industry by initially erecting pumping engines to drain the Cornish tin mines. Boulton foresaw great industrial demand for ***steam power*** and urged Watt to design the double-acting rotative engine, patented in 1782, and the Watt engine (1788) for driving the ***lapping machines*** at his factory.

4. In 1786 Boulton applied steam power to coining machinery, obtaining a patent in 1790. He made large quantities of coins for the East India Company and also supplied machinery to the Royal Mint. He became a fellow of the Royal Society in 1785 and established a theatre in Birmingham in 1807. By 1809, when Boulton's son took over his father's share of the business, almost 500 steam engines had been installed in British Isles and abroad.

Notes:

1. steam power – паровая тяга
2. lapping machine – доводочный станок, притирочный станок

VIII. Read and translate text 40.3. Answer the following questions:

1. What was M. Boulton?
2. What was he famous for?
3. What was his business?
4. Why was Boulton interested in Watt's invention?
5. Where did he apply steam power?
6. How did they establish the steam engine industry?
7. What did Boulton urge Watt to design?
8. What did Boulton and Watt become partners in?

TEXT 40.4. WATT-HOUR METER

1. ***Watt-hour meter*** is a device that measures and records over time the electric power flowing through a circuit. Although there are several different types of watt-hour meters, each consists essentially of a small electric motor and a counter. A precise fraction of the current flowing in the circuit is diverted to operate the motor. The speed of which the motor turns is proportional to the current in the circuit and therefore, each revolution of the motor's rotor corresponds to a given amount of current flowing through the circuit. The counter is connected to the rotor and adds and displays the amount of power, the circuit has carried, based on the

number of revolutions of the rotor. The counter is usually marked in kilowatt-hours (1,000 watt-hours).

2. Mercury type and commutator-type watt-hour meters measure power in direct-current circuits. Induction-type meters measure power in alternating-current circuits and are the type commonly seen on the outside of houses. Specialized watt-hour meters include totalizing meters, which record the power used in more than one circuit, and highly accurate portable meters, which are used for testing installed watt-hour meters.

3. Watt is unit of ***power*** in the International System of Units (SI) equal to one joule of work performed per second, or to 1/746 horse power. An equivalent is the power dissipated in a electrical conductor carrying one ampere current between points at one volt potential difference. It is named in honour of James Watt, British engineer and inventor. One thousand watts equal one kilowatt. Most electrical devices are ***rated*** in watts.

Notes:

1. watt-hour meter – счётчик электроэнергии, электрический счётчик
2. power – мощность
3. rate – устанавливать, определять

IX. Read and translate text 40.4. Identify, define or explain:

1. Watt-hour meter
2. Its construction
3. Direct-current circuits
4. Alternating-current circuits
5. Specialized watt-hour meters
6. Watt and its equivalent

TEXT 40.5. ENGINEERING AND SCIENCE

1. ***Engineering*** is the professional art of applying science to the optimum conversion of the resources of nature to the uses of mankind. Engineering is the creative application of scientific principles to design or develop structures, machines, apparatus or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behaviour under specific operating conditions; all as respect to an intended function, economics of operation and safety to life and property. Engineering is sometimes defined as the manufacture or assembly of engines, machine tools and machine parts.

2. The word ‘engine’ and ‘ingenious’ are derived from the same Latin root ‘ingenerare’ which means ‘to create’. The early English verb ‘engine’ meant to contrive. Thus the engines of war were devices such as catapults, floating bridges and ***assault towers***; their designer was the ‘engine – er’ or military engineer. The counterpart of the military engineer was the ***civil engineer***, who applied essentially the same knowledge and skills to designing buildings, streets, water supplies, sewage systems and other projects.

3. Associated with engineering is a great body of special knowledge; preparation for professional practice involves extensive training in the application of that knowledge. Standards of engineering practice are maintained through the efforts of professional societies, usually organized on a national or regional basis., with each member acknowledging a responsibility of the public over and above responsibilities to his employer or to other members of his society.

4. The function of the scientist is to know, while that of the engineer is to do. The scientist adds to the store of verified, systematized knowledge of the physical world; the engineer brings this knowledge to ***bear on*** practical problems. Engineering is based principally on physics, chemistry. mathematics and their extensions onto ***materials science***, solid and ***fluid machines***, thermodynamics, transfer and rate processes and systems analysis.

5. Unlike the scientist, the engineer is not free to select the problem that interests him; he must solve problems as they arise; his solution must satisfy conflicting requirements. Usually efficiency costs money; safety adds to complexity; improved ***performance*** increases weight. The engineering solution is the optimum solution, the end result that, taking many factors into account, is most desirable. It may be the most reliable within a given weight limit, the simplest that will satisfy certain safety requirements or the most efficient for a given cost. In many engineering problems the ***social costs*** are significant.

6. Engineers employ two types of natural resources – materials and energy. Materials are useful because of their properties: their strength, ease of fabrication, lightness or durability; their ability to insulate or conduct; their chemical, electrical or acoustical properties. Important sources of energy include ***fossil fuels*** (coal, petroleum, gas), wind, sunlight, falling water and nuclear fission. Since most resources are limited, the engineer must concern himself with the continual development of new resources as well as the efficient utilization of existing ones.

Notes:

1. engineering – техника, технология, разработка, иженерное искусство
2. assault tower – штурмовая вышка
3. civil engineer – инженер-строитель (гражданских объектов)
4. bear on – касаться, иметь отношение
5. materials science – материаловедение
6. fluid machine – машина с гидравлическим (или пневмо) устройством
7. performance – рабочие характеристики, эксплуатационные данные
8. social costs – расходы на общественные нужды
9. fossil fuel – ископаемое топливо

X. Read and translate text 40.5. Identify, define or explain:

1. Engineering
2. Latin root of the word 'engine'
3. Standards of engineering practice
4. Function of scientist and engineer
5. Base of engineering
6. Problem solution by engineer
7. Engineering solution
8. Two types of natural resources

TEXT 40.6. ENGINEERING FUNCTION

1. Problem solving is common to all engineering work. The problem may involve quantitative or qualitative factors; it may be physical or economic; it may require abstract mathematics or common sense. Of great importance is the process of creative synthesis or design, putting ideas together to create a new and optimum solution.

2. Although the engineering problems vary in scope and complexity, the same general approach is applicable. First comes an analysis of the situation and a preliminary decision on a plan of attack. In line with this plan, the problem is reduced to a more categorical question that can be clearly stated. The stated question is then answered by deductive ***reasoning*** from known principles or by creative synthesis, as a new design. The answer or design is always checked for accuracy and adequacy. Finally, the results for the simplified problem are interpreted in terms of the original problem and reported in an appropriate form.

3. The major functions of all engineering branches are the following:

a) Research. Using mathematical and scientific concepts, experimental techniques and inductive reasoning, the research engineer seeks new principles and processes.
b) Development. ***Development engineers*** apply to results of research to useful purposes. Creative application of new knowledge may result in a

working model of a new electrical circuit, a chemical process or an industrial machine.

c) Design. In ***designing*** a structure or a product, the engineer selects methods, specifies materials and determines shapes to satisfy technical requirements and to meet ***performance specifications***.

d) Construction. The construction engineer is responsible for preparing the site, determining procedures that will economically and safety yield the desired quality, directing the placement of materials and organizing the personnel and equipment.

e) Production. Plant ***layout*** and equipment selection are the responsibility of the ***production engineer***, who chooses processes and tools, integrates the flow of materials and components and provides for testing and inspection.

f) Operation. The ***operating engineer*** controls machines, plants and organizations providing power, transportation and communication; determines procedures; and ***supervises*** personnel to obtain reliable and economic operation of complex equipment.

g) Management and other functions. In some countries and industries, engineers analyze customers' requirements, recommend units to satisfy needs economically, and resolve related problems.

Notes:

1. reasoning – рассуждение, вывод
2. development engineer – инженер-разработчик, инженер по развитию производства
3. designing – проектирование, конструирование
4. performance specifications – технологические условия (характеристики)
5. layout – схема расположения, размещения; разбивка, разметка (участка)
6. production engineer – специалист по организации производства, инженер-технолог
7. operating engineer – инженер по эксплуатации, инженер – эксплуатационник
8. supervise – смотреть, наблюдать; контролировать

XI. Read and translate text 40.6. Explain in brief:

1. Problem
2. Problem solving approach
3. Major functions of all engineering branches

XII. Make up the abstracts of texts 40.1–40.6 (in English or in Russian).

XIII. Comment on the following quotations. Do you agree or disagree with them?

1. Those who consider James Watt only as a great practical mechanic form a very erroneous idea of his character: he was equally distinguished as a natural philosopher and a chemist, and his inventions demonstrate his profound knowledge of those sciences, and that peculiar characteristic of genius, the union of them for practical application. (Humphry Davy)
2. The fact that science walks forward on two feet, namely theory and experiment, is nowhere better illustrated than in the two fields for slight contributions to which you have done me the great honour of awarding me the Nobel Prize in Physics for the year of 1923. Sometimes it is one foot that is put forward first, sometimes the other, but continuous progress is only made by the use of both – by theorizing and then testing, or by finding new relations in the process of experimenting and then bringing the theoretical foot up and pushing it beyond, and so on in unending alterations.(Robert Andrews Millikan 1868–1953, – American physicist)

SECTION 41

TEXT 41.1. WILHELM WEBER

1. Wilhelm Eduard Weber (1804-1891) was German physicist who, with his friend Carl Friedrich Gauss, investigated terrestrial magnetism and in 1833 devised an electromagnetic telegraph. The magnetic unit, termed a Weber, formerly the coulomb, is named after him.

2. Weber was educated at Halle, and later Göttingen, where he was appointed professor of physics in 1831. In 1833 he and Karl Gauss built an electric telegraph between their laboratories. In 1843 Weber moved to Leipzig, where his main work was to develop a system of self-consistent electrical units. He was professor at the University of Leipzig from 1843 to 1849, and then he returned to Göttingen and became director of the astronomical observatory there. He played an important role in the development of electrical science, particularly by his work to establish a system of absolute electrical units. Gauss had introduced a logical arrangement of units for magnetism involving the basic units of mass,

length and time. Weber repeated this for electricity in 1846. Both systems were adopted in 1881. Occasionally he collaborated with his brothers, the physiologists Ernst Heinrich Weber (1795-1878) and Edward Friedrich Weber (1806-1871). During his final years at Göttingen, Weber studied electrodynamics and the electrical structure of matter.

3. He received many honours from England, France and Germany, among which were the title of Geheimrat (***privy councillor***) and the Copley Medal of the Royal Society. Many of his extensive articles are in six volumes of 'Results of Observations of Magnetic Phenomena' (1837-43), edited by himself and Gauss.

4. Weber (Wb) is the SI unit of magnetic flux equal to the flux that, linking a circuit of one turn, produces in it an e.m.f. of one volt as it is reduced to zero at a uniform rate in one second.

Notes:

1. privy councillor – член Тайного Совета (юридически основной орган государственного управления, являющийся совещательным органом при монархе)

I. Find Russian equivalents for:

German physicist, devise an electromagnetic telegraph, to develop a system of self-consistent electrical units, become, play an important role, basic units of mass, length and time; electricity, to study electrodynamics and electrical structure of matter, articles, edit, unit of magnetic flux

V. Find English equivalents for:

исследовать земной магнетизм, раньше (прежде), называть в честь кого-либо, назначать профессором физики, возвращаться, развитие электротехники, создать систему абсолютных электрических единиц, логическое расположение единиц, сотрудничать, получать много наград, в шести томах, схема (цепь), с постоянной скоростью

III. Read and translate text 41.1. Answer the following questions:

1. What was W. Weber?
2. What was he famous for?
3. Where did Weber study?
4. Where did he work?
5. What did Weber and Gauss build?
6. What was his important role?
7. Who did Weber collaborate with?
8. Did he receive many honours?

9. What is Weber as a unit?

IV. What do the following dates refer to:

1804, 1831, 1833, 1843-1849, 1946, 1881

TEXT 41.2. SI UNITS

1. SI units (System of International units) is the international system of units now used for most scientific purposes. A coherent and ratioanalized system of units derived from the m.k.s. units (based on the metre, kilogram and second), SI units have now replaced c.g.s. units (based on the centimetre, gram, and second) and Imperial units (based on the pound and the yard) for many purposes. The system has seven ***base units*** and two dimensionless units (formerly called supplementary units) from which all other units are derived.

2. There are 18 ***derived units*** with special names. Each unit has an agreed symbol (a capital letter or an initial capital letter if it is named after a scientist, otherwise the symbol consists of one or two lower-case letters).

Notes:

1. base units – основные единицы
2. derived units – производные единицы

Derived SI Units

Physical quantity	Names of SI unit	Symbol of SI unit
frequency	hertz	Hz
energy	joule	j
force	newton	N
power	watt	W
pressure	pascal	Pa
electric charge	coulomb	C
electric potential difference	volt	v
electric resistance	ohm	Ω
electric conductance	siemens	S
electric capacitance	farad	F
magnetic flux	weber	Wb
inductance	henry	H
magnetic flux density (magnetic induction)	tesla	T

luminous flux	lumen	lm
illuminance	lux	lx
absorbed dose	gray	Gy
activity	becquerel	Bq
dose equivalent	sievert	Sv

V. Read and translate text 41.2. In pairs discuss the following questions:

1. What units do you commonly use in your everyday life?
2. What units do you use in your work?
3. What units are used in household untensiles?

TEXT 41.3. TECHNOLOGY AND EDUCATION

1. The history of technology shows the growing importance of education. In the early millennia of human existence, ***a craft*** was acquired in a lengthy and laborious manner by serving with a master who gradually trained the initiate in the arcane mysteries of the skill. Such instruction was set in a matrix of oral tradition and practical experience. Thus, the ***artisan*** in ceramics or sword making protected the skill while ensuring that it would be perpetuated. Craft training was institutionalized in Western civilization in the form of ***apprenticeship,*** which has survived into the 20th century as a ***framework*** for instruction in technical skills.

2. Increasingly, however, instruction in new technologies has required access both to general theoretical knowledge and to realms of practical experience that, on account of their novelty, were not available through traditional apprenticeship. Thus the requirement for a significant proportion of academic instruction has become an important feature of most aspects of modern technology. This has accelerated the convergence between science and technology in the 19th and 20th centuries and has created a complex system of educational awards representing the level of ***accomplishment*** from simple instruction in schools to advanced research in Universities.

3. French and German academies led in the provision of such theoretical instruction, while Britain lagged somewhat in the 19th century, owing to its long and highly successful tradition of apprenticeship in engineering and related skills. By the 20th century all the advanced industrial countries, including newcomers like Japan, had recognized the

crucial role of a theoretical technological education in achieving commercial and industrial ***competence***. Nowadays high technological competence requires a high level of educational achievement.

Notes:

1. a craft – ремесло, специальность, профессия
2. artisan – ремесленник, мастеровой
3. apprenticeship – ученичество, учение
4. framework – структура, рамки
5. accomplishment – образованность, воспитание, достоинство, достижение
6. competence – компетенция, способность, умение

VI. Read and translate text 41.3. Discuss in brief:

1. Craft training 2. Important feature of instruction in new techniques
3. Significant role of theoretical technological education

VII. Make up the abstracts of texts 41.1–41.3 (in English or in Russian).

VIII. Comment on the following quotations. Do you agree or disagree with them?

1. No man's knowledge here can go beyond his experience. (Robert Lloyd 1733-1764)
2. Anyone who stops learning is old, whether at 20 or 80. Anyone who keeps learning stays young. The greatest thing in life is to keep your mind young. (Henry Ford 1863-1947)

SECTION 42

TEXT 42.1. CHARLES WHEATSTONE

1. Sir Charles Wheatstone (1802-1875) was English physicist who constructed the ***Wheatstone bridge***, a device that accurately measured electrical resistance and became widely used in laboratories.

2. He was appointed professor of experimental philosophy at King's College, London, in 1834, the same year that he used a ***revolving mirror*** in an experiment to measure the speed of electricity in a conductor. The same

revolving mirror, by his suggestion, was also used in measurements of the speed of light. Three years later (1837), with Sir William Fothergill Cooke (1806-1879) of England, he patented an early telegraph. In 1843 at the suggestion of the British mathematician Samuel Cristie, he constructed Wheatstone bridge and popularized its use.

3. His own investigations include the consertina, a type of small accordion, and the stereoscope, a device for observing pictures in three dimensions still used in viewing X-rays and ***aerial photographics***. He initiated the use of electromagnets in electric generators and invented the Playfair cipher, which is based on substituting different pairs of letters for paired letters in the message. He was knighted in 1868.

Notes:

1. Wheatstone bridge – мост для измерения сопротивления, мост Уит-стона
2. revolving mirror – вращающееся зеркало
3. aerial photographics – аэрофотосъёмка

I. Find Russian equivalents for:

English physicist, Wheatstone bridge, to measure electrical resistance, professor of experimental philosophy, speed of electricity in a conductor, speed of light, patent an early telegraph, mathematician, a device for observing pictures in three dimensions, use of electromagnets in electric generators, invent

II. Find English equivalents for:

строить, точно, широко использоваться в лабораториях, назначать, вращающееся зеркало, измерять, по его предложению, его собственные исследования включают, при рассматривании рентгеновских лучей, инициировать (начинать) использование электромагнитов, шифр

III. Read and translate text 42.1. Answer the following questions:

1. What was Sir Charles Wheatstone?
2. What was he famous for?
3. Where did Wheatstone work?
4. What experiments did he conduct?
5. What did Wheatstone patent?
6. What did he construct?
7. What were his achievements?

IV. What do the following dates refer to:

1802, 1834, 1837, 1843, 1868

TEXT 42.2. WHEATSTONE BRIDGE

1. Wheatstone bridge is an electrical circuit for measuring the ***value*** of a resistance. If R_1 is a resistance of unknown value, R_2 is a fixed resistance of known value, R_3 and R_4 are ***variable resistances*** with known values. When no current flows between points A and B the bridge is said to be balanced, the galvanometer registers no deflection, and $R_1/R_2 = R_3/R_4$. R_1 can therefore be calculated.

2. The Wheatstone bridge is used in various forms. In the metre bridge, ***a wire*** 1 metre long of uniform resistance is attached to the top of a board alongside a metre rule. A sliding contact is run along the wire, which corresponds to R_3 and R_4, until the galvanometer registers zero. Most practical forms use one or more rotary rheostats to prove the variation. The device was popularized by Sir Charls Wheatstone.

Notes:

1. value – величина
2. variable resistance – переменное сопротивление
3. wire – провод, проволока

V. Read and translate text 42.2. Explain in brief:

1. Weatstone bridge	2. R_1 calculation
3. Metre bridge	4. Practical forms of the bridge

TEXT 42.3. DEVELOPMENT OF TELEGRAPH

1. Telegraph is a system allowing the transmission of enconded information by signal across a distance. The word was coined about 1792 from the Greek 'tele' (far) and 'graphen' (to write), but the principle is far older. While telegraph systems have used a variety of signalling methods and devices, the term is most often applied to the electrical telegraph developed in the 19th century.

2. The earliest forms of telegraphy were probably smoke, fire or drum signals. By around 300 BC Greeks had devised a method of alphabatic signalling using large vases visible from a distance; letters were signified according to the positions of vases visible in a ***grid*** of rows and

columns. A similar system was employed by medieval prisons ***tapping*** signals between cells and using a five-row, five-column grid for the Roman alphabet.

3. In the late 18th century optical telegraphs were invented by Claude Chape in France and by George Murray in England. Called semaphores, these telegraphs relayed message from hilltop to hilltop with the aid of telescopes. Chappe's systems used a vertical ***timber*** holding a movable ***crossbar*** with indicators at each end that could essume various configurations, like a signalman with flags. Murray's system used a large tower-mounted box with six panels that opened and closed in different combinations according to a ***code***.

4. Rapid development of telegraph systems came with the discovery that electric impulses could be used to transmit signals along a wire. Among the many electric systems attempted was the ***needle telegraph*** based on Hans Christian Ørsted discovery in 1819 that an electric current caused an adjacent magnetized needle or pointer to deflect. The Cooke and Wheatstone five-needle telegraph of 1837 utilized this phenomenon with a panel imprinted with letters and numerals to which the five needles pointed singly or in pairs. This apparatus was widely used in Great Britain, especially for railroad signaling.

5. The development of the electromagnet about that time provided Samuel Morse with a way to transmit and receive electric signals. Together with Alfred Vail, his partner from 1837, Morse developed the simple ***operator key***, sometimes like a signal typewriter key, which was originally a device that embossed a series of dots and dashes on a paper roll. About 1856 a sounding key was developed; skilled operators could listen to what the key 'said' and write the messages directly, or, after 1878, type them. Telegraph systems quickly spread across Europe and the United States, and soon resulted in mergers and associations such as the Western Union Telegraph Company 1856.

Notes:

1. grid – сетка, решётка
2. tap – стучать, постукивать
3. timber – бревно, брус (Клод Шапп использовал три подвижные линейки, укреплённые на вертикальной матче; при помощи шнуров и блоков линейки могли принимать много различных положений, изображая буквы и некоторые особенно частотные слова. Обслуживающий станцию работник наблюдал за соседней

станцией в подзорную трубу и воспроизводил на своей мачте увиденные сигналы)
4. crossbar – поперечина, перекладина
5. code – система кодирования
6. needle telegraph – игольчатый телеграф (передаваемая буква обозначалась положением магнитной стрелки на экране)
7. operator key – телеграфный ключ

VI. Read and translate text 42.3. Discuss in brief:

1. Telegraph
2. Earliest forms of telegraphy
3. Optical telegraphs
4. Needle telegraph
5. Operating and sounding key

TEXT 42.4. REFINEMENTS IN TELEGRAPH

1. With growing telegraph traffic, refinements were necessary. The ***duplex circuit***, developed in Germany, made it possible for messages on the same line. Thomas Edison devised a ***quadruplex*** in 1874 that permitted four messages to travel at once, two going in either direction. The most revolutionary innovation belonged to Jean-Maurice-Emile Baundot. His ***time-division multiplex***, invented in 1872, consisted of a ***brush arm*** that travelled around a copper ring divided into equal sectors. In each sector there were five segments capable of receiving electric impulses and corresponding to a ***five-level code***, and as the brush arm moved in its circle it would pick up a code number from one sector and then the next and so on. As many messages as there were sectors could be sent simultaneously. The Baundot Code is still used in some teletype machines.

2. By the end of the 19^{th} century the world was crisscrossed by telegraph lines, including numerous cables across the Atlantic Ocean. Some early telegraphs using keyboards and typewheels were capable of producing tapes of printed messages, which were long used in stock tickers. In 1903 Donald Murray of England combined Baudot's time-division multiplex system and its 5-level code with a system for ***punching tape*** devised by Wheatstone to produce a system that transmitted page form telegrams. Between 1924 and 1928 the simplex printer or teleprinter, commonly known by the American Telephone and Telegraph trade name Teletype, was developed to serve the simple back-and-forth needs of business communication. Teleprinters in 1933 were capable of printing up

to 500 characters per minute. By 1964 improved versions produced 900 characters per minute.

3. The invention and technical improvement of the telephone made a new range of technology available to telegraphy, particularly in the field of high-speed information transmission. Other important developments in telegraphy in the 20th century include the use of microwave radio links to carry up to 1,800 characters in a single circuit. Setellite transmission is now widely used for international telegraphy, as are the high-frequency radio bands. Many modern telegraph terminals consist of teleprinters using the American Standard Code for Information Interchange, a seven-level code capable of producing 128 alphanumeric and control signals. Some teleprinters use over a hundred tiny typewheels gauged together to print entire lines at once at rates of up to 1,000 a minute. Electrostatic, photgraphic, and electrothermal copies are also made. Digital computers have come to play an important role in coding and decoding transmission signals rapidly; they are also important for their memory storage capabilities.

Notes:

1. duplex circuit – дуплексный канал
2. quadruplex circuit – квадриплексная схема
3. time-division multiplex – временнóе уплотнение (объединение, разделение)
4. five-level code – пятибитный код (Бодо)
5. brush arm – ползунок скользящего (подвижного) контакта
6. typewheel – литерное (шрифтовое) колесо, лепестковый литероноситель (шрифтоноситель)
7. punching tape – перфорированная лента, перфолента

VII. Read and translate text 42.4. Chatarize in brief:

1. Duplex and quadruplex
2. Time-division multiplex
3. Keyboards and type wheels
4. Punching tape
5. Teleprinter (teletype)
6. High-speed information transmission

VIII. Sum up what you know about the development and refinement of telegraph:

date	invention	inventor	features

IX. Make up the abstracts of texts 42.1–42.4 (in English or in Russian).

X. Comment on the following quotation. Do you agree or disagree with it?

1. Talent developes in quite places, character in the full current of human life. (Johann Wolfgang von Goethe 1749-1832, German poet, novelist and playwright)

SECTION 43

TEXT 43.1. CHARLES WILSON

1. Charles Thomson Rees Wilson (1869-1959) was a Scottish physicist, joint recipient, with Arthur H. Compton, of the Nobel Prize for Physics in 1927 for his invention of a device called the ***Wilson cloud chamber***, widely used in the study of radioactivity, X-rays, cosmic rays and other nuclear phenomena.

2. Wilson began studying clouds as a meteorologist is 1895. In an effort to duplicate the effect of certain clouds on mountaintops he devised a way of expanding moist air in a closed container. The expansion of air was so that it became supersaturated and moisture condensed on dust particles.

3. Wilson noted that when he used dust-free air, the air remained supersaturated and that clouds did not form until the degree of supersaturation reached a certain critical point. He believed that in the absence of dust the clouds formed by condensing on ions (charged atoms or molecules) in the air. Hearing of the discovery of X-rays, he thought that ion formation as a result of such radiation might bring about more intensive cloud formation. He experimented and found that rotation left a ***trail*** of condensed water droplets in his cloud chamber. Perfected by 1912, his chamber proved indispensable in the study of nuclear physics and eventually led to the development (by Donald A. Glasser in 1952) of the ***bubble chamber***.

4. From 1916 Wilson became involved in the study of lightning and in 1925 was appointed Jacksonian professor of natural history at the University of Cambridge. Applying his studies of thunderstoms, he devised a method of protecting British wartime ***barrage balloons*** from lightning, and in 1956 he published a theory of thunderstorm electricity.

Notes:

1. Wilson cloud chamber – диффузионная камера, камера Вильсона
2. trail – след
3. bubble chamber – пузырьковая камера
4. barrage balloon – аэростат заграждения

I. Find Russian equivalents for:

Scottish physicist, joint recipient of the Nobel Prize, invention of a device, X-rays, nuclear phenomena, meteorologist, closed container, moisture, degree of supersaturation, discovery, ion formation, more intensive cloud formation, rotation, study nuclear physics, lightning, devise a method of protecting, to publish a theory

II. Find English equivalents for:

диффузионная камера, использовать при изучении радиоактивности, изучать облака, удвоить эффект, придумывать (изобретать) способ расширения влажного воздуха, перенасыщенный воздух, замечать, воздух без пыли, достигать критической точки, в результате такого излучения, вызвать, обнаруживать (находить), оставлять след, необходимый (незаменимый), разработка пузырьковой камеры, назначать, изучение грома

III. Read and translate text 42.1. Answer the following questions:

1. What was Charles Wilson?
2. What was he famous for?
3. What did Wilson study?
4. What did he find?
5. Where was his chamber used?
6. What method did Wilson devise?
7. What did he publish?

IV. What do the following dates refer to:

1869, 1895, 1912, 1916, 1927, 1952, 1956, 1959

TEXT 43.2. CLOUD CHAMBER

1. Cloud chamber is a device for making visible the paths of particles of ionizing radiation. Ionizing radiation is radiation of sufficient high energy to cause ionization (the process of producing ions) in the medium

through which it passes. It may consist of a stream of high-energy particles (electrons, protons, alpha-particles) or short-wavelength electromagnetic radiation (ultraviolet, X-rays, gamma-rays). This type of radiation can cause extensive damage to the molecular structure of a substance either as a result of the direct ***transfer*** of energy to its atoms or molecules or as a result of the secondary electrons released by ionization.

2. The Wilson (expansion) cloud chamber consists of a container containing air and ethanol vapour, which is cooled suddenly by ***adiabatic expansion***, causing the vapour to become supersaturated. The excess moisture in the vapour is then deposited in drops on the tracks of ions created by the passage of the ionizing radiation. The resulting row of droplets can be photographed. If the original moving particle was being deflected by electric or magnetic fields, the extent of the deflection provides information on its mass and charge. This device was invented in 1911 by C.T.R. Wilson.

3. A simpler version of this apparatus is the diffusion cloud chamber, developed by Cowan, Needels and Nielsen in 1950, in which supersaturation is achieved by placing a row of felt strips coaked in a suitable alcohol at the top of the chamber. The lower part of the chamber is cooled by solid carbon dioxide. The vapour continuously diffuses downwards, and that in the centre (where it becomes supersaturated) is almost continuously sensitive to the presence of ions created by the radiation.

Notes:
1. transfer – передача, перенос
2. adiabatic expansion – адиабатическое расширение

V. Read and translate text 43.2. Characterize in brief:

1. Cloud chamber	2. Design of Wilson cloud chamber
3. Ionizing radiation	4. A simpler version of cloud chamber

TEXT 43.3. SCIENCE AND TECHNOLOGY

1. Technology means the use of people's inventions and discoveries to satisfy their needs. Since people have appeared on the earth, they have had to get food, clothes, and shelter. Through the ages, people have invented tools, machines, and materials to make work easier.

2. Nowadays, when people speak of technology, they generally mean

industrial technology. Industrial technology began about 200 years ago with the development of the steam engine, the growth of factories, and with the development and the mass production of goods. It influenced different aspects of people's lives. The development of the car influenced where people lived and worked. Radio and television changed their leisure time. The telephone revolutionized communication.

3. Technology is the application of science to the practical aims of human life or to the change and manipulation of the human environment. The term originally signified the study of or a discourse upon the arts, both fine and applied. By the late 20^{th} century it had become to mean the pursuit of results, especially the useful results of scientific research and it had become a global term connoting not only the tangible products of science but also the associated attitudes, processes, artefacts and consequences.

4. Science has contributed much to modern technology. Science attempts to explain how and why things happen. Technology makes things happen. But not all technology is based on science. For example, people had made different objects from iron for centuries before they learnt the structure of the metal. But some modern technologies, such as nuclear power production and space travel, depend heavily on science.

VI. Read and translate text 43.3. Explain in brief:

1. Technology
2. Industrrial technology
3. The term 'technology'
4. Science

TEXT 43.4. IVAN KULIBIN

1. Russian inventor Ivan Kulibin (1735-1818) was born in the family of a patty trader in Nizhny Novgorod, a center of trade and enterprise on the Volga River. In his younger years, Ivan already showed an interest in all sorts of ***weathercocks***, mills, and particularly, the wooden mechanism of the wall clock. He learned to read from a local ***sexton***, but received no formal education.

2. The boy's talent for making mechanical objects was noticed by a wealthy local merchant, Kostromin, who became his sponsor. Kostromin's money enabled Kulibin to make an incredibly complicated clock the shape and size of a duck's egg. The clock chimed melodiously every hour, and a pair of tiny gates opened to reveal inside the ***Holy Sepulchre*** surrounded by armed ***warriors*** (silver figurines). An angel then pushed a stone from the grave, the guards fell to the ground, and the chimes played the melody

of the resurrection prayer three times. After each performance, the gates closed again. The clock's mechanism consisted of a thousand tiny parts.

3. When Catherine the Great visited Nizhny Novgorod in 1768, Kulibin was presented to her with the as yet unfinished clock, telescope, microscope, and electric machine, all of which he had, also made himself. As a result, Vladimir Orlov, the Director of the Academy of Sciences, invited him to come to St. Petersburg. In 1769, he completed the clock and presented it to Catherine the Great. In 1770 he began service at the Academy of Sciences with a wage of 300 rubles a year, supervising the mechanical and optical shops and teaching the academy's artists his mechanical skills. He was promised 100 rubles for every artist he trained. His instruments were used by all the scientific expeditions of the age, and Kulibin shared with scientists the credit for many of the period's discoveries.

4. Perhaps Kulibin's most famous project, never realized, was the design and scale model of a single-arch bridge. In 1772 the London Royal Society announced a contest for the best design of a 250-meter single-arch bridge across the Thames. Kulibin had just been thinking of building a permanent bridge across the Neva. Working on his own, he invented the first truss bridge in the world (or so say Russian scholars). The bridge consisted of a single 300-meter arch without any supports in between. Kulibin built a scale model of the bridge, which was about 15 meters long. It was demonstrated to a group of elite scientists at the academy in 1776. Outstanding scientist Daniel Bernoulli called Kulibin a great artist. In an age when bridges were made of stone and wood, Kulibin suggested using metal. The scientists were unanimous in their high praise for the bridge model. Typically for Russia, the bridge was never built, although Kulibin was awarded 2,000 rubles and a gold medal for his design. In 1792 he was granted membership in the Imperial Free Economic Society.

5. Kulibin lived for 83 years and made ***innumerable*** inventions, none of which were destined to have any practical significance. He invented an optical telegraph with a system of signal posts, a searchlight, unusual watermills, a tricycle, a vessel that moved upstream without any outside assistance (one wonders what that was all about), a mechanical sowing machine, pumps, loading mechanisms, and lots of other curiosities. Meanwhile for at least a century longer peasant Russia continued to draw water, sow, ***plough*** and harvest with the most primitive implements. All of Kulibin's inventions remained on paper, and technology was brought to Russia exclusively from the West. In 1801 Kulibin retired from the

Academy with an annual pension of 3,000 rubles. He also received a 12,000 ***lump sum*** to build a vessel for the Volga. He returned to Nizhny Novgorod, and the vessel was tested in 1804. In 1813 a fire destroyed almost all of Kulibin's property.

6. Yet, ***undaunted***, Kulibin continued to work until the last years of his life. In 1814 he submitted a model of a three-arch iron bridge to ***span*** the Neva River. A model and a large ***engraving*** of this extraordinary bridge have come down to us. But once again, the bridge itself was never built. Although Catherine the Great, Paul I and Alexander I occasionally paid Kulibin considerable sums of money for his inventions, the inventor spent his last years in poverty, alone and forgotten.

7. In any other civilized country Kulibin's talents would have been put to better use. His natural abilities were incredibly ***versatile***. However, being uneducated, Kulibin often worked on problems that had already been solved, wasting time and talent. He died on June 30, 1818.

Notes:
1. weathercock – флюгер
2. sexton – дьячок, пономарь
3. the Holy Sepulchre – гроб Господен
4. warrior – воин, (здесь) стражник
5. innumerable – бесчисленный
6. plough – пахать
7. lump sum – общая сумма; единовременно выплачиывемая сумма
8. undaunted – неустрашимый, бесстрашный
9. span – соединять берега (мостом)
10. engraving – гравюра
11. versatile – разносторонний

VII. Read and translate text 43.4. Answer the following questions:

1. What was Ivan Kulibin?
2. What was he fampous for?
3. Where was Kulibin born?
4. What was he interested for?
5. Did Kulibin receive formal education?
6. What clock did he make?
7. What instruments did Kulibin make?
8. What did Kulibin teach the artists?
9. Why did he come to St. Petersburg?
10. Where were his instruments used?
11. What was Kulibin's famous project?
12. What inventions did he make?
13. What model did he submit?

VIII. Make up the abstracts of texts 43.1–43.4 (in English or in Russian).

IX. Comment on the following quotation. Do you agree or disagree with it?

1. When you make a mistake, don't look back at it long. Take the reason of the thing into your mind and then look forward. Mistakes are lessons of wisdom. The past cannot be changed. The future is yet in your power.

SECTION 44

TEXT 44.1. THOMAS YOUNG

1. Thomas Young (1733-1829) was English physician and physicist who established the principle of interference of light and thus resurrected the century-old wave theory of light. He was an Egyptologist who helped decipher the ***Rosetta Stone***.

2. In 1799 Young set up a medical practice in London. His primary interest was in sense perception, and, while still a medical student, he had discovered the way in which the lens of the eye changes shape to focus on objects at differing distances. He discovered the cause of astigmatism in 1801, the same year he turned to the study of light.

3. By allowing light to pass through two closely set pinholes onto a screen, Young found that the light beams spread apart and overlapped, and, in the area of overlap, bands of bright light alternated with bands of darkness. With this demonstration of the interference of light Young definitely established the wave nature of light. He used his new theory of light to explain the colours of thin films (such as soap bubbles), and, relating colour to wavelength, he calculated the approximate wave-lengths of the seven colours recognized by Newton. In 1817 he proposed that light wave was transverse (vibrating at right angles to the direction of travel), rather than longitudinal (vibrating in the direction of travel) as had long been assumed, and thus explained polarization, the ***alignment*** of light waves to vibrate in the same plane.

4. Young's work was disparaged by most English scientists. It was only with the work of the French physicists Augustin J. Fresnel and François Arago that Young's wave theory finally achieved acceptance in Europe. T.Young also studied the problem of colour perception and proposed that there is no need for a separate mechanism in the eye for

every colour, it being sufficient to have three-one each for blue, green, and red. Developed later by the German physicist Hermann L.F. von Helmholtz, this theory is known as the Young-Helmholtz three-colour theory.

5. Having become interested in Egyptology, Young began studying the texts of the Rosetta Stone in 1814. After obtaining additional hieroglyphic writing from other sources, he succeeded in providing a nearly accurate translation within a few years and thus contributed heavily to deciphering the ancient Egyptian language.

6. Young also did work on measuring the size of molecules, ***surface tension*** in liquids, and elasticity. He was the first to give the work energy its scientific significance, and Young's modulus, a constant in the mathematical equation describing ***elasticity***, was named in his honour.

Notes:

1. Rosetta Stone – Розеттский камень, древняя базальтовая плита с иероглифами на греческом и древне-египетском языках, найденный около г. Rosetta в Египте (1799). Дешифровка этих текстов помогла археологам понять и перевести многие другие древнеегипетские иероглифы (тексты)
2. alignment – выравнивание, совмещение
3. surface tension – поверхностное натяжение
4. elasticity – упругость

I. Find Russian equivalents for:

English physician and physicist, interference of light, wave theory of light, primary interest, lens of eye, change shape, discover, study of light, light beam, band of bright light, wave nature of light, to explain the colours of thin films, wavelength, to calculate, to vibrate at right angles to direction of travel, to study the problem, Egyptology, accurate translation, measuring the size of molecules, elasticity, scientific significance, mathematical equation

II. Find English equivalents for:

установить (создать) принцип, египтолог, расшифровать Розеттский камень, чувственное восприятие, фокусироваться на предметах, при меняющихся расстояниях, причина астигматизма, проходить через, рассеиваться (расширяться) и перекрываться (совмещаться), чередоваться, приблизительная длина волны, поперечная и продольная волна света, плоскость, цветовосприятие, дешифровка древне-египетского языка, поверхностное натяжение

III. Read and translate text 42.1. Answer the following questions:

1. What was Thomas Young?
2. What was he famous for?
3. Where did he work?
4. What did he discover?
5. What did Young explain?
6. What did he calculate?
7. What was Young's primary interest?
8. What did Young definitely establish?
9. What were his achievements in colour perception?
10. Why did Young study the texts of Rosetta Stone?
11. What did Young also examine?

IV. What do the following dates refer to:

1733, 1799, 1817, 1814, 1829

TEXT 44.2. YOUNG'S MODULUS OF ELASTICITY

1. Elasticity is the property of certain materials that enable them to return to their original dimensions after an applied ***stress*** has been removed. In general, if a stress is applied to a wire, the ***strain*** will increase in proportion until a certain point called the limit of proportionality is reached. This is in accordance with Hooke's law. Thereafter there is at first a slight increase in strain with increased load until a point of elastic limit is reached. Up to this point the deformation of the specimen is elastic, i.e. when the stress is removed the specimen returns to its original length. Beyond the point of elastic limit there is permanent deformation when the stress is removed, i.e. the material has ceased to be elastic and has become plastic.

2. In the plastic stages individual materials vary somewhat. In general, however, at the ***yield point*** there is a sudden increase in strain with further increases of stress. Beyond the point of the breaking stress, the wire will snap.

3. Elastic modulus is the ratio of the stress applied to a body to the strain produced. Young's modulus is a numerical constant, named after the 18th century English physicist Thomas Young that refers to longitudinal stress and strain. Young's modulus describes the elastic properties of a solid undergoing tension or compression in only one direction, as in the case of a metal rod that after being stretched or compressed lengthwise

returns to its original length. Young's modulus is a measure of the ability of a material to withstand changes in length when under lengthwise tension or compression. Young's modulus is equal to the longitudinal stress divided by the strain.

Notes:
1. stress – напряжение
2. strain – деформация, деформированное состояние, растяжение, напряжение
3. yield point – предел текучести

V. Read and translate text 44.2. Define and explain in brief:

1. Elasticity 2. Elastic limit 3. Elastic modulus

TEXT 44.3. STRESS AND STRAIN

1. Stress and strain may be described as follows in the case of a metal bar under tension. Stress is the force per unit area on a body that tends to cause it to deform. It is a measure of the internal forces in a body between particles of the material of which it consists as they resist separation, compression, or sliding in response to externally applied forces. Tensile stress and compressive stress are axial forces per unit area applied to a body that tend either to extend it or compress it linearly. ***Shear stress*** is a tangenial force per unit area that tends ***to shear*** a body.

2. Strain is a measure of the extent to which a body is deformed when it is subjected to a stress. A linear strain or tensile strain is the ratio of the change in length to the original length. The bulk strain or volume strain is the ratio of the change in volume to the original volume. The shear strain is the angular distortion in radians of a body subjected to a shearing force.

3. Stress and strain may be described as follows in the case of a metal bar under tension. If a metal bar of cross-sectional area is pulled by a force at each end, the bar stretches from its original length to a new length (simultaneously the cross section decreases). The stress is the ***quotient*** of the tensile force divided by the cross-sectional area. (Its units in the English system are pounds per square inch, usually abbreviated psi.). The strain or relative deformation is the change in length, divided by the original length (strain is dimensionless). Thus Young's modulus may be express mathematically as Young's modulus = stress / strain.

4. This is a specific form of Hooke's law of elasticity. The units of Young's modulus in the English system are pounds per square inch, and in the metric system newtons per square metre (N/m^2). The value of Young's modulus for aluminium is about 1.0 x 10^7 psi., or 7.0 x 10^{10} N/m^2. The value for steel is about three times greater, which means that it takes three times as much force to stretch a steel bar the same amount as a similarly shaped aluminium bar.

5. Young's modulus is meaningful only in the range in which the stress is proportional to the strain, and the material returns to its original dimensions when the external force is removed. As stresses increase, Young's modulus may no longer remain constant but decrease, or the material may either flow, undergoing permanent deformation, or finally break.

Notes:

1. shear stress – касательное напряжение
2. to shear – сдвигать, срезать
3. shearing force – сдвигающее (срезающее) усилие
4. quotient – отношение

VI. Read and translate text 44.3. Explain in brief:

1. Stress (tensile stress and compressive stress, shear stress)
2. Strain (linear strain, volume strain, shear strain)
3. Stress and strain in a metal bar under tension
4. Units of Young's modulus
5. Application of Young's modulus

VII. Make up the abstracts of texts 44.1–44.3 (in English or in Russian).

VIII. Comment on the following quotations. Do you agree or disagree with them?

1. Experiment is the sole source of truth. It alone can teach us something new, it alone can give us certainty. (Jules Henri Poincare 1854–1912, – French philosopher and mathematician)
2. A discovery is like falling in love and reaching the top of a mountain after a hard climb all in one, an ecstasy not induced by drugs but by the revelation of a face of nature that no one has seen before and that often

turns out to be more subtle and wonderful than anyone had imagined. (Max Ferdinand Perutz 1914–2002, – Austrian-born British molecular biologist)

SECTION 45

TEXT 45.1. VLADIMIR ZWORYKIN

1. Vladimir Zworykin (1889-1982) was Russian-born U.S. electronic engineer, inventor, and the father of modern television.

2. After getting education at the St. Petersburg Institute of Technology and the College de France, in Paris, Zworykin served during World War I in the Russian Signal Corps. He emigrated to the United States in 1919 and became a naturalized citizen in 1924. In 1920 he joined the Westinghouse Electric Corporation in Pittsburg, and in 1923 he ***filed a patent*** application for the iconoscope or television transmission tube, and in 1924 an application for the ***kinescope*** or television receiver. These two inventions formed the first all-electronic television system, as all older systems had been electromechanical, involving a rapidly rotating perforated disk or some similar device.

3. Although Westinghouse officials expressed little enthusiasm at the first demonstration of Zworykin's television, an improved system demonstrated in 1929 impressed an official of Radio Corporation of America (RCA). Zworykin was offered a position as director of electronic research of RCA at Camden (N.J.) and subsequently at Princeton (N.J.) to continue the development of his invention.

4. Zworykin's television system provided the impetus for the development of modern television as an entertainment and education medium. Although ultimately replaced by the orthicon and image ***orthicon*** tubes, the iconoscope was the basis for further important developments in television cameras. The modern television picture tube is basically Zworykin's kinescope. He also developed a colour television system, for which he received a patent in 1928. His other developments in electronics include an early form of the ***electric eye*** and innovations in the electron microscope. His ***electron image tube***, sensitive to infrared light, was the basis for the sniperscope and the ***snooperscope***, devices first used in World War II seeing in the dark. His ***secondary-emission multiplier*** was used in the ***scintillation counter***, one of the most sensitive of radiation detectors.

5. Named an honorary vice president of RCA in 1954, from then until 1962 Zworykin also served as director of the medical electronics

centre of the Rockefeller Institute for Medical Research (now Rockefeller University) in New York City. In 1967 the national Academy of Sciences awarded him the National Medal of Science for his contributions to the instruments of science, engineering and television and for his stimulation of the application of engineering to medicine. He was also founder-president of the International Federation for Medical Electronics and Biological Engineering, a recipient of the Faraday Medal from Great Britain (1965) and the U.S. Presidential Medal of Science (1966) and a member of the U.S. National Hall of Fame from 1977.

6. Zworykin wrote ‘Photocells and Their Applications’ (1932), ‘Television’ (1940), ‘Electron Optics and the Electron Microscope’ (1946), ‘Photoelectricity and Its Application’ (1949), ‘Television in Science and Industry’ (1958).

Notes:
1. file a patent – регистрировать (подавать) патент
2. kinescope – приёмная телевизионная трубка (ЭЛТ)
3. orthicon – ортикон
4. electric eye – фотоэлемент; электронный индикатор настройки
5. electron image tube – электронно-оптический преобразователь
6. snooperscope – прибор ночного видения с источником инфракрасного (ИК) излучения
7. secondary-emission multiplier – вторично-электронный умножитель
8. scintillation counter – сцинтилляционный счётчик

I. Find Russian equivalents for:

electronic engineer and inventor, television transmission tube, television receiver, similar device, demonstration, electronic research, development of invention, entertainment and education medium, colour television system, innovations, basis, radiation detectors, medical electronics centre, Academy of Sciences, application of engineering to medicine, U.S. National Hall of Fame

II. Find English equivalents for:

получать образование, корпус сигнальщиков, быстро вращающийся перфорированный диск, улучшенная (усовершенствованная) система, предлагать должность, обеспечить стимул (толчок), чувствительная к инфракрасному свету, почётный вице-президент, награждать медалью за вклад в создание приборов для науки, техники и телевидения; президент-основатель, телевидение в науке и промышленности

III. Read and translate text 45.1. Answer the following questions:

1. What was Zworykin?
2. What was he famous for?
3. Where did Zworykin study?
4. What did he do during WW II?
5. Where did Zworykin emigrate?
6. Where did he work?
7. What patents did Zworykin file?
8. What did he also develop?
9. Why was Zworykin's television system so important?
10. What awards did Zworykin receive?
11. What books did he write?

IV. What do the following dates refer to:

1889, 1919, 1924, 1920, 1923, 1924, 1928, 1929, 1962, 1965, 1966, 1967, 1982

TEXT 45.2. ICONOSCOPE

1. ***Television camera*** is the part of a television system that converts optical images into electronic signals. It consists of a lens system, which focuses the image to be televised on the photosensitive mosaic of the camera tube, causing localized discharge of those of its elements that are illuminated. This mosaic is scanned from behind by an electron beam so that the beam current is varied as it passes over areas of light and shade. The signal so picked up by the scanning beam is preamplified in the camera and passed to the transmitter with sound and synchronization signals. In colour television three separate camera tubes are used, one for each primary colour (red, green and blue).

2. Iconoscope is a form of television camera tube in which the beam of light from the scene is focused on to a thin ***mica plate***. One side of the plate is ***faced*** with a thin metallic electrode, the other side being covered with a mosaic of small globules of photoemissive material. The light beam falling on a mosaic causes photoemission of electrons, creating a ***pattern*** of positive charges in what is effectively an array of tiny ***capacitors***. A high-velocity electron beam scans the mosaic, discharging each capacitor in turn through the metallic electrode. The resulting current is fed to amplification circuits, the current from a particular section of the mosaic

depending on the illumination it has received. In this way the optical information in the light beam is converted into an electrical signal.

Notes:

1. television camera – телевизионная, передающая камера
2. mica plate – листовой миканит, миканитовый лист
3. face – облицовывать
4. pattern – изображение, рисунок, узор
5. capacitor – конденсатор

V. Read and translate text 45.2. Define or explain the following:

1. Television camera (function, design, mosaic, signal)
2. Iconoscope (mica plate, light beam, electron beam)

TEXT 45.3. TELEVISION

1. Television is the transmission and reception of moving images (the broadcasting of pictures) by means of radio waves or electric cable. The scene to be transmitted is focused onto a photoelectric screen in the television camera. This screen is ***scanned*** by an electron beam. The camera produces an electric current, the instantaneous magnetude of which is proportional to the brightness of the portion of the screen being scanned. In Europe the screen is scanned by 625 ***lines*** and 25 such ***frames*** are produced every second. In the USA and Japan 525 lines and 30 frames per second are used. High-definition television (HDTV) employs pictures with up to 1125 lines in a wide-screen format.

2. The picture signal so produced is used to modulate a ***VHF*** or ***UHF*** carrier wave and is transmitted with an independent sound signal, but with colour information (if any) incorporated into the brief gaps between the picture lines. The signals received by the receiving aerial are demodulated in the receiver. The demodulated picture signal controls an electron beam in a cathode-ray tube, on the screen of which the picture is reconstructed.

3. Colour television is a television system in which the camera filters the light from the scene into the three component primary colours (red, blue and green) which are detected by separate camera tubes. The separate information so obtained relating to the colour of the image is combined with the sound and synchronization signals and transmitted using one of three systems, the American, British, or French. At the receiver, the signal

is split again into red, blue and green components, each being fed to a separate electron gun in the cathode-ray tube of the receiver. By an additive process the picture is reconstituted by the beam from each gun activating a set of phosphor dots of that colour on the screen.

4. The aerial or dish (for ***satellite broadcasts***) of the TV receiver detects the broadcast radio waves and the picture and sound signals are separated within the receiver. The picture signal demodulated, and the resulting current is used to control the electron beam in a cathode-ray tube so that the picture is reconstructed.

5. Experimentation to create a workable television system began in the late 19^{th} century. In 1884 Paul Nipkov, A German scientist, patented his ideas for a complete television system, the key to which was a rotating disc with holes in a spiral pattern. This provided an effective mechanical means of image scanning that was used until electronic scanning was technically possible. Developments in the period from 1900 to 1920 produced early versions of the picture tube, methods of amplifying an electronic signal, and the theoretical formulation of the electronic-scanning principle, these later became the basis of modern television. In 1926 in England, John L. Baird first demonstrated a true television system by electrically transmitting moving pictures. In 1932 the Radio Corporation of America demonstrated all-electronic television using a camera tube called the iconoscope (patented by Vladimir Zworykin in 1923) and a cathode-ray tube in the receiver.

6. Since the 1950s the improvements in colour television technology have resulted in larger picture tubes with clearer images. In addition, a device for projecting television onto large screen became available in the late 1970s.

Notes:

1. scan – развёртывать, сканировать
2. line – строка
3. frame – кадр
4. VHF (very high frequency) – очень высокая частота (УКВ)
5. UHF (ultrahigh frequency) – ультра-высокая частота (УВЧ)
6. satellite brosdcast – спутниковое телевидение

VI. Read and translate text 45.3. Characterize in brief:

1. Television	3. Picture signal
2. Screen scanning	4. Colour television

5. Aerial 6. History of TV development

TEXT 45.4. BORIS ROZING

1. Boris Ivanovich Rozing (1869-1933) was a Russian scientist and inventor in the field of television.

2. He was born to a family of Swedish descent. He graduated from the department of physics and mathematics of St. Petersburg University in 1891. He taught at the St. Petersburg Institute of Technology (1894-1918; 1924-1931) and a number of other higher educational institutions. He carried out the research at the Leningrad Experimental Electrotechnical Laboratory from 1924 to 1928 and at the Central Laboratory for Wire Communications from 1928 to 1931. From 1931 to 1933 he worked at the Arkhangelsk Institute of Forestry Technology.

3. In 1892 Rozing expounded a theory of molecular field existence that caused the spontaneous magnetization of ferromagnets. In 1897 he began experimenting with the electrical transmission of images over a distance. In 1907 B. Rozing envisioned a television system using the cathode-ray tube (CRT) to generate television pictures, and he filed a patent application in Germany. In 1911, in his laboratory he demonstrated the television transmission and reception of images of simple geometric figures, with reproduction of the images on a cathode-ray screen. He patented the improved version of his system in 1911.

4. Rozing's system employed a mirror-drum apparatus as a camera and cathode-ray tube as a receiver. The cathode-ray tube had been developed a decade earlier by a German physicist Karl Ferdinand Braun (1897). Rozing's system was primitive, but it was one of the first experimental demonstrations when the CRT was employed for the purpose of television. Vladimir Zworykin (before emigrating to the U.S.A) was a student of Rozing and assisted him in some of his laboratory work.

5. Rozing continued his research in television until 1931 when he was exiled as a counter-revolutionary to Kotlas without right to work, but in 1932 he was moved to Arkhangelsk where he worked at physics department of Forestry Institute. Rozing died in exile in 1933.

VII. Read and translate text 45.4. Answer the following questions:

1. What was B. Rozing?
2. What was he famous for?
3. Where did Rozing study?
4. Where did he work?

5. What system did Rozing invision?
6. What did Rozing's system employ?

TEXT 45.5. FERDINAND BRAUN

1. (Karl) Ferdinand Braun (1850-1918) was a German physicist who shared the Nobel Prize for Physics in 1909 with Guglielmo Marconi for the development of wireless telegraphy.

2. Braun received his Ph.D. from the University of Berlin in 1872. After appointments at Würzburg, Leipzig, Marburg, Karlsruhe and Tübingen, he became director of the Physical Institute and professor of physics at the University of Strasbourg in 1895.

3. Braun was recognized by the Nobel committee for his improvement of Marconi's transmitting system. In early wireless transmission, the antenna was directly in the power circuit and broadcasting was limited to a range of about 15 kilometres. Braun solved this problem by producing a sparkless antenna circuit (patented in 1899) that linked transmitter power to the antenna circuit inductively. This invention greatly increased the broadcasting range of a transmitter and has been applied to radar, radio and television. Braun's discovery of crystalline materials that act as rectifiers, allowing current to flow in one direction only, led to the development of crystal radio receivers.

4. Braun is also known as the developer of the cathode-ray tube. He demonstrated the first oscilloscope (Braun tube) 1897, after work on high-frequency alternating currents. Cathode-ray tubes (CRT) had previously been characterized by uncontrolled rays; Braun succeeded in producing a narrow stream of electrons, guided by means of alternating voltage that could trace patterns on a fluorescent screen. This invention, the forerunner of the television tube and radarscope, also became an important laboratory research instrument. Braun travelled to New York City in 1915 to testify in a radio-related patent case. He was detained there because of his German citizenship when the U.S. entered World War I in 1917; he died before the war ended.

VIII. Read and translate text 45.5. Explain in brief:

1. K.F. Braun's occupation
2. The Nobel Prize
3. Braun's study and work
4. His improvement of Marconi's transmitting system
5. Cathode-ray tube

TEXT 45.6. ALEXANDER M. PONIATOFF

1. Alexander Matveevich Poniatoff (1892-1980) was a Russian – American electrical engineer who invented video tape recorder and improved recording technology. He was born in Aisha, Zelenogorsky district (Tatarstan, Russian Empire). His father, a prosperous ***lumberman*** in Kazan, recognized his son's engineering talent and sent him to a technical academy in Karlsruhe (Germany) to study. Poniatoff had planned to build a ***turbine engine*** factory in Russia but World War I began and he had to serve in the army.

2. When he returned home, he escaped to China, where he worked for the Shanghai Power Company until he immigrated to the United States in 1927 as an experienced electrical engineer, he was in demand moving from GE (General Electric) to PG&E to Dalmo-Victor during World War II. There, he perfected a line of motors and generators for ***airborne*** radar systems. The wartime manufacture of airborne radar motors became skilled at adapting its precision-tuned motors to German technology that had been developed to record sound on tape.

3. In 1944, Poniatoff founded his own company in Redwood City (California) using his initials, A.M.P., plus "ex" for "excellence" to create the name, Ampex. When singer Bing Crosby ***staked*** Ampex Corporation to develop audio recording equipment after World War II, the company began a venture that has created many of the major innovations in commercial recording technology and produced the first U.S.-built magnetic audio tape recorder in 1948 revolutionizing the radio industry. Not long after creating the standard for audio recording in the late 1940s, Ampex produced the first data instrumentation recorder for storing large amounts of information on tape. The machines were used in laboratories and aboard aircraft to record rapidly generated scientific information.

4. By 1951, Poniatoff needed new products to keep the company growing. He had the idea to create a magnetic tape and a recorder for television images. He hired Harold Lindsay to design heads for the new machine and Charles Ginsburg who led a research team consisting of Milton M. Dolby, Charles Anderson, Fred Pfost, Alex Maxey and Shelby Henderson. The team ***raced*** against several electronics companies that were pursuing the same goal but overcame technical problems to create the first commercial video tape recorder (VTR) and the tape to go with it. It was first demonstrated in Chicago in 1956 at the National Association of Broadcasters (NAB) conference. The era of all-live television was over.

The video tape recorders allowed the broadcast networks to delay programming for the different time zones and established Ampex as an innovator.

5. A portable video recorder that sold for $1,500 followed in early 1971. It was a ***stock market*** star in the early 1960s and employment swelled to 13,000 by 1969. Poniatoff's quest for excellence became the company’s philosophy as it became a world leader in audio and video recording, magnetic tape, digital and analog data ***handling*** and sophisticated memory products. He served as president of Ampex until 1955, when he was elected chairman of the board. In 1970, he was named chairman ***emeritus***. Poniatoff died in 1980.

Notes:
1. lumberman – лесопромышленник, торговец лесом
2. turbine engine – газотурбинный двигатель
3. airborne – бортовой, установленный на воздушном судне
4. stake – рисковать, ставить на карту
5. race – состязаться в скорости
6. stock market – фондовая биржа
7. handling – обработка
8. emeritus – почётный

IX. Read and translate text 45.6. Characterize in brief:

1. A. Poniatoff’s occupation
2. His study
3. Work in China
4. AMPEX Corporation
5. VTR
6. The company’s philosophy

VII. Make up the abstracts of texts 45.1–45.6 (in English or in Russian).

VIII. Comment on the following quotations. Do you agree or disagree with them?

1. By science I understand the consideration of all subjects, whether of a pure or mixed nature, capable of being reduced to measurement and calculation. All things comprehended under the categories of space, time and number properly belong to our investigations, and all phenomena capable of being brought under the semblance of a law are

legitimate objects of our inquiries. (William Whewell 1794–1866, – British natural scientist, historian and philosopher of science)
2. As we cannot use physician for a cultivator of physics, I have called him a physicist. We need very much a name to describe a cultivator of science in general. I should incline to call him a scientist. Thus we might say, that as an artist is a musician, painter or poet; a scientist is a mathematician, physicist or naturalist. (William Whewell 1794–1866, – British natural scientist, historian and philosopher of science)

SECTION 46

TEXT 46.1. SKOLKOVO – RUSSIAN 'SILICON VALLEY'

1. Russia aims to ***challenge*** the renowned Silicon Valley with its own Skolkovo ***innovation*** center in the suburbs of Moscow. The modern center for research and development will be built in the village of Skolkovo located in the Odintsovo area, Moscow region. The Russian 'Silicon Valley' will host five different scientific communities next to the campus of Skolkovo Moscow School of Management, a top-level business school founded by leading Russian and international companies.

2. The idea to create a Russian equivalent of Silicon Valley was announced by President Dmitry Medvedev in March 2010. Russia has many talented and creative scientists working on the cutting-edge technologies in a variety of fields. In addition, there is a potential to create favourable conditions for "brains" from abroad. Building a high-tech ***hub*** for scientists and business people in Skolkovo should help Russia to develop and commercialize new technologies in the right way.

3. Initially, Skolkovo will become a center of research and innovation in five directions that carry top priority for Russia – energy, IT, telecommunications, biomedicine and nuclear technologies. The territory of Skolkovo innovation center will host the branches of the largest corporations and the best graduate programs. It will provide tax incentives, easy access to new clients, and mechanisms to finance and sell new ideas. For all these reasons, the center is sometimes called "innograd" which means "innovation city" in Russian.

4. The Russian government considered a number of locations for the new high-tech town, including the city of Novosibirsk, Saint Petersburg, Obninsk and many other regions which already host large scientific communities. The choice of the village of Skolkovo might be explained by

a number of reasons. First, it is an opportunity ***to start from scratch*** and create new conditions for the best people who will power the future of Russian economy. Second, Skolkovo is conveniently located in close proximity to the capital of Russia and such institutions as Moscow School of Management and the Center of Space Communication. In addition, the suburbs of Moscow have very efficient infrastructure which will further help the Russian government control the development and progress of its new ambitious project.

5. Known as "the city of the future" in Russia, Skolkovo construction was planned to begin in the second half of 2011. There are number of prestigious businessmen involved in the Skolkovo. The winner of 2000 Nobel Prize in Physics Zhores Alfyorov was appointed the scientific director of the project. Russian President Medvedev has also extended an invitation to all businessmen to discuss the issues of financing and tax policy in the Skolkovo center.

Notes:
1. challenge – бросать вызов, вызывать
2. innovation – нововведение, новшество, новаторство
3. hub – центр деятельности, внимания, интереса
4. to start from scratch – начинать с самого начала (с нуля)

I. Find Russian equivalents for:

renowned Silicon Valley, innovation center, modern center for research and development, Moscow region, Skolkovo Moscow School of Management, leading Russian and international companies, talented and creative scientists, to create favourable conditions, directions, telecommunications, nuclear technologies, Russian government, to control the development and progress, to discuss the issues

II. Find English equivalents for:

бросать вызов, в окрестностях (пригороде) Москвы, деревня, различные научные объединения (сообщества), основывать, создавать русский эквивалент, работать над новейшими (прорывными) технологиями, строительство центра высокой технологии, центр исследований и инноваций, размещение (местоположение), объяснять рядом причин, благоприятная возможность, иметь очень рациональную инфраструктуру

III. Read and translate text 46.1. Answer the following questions:

1. What is Skolkovo?
2. What will Skolkovo host?
3. What can you say about the idea to create Skolkovo?
4. Why is the centre called 'inno-grad'?
5. Why was the village of Scolkovo chosen?
6. Who was appointed the scientific director of the project?

TEXT 46.2. SKOLKOVO INNOVATION CENTRE

1. The strategic goal of the Skolkovo Innovation Centre is to concentrate international intellectual capital, thereby stimulating the development of break-through projects and technologies, in the course of implementation of the project, companies that are engaged in innovative development are discovered. After a selection process, some of these become project participants of the centre. They are provided with all assistance necessary for development. The Skolkovo Foundation and its partners transform the infrastructure, resources and other possibilities of the centre, into effective services for companies that are project participants.

2. Within the Skolkovo project, five clusters are created, each one developing innovative projects. These are the information, biomedical, energy efficiency, nuclear and space technologies clusters:

- IT Cluster develops strategic directions of information technologies – from search systems to cloud calculations. Over 100 companies are part of the cluster today.
- Space Cluster companies are engaged in space projects and the development of telecommunication technologies. Thereby the fields of activity are wide – from space tourism to systems of satellite navigation.
- Biomed Cluster supports and develops innovations in the field of biomedical technologies. Over 90 companies were a part of this cluster from the beginning of autumn of 2011.
- Energy Efficiency Cluster supports innovations and advanced technologies, aimed at the reduction of energy consumption by industrial and residential objects, as well as lower energy consumption by communal services and municipal infrastructure facilities. Over 80 companies are part of the cluster today.
- Nuclear Technology Cluster's main objective is the innovative development of nuclear technologies. The companies of this cluster

create new products for the power markets, develop new materials and design complex technological systems.

3. The main task of Technoparks of the Skolkovo project is to provide assistance to innovative companies that are project participants. This is the tool which – with the help of resources of Skolkovo, scientific and educational institutions, as well as international technoparks and innovation centers – can be used by companies.

IV. Read and translate text 46.2. Enumerate in brief:

1. Strategic goal of Skolkovo Innovation centre
2. Clusters of Skolkovo   3. Main tasks of Technoparks

TEXT 46.3. SKOLKOVO OPEN UNIVERSITY – A UNIVERSITY OPEN TO THE FUTURE

1. SOU Mission is to develop students' imagination and creativity showing the diversity of current world views and types of thinking. World-leading researchers and practitioners allow the SOU to look beyond technological frontiers, helping it to ask the most important questions to which there are no answers for the time being.

2. SOU is a part of the ecosystem of Skolkovo Innovation Centre. It is a source of prospective applicants (Masters and PhD) for the future Skolkovo University, a source of interns for Skolkovo partner companies, a source of projects for business incubators. SOU is not an educational institution, it does not award diplomas upon completion of education, nor is not tied to any particular location.

3. SOU is a series of lectures, master classes, and educational courses by leading thinkers, scientists and practitioners It is a supported and moderated network of self-education, internship training and seasonal schools, including those at partner companies and in the world's leading higher educational establishments.

4. SOU educational programme develops leading-edge knowledge in the priority research and development areas of Skolkovo (energetics, biomedicine, space informational technologies, nuclear technologies), academic and innovative competencies (foresight, forecasting, thinking, projecting), entrepreneur competence, experience in team work on projecting and solving inter-disciplinary problems.

5. Skolkovo Open University started its work on April 21, 2011. The first attendees of Skolkovo Open University were 105 students, graduate students and young scientists, picked out of 500 finalists from six partner higher educational institutions of Skolkovo in Moscow (HSE, MISIS, MIPT, MEPhl, MSU, MSTU).

V. Read and translate text 46.2. Discuss in brief:

1. Mission of SOU
2. Educational programme of SOU
3. SOU as a source of prospective applicants
4. SOU as a serious of lectures, courses, etc.
5. Beginning of work and attendees of SOU

TEXT 46.4. ZHORES ALFYOROV

1. Zhores Ivanovich Alfyorov (born in 1930) is a Russian physicist and academician who contributed significantly to the creation of modern ***heterostructure*** physics and electronics. He is an inventor of the heterotransistor and the winner of 2000 Nobel Prize for Physics. He is also a Russian politician and has been a member of the Russian State Parliament, the Duma, since 1995.

2. Alfyorov was born in Vitebsk, (Belorussia, Soviet Union). In 1952 he graduated from V. I. Ulyanov (Lenin) Electrotechnical Institute in Leningrad. Since 1953 he has worked in the Ioffe Physico-Technical Institute of the USSR Academy of Sciences. At the Institute he defended the scientific theses: a Candidate of Sciences in Technology (1961) and a Doctor of Sciences in Physics and Mathematics (1970). He has been director of the Institute since 1987. He was elected a corresponding member of the USSR Academy of Sciences in 1972, and a full member in 1979. From 1989 he has been Vice-President of the USSR Academy of Sciences and President of its Saint Petersburg Scientific Center. Since 1995 he is a member of the State Duma on the list of the Communist Party of the Russian Federation. He received 2000 Nobel Prize for Physics together with Herbert Kroemer and Jack S. Kilby “for developing semiconductor heterostructures used in high-speed-and optoelectronics”, their work laid the foundation for the modern era of computers and information technology.

3. In the 1950s Alfyorov began to develop fast optoelectronic and microelectronic components made from semiconductor heterostructures. (While most computer chips and other semiconductor components were

made from one kind of material, such as silicon, heterostructure semiconductors were made from layers of different materials.) Using Kroemer's theory, which suggested that a heterostructure transistor was superior to a conventional transistor, Alfyorov and his research team developed the first practical heterostructure electronic device in 1966. They then pioneered electronic components made from heterostructures, including the first heterostructure laser, which both Alfyorov and Kroemer had proposed independently in 1963. Heterostructure solid-state lasers made possible ***fibre-optic communications***, and heterostructure devices were later used in communications satellites, ***bar-code readers, cellular telephone*** communications, and other products. Hermann Grimmeiss, of the Royal Swedish Academy of Sciences, which awards Nobel prizes, said: "Without Alfyorov, it would not be possible to transfer all the information from satellites down to the Earth or to have so many telephone lines between cities."

4. Since 1962 he has been working in the area of semiconductor heterostructures. His contributions to physics and technology of semiconductor heterostructures, especially investigations of injection properties, development of lasers, solar cells, LED's, and epitaxy processes have led to the creation of modern heterostructure physics and electronics. He has an almost messianic conception of heterostructures, writing: "Many scientists have contributed to this remarkable progress, which not only determines in large measure the future prospects of solid state physics, but in a certain sense affects the future of human society as well".

5. Zh. Alfyorov was awarded many prizes: The Stuart Ballantine Medal (1971), Lenin Prize (1972), USSR State Prize (1984) Ioffe Prize (Russian Academy of Sciences, 1996), Demidov Prize (1999), Nobel Prize for Physics in 2000 (together with Herbert Kroemer and Jack Kilby), Kyoto Prize in Advanced Technology (2001), and etc.

Notes:

1. heterostructure – гетероструктура
2. fibre-optic communication – волоконно-оптическая связь
3. bar-code reader – автомат (для) считывания штрихового кода
4. cellular telephone – сотовый телефон

VI. Read and translate text 46.4. Answer the following questions:

1. What is Zhores Alfyorov? 2. What is he famous for?
3. Where did Alfyorov study? 4. Where did he work?

5. What did Alfyorov invent? 6. Why is his invention so important? 7. What are his contributions to physics? 8. What awards did he receive?

TEXT 46.5. SILICON VALLEY

1. Silicon Valley refers to the southern part of the San Francisco Bay Area in Northern California in the United States. The region is home to many of the world's largest technology corporations. The term originally referred to the region's large number of ***silicon chip*** innovators and manufacturers, but eventually came to refer to all the high-tech businesses in the area; it is now generally used as a synonym for the American high-tech sector. Despite the development of other high-tech economic centers throughout the United States and the world, Silicon Valley continues to be the leading ***hub*** for high-tech innovation and development, accounting for one-third (1/3) of all of the venture capital investment in the United States. Geographically, the Silicon Valley encompasses all of the Santa Clara Valley including the city of San Jose (and adjacent communities), the southern Peninsula Valley, and the southern East Bay.

2. The term Silicon Valley was coined by Ralph Vaerst, a successful Central California entrepreneur. Its first published use is credited to Don Hoefler, a friend of Vaerst's, who used the phrase as the title of a series of articles in the weekly trade newspaper Electronic News. The series, entitled "Silicon Valley in the USA," began in the paper's issue dated January 11, 1971. Valley refers to the Santa Clara Valley, located at the southern end of San Francisco Bay, while Silicon refers to the high concentration of companies involved in the semiconductor (silicon is used to create most semiconductors commercially) and computer industries that were concentrated in the area. These firms slowly replaced the orchards which gave the area its initial nickname, the Valley of Heart's Delight.

3. Stanford University, its affiliates, and graduates have played a major role in the development of this area. Some examples include the work of Lee De Forest with his invention of a pioneering vacuum tube called the Audion and the oscilloscopes of Hewlett-Packard. A powerful sense of regional solidarity accompanied the rise of Silicon Valley. From the 1890s, Stanford University's leaders saw its mission as service to the West and shaped the school accordingly. Thus, regionalism helped align Stanford's interests with those of the area's high-tech firms for the first fifty years of Silicon Valley's development.

4. During the 1940s and 1950s, Frederick Terman, as Stanford's dean of engineering and ***provost***, encouraged faculty and graduates to start their

own companies. He is credited with nurturing Hewlett-Packard, Varian Associates, and other high-tech firms, until what would become Silicon Valley grew up around the Stanford campus. Terman is often called “the father of Silicon Valley”. During 1955-85, ***solid state technology*** research and development at Stanford University followed three waves of industrial innovation made possible by support from private corporations, mainly Bell Telephone Laboratories, Shockley Semiconductor, Fairchild Semiconductor, and Xerox PARC. In 1969 the Stanford Research Institute (now SRI International), operated one of the four original ***nodes*** that comprised ARPANET, predecessor to the Internet.

5. In 1953, William Shockley left Bell Labs in a disagreement over the ***handling*** of the invention of the transistor. After returning to California Institute of Technology for a short while, Shockley moved to Mountain View, California in 1956, and founded Shockley Semiconductor Laboratory. Unlike many other researchers who used germanium as the semiconductor material, Shockley believed that silicon was the better material for making transistors. Shockley intended to replace the current transistor with a new three-element design (today known as the Shockley diode), but the design was considerably more difficult to build than the “simple” transistor. In 1957, Shockley decided to end research on the silicon transistor. As a result of Shockley's abusive management style, eight engineers left the company to form Fairchild Semiconductor; Shockley referred to them as the “traitorous eight”. Two of the original employees of Fairchild Semiconductor, Robert Noyce and Gordon Moore, founded Intel.

Notes:

1. silicon chip – интегральная схема (И.С.), кристалл, микросхема из кремния
2. hub – центр деятельности, внимания, интереса
3. provost – проректор
4. solid state technology – твёрдотельная (полупроводниковая) технология
5. node – узловой пункт
6. handling – трактовка, подход к решению (вопросов и т.п.)

VII. Read and translate text 46.5. Explain in brief:

1. Silicon Valley (geographicallyand technically) 2. Silicon transistor
3. The term Silicon Valley 4. Stanford University (graduates, rector)

TEXT 46.6. INFORMATION TECHNOLOGY REVOLUTION

1. It was in Silicon Valley that the silicon-based integrated circuit, the microprocessor, the microcomputer, among other key technologies, were developed. The region employs about a quarter of a million information technology workers. Silicon Valley was formed as a ***milieu*** of innovations by the ***convergence*** on one site of new technological know-ledge; a large pool of skilled engineers and scientists from major univer-sities in the area; generous funding from an ***assured*** market with the Defense Department; the development of an efficient network of ***venture capital*** firms; and, in the very early stage, the institutional leadership of Stanford University.

2. Although semiconductors are still a major component of the area's economy, Silicon Valley has been most famous in recent years for innovations in software and Internet services. Silicon Valley has significantly influenced computer operating systems, software, and user interfaces. Using money from NASA and the United States Air Force, Doug Engelbart invented the mouse and hypertext-based collaboration tools in the mid-1960s, while at Stanford Research Institute (now SRI International). When Engelbart’s Augmentation Research Center declined in influence due to personal conflicts and the loss of government funding, Xerox hired some of Engelbart’s best researchers. In turn, in the 1970s and 1980s, Xerox’s Palo Alto Research Center (PARC) played a pivotal role in object-oriented programming, graphical user interfaces (GUIs), Ethernet, PostScript, and laser printers.

3. While Xerox marketed equipment using its technologies, for the most part its technologies flourished elsewhere. The diaspora of Xerox inventions led directly to 3Com and Adobe Systems, and indirectly to Cisco, Apple Computer and Microsoft. Apple’s Macintosh GUI was largely a result of Steve Jobs’ visit to PARC and the subsequent hiring of key personnel. Cisco’s impetus stemmed from the need to route a variety of protocols over Stanford’s campus Ethernet.

4. Silicon Valley was the third (2008) largest high-tech center (cybercity) in the United States, behind the New York metropolitan area and Washington metropolitan area, with 225,300 high-tech jobs. The Bay Area as a whole however, of which Silicon Valley is a part, ranked first with 387,000 high-tech jobs. Silicon Valley has the highest concentration of high-tech workers of any metropolitan area, with 285.9 out of every 1,000 private-sector workers. Silicon Valley has the highest average high-

tech salary at $144,800. Largely a result of the high technology sector, the San Jose-Sunnyvale-Santa Clara, CA Metropolitan Statistical Area has the most millionaires and the most billionaires in the United States per capita. The region is the biggest high-tech manufacturing center in the United States. The ***unemployment rate*** of the region was 9.4% in 2009. Silicon Valley received 41% of all U.S. venture investment in 2011.

5. Thousands of high technology companies are headquartered in Silicon Valley. Among those, the following are in the Fortune 1000: Adobe Systems, Advanced Micro Devices, Agilent Technologies, Apple Inc., Applied Materials, Cisco Systems, eBay, Google, Hewlett-Packard, Intel, Intuit, Juniper Networks, KLA Tencor, LSI Logic, Marvell Semiconductors, Maxim Integrated Products, National Semiconductor, NetApp, Nvidia, Oracle Corporation, Salesforce. com, SanDisk, Sanmina-SCI, Symantec, Yahoo. Notable government facilities are: Moffett Federal Airfield, NASA Ames Research Center, Onizuka Air Force Station.

STANFORD INDUSTRIAL PARK

6. After World War II, universities were experiencing enormous demand due to returning students. To address the financial demands of Stanford's growth requirements, and to provide local employment opportunities for graduating students, Frederick Terman proposed the ***leasing*** of Stanford's lands for use as an office park, named the Stanford Industrial Park (later Stanford Research Park). Leases were limited to high technology companies. Its first ***tenant*** was Varian Associates, founded by Stanford alumni in the 1930s to build military radar components. However, Terman also found venture capital for civilian technology start-ups. One of the major success stories was Hewlett-Packard. Founded in Packard's garage by Stanford graduates William Hewlett and David Packard, Hewlett-Packard moved its offices into the Stanford Research Park slightly after 1953. In 1954, Stanford created the Honors Cooperative Program to allow full-time employees of the companies to pursue graduate degrees from the University on a part-time basis. The initial companies signed five-year agreements in which they would pay double the tuition for each student in order to cover the costs. Hewlett-Packard has become the largest personal computer manufacturer in the world, and transformed the home printing market when it released the first ink jet printer in 1984. In addition, the tenancy of Eastman Kodak and General Electric made Stanford Industrial Park a center of technology in the mid-1990s.

Notes:
1. milieu – окружение, окружающая обстановка
2. convergence – схождение в одной точке
3. assured – застрахованный
4. venture capital – капитал, вложенный (или вкладываемый) в новое предприятие, связанное с риском
5. unemployment rate – процент (доля) безработных
6. leasing – лизинг, долгосрочная аренда
7. tenant – арендатор, владелец, житель

VIII. Read and translate text 46.6. Explain in brief:

1. Development of key technologies
2. The rise of software
3. High-tech jobs, workers, salary
4. High-tech companies
5. Stanford Industrial park (leasing, tenants)

TEXT 46.7. AKADEMGORODOK

1. Akademgorodok is a part of the Russian city Novosibirsk, located 20 km south of the city center. It is the educational and scientific centre of Siberia. The area is called Silicon Forest by some.

2. It is located in the center of birch and pine forest on the shore of the Ob Sea, a man-made reservoir on Siberian river Ob. Formally it is a part of Novosibirsk city. Within Akademgorodok there is Novosibirsk State University (NSU), 35 research institutes, medical academy, apartment buildings and houses, and a variety of community amenities including stores, hotels, hospitals, restaurants and cafes, cinemas, clubs and libraries. The House of Scientists, a social center of Akademgorodok, hosts a library containing 100,000 volumes — Russian classics, modern literature and also many American, British, French, German, Polish books and magazines. The House of Scientists also includes a picture gallery, lecture halls and a concert hall.

3. Akademgorodok was founded in the 1950s by the Soviet Academy of Sciences. Academician Mikhail Alexeyevich Lavrentiev, a physicist and mathematician, the first Chairman of the Siberian Branch of the Soviet Academy of Sciences, played a prominent role in establishing Akademgorodok. At its peak, Akademgorodok was home to 65,000 scientists and their families.

4. In 1992, a software company called Novosoft was founded here, and its chief client was IBM. Around the same time CFT started, which

specialize in banking and financial software. Intel and Schlumberger have brought work to Akademgorodok, and other companies are following them into the area. Dr. Lavrentiev's son, also named Mikhail and also an accomplished mathematician in his own right, has been deeply involved in this renaissance.

5. There are research and education facilities in Akademgorodok: Kutateladze Institute of Thermal Physics, Nikolaev Institute of Inorganic Chemistry, Boreskov Institute of Catalysis, Vorozhtsov Institute of Organic Chemistry, Budker Institute of Nuclear Physics, Ershov Institute of Informatics Systems, Institute of Informatics and Mathematical Geophysics, Institute of Chemical Biology and Fundamental Medicine, Institute of Cytology and Genetics, Sobolev Institute of Mathematics, United Institute of Geology, Geophysics and Mineralogy, Institute of Automation and Electrometry, Institute of Semiconductors Physics, Institute of Theoretical and Applied Mechanics, Institute of Chemical Kinetics and Combustion, Lavrentiev Institute of Hydrodynamics, United Institute of History, Philology and Philosophy, Institute of Laser Physics, Central Siberian Botanical Garden, Institute of Solid State Chemistry and Mechanochemistry, Research Institute of Circulation Pathology, Institute of Economics and Industrial Engineering, Presidium of the Siberian Branch of the Russian Academy of Sciences, House of Scientists, Novosibirsk State University, Specialized Educational Scientific Center on Physics, Mathematics, Chemistry and Biology of Novosibirsk State University, Museum of Archaeology and Ethnography, Central Siberian Geological Museum, Institute of Computational Technologies.

IX. Read and translate text 46.7. Enumerate in brief:

1. Akademgorodok (location) 2. Foundation of Akademgorodok
3. New companies 4. Research and educational institutions

TEXT 46.8. NOVOSIBIRSK STATE UNIVERSITY

1. Novosibirsk State University (NSU) was founded in May 1959 in the USSR by Soviet academicians Mikhail Alekseevich Lavrentiev, Sergei Lvovich Sobolev and Sergey Alekseyevich Khristianovich in a program of establishing a Siberian branch of the USSR Academy of Sciences. Novosibirsk State University is one of the most famous universities in Russia, although is somewhat young. The university is located 20

kilometers from the city of Novosibirsk, a cultural and industrial center of Siberia. The total number of students is about 5 000.

2. Three fellow members of the USSR Academy of Sciences, decided to bring international level research over the Urals from Moscow to the vast territories of Siberia. Siberia possessed copious natural resources, but lacked large research institutions which would promote economic development and growth in the region. The idea was implemented with the establishment of the Siberian Branch of the USSR Academy of Sciences in 1958 near the large industrial city of Novosibirsk. A new academic town (Akademgorodok) started to grow rapidly and half a year later a new university was founded to train young researchers for the newly born science center.The official opening of the University took place on September 26, 1959 at the Concert Hall of the Opera and Ballet Theatre in Novosibirsk.

3. First lectures were held in the building of a secondary school, and first dormitories for the students were just tents amidst the forest; but the spirit of novelty and the lust for education and research created a strong motivation among the first students. At first, the only department of the University, the Department of Natural Sciences, combined Mathematics, Physics, Mechanics, Biology, Chemistry and Geology. Between 1960 and 1967 new departments began to separate into their own disciplines. In December, 1963 the first graduates of the Novosibirsk State University, including 26 physicists, 24 mathematicians and ten researchers in mechanics, received diplomas.

4. There are the following departments at NSU: Department of Mechanics and Mathematics (DMM), Department of Physics (DP), Department of Natural Sciences (DNS), Department of Geology and Geophysics (DGG), Department of Economics (DE), Department of Information Technologies (DIT), Department of Humanities (DH), Department of Foreign Languages (DFL), Department of Journalism (DJ), Department of Psychology (DPs), Department of Philosophy (DPh), Department of Law (DL), Department of Medical Science (DMS), Confucius Classroom.

5. The Department of Mechanics and Mathematics was founded in 1961. Before separating out in the frameworks of a proper department, the training in mathematics and mechanics was offered first at the Natural Sciences Department (1959), then at the Physical Mathematical Department (1960). Since 1976, the Department of Mechanics and Mathematics has conducted training in applied mathematics as well. The

founders of the Department of Mechanics and Mathematics were such distinguished scientists as Academicians M.A. Lavrentiev, I.N.Vekua, A.I. Maltsev, and S.L. Sobolev.

X. Read and translate text 46.8. Characterize in brief:

1. Foundation and location of NSU
2. The first department
3. Different departments of NSU

TEXT 46.9. SYSTEM OF TRAINING AT NSU

1. In 1991, the Academic Council of the Department of Mechanics and mathematics came to the decision to accept a 2-level system of training (undergraduate and postgraduate). Having completed the 4-year (undergraduate) program of the Department, students normally submit a thesis or take a final (state) examination in mathematics (about 5 or 10% of graduates) and get a Bachelor's degree in mathematics, applied mathematics and informatics (computer science) or mechanics. About half of the graduates have the opportunity to continue their education at 2-year postgraduate courses leading to a Master's degree. The department was one of the pioneers in Russia which start offering Master programs in mathematics, computer science, mechanics, mathematics and applied mathematics, mechanics and applied mathematics. The first Masters graduated from the department in 1993.

2. Novosibirsk State University is a coeval and a creation of the Siberian Branch of the USSR Academy of Sciences. The "Fathers of Siberian Science" believed that it was impossible to organize a scientific center without solving the problem of training young researchers. On the other hand, almost 80% of the Siberian Branch staff consists of NSU graduates. Journalists still argue whether the Siberian Branch gave birth to the University or the University built up the Siberian Branch.

3. The main idea of NSU founders was to combine research and education in the University by inviting scientists from the nearby research institutions in Akademgorodok as part-time university faculty. This allowed students to gain laboratory experience in addition to regular coursework. Additionally, it allowed students to undertake the writing of theses. This idea made NSU one of the best Russian universities. NSU graduates usually receive a Specialist's diploma. Soviet and Russian Specialist's diploma falls between the Western Bachelor's and Master's

diplomas. However, since NSU students are required to do research for the last two years of their training and write a thesis, NSU Specialist's diploma is generally accepted as Master's outside of Russia. Some NSU majors grant Bachelor's and Master's diplomas.

4. Famous people of Novosibirsk State University are the faculty (Aleksandr Danilovich Aleksandrov, Gersh Budker, Boris Chirikov, Alexey Okladnikov, Dmitrii Knorre, Samson Semenovich Kutateladze, Sergei Lvovich Sobolev, Sergey Alekseyevich Khristianovich, Leonid Vitaliyevich Kantorovich, etc.) and alumni (Eugene Nalimov, Efim Zelmanov, Vladimir E. Zakharov, Anatolii Ivanovich Sivkov, etc.)

XI. Read and translate text 46.9. Explain in brief:

1. Two-level system of training
2. The main idea of NSU founders
3. Specialist's diploma
4. Faculty and alumni of NSU

TEXT 46.10. SIBERIAN BRANCH OF THE RUSSIAN ACADEMY OF SCIENCES

1. The Russian Academy of Sciences (RAS) was founded in 1724 by the great reformer Peter I, and it has functioned as a governmental body, in contrast to the liberal scholarly societies of Europe. According to the first Charter of the Academy, its primary goal was 'to produce and to do science'. The secondary goal was formulated by the Academy's Secretary Academician A.H. Middendorf: 'to make direct benefit for the state'. The first scientific outposts based in Siberia and in the Russian Far East were universities.

2. A lot of plants, factories and scientific institutions were evacuated to Siberia from Central Russia at the time of the World War II. In 1943, the West Siberian Branch of the USSR Academy of Sciences was founded in Novosibirsk; later, Academy branches sprang up in Irkutsk, Vladivostok and Yakutsk. A real breakthrough in the development of science and research in Siberia became possible thanks to the creation of the Siberian Branch of the Russian Academy of Sciences in 1957, when the leading scientists and enthusiastic university graduates moved voluntarily, on a mass scale, from the capitals (Moscow and Leningrad) to Siberia – this was a phenomenon that does not have many analogues in history.

3. Academicians S.A. Christianovich, S.L. Sobolev and M.A. Lavrentiev put forward the idea of setting up large research centers of the USSR AS in the east of the country. They are considered to be the

founding fathers of the Siberian Branch of RAS. Academician M.A. Lavrentiev was the first SB RAS Chairman from 1957 to 1975. He said the remarkable words: ‘When I am asked what the future of the Siberian Branch depends on, I say that it depends on keeping in harmony the trinity of research, personnel and industrial production. If any of these three components dominates, this will lead to stagnation and regress. The harmony between the three ingredients should result from collective efforts of researches, top managers of production industries and state authorities. Time will make the necessary revisions but the principles that have proved fruitful should work after we are gone’.

4. Akademgorodok, the outpost and headquarters of the Siberian Branch built in Novosibirsk, was the first structure specifically designed to develop pure research and theoretical education. In ‘Lavrentiev triangle’ which reflects the three-component objective of the Siberian Branch: personnel training, interdisciplinary research and adoption of research achievements in industry, the first component is personnel, namely research schools created by prominent researchers who came to Siberia together with their disciples. There is the Akademgorodok – based School of Physics and Mathematics and famous all-Siberia contests for school-children in mathematics, physics, chemistry, biology and other subjects. Krasnoyarsk State University and Buryat State University developed from the branches of Novosibirsk State University (1959), which influenced profoundly many other higher educational establishments of Siberia, the Russian Far East and the Urals.

5. The next important component of the Siberian Branch of RAS is research organization, namely, integral interdisciplinary studies and search for discoveries in the areas where branches of learning overlap. Mikhail Lomonosov expressed this idea in the 18th century: ‘An astronomer often needs mechanic’s or physicist’s advice, a botanist and anatomist needs advice from a chemist, an algebraist can write formulas and has to take a physical substance. To do this they always have to be on friendly terms. Freedom and unity of sciences often require communication and permission to practice in what the other person knows’. Such interaction of disciplines manifested in the adoption of mathematical methods by various areas of knowledge and the current integrated projects unite experts of various branches of learning: physicists and chemists, physicists and biologists, chemists and biologists, economists and mathematicians, etc.

6. The third component of ‘Lavrentiev triangle’ was practical application of research achievements. Alongside theoretical studies,

research workers and top managers of the Siberian Branch focused on using the research potential accumulated to the advantage of regional and national industries. Most Institutes were designed to have pilot production facilities, and a number of design and technology units and pilot plants were created.

XII. Read and translate text 46.10. Explain in brief:

1. Russian Academy of Sciences (foundation, goal)
2. Siberian Branch of RAS
3. Founding fathers of SB RAS (the first Chairman)
4. Akademgorodok
5. 'Lavrentiev triangle' (three components)

XIII. Try to find additional information about the faculty and alumni of NSU. Tell about them to your group mates.

XIV. Comment on the following quotations. Do you agree or disagree with them?

1. Intelligence is quickness in seeing things as they are. (George Santayana 1863-1952)
2. Learning to learn is to know how to novigate in a forest of facts, ideas and theories, a proliferation of constantly changing items of knowledge. Learning to learn is to know what to ignore but at the same time not rejecting innovation and research. (Raymond Queneau 1903-1976)
3. Education has for its object the formation of character. (John Sparrow 1906-1992)
2. Remember that happiness is a way of travel – not a destination. (Roy M. Goodman)
4. Science is organized knowledge. (Herbert Spencer 1820-1903)
5. Discovery consists of seeing what everybody has seen and thinking what nobody has thought. (Albert von Szell-Györgyi 1893-1986)
6. History is a gallery of pictures in which there are few originals and many copies. (Alexis de Tocqueville 1805-1859)
7. Education is not the filling of a pail, but the lighting of a fire. (William Butler Yeats 1865-1939)
8. Success is that old A, B, C – ability, breaks and courage. (Charles Luckman)

INDEPENENT WORK

1. What kind of people are liked and respected by all members of society and why?
2. Are there stereotypes of people of different professions?
3. What makes people famous (writers, politicians, scientists, engineers, etc.)?
4. Where do you prefer to get your information about famous people from and why?
5. Is life of famous person easy and why / why not?
6. Does fame change people?
7. Say what is more important in a person – his character or his appearance. Give your reasons. What is easier to change – your appearance or your character? Why?
8. Give examples of mobility of character taken from biographies of scientists, inventors, engineers, etc. Say which character is your favourite and why you like this character.
9. Some people are respected by everybody, others only by one or two. Why? Express your opinion.
10. A person's character is usually formed in childhood. Do you agree or disagree? Give your reasons. What are the essential factors that help mould a person's character: background and environment; educational possibilities; cultural standards or circumstances?
11. Some people may not be able to see beauty when it is near them. What do we mean when speak about someone's beauty? What is your idea of physical beauty? Can you name some famous people who are really beautiful?
12. One of Chekhov's characters said that everything must be beautiful in a person – face, dress, spirit and mind. How do you understand this?
13. What are the traits of an ideal scientist, inventor, leader, friend? Do you think it's good to live with an ideal? Give your reasons.
14. We meet different people during our lives. Say what kind of people you like and what kind of people you dislike. Speak about reasons for your likes and dislikes.
15. Say what you first notice about a person when you meet him / her for the first time. How do you judge people from first impressions?
16. Speak about possible people for this year's title 'PERSONALITY OF THE YEAR.' They can be from the world of science, engineering,

politics, business. Speak about reasons why you think he / she deserves the title.

17. What qualities, in your opinion, are necessary for scientist / inventor (leader) to have?
an ability to organize and inspire others, an ability to plan,
an ability to choose the right person for the right job,
readiness to accept responsibility, honesty, enthusiasm.
willingness to make difficult decisions and stand by them,
high standards of personal conduct, resolute determination
18. How to be successful in life. What is your opinion?
19. Make notes to complete the table:

name of famous person	
his / her appearance	
what he /she is famous for	
why you like he / her	

20. Name the characters and personalities you like / dislike:

absent-minded (рассеянный), *broad-minded* (с широким кругозором)
aggressive (агрессивный), *calm* (спокойный), *cheeky* (нахальный)
conceited (самодовольный, высокомерный), *boastful* (хвастливый)
blunt (грубый, резкий, недалёкий), *bright* (умный, одарённый),
confident (уверенный), *considerate* (внимательный к другим)
courageous (смелый, храбрый), *enthusiastic* (полный энтузиазма)
conscientious (сознательный, добросовестный),
creative (творческий), *modest* (скромный), *hospitable* (гостеприимный)
impatient (нетерпеливый), *indecisive* (нерешительный)
loyal (верный, преданный), *malicious* (злобный, ехидный)
narrow-minded (ограниченный), *obstinate* (упрямый)
sensible (разумный, рассудительный), *strict* (строгий)
talented (талантливый), *unreliable* (ненадёжный)

21. They say the life of creative people is usually hard. What do you think about it?
22. (Project work). Choose one of the scientists/inventors that appeals to you most. Find as much additional information about him and his works as possible. Write a story about him/her and tell about him to your groupmates.
23. Read and translate the text. Find an interesting additional information about other units and tell your groupmates about them:

A FEW UNITS NAMED AFTER FAMOUS SCIENTISTS

Words like volt or watt have become part of our language so completely that we sometimes forget that these are the names of famous scientists.

Let us recall a few such units...

An *ampere* ['æmpɛə] is the unit of electric current in common use. It is that current which, when passed through a solution of *silver nitrate* in water, will deposit silver at the rate of 0.001118 grams per second. The unit is named after Andre-Marie Ampere (1775–1836) a famous French physicist and mathematician.

A *bel* is a unit for comparing two values of power. It *is ten times the size* of the more frequently used decibel, which is used as *a measure of response* in all types of electrical communication circuits. The unit is named after Alexander Graham Bell (1847–1922), the American inventor of the telephone.

A *coulomb* ['ku:ləm] is a unit of electric charge equal to the quantity of electricity transferred in one second by a current of one ampere. It is named after Charles Augustin de Coulomb (1736–1806), a prominent French physicist.

A *curie* (Cu) ['kjuəri] is the unit of the measurement of radioactivity. It is named after Pierre and Marie Curie, French physicists.

A *farad* ['færəd] is a unit of electrical capacitance. It is named after Michael Faraday (1791–1867), a famous English physicist.

A *gal* is a unit of acceleration used in describing the effects of gravity. It is an acceleration of one centimetre per second each second. The unit is named after Galileo Galilei (1564–1642), a famous Italian scientist.

A *kelvin* is a degree on the thermometric scale that takes absolute zero as its starting point (0° K). It is named after William Thomson (1824–1907), who later became Lord Kelvin, a British professor, the inventor of mirror galvanometer.

A *newton* is the unit of force in the metre-kilogram-second measurement system. It is named after Sir Isaac Newton (1642–1727), an English scientist, a professor of Cambridge University.

An *oersted* ['ə:stəd] is a unit of magnetic field intensity. It is named after Hans Christian Oersted (1777–1851), a Danish physicist.

A *roentgen* ['rō̄ntjən] is a unit of radiation. It is named after Wilhelm Conrad Roentgen (1845–1923), a famous German physicist.

A *volt* [voult] is the difference of potential between two points if one joule of work is required to transport one coulomb of charge from one point to the other. It is named after Alessandro Volta (1745–1827), an Italian physicist.

A *watt* [wɔt] is a unit of power. It is named after James Watt (1736 – 1819), the English inventor of a steam-engine.

Notes:

1. silver nitrate – азотнокислое серебро
2. it is ten times the size – в десять раз больше
3. a measure of response – мера чувствительности

АФОРИЗМЫ, ИЗРЕЧЕНИЯ, ЦИТАТЫ (О НАУКЕ И ЖИЗНИ)

1. Измеряй всё доступное измерению и делай недоступное измерению доступным. (Галилео Галилей 1564-1642)
2. Для того, чтобы уничтожить учение Коперника, вовсе недостаточно заткнуть кому-то рот. Нужно ещё наложить запрет на всю астрономическую науку и, сверх того, воспретить кому бы то ни было глядеть на небо! (Галилео Галилей)
3. Геометрия владеет двумя сокровищами: одно из них – это теорема Пифагора, а другое – деление отрезка в среднем и крайнем отношении. Первое можно сравнить с мерой золота, второе же больше напоминает драгоценный камень. (Иоганн Кеплер 1571-1630)
4. Я мыслю, следовательно, я существую. (Рене Декарт 1596-1650)
5. Зародыши знания имеются в нас наподобие огня в кремне, философы культивируют их с помощью разума, поэты же разжигают их посредством воображения. (Рене Декарт)
6. Истины, какие должны быть найдены, в значительной мере зависят от отдельных опытов; последние же никогда не совершаются случайно, но должны быть изыскиваемы проницательными людьми с тщательностью и издержками. (Рене Декарт)
7. Вместо большого числа правил, составляющих логику, я заключил, что было бы достаточно следующих. *Первое:* включать в свои суждения только то, что представляется моему уму так ясно и отчётливо, что никаким образом не сможет дать повод к сомнению. *Второе:* делить каждую из рассматриваемых трудностей на столько частей, на сколько потребуется, чтобы лучше их разрешить. *Третье:* руководить ходом своих мыслей, начиная с предметов простейших и легко познаваемых, и восходить мало-помалу, как по ступням, до познания наиболее сложных идей. (Рене Декарт)
8. Случайные открытия делают только подготовленные умы. (Блез Паскаль 1623-1662)
9. Всё наше достоинство в том, что мы способны мыслить. (Блез Паскаль)
10. Суть человеческого естества – в движении. Полный покой означает смерть. (Блез Паскаль)

11. Вся трудность физики состоит в том, чтобы по явлениям движения познать силы природы, а затем по этим силам объяснить остальные явления. (Исаак Ньютон 1643-1727)
12. Как в математике, так и в натуральной философии исследование трудных предметов методами анализа всегда должно предшествовать методу соединения. Такой анализ состоит в производстве опытов и наблюдений, извлечений общих заключений из них посредством индукции и недопущении иных возражений против заключений, кроме полученных из опыта или других достоверных истин. (Исаак Ньютон)
13. Гений есть терпение мысли, сосредоточенной в известном направлении. (Исаак Ньютон)
14. Я кажусь себе мальчиком, играющим у моря, которому удалось найти более красивый камешек, чем другим; но океан неизведанного лежит передо мною. (Исаак Ньютон)
15. Все во вселенной находится в такой связи, что настоящее всегда в своих недрах скрывает будущее, и всякое данное состояние объяснимо естественным образом только из непосредственно предшествовавшего ему. (Готфрид Вильгельм Лейбниц 1646-1716)
16. Библиотеки – это сокровищницы всех богатств человеческого духа. (Готфрид Вильгельм Лейбниц)
17. Лень, как ржавчина, разъедает быстрее, чем труд изнашивает. (Бенджамин Франклин 1706-1790)
18. Если время – самая драгоценная вещь, то растрата времени является самым большим мотовством. (Бенджамин Франклин)
19. Все, что мы сейчас достаточно знаем из физики, было прежде облечено в догадки, и если бы никогда не допускались догадки, даже ошибочные, то мы бы не добыли ни одной истины. (Леонард Эйлер 1707-1783, великий швейцарский математик и физик)
20. Именно математика, в первую очередь защищает нас от обмана чувств и учит, что одно дело – как на самом деле устроены предметы, воспринимаемые чувством, другое дело – какими они кажутся; эта наука дает надежнейшие правила; кто им следует – тому не опасен обман чувств. (Леонард Эйлер)
21. Один опыт я ставлю выше, чем тысяча мнений, рожденных только воображением. (Михаил Васильевич Ломоносов)
22. Неусыпный труд все препятствия преодолевает. (М.В. Ломоносов)
23. Науки юношей питают, отраду старым подают, в счастливой жизни украшают, в несчастный случай берегут. (М.В. Ломоносов)

24. Истинно честный человек должен предпочитать себе – семейство, семейству – отечество, отечеству – человечество. (Жан Лерон Д'Аламбер 1717-17830)
25. Мы должны рассматривать настоящее состояние Вселенной как следствие ее предыдущего состояния и как причину последующего. (Пьер Симон Лаплас 1749-1827, великий французский физик, астроном и математик)
26. Я потому так много успел, что стремился каждый день сделать хоть что-нибудь. (Томас Юнг 1773-1829)
27. Начать с наблюдения фактов, изменять, по возможности, сопутствующие им условия, сопроовождая эту первоначальную работу точными измерениями, чтобы вывести общие законы, основанные всецело на опыте, и в свою очередь вывести из этих законов, независимо от каких-либо предположений о природе сил, вызывающих эти явления, математическое выражение этих сил, т.е. вывести представляющую формулу, – вот путь, которому следовал Ньютон. (Андре Мари Ампер 1775-1835, великий французский физик, математик и химик)
28. Математика есть царица, а арифметика есть царица математики. (Карл Фридрих Гаусс 1777-1855, великий немецкий математик (король математиков) и физик)
29. Полезность теории не ограничивается только тем, что облегчает изучение фактов, соединяя их в более или менее многочисленные группы по наиболее характерным соотношениям. Другая, не менее важная цель всякой хорошей теории должна состоять в том, чтобы содействовать прогрессу науки открытием связующих фактов и соотношений между наиболее различными и кажущимися наиболее независимыми друг от друга категориями явлений. (Огюстен Жан Френель, 1788-1827)
30. Природа не останавливалась перед трудностями анализа, она избегала только усложнения средств. Она склонна делать многое при помощи малого. Этот принцип с совершенствованием физической науки находит все большее подтверждение. (Огюстен Жан Френель)
31. Ученый должен быть человеком, который стремится выслушать любое предположение. (Майкл Фарадей 1791-1861, великий английский физик)
32. Чем больше у меня работы, тем больше я учусь. (Майкл Фарадей)

33. Изучение естественных наук я считаю отличной школой для ума. Нет школы для ума лучше той, где дается понятие о чудном единстве и неуничтожимости материи и сил природы. (Майкл Фарадей)
34. В каждой физической науке мы должны восходить от фактов к законам путем индукции и анализа; и можем исходить от законов к следствиям дедуктивным. Мы должны собирать и группировать видимости до тех пор, пока научное воображение не различит их скрытый закон, и единство возникает из разнообразия; и затем от единства мы должны вывести вновь разнообразие и заставить скрытый закон обслуживать будущее. (Уильям Роуан Гамильтон 1805-1865, выдающийся ирландский физик и математик)
35. Цель физики как науки – констатировать и объяснять видимые явления; классифицировать и обобщать факты; открывать разнообразия и изменчивости; построить, по крайней мере, отчасти, историю внешнего мира, приспособленную к пониманию человека; дать отчет о прошлых явлениях и предвидеть будущее, изучать язык и истолковывать пророчества Вселенной. (Уильям Роуан Гамильтон)
36. Помимо всякого тщеславия, проработав, как наш брат, целую жизнь, имеешь право задаться вопросом, какую ценность представляет то, что ты сделал, полезно ли оно. Но ответить на этот вопрос имеют право те, кто имел случай им пользоваться и оценить. (Герман Людвиг Фердинанд Гельмгольц 1821-1894, великий немецкий ученый – физик, математик, физиолог и психолог)
37. Физические исследования постоянно обнаруживают перед нами новые особенности процессов природы, и мы вынуждены находить новые формы мышления, соответствующие этим особенностям. (Джеймс Кларк Максвелл, 1831-1879)
38. Мы (физики) должны постоянно стремиться поддерживать живую связь между нашей работой и гуманитарными курсами Кембриджа: литературными, филологическими, историческими и философскими. (Джеймс Кларк Максвелл)
39. Для изучающего любой предмет, чтение оригинальных трудов представляет собой большое преимущество, так как наука всегда наиболее полно усваивается в состоянии рождения. (Д.К.Максвелл)
40. Если искусство математика позволило экспериментатору заметить, что измеренные им количества связаны необходимыми соотношениями, то физические открытия показали математику

новые формы количеств, которые он никогда бы не мог себе представить. (Д.К. Максвелл)

41. Наука о природе все больше и больше сознает свою задачу как изучение механизма вселенной. Разнообразные явления, когда-то казавшиеся не имеющими ничего общего с механикой (явления тепла, света, электричества), постепенно сводятся, а частью уже сведены на механическую почву, приписываются незаметным движением вещества. Дать им объективное истолкование, – значит указать, что и как движется. Основы механики, в окончательной форме положенные Ньютоном, становятся поэтому основами всей рациональной физики («натуральная философия», как назвал ее Ньютон), которая зиждется на них и прилагает их к новому и новому содержанию. Следуя этому пути, физика выполняет завет Ньютона. (Александр Григорьевич Столетов 1839-1896, выдающийся русский физик)
42. Если однажды мы открыли физические явления, которые составляют основу звука, то наши исследования переносятся в другую область, именно в область механики. (Джон Уильям Стретт (Лорд Рэлей 1842-1919, английский физик)
43. Вероятно, всякий согласится, что произведенная нами работа в достаточной степени вознаградила нас за отрицательный результат опыта тем, что привела к изобретению интерферометра. Этот опыт имеет для меня исторический интерес, т.к. именно для решения указанной задачи был изобретен интерферометр. (Альберт Абрахам Майкельсон 1852-1931)
44. Физики всех стран мира, когда речь заходит о науке, являются хорошими товарищами, стремящимися в мирном соревновании к одной и той же цели. Каждый радуется достижениям другого, и находки одного становятся достоянием всех остальных и служат дальнейшему развитию. (Хендрик Антон Лоренц 1853-1928, голландский физик-теоретик)
45. В форме выражения мысли отражается сам образ мысли. (Х.А. Лоренц)
46. Изыскание истины должно быть целью нашей деятельности: это – единственная цель, которая достойна её. (Анри Пуанкаре 1854-1912, французский математик, физик, астроном и философ)
47. Наука является коллективным творчеством и не может быть ничем иным; она как монументальное сооружение, строить которое нужно

века и где каждый должен принести камень, а этот камень часто сто́ит ему целой жизни. (А. Пуанкаре)

48. Как нужна способность, которая позволяла бы нам видеть цель издали, а эта способность есть интуиция. Она необходима для исследователя в выборе пути, она не менее необходима и для того, кто идет по его следам и хочет знать, почему он избрал его. (Анри Пуанкаре)
49. Великое открытие – это не конечная станция, а скорее дорога, ведущая в области, до сих пор неизвестные. Мы взбираемся на вершину пика, и нам открывается другая вершина, ещё более высокая, чем когда-либо видели до сих пор, и так продолжается дальше. (Джозер Джон Томсон 1856-1940, английский физик)
50. Ближайшая и в определенном смысле важнейшая задача нашего созидательного познания природы заключается в том, чтобы найти возможность предвидеть будущий опыт и в соответствии с этим регулировать наши действия в настоящем. Основой для решения этой задачи познания при всех обстоятельствах служит предшествующий опыт, полученный или из случайных наблюдений или из специальных экспериментов. (Генрих Герц 1857-1894, немецкий физик)
51. С тех пор как существует физическая наука, высшей целью её достижений было установление такого единого простого принципа, который охватывал бы все наблюдаемые и доступные наблюдению явления природы и дал бы возможность вычислить на основании известных факторов прошедшие и в особенности будущие события. (Макс Планк 1858-1947, немецкий физик-теоретик, родоначальник квантовой теории)
52. Преследование определенной цели, далёкий свет которой не меркнет от первых неудач, является необходимой предпосылкой, хотя далеко не гарантией успеха. (Макс Планк)
53. Нетрудно предвидеть, что в преступных руках радий может сделаться крайне опасным, и вот возникает вопрос, действительно ли полезно для человечества знать секреты природы, действительно ли оно достаточно зрело для того, чтобы их правильно использовать, или это знание принесёт ему только вред. Пример сделанного Нобелем открытия является в этом отношении характерным. Мощные взрывчатые вещества позволили людям совершить замечательные деяния, и они же явились страшным средством в руках великих преступников, толкавших народы на путь войны. Я

принадлежу к числу тех, которые, подобно Нобелю, считают, что все же новые открытия, в конечном счете, приносят человечеству больше пользы, чем вреда. (Пьер Кюри 1859-1906, французский физик)

54. Постоянно пользуясь трудом своих предшественников, ученый может больше, чем кто-либо другой, ежедневно убеждаться в преемственности идей, учиться чувствовать и ценить то духовное наследие, которым бескорыстно одарили его и его сверстников предшествующие поколения, и, естественно, у него является сознание нравственной обязанности перед будущими поколениями так же работать, покуда хватит сил, как работали его предшественники. (Пётр Николаевич Лебедев 1866-1912, русский физик)
55. Жизнь, как видно, не дается никому из нас легко. Ну что ж, надо иметь настойчивость, а главное – уверенность в себе. Надо верить, что ты на что-то годен, и этого ‘что-то’ нужно достигнуть во что бы то нистало. (Мария Складовская-Кюри 1867-1934, французский физик)
56. Жизнь великого ученого в лаборатории не спокойная идиллия, как думают многие; она чаще всего – упорная борьба с миром, с окружающим и с самим собой. Великое открытие не выходит готовым из мозга ученого, оно есть плод предварительного сосредоточенного труда. Среди дней плодотворной работы попадаются дни сомнений, когда ничто как будто не выходит, когда сама материя кажется враждебной, и тогда надо бороться с отчаянием. (Мария Кюри)
57. Наука является основой всякого прогресса, облегчающего жизнь человечества и уменьшающего его страдания. (М. Кюри)
58. Я принадлежу к числу тех людей, которые думают, что наука – это великая красота. Ученый у себя в лаборатории не просто техник: это ребёнок лицом к лицу с явлениями природы, действующими на него, как волшебная сказка. (М. Кюри)
59. Ценность любой рабочей теории основана на том числе экспериментальных факторов, которые она может объяснить, и на её способности предположить новые направления исследований. (Эрнест Резерфорд 1871-1937, английский физик)
60. Опыт без фантазии или воображение без проверки опытом может дать немногое. (Эрнест Резерфорд)

61. Сегодня перед нами, кто создает науку, стоит обязанность следить за тем, какое употребление люди делают из науки. (Поль Ланжевен 1872-1946, французский физик)
62. На протяжении моей долгой жизни я знал великую радость: понимать, учить и действовать. (Поль Ланжевен)
63. Доброта, красота и правда – вот жизненные идеалы, которые освещали мой жизненный путь, вновь и вновь возраждая в моей душе радость и мужество.(Альберт Эйнштейн 1879-1955, немецкий физик-теоретик)
64. В научном мышлении всегда присутствует элемент поэзии. Настоящая наука и настоящая музыка требуют однородного мыслительного процесса. (Альберт Эйнштейн)
65. Для нашей работы необходимы два условия: неустанная выдержка и готовность всегда выбросить за борт то, на что ты потратил так много сил и труда. (Альберт Эйнштейн)
66. Наука – это драма идей. (Альберт Эйнштейн)
67. Теория преследует две цели: охватить по возможности все явления и их взаимосвязи; и помочь нам не только знать, как устроена природа и как происходят природные явления, но и по возможности достичь цели, может быть, утопической и дерзкой на вид, – узнать, почему природа является такой, а не другой. (Альберт Эйнштейн)
68. Истина – это то, что выдерживает проверку опытом. (Альберт Эйнштейн)
69. Объяснение природы может состоять только в том, чтобы поставить его связь с другими явлениями природы посредством известных законов, в результате чего комплекс связанных явлений описывается как целое. (Макс Феликс Теодор фон Лауэ 1879-1960, немецкий физик-теоретик)
70. Подобно тому, как история народов и государств отмечает только более значительные события и выдающихся людей, история науки рассматривает лишь вершины исследования и рассказывает о тех, кто участвовал в её созидании. В тени остаются тысячи людей, пришедших в физику с начала 17 века и из чисто идеальных побуждений посвятивших себя ей иногда до самопожертвования. Но их деятельность была и остается необходимой предпосылкой для появления выдающихся или даже гениальных открытий. (Макс фон Лауэ)
71. Пусть же в борьбе возможностей надежда на благотворное действие атомной энергии, поставленной на службу человечеству,

одержит победу над страхом перед все уничтожающим действием бомбы! (Отто Ган 1879-1968, немецкий физик-теоретик)

72. Прогресс создается сознательным движением миллионов людей, вдохновленных общими идеями. (Абрам Федорович Иоффе 1880-1960, советский физик-экспериментатор)
73. Техника будущего – это прежде всего физика в ее приложениях. (А.Ф. Иоффе)
74. Один талант ничто, нужна ещё громадная трудоспособность, работа над собой, непрерывная работа всю жизнь. Недаром сравнивают научное творчество с подъемом на высоту, но подъему нет конца: только вечное стремление вперед движет науку. (А.Ф. Иоффе)
75. Научная истина не самоцель, а верный путь к подъему культуры, к овладению силами природы на благо народа. Поэтому, приобретая знания, ученый несет их своему народу, поэтому он растит новые кадры и стремится к тому, чтобы его ученики знали больше и умели работать лучше, чем он. (А.Ф. Иоффе)
76. На своем опыте я узнал, какую полноту счастья дает настойчивый труд, разрешение загадок, которых ещё немало в окружающей нас природе. (А.Ф. Иоффе)
77. На моих глазах наука превратилась в дело государственной важности. Наука стала неотъемлемой и наиболее важной частью нашей цивилизации, а научная деятельность непосредственно влияет на развитие цивилизации. (Макс Борн 1882-1970, немецкий физик-теоретик)
78. Истинная наука философична: физика, в частности, не только первый шаг к технике, но и путь к глубочайшим пластам власти человеческой мысли. (Макс Борн)
79. Любой современный учёный-естественник, особенно каждый физик-теоретик, глубоко убежден, что его работа теснейшим образом переплетается с философией и что без серьезного знания философской литературы это будет работа впустую. Этой идеей я руководствовался сам, старался вдохнуть её в своих учеников, чтобы сделать их не какими-то приверженцами традиционной школы, а специалистами, способными к критике. (Макс Борн)
80. Чувство, охватывающее исследователя в науке, неизмеримо сильнее того, что можно испытывать от любой творческой работы, за исключением, разве что, искусства. Эту творческую радость вы переживаете, проникая в самые сокровенные тайны природы, разгадывая секреты происхождения Вселенной и внося смысл и

определенный порядок в какую-то часть хаотического мира. (Макс Борн)

81. Квантовая теория представляет собой обобщение классической механики в несколько ином направлении, чем теория относительности: тогда как последняя видоизменяет наши представления о пространстве и времени, квантовая теория меняет наше отношение к понятию причинности. (Макс Борн)
82. Наше проникновение в мир атомов модно сравнивать с великими, полными открытий кругосветными путешествиями и дерзкими исследованиями астрономов, проникших в глубины мирового пространства. (Нильс Бор 1885-1962, датский физик-теоретик)
83. Нильс Бор был не только гениальным учёным, не только передовым человеком, но и поистине обаятельным человеком. Всякий, кто имел счастье лично с ним встречаться, неизменно бывал очарован и покорён его личностью, его совершенно необыкновенной простотой, общительностью и доброжелательностью. Бор был подлинным воплощением человечности и доброты, в самом возвышенном смысле этих слов. (Игорь Евгеньевич Тамм 1895-1971, советский физик-теоретик)
84. Будем надеяться, что наука, которая веками оставалась символом прогресса, достигаемого объединенными усилиями людей, может внести решающий вклад в гармоническое развитие отношений между всеми народами. (Нильс Бор)
85. Мы унаследовали от предков острое стремление к объединенному всеохватывающему знанию. Самое название, данное высочайшим институтам познания – университетам, напоминает нам, что с древности и в продолжение многих столетий универсальный характер знаний был единственным, к чему могло быть полное доверие. (Эрвин Шредингер 1887-1961, австрийский физик-теоретик)
86. Самая плодотворная гипотеза кладет начало удивительному извержению потока непредвиденных открытий. (Леон Бриллюэн 1889-1969, французский физик-теоретик)
87. Совершенная теория – лишь удивительная мечта, яркая поэтическая зарисовка. Если мечта становится истиной, если поэзия отвечает фактам, она превращается в информацию. (Леон Бриллюэн)
88. Воображение, позволяющее нам представить себе сразу часть физического мира в виде наглядной картины, выявляющей некоторые её детали; интуиция, неожиданно раскрывающая нам в каком-то внутреннем прозрении глубины реальности, являются возмож-

ностями, органически присущими уму; они играли и повседневно играют существенную роль в создании науки. (Луи де Бройль 1892-1887, французский физик)

89. Только преодолевая ошибку за ошибкой, вскрывая противоречия, мы получаем все более близкое решение поставленной проблемы. (Пётр Леонидович Капица 1894-1984, советский физик-экспериментатор)
90. Ошибка не есть лженаука. Лженаука – это непризнание ошибок. Только поэтому она тормоз для здорового научного развития. (Пётр Капица)
91. Развитие науки немыслимо без борьбы мнений и научной критики. В научных спорах, в творческих дискуссиях быстрее рождается истина, оттачивается идея, вырисовываются пути её воплощения в жизнь. (Пётр Капица)
92. Только при живом и здравом единении науки и техники они помогают друг другу: наука открывает перед техникой новые возможности, за которые она смело, без принуждения ухватывается. При росте техники, наука со своей стороны, не только обогащается новыми техническими возможностями, но и её тематика расширяется и становится более целеустремлённой. (Пётр Капица)
93. Успешно готовить творчески активных исследователей в науке и технике могут лишь те учёные, которые сами непосредственно занимаются – и не только занимаются, но и увлекаются – исследовательской работой. Никакой пересказ учебников и даже новейших статей из научных журналов людьми, которые сами не ведут научно-исследовательской работы, не решит задачи: ведь ‘ум юноши – не сосуд, который нужно наполнить, а факел, который надо зажечь’. (Игорь Евгеньевич Тамм 1895-1971, советский физик-теоретик)
94. Вся история развития науки показывает, что овладение всякой новой областью явлений природы всегда приводит к практическим применениям, часто совершенно неожиданным. (Игорь Тамм)
95. Развитие науки не имеет предела. (Игорь Тамм)
96. Потребность в творческой деятельности – не только одна из самых благородных, но и одна из самых первичных, глубоких и неискоренимых потребностей человека. (Николай Николаевич Семёнов 1896-1986, один из основателей советской химической физики)
97. Не следует думать, что молодой учёный – это только тот, кто работает в соответствующем институте под руководством акаде-

миков и профессоров, имеет научное звание и учёную степень. Науку движут вперёд и молодые новаторы, рационализаторы, изобретатели, упорно работающие каждый в своей области, создающие немало нового, ложащегося в фундамент величественного здания науки. (Николай Семёнов)

98. Наука – это основной связующий элемент между мыслями людей, рассеянных по земному шару, и в этом одно из самых высоких её достоинств. По-моему, нет никакого другого вида человеческой деятельности, для которого всегда так надёжно достигалось бы согласие между людьми. (Фредерик Жолио Кюри 1900-1958, французский физик-ядерщик)
99. Учёные знают, что наука не может быть виновата. Виноваты те люди, которые плохо используют её достижения. (Ф. Жолио Кюри)
100. Часто слава приходит к учёному, сделавшему лишь последнее прикосновение к общему творению многих искателей. (Ф. Жолио Кюри)
101. Технический прогресс, вытекающий из развития какой-то главы чистой науки, всегда следует за её эволюцией со значительным опозданием. Необходимое разделение труда приводит к тому, что одни и те же исследователи редко занимаются и чистой наукой, и проблемами техники. Чтобы идеи учёных могли найти приложение, они должны стать яснее, выкристаллизовываться и распространиться, но то требует продолжительного времени, иногда десятков лет. (Энрико Ферми 1901-1954, итальянский физик-теоретик)
102. Подлинно новую землю в науке можно открыть лишь тогда, когда вы в решающий момент готовы покинуть ту почву, на которой покоилась прежняя наука, и в известном смысле совершить прыжок в пустоту. (Вернер Гейзенберг 1901-1976, немецкий физик-теоретик)
103. В определённом смысле человеческая способность к познанию безгранична. Современная физика открыла дверь новому и более широкому взгляду на отношения между человеческим духом и реальностью. (Вернер Гейзенберг)
104. Путём только рационального мышления никогда нельзя прийти к абсолютной истине. (Вернер Гейзенберг)
105. Физический закон должен быть математически красивым. (Поль Дирак 1902-1984, английский физик-теоретик)
106. Наблюдая за быстрым ростом науки и увеличением мощи человека, невольно начинаешь опасаться худшего. Человек явно не

в силах соразмерить свой умственный кругозор с той ответственностью, которую возлагает на него его собственная, всё вырастающая мощь. (Юджин Пол Вигнер 1902-1995, американский физик-теоретик)

107. Жизнь человека не вечна, но наука и знания переступают пороги столетий. (Игорь Васильевич Курчатов 1903-1960, русский физик-ядерщик)

108. Расчеты показывают, что если и впредь испытания атомного оружия будут продолжаться в том же темпе, как сейчас (1958), то вследствие выпадения на поверхность земли обрушающихся при взрыве и распространяющихся по всему земному шару радиоактивных изотопов стронция, цезия, и углерода, в будущем в каждом поколении будет поражено наследственными заболеваниями несколько миллионов человек. (Игорь Курчатов)

109. Мы надеемся, что стремление народов к миру победит, что в ближайшее время между заинтересованными государствами будет заключено соглашение (при соответствующем контроле) о прекращении испытаний ядерного оружия повсеместно и на вечные времена. (Игорь Курчатов)

110. Возможны самые разные стили и уровни духовной и познавательной активности, образа жизни, занятий наукой. Но истинно мудрым можно назвать лишь человека, органично совмещающего способность к предельной концепции внимания с широтой всестороннего охвата действительности. (Хидэки Юкава 1907-1981, японский физик)

111. Метод важнее открытия, ибо правильный метод исследования приведёт к новым, ещё более ценным открытиям. (Лев Давыдович Ландау 1908-1968, советский физик-теоретик)

112. Настоящая теоретическая физика – неразрывная часть всей физики, которая не может даже существовать без экспериментальной физики и не господствует над ней. Физик-теоретик – это не жрец и не пророк, а чаще всего просто счастливчик, не обремененной массой забот, преследующих физика-экспериментаторова. (Виталий Лазаревич Гинзбург 1916- , советский физик-теоретик)

113. Каждый шаг в изучении природы – это всегда только приближение к истине, вернее к тому, что мы считаем истиной. Всё, что мы знаем, – это какое-то приближение, ибо мы знаем, что не все ещё законы мы знаем. Всё изучается лишь для того, чтобы снова

стать непонятным или, в лучшем случае, потребовать исправления. (Ричард Фейнман 1918-1988, американский физик)

114. Отойти от края пропасти всемирной катастрофы, сохранить цивилизацию и саму жизнь на планете – настоятельная необходимость современного этапа мировой истории. Это, как я убеждён, возможно, лишь в результате глубоких геополитических, социально-экономических и идеологических изменений в направлении сближения (конвергенции) капиталистической и социалистической систем и открытости общества. Нужно новое мышление человечества! (Андрей Дмитриевич Сахаров 1921-1989, советский физик-теоретик)
115. Проблему преобразования солнечной энергии в электрическую необходимо решить в самом ближайшем будущем. (Жорес Иванович Алфёров 1930- , советский физик-теоретик)
116. Десятилетним мальчиком я прочитал замечательную книгу Вениамина Каверина «Два капитана». И всю последующую жизнь я следую принципу её главного героя Сани Григорьева: «Бороться и искать, найти и не сдаваться!». Очень важно при этом понимать, за что ты борешься. (Жорес Алфёров)
117. Глуп тот человек, который остается всегда неизменным. (Вольтер – 1694-1778 гг. – французский писатель, философ, историк)
118. Для великих дел необходимо неутомимое постоянство. (Вольтер)
119. Жить – значит работать. Труд есть жизнь человека. (Вольтер)
120. Знать много языков – значит иметь много ключей к одному замку. (Вольтер)
121. Ленивые всегда бывают людьми посредственными. (Вольтер)
122. Люди мало размышляют; они читают небрежно, судят поспешно и принимают мнения, как принимают монету, потому что она ходячая. (Вольтер)
123. Никогда не бывает больших дел без больших трудностей. (Вольтер)
124. Работа избавляет нас от трех великих зол: скуки, порока, нужды. (Вольтер)
125. Успехи науки – дело времени и смелости ума. (Вольтер)
126. Дурные книги могут так же испортить нас, как и дурные товарищи. (Генри Филдинг – 1707-1754 гг. английский писатель и драматург)

127. Берись за дело, как следует, и ты получишь хорошие результаты, потому что капля по капле камень долбит, и небольшими ударами можно свалить и дуб, и мышь с терпением и упорством перегрызает корабельный канат. (Бенджамин Франклин – 1707-1790 гг. – американский просветитель, государственный деятель, ученый)
128. Без благословения небес может быть разрушено все, что создано человеком, хотя в основе его благополучия могут лежать трудолюбие, бережливость, предусмотрительность и благоразумие. (Б. Франклин)
129. Если любишь жизнь, не трать время зря, потому что жизнь состоит из времени. (Б. Франклин)
130. Лень делает всякое дело трудным. (Б. Франклин)
131. Настоящая честь – это решение делать при всех обстоятельствах то, что полезно большинству людей. (Б. Франклин)
132. Не исправление ошибки, а упорство в ней роняет честь любого человека или организации людей. (Б. Франклин)
133. Опытность – это школа, в которой уроки стоят дорого, но это – единственная школа, в которой можно научиться. (Б. Франклин)
134. Способный терпеть, способен добиваться всего, чего он хочет. (Б. Франклин)
135. Стыдись своего безделья, когда так много можно сделать для самого себя, для своей семьи, для своей страны. (Б. Франклин)
136. Наука есть ясное познание истины, просвещение разума, непорочное увеселение жизни, похвала юности, старости подпора, строительница градов, полков, крепость успеха в несчастии, в счастии – украшение, везде верный и безотлучный спутник. (Михайло Ломоносов – 1711-1765 гг. – первый русский ученый-естествоиспытатель, поэт, реформатор русского языка)
137. Неусыпный труд все препятствия преодолевает. (М. Ломоносов)
138. Разум с помощью науки проникает в тайны вещества, указывает, где истина. Наука и опыт – только средства, только способы собирания материалов для разума. (М. Ломоносов)
139. Только в бодром горячем порыве, в страстной любви к своей родной стране, смелости и энергии родится победа. И не только, и не столько в отдельном порыве, сколько в упорной мобилизации всех сил, в том постоянном горении, которое медленно и неуклонно сдвигает горы, открывает неведомые глубины и выводит их на солнечную ясность. (М. Ломоносов)

140. Фантазия пробегает весь мир, собирая идеи, относящиеся к какому-нибудь предмету. (Девид Юм – 1711-1776 гг. – английский философ, историк, экономист и публицист)
141. Важно знать не то, что есть, а то, что полезно. (Жан Жак Руссо – 1712-1778 гг. – французский писатель, мыслитель, философ)
142. Воздержанность и труд – вот два истинных врача человека: труд обостряет его аппетит, а воздержанность мешает злоупотреблять им. (Ж. Руссо)
143. Знать хорошее важнее, чем знать многое. (Ж. Руссо)
144. С первой минуты жизни надо учиться быть достойными жить. (Ж. Руссо)
145. Знание того, какими вещи должны быть, характеризует человека умного; знание того, каковы вещи на самом деле, опытного; знание же того, как их изменить к лучшему, характеризует человека гениального. (Дени Дидро – 1713-1784 гг. – философ-просветитель)
146. Люди перестают мыслить, когда перестают читать. (Д. Дидро)
147. Умный человек видит перед собой неизмеримую область возможного, глупец же считает возможным только то, что есть. (Д. Дидро)
148. Широта ума, сила воображения и активность души – вот что такое гений. (Д. Дидро)
149. Кто не знает цену времени, тот не рожден для славы. (Люк де Клапье де Вовенарг –1715-1747 гг. – французский писатель-моралист)
150. Мы слишком мало пользуемся мудростью стариков. (Вовенарг)
151. Нет покровителей надежнее, чем наши собственные способности. (Вовенарг)
152. О людях надо судить не потому, чего они не знают, а потому, что знают, – и насколько глубоко. (Вовенарг)
153. Твердый характер должен сочетаться с гибкостью разума. (Вовенарг)
154. Терпение – это искусство надеяться. (Вовенарг)
155. В каждой естественной науке заключено столько истины, сколько в ней есть математики. (Иммануил Кант –17724-1804 гг. – немецкий философ и ученый, родоначальник немецкой классической философии)
156. Умение ставить разумные вопросы есть уже важный и необходимый признак ума и проницательности. (И. Кант)

157. В том-то и заключается преимущество древних, что они во всем умели отыскать меру. (Готхольд Эфраим Лессинг –1729-1781 гг. – немецкий писатель-драматург, литературный критик-просветитель)
158. Книги суть зерцало: хотя и не говорят, всякому вину и порок объявляют. (Екатерина II Великая – 1729-1796 гг. русская императрица)
159. Дисциплина – мать победы. (Александр Васильевич Суворов – 1730-1800 гг. – русский полководец)
160. Непреодолимого на свете нет ничего. (А.В. Суворов)
161. Ученье – свет, а неученье – тьма. Дело мастера боится, и коль крестьянин не умеет сохою владеть,– хлеб не родится. (А.В. Суворов)
162. Для того чтобы какая-нибудь наука сдвинулась с места, чтобы расширение ее стало совершеннее, гипотезы необходимы так же, как показания опыта и наблюдения. (Иоганн Вольфганг Гёте – 1749-1832 гг. – немецкий поэт)
163. Кто хочет многого достигнуть, должен ставить высокие требования. (И. Гёте)
164. Гораздо легче найти ошибку, нежели истину. Ошибка лежит на поверхности, и ее замечаешь сразу, а истина скрыта в глубине, и не всякий может отыскать ее. (И. Гёте)
165. Умные люди – лучшая энциклопедия. (И. Гёте)
166. Человек, обладающий врожденным талантом, испытывает величайшее счастье тогда, когда использует этот талант. (И. Гёте)
167. Никто не знает, каковы его силы, пока их не использует. (И. Гёте)
168. Трудности возрастают по мере приближения к цели. Но пусть каждый совершает свой путь, подобно звездам, спокойно, не торопясь, но беспрерывно стремясь к намеченной цели. (И. Гёте)
169. Жизнь – это долг, хотя б она была мгновением. (И. Гёте)
170. Человек вырастает по мере того, как растут его цели. (Фридрих Шиллер – 1759-1805 гг. – немецкий поэт, драматург, теоретик искусства, историк)
171. Гениальные люди – это метеоры, призванные сгореть, чтобы озарить свой век. (Наполеон I Бонапарт – 1769-1821 гг. – французский государственный деятель, полководец, император)
172. Честь человека заключается в том, чтобы в отношении удовлетворения своих потребностей он не зависел только от своего ума. (Георг Вильям Фридрих Гегель – 1770-1831 гг. – немецкий философ)
173. Речь удивительно сильное средство, но нужно много ума, чтобы пользоваться им. (Гегель)

174. Просто удивительно, какая целеустремленность, отвага и сила воли пробуждаются от уверенности в том, что мы исполняем свой долг. (Вальтер Скотт – 1771-1832 гг. – английский писатель)
175. Будем трудиться, потому что труд – это отец удовольствия. (Стендаль –1783-1842 гг. – французский писатель)
176. Гениальный человек не есть только моральное существо, каким бывают обыкновенные люди; напротив, он носитель интеллекта многих веков и целого мира. Он поэтому живет больше ради других, чем ради себя. (Артур Шопенгауэр – 1788-1860 гг. – немецкий философ-идеалист)
177. Нет лучшего средства для освежения ума, как чтение древних классиков; стоит взять какую-нибудь из них в руки, хотя на полчаса, – сейчас же чувствуешь себя освеженным, облегченным и очищенным, поднятым и укрепленным, – как будто бы освежился купанием в чистом источнике.
178. Благословен тот, кто нашел дело в жизни; бóльшего нам не дано. (Томас Карлейль – 1795-1881 гг. – английский критик, романист, философ, историк и публицист)
179. Всякий труд благороден, и благороден один лишь труд. (Т. Карлейль)
180. Гениальность – это прежде всего выдающаяся способность быть за все в ответе. (Т. Карлейль)
181. Новая точка зрения всегда оказывается в меньшинстве. (Т. Карлейль)
182. Вдохновение есть расположение души к живому приятию впечатлений, следовательно, к быстрому соображению понятий, что и способствует объяснению оных. (Александр Сергеевич Пушкин – 1799-1837 гг. – великий русский поэт)
183. Время – это капитал работника умственного труда. (Оноре де Бальзак – 1799-1850 гг. французский писатель-романист)
184. Истинный ученый – это мечтатель, а кто им не является, тот называет себя практиком. (Бальзак)
185. Ключом ко всякой науке является вопросительный знак. (Бальзак)
186. Постоянный труд есть закон, как для искусства, так и для жизни. (Бальзак)
187. Талант – это развитие природных склонностей. (Бальзак)
188. Талант в мужчине то же, что красота в женщине, – всего лишь обещание. Для того чтобы быть подлинно великим, его сердце и характер должны быть равны его таланту. (Бальзак)

189. Чтобы дойти до цели, надо прежде всего идти. (Бальзак)
190. Будущее отныне принадлежит двум типам людей: человеку мысли и человеку труда. В сущности, оба они составляют одно целое, ибо мыслить – значит трудиться. (Виктор Гюго – 1802-1885 гг. – французский писатель)
191. Дерзай! Ценой дерзаний достигается прогресс. Все блистательные победы являются в большей или меньшей степени наградой за отвагу. (В. Гюго)
192. Воспитание – дело совести; образование – дело науки. Позднее, уже в сложившемся человеке, оба этих вида дополняют друг друга. (В. Гюго)
193. Величие народа не измеряется его численностью, как величие человека не измеряется его ростом; единственной мерой служит его умственное развитие и его нравственный уровень. (В. Гюго)
194. Почти вся тайна великой души заключается в слове настойчивость. (В. Гюго)
195. Труд в наше время – это великое право и великая обязанность. (В. Гюго)
196. Вся человеческая мудрость заключается в двух словах: ждать и надеяться! (Александр Дюма – отец – 1802-1870 гг. – французский писатель)
197. Знание существует для того, чтобы его распространять. (Ралф Уолд Эмерсон – 1803-1882 гг. американский философ-идеалист, поэт и эссеист)
198. Ничего великого никогда не было достигнуто без энтузиазма. (У. Эмерсон)
199. Сознание есть отличительный признак совершенного существа. (Людвиг Фейербах – 1804-1872 гг. – немецкий философ-идеалист)
200. Любовь к науке – это любовь к правде, поэтому честность является основной добродетелью ученого. (Л. Фейербах)
201. Не смотри на прошлое с тоской. Оно не вернется. Мудро распорядись настоящим. Оно твое. Иди вперед, навстречу туманному будущему, без страха и с мужественным сердцем. (Генри Лонгфелло – 1807-1882 гг. – американский поэт)
202. Книги просвещают душу, поднимают и укрепляют человека, пробуждают в нем лучшие стремления, острят его ум и смягчают сердце. (Уильям Теккерей – 1811-1864 гг. – английский писатель)
203. Без цели нет деятельности, без интересов нет цели, а без деятельности нет жизни. Источник интересов, целей и деятельности –

субстанция общественной жизни. (Виссарион Григорьевич Белинский – 1811-1848 гг. – русский критик, публицист)

204. Вдохновение не есть исключительная принадлежность художника: без него не далеко уйдет и ученый, без него немного сделает даже и ремесленник, потому что оно везде, во всяком деле, во всяком труде. (В. Белинский)

205. Воспитание – великое дело: им решается участь человека. (В. Белинский)

206. Создает человека природа, но развивает и образует его общество. (В. Белинский)

207. Способность творчества есть великий дар природы; акт творчества в душе творящей есть великое таинство; минута творчества есть минута великого священнодействия. (В. Белинский)

208. Только в силе воли заключается условие наших успехов на избранном поприще. (В. Белинский)

209. Ум – это духовное оружие человека. (В. Белинский)

210. В науке нет другого способа приобретения, как в поте лица; ни порывы, ни фантазии, ни стремления всем сердцем не заменят труда. (Александр Иванович Герцен – 1812-1870 гг. – русский писатель, философ)

211. Наука требует всего человека, без задних мыслей, с готовностью все отдать и в награду получить тяжелый крест трезвого знания. (А. Герцен)

212. Ничего не делается само собой, без усилий и воли, без жертв и труда. Воля людская, воля одного твердого человека – страшно велика. (А. Герцен)

213. Трудолюбие – душа всякого дела и залог благосостояния. (Чарльз Диккенс – 1812-1870 гг, английский писатель)

214. В науке нет широкой столбовой дороги, и только тот может достигнуть ее сияющих вершин, кто, не страшась усталости, карабкается по ее каменистым тропам. (Карл Маркс – 1818-1889 гг. – основоположник научного коммунизма)

215. Человеческая природа устроена так, что человек может достичь своего усовершенствования, только работая для усовершенствования своих современников, для их блага. (К. Маркс)

216. Наука – это организованное знание. (Герберт Спенсер – 1820-1903 гг. – английский ученый, философ)

217. Знание законов жизни несравненно важнее многих других знаний, и знание первейшей важности. (Г. Спенсер)

218. В деле воспитания процессу саморазвития должно быть отведено самое широкое место. Человечество всего успешнее развивалось только путем самообразования. (Г. Спенсер)
219. Всякая душа измеряется огромностью своего стремления. (Гюстав Флобер – 1821-1880 гг. – французский писатель)
220. Настойчивость смягчает судьбу. (Г. Флобер)
221. Безумцы прокладывают пути, по которым следом пойдут рассудительные. (Федор Михайлович Достоевский – 1821-1881 гг. – русский писатель)
222. Без идеалов, то есть без определенных хоть сколько-нибудь желаний лучшего, никогда не может получиться никакой хорошей действительности. (Ф. Достоевский)
223. Каждый человек несет ответственность перед всеми людьми за всех людей и за все. (Ф. Достоевский)
224. Лишь трудом и борьбой достигается самобытность и чувство собственного достоинства. (Ф. Достоевский)
225. Таланту нужно сочувствие, ему нужно, чтоб его понимали. (Ф. Достоевский)
226. Учитесь и читайте. Читайте книги серьезные. Жизнь сделает остальное. (Ф. Достоевский)
227. Важно не количество знаний, а качество их. Можно знать очень многое, не зная самого себя. (Лев Николаевич Толстой – 1827-1910 гг. – русский писатель)
228. Имей цель для всей жизни, цель для известного времени, цель для года, для месяца, для недели, для дня, и для часа, и для минуты, жертвуя низшие цели высшим. (Л. Толстой)
229. Недовольство собою есть необходимое условие разумной жизни. Только это недовольство побуждает к работе над собою. (Л. Толстой)
230. Правильный путь таков: усвой то, что сделали твои предшественники, и иди дальше. (Л. Толстой)
231. Призвание можно распознать и доказать только жертвой, которую приносит ученый или художник своему покою и благосостоянию, чтобы отдаться своему призванию. (Л. Толстой)
232. Усилие есть необходимое условие нравственного совершенствования. (Л. Толстой)
233. Весь смысл жизни заключается в бесконечном завоевании неизвестного, в вечном усилии познать больше. (Эмиль Золя – 1840-1902 гг. – французский писатель)

234. Науку часто смешивают со знанием. Это грубое недоразумение. Наука есть не только знание, но и сознание, то есть умение пользоваться знанием как следует. (Василий Осипович Ключевский – 1841-1911 гг. – русский историк.)
235. Уметь разборчиво писать – первое правило вежливости. (В. Ключевский)
236. Только для созидания должны вы учиться! (Фридрих Ницше – 1844-1900 гг. – немецкий философ)
237. Будущее – в настоящем, но будущее – и в прошлом. Это мы создаем его. Если оно плохо, в этом наша вина. (Анатоль Франс – 1844-1924 гг. – французский писатель)
238. Жить – значит действовать. (А. Франс)
239. Любознательность создает ученых и поэтов. (А. Франс)
240. Самое редкое мужество – это мужество мысли. (А. Франс)
241. Труд наилучшее лекарство, нравственное и эстетическое. (А. Франс)
242. Труд – это душа гения, сердце таланта, он – внутренний огонь всякого таланта. (А. Франс)
243. В человеке должно быть все прекрасно: и лицо, и одежда, и душа, и мысли. (Антон Павлович Чехов – 1860-1904 гг. – русский писатель)
244. Человек должен трудиться, работать в поте лица, кто бы он ни был, и в этом одном заключается смысл и цель его жизни, его счастье, его восторги. (А. Чехов)
245. Наука изощряет ум, ученье вострит память. (Козьма Прутков)
246. Усердие все превозмогает! (К. Прутков)
247. Деятельность – единственный путь к знанию. (Бернард Шоу – 1856-1950 гг. – английский драматург)
248. Жизнь для меня не тающая свеча. Это что-то вроде чудесного факела, который попал мне в руки на мгновение, и я хочу заставить его пылать как можно ярче, прежде чем передать грядущим поколениям. (Б. Шоу)
249. Воспитать человека интеллектуально, не воспитав его нравственно, – значит вырастить угрозу для общества. (Теодор Рузвельт – 1858-1919 гг. американский политический деятель, президент США)
250. Нам многое дано, и от нас многое ожидается. У нас есть обязанности перед другими людьми и перед собой; и ни одной из этих обязанностей мы не вправе пренебречь. (Т. Рузвельт)

251. Пожалуй, не существует более важной черты характера, чем твердая решимость. Юноша, который желает стать великим человеком или так или иначе оставить след в этой жизни, должен решиться не только преодолеть тысячу препятствий, но и победить, несмотря на тысячу неудач и поражений. (Т. Рузвельт)
252. Беспредельная надежда и энтузиазм – главное богатство молодежи. (Рабиндранат Тагор –1861-1941гг.– индийский писатель и поэт)
253. Жизнь ниспосылается нам даром; заслуживаем мы ее, – отдавая ее. (Р. Тагор)
254. Множество людей могут говорить хорошие вещи, но очень немногие умеют слушать, потому, как это требует силы ума. (Р. Тагор)
255. Не падай духом, брат, не отрекайся от замыслов своих первоначальных. Одна дорога у тебя, мой брат, спеши, не поворачивай назад, верши своё и не служи чужому, не бойся осуждения и преград. (Р. Тагор)
256. Плоды истинной науки и истинного искусства – это плоды жертв, а не материальных выгод. (Ромен Роллан – 1866-1944 гг. – французский писатель)
257. Доказывать человеку необходимость знания – это все равно, что убеждать его в полезности зрения. (Максим Горький –1868-1936 гг. русский писатель)
258. Труд ученого достояние всего человечества, и наука является областью наибольшего бескорыстия. (М. Горький)
259. Время – драгоценный подарок, данный нам, чтобы в нем стать умнее, лучше, совершеннее и более зрелым. (Томас Манн – 1875-1955 гг. немецкий писатель)
260. Выдающиеся личности формируются не посредством красивых речей, а собственным трудом и его результатами. (Альберт Эйнштейн – 1879-1955 гг. – немецкий физик, создатель теории относительности)
261. Достойна только та жизнь, которая прожита ради других людей. (А. Эйнштейн)
262. Настоящий прогресс человечества зависит не столько от изобретательного ума, сколько от сознательности. (А. Эйнштейн)
263. Наука не является и никогда не будет являться законченной книгой. Каждый важный успех приносит новые вопросы. Всякое развитие обнаруживает со временем все новые и более глубокие трудности. (А. Эйнштейн)

264. Невозможно решить проблему на том же уровне, на котором она возникла. Нужно встать выше этой проблемы, поднявшись на следующий уровень. (А. Эйнштейн)
265. Книга есть альфа и омега всякого знания, начало начал каждой науки. (Стефан Цвейг – 1881-1942 гг. – австрийский писатель)
266. Я полагаю, что ни в каком учебном заведении образованным человеком стать нельзя, но во всяком хорошем учебном заведении можно стать дисциплинированным человеком и приобрести навык, который пригодится в будущем, когда человек вне стен учебного заведения станет образовывать сам себя. (Михаил Афанасьевич Булгаков – 1891-1940 гг. – русский писатель)
267. Гений настолько внутренне богат, что любая тема, любая мысль, случай или предмет вызывает у него неиссякаемый поток ассоциаций. (Константин Георгиевич Паустовский –1892-1968 гг. русский писатель)
268. Если отнять у человека способность мечтать, то отпадет одна из самых мощных побудительных причин, рождающих культуру, искусство, науку и желание борьбы во имя прекрасного будущего. (К. Паустовский)
269. Знание органически связано с человеческим воображением. Этот на первый взгляд парадоксальный закон можно выразить так: сила воображения увеличивается по мере роста познаний. (К. Паустовский)
270. Самое главное – научить человека мыслить. (Бертольт Брехт – 1898-1956 гг. – немецкий писатель)
271. Единственная настоящая роскошь – это роскошь человеческого общения. (Антуан де Сент-Экзюпери –1900-1944 гг. – французский писатель)
272. Не спрашивай, что твоя родина может сделать для тебя, – спроси, что ты можешь сделать для своей родины. (Джон Кеннеди – 1917-1963 гг. – президент США)

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