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ЛАЗЕРНЫЕ И НАНОТЕХНОЛОГИИ
LASER- AND NANOTECHNOLOGIES

Учебно-практическое пособие
по английскому языку

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Предназначено для студентов вузов, обучающихся по специальностям 12.03.05 «Лазерная техника и лазерные технологии» и 28.03.01 «Нанотехнологии и микросистемная техника».

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INTRODUCTION

Учебно-практическое пособие составлено в соответствии с программами обучения иностранному языку для специальностей «Лазерная техника и лазерные технологии» и «Нанотехнологии и микросистемная техника».

Пособие состоит из двух частей:

1. Лазерные технологии.
2. Нанотехнологии.

Разделы содержат тематические списки слов для активного усвоения и упражнения, которые помогают преодолеть грамматические и лексические трудности и обеспечивают полное понимание текста. Для закрепления материала приведены задания коммуникативной направленности.

Цель пособия – расширение словарного запаса по изучаемым темам, развитие навыка чтения англоязычной профессиональной литературы, умений и навыков перевода с английского языка на русский, говорения по темам профессионального общения, а также выработка навыков аннотирования и реферирования текстов.

Составитель благодарит рецензентов: кандидата педагогических наук и доцента кафедры профессиональной языковой подготовки Владимирского юридического института Федеральной службы исполнения наказаний С. П. Фокину и кандидата филологических наук С. В. Бузину, в настоящее время заведующую кафедрой гуманитарных и естественно-научных дисциплин Владимирского филиала Российского университета кооперации, за ценные замечания, высказанные ими в процессе работы над рукописью.

UNIT I

LASER TECHNOLOGY

Text 1
Laser (Light Amplification by Stimulated Emission of Radiation)

LEARN THE WORDS:
a laser – лазер
quantum mechanics – квантовая механика
a beam of light – луч света
a photon – фотон
a coherent state – когерентное состояние
frequency – частота
a phase – фаза
a light source – источник света
to emit – излучать
an excited state – возбужденное состояние
optical pumping – оптическая накачка
a mirror – зеркало
to amplify – усиливать
a hole – отверстие
to escape – исчезать
electromagnetic radiation – электромагнитное излучение
a maser – мазер
microwave – микроволново́й
a particle – частица

Definition: A **laser** is a device which is built on the principles of **quantum mechanics** to create **a beam of light** where all of the **photons** are in **a coherent state** – usually with the same **frequency** and **phase** (Most **light sources emit** incoherent light, where the phase varies randomly). Among the other effects, this means that the light from a laser is often tightly focused and does not diverge much, resulting in the traditional laser beam.

How a Laser Works

In simplest terms, a laser uses light to stimulate the electrons in a "gain medium" into an **excited state** (called **optical pumping**). When the electrons collapse into the lower-energy unexcited state, they emit photons. These photons pass between two **mirrors**, so there are more and more photons exciting the gain medium, "**amplifying**" the intensity of the beam. A narrow **hole** in one of the mirrors allows a small amount of the light **to escape** (i. e. the laser beam itself).

Other Types of Laser

The "light" of a laser does not need to be in the visible spectrum but can be any sort of **electromagnetic radiation. A maser**, for example, is a type of laser that emits **microwave** radiation instead of visible light (The maser was actually developed before the more general laser. For a while, the visible laser was actually called an optical maser, but that usage has fallen well out of common usage). Similar methods have been used to create devices, such as an "atomic laser," which emit other types of particles in coherent states.

Examples by Power

Laser application in astronomical adaptive/optics imaging.

Different applications need lasers with different output powers. Lasers that produce a continuous beam or a series of short pulses can be compared on the basis of their average power. Lasers that produce pulses can also be characterized based on the *peak* power of each pulse. The peak power of a pulsed laser is many orders of magnitude greater than its average power. The average output power is always less than the power consumed.

The continuous or average power required for some uses:

Power	Use
1 – 5 mW	Laser pointers
5 mW	CD-ROM drive
5 – 10 mW	DVD player or DVD-ROM drive
100 mW	High-speed CD-RW burner
250 mW	Consumer 16× DVD-R burner
400 mW	Burning through a jewel case including disc within 4 seconds DVD 24× dual-layer recording.
1 W	Green laser in current Holographic Versatile Disc prototype development
1 – 20 W	Output of the majority of commercially available solid-state lasers used for micromachining
30 – 100 W	Typical sealed CO_2 surgical lasers
100 – 3000 W	Typical sealed CO_2 lasers used in industrial laser cutting

TASK: Make a summary to the text.

Text 2
Lasers and Masers

LEARN THE WORDS:

a light wave – световая волна
length – длина
to increase – увеличивать
a neutron – нейтрон
a proton – протон
liquid – жидкость, жидкий
solid – твердый
a semiconductor – полупроводник

to join – соединять
a drill – дрель
steel – сталь
a diamond – алмаз
holography – голография
a photograph – фотография
a molecule – молекула
an amplifier – усилитель
to oscillate – колебаться
accuracy – точность

A laser is a machine for making and concentrating **light waves** into a very intense beam. The light made by a laser is much more intense than ordinary light. With ordinary light, all the light waves are different **lengths**. With lasers, all the light waves have the same length, and this **increases** the intensity.

Atoms are made up of **neutrons**, electrons and **protons**. The electrons circle round the protons and neutrons. In a laser, the electrons are "excited" to a high energy level. As the electrons fall back from their "excited" state to their normal state, they give off energy. This energy is given off as light which can be seen. A number of materials have this property including some gases, **liquids**, **solids** and **semiconductors**. Thus, a number of different types of lasers have been developed.

Lasers are now used for many scientific, medical and industrial purposes. The thin beam of light gives a lot of heat and it is used **to join** metal when a very small joint is needed. The beam can also be used as **a drill**, to make holes in **steel**, or even in **diamonds**. Because the beam is so small, it's very important in delicate **surgery** and is used in eye operations.

Lasers are also used in **holography**. A hologram is a three-dimensional image, a bit like **a photograph**. It's different from a photograph because it looks solid. As you walk round a hologram, it changes, as if it were real. Now holography is used for testing engineering ideas. An engineer can use a hologram to build up and check a new building such as a bridge. He can find out all about it before he builds it.

The word MASER is also an acronym – for Microwave Amplification by Stimulated Emission of Radiation. The maser is operated on the same principle as the laser except that the wavelengths generated are much longer and therefore the energy jumps involved are smaller. The excited bodies in a maser are **molecules** rather than atomic electrons and the beam generated is a coherent beam of microwaves which is not visible to the eye.

Masers have made revolutionary advance possible in a number of different fields. They are up to 1 000 times more sensitive than any other type of **amplifiers**. Maser amplifiers mounted on radio telescopes can increase even their great range by a factor of 10, allowing us to reach out to the bounds of the known universe. Because of the very constant frequency with which masers can be made **to oscillate** they can be used as master controls for atomic clocks of unbelievable **accuracy**: an error not exceeding 1 second in 10 000 years has already been achieved.

The idea of using stimulated emission of radiation for amplification of very short waves came from A. Prokhorov and N. Basov of the Lebedev Institute in Moscow.

TASKS:

1. Say whether the following statements are true or false*:*

1. The light made by a laser is much more intense than ordinary light. 2. With ordinary light, all the light waves have the same length. 3. With lasers all the light waves have different length. 4. A laser concentrates light waves into a very intense beam.

2. Answer the following questions on paragraph 2:

1. What are atoms made up of? 2. To what level are the electrons excited in a laser? 3. When do they give off energy? 4. In what form is this energy given off?

3. Find the place in paragraph 3 containing the information of the uses of lasers. Render this information to your group-mate.

4. In paragraph 4 find the English equivalents of the following words:

голография, голограмма, объемное изображение, выглядеть, испытывать, проверять, выяснять.

5. Make an abstract of the text.

Text 3
How a Laser Works

LEARN THE WORDS:

an electron – электрон
an energy level – энергетический уровень
an atom – атом
a nucleus – ядро
an outer ring – внешнее кольцо
an inner ring – внутреннее кольцо
a flash of light – вспышка света
a wavelength – длина волны
to absorb – поглощать
ruby – рубиновый
a cylinder – цилиндр
a high-intensity lamp – лампа высокой интенсивности
to spiral – вращаться вокруг
to trigger – инициировать, вызывать
chromium – хромовый
to reflect – отражать
a crystal – кристалл
to drain the energy – слить энергию
voltage – напряжение
a quartz flash – вспышка кварца
a burst of light – пучок света
emission – излучение

Lasers are possible because of the way light interacts with **electrons**. Electrons exist at specific **energy levels** or states characteristic of that particular **atom** or molecule. The energy levels can be imagined as rings or orbits around **a nucleus**. Electrons in **outer rings** are at higher energy levels than those in **inner rings**. Electrons can be bumped up to higher energy levels by the injection of energy, for example, by **a flash of light**. When an electron drops from an outer to an inner level, "excess" energy is given off as light. The **wavelength** or colour of the emitted light is precisely related to the amount of energy released. Depending on the particular lasing material being used, specific wavelengths of light are **absorbed** (to energize or excite the electrons) and specific wavelengths are emitted (when the electrons fall back to their initial level).

For a **ruby** laser, a crystal of ruby is formed into **a cylinder**. A fully reflecting mirror is placed on one end and a partially reflecting mirror on the other. **A high-intensity lamp** is **spiraled** around the ruby cylinder to provide a flash of white light that **triggers** the laser action. The green and blue wavelengths in the flash excite electrons in the **chromium** atoms to a higher energy level. Upon returning to their normal state, the electrons emit their characteristic ruby-red light. The mirrors **reflect** some of this light back and forth inside the ruby **crystal**, stimulating other excited chromium atoms to produce more red light, until the light pulse builds up to high power and **drains the energy** stored in the crystal.

High-**voltage** electricity causes the **quartz flash** tube to emit an intense **burst of light**, exciting some of the atoms in the ruby crystal to higher energy levels.

At a specific energy level, some atoms emit particles of light called photons. At first the photons are emitted in all directions. Photons from one atom stimulate **emission** of photons from other atoms and the light intensity is rapidly amplified.

Mirrors at each end reflect the photons back and forth, continuing this process of stimulated emission and amplification.

The photons leave through the partially silvered mirror at one end. This is laser light.

TASKS:

1. **Make up 7 – 8 questions to the text.**
2. **Make an abstract of the text.**

Text 4
Laser Technology

LEARN THE WORDS:
application – применение
cutting – резка
welding – сварка
machining – обработка
machine tool – станок
a consumer – потребитель
domestic – домашний, внутренний, отечественный
to estimate – определять, оценивать, оценка
influence – влияние
complexity – сложность
rotary – вращательный, ротативный
an axe – ось

In the last decade there was outstanding progress in the development of laser technology and its **application** in science, industry and commerce. Laser **cutting**, **welding** and **machining** are beginning to be big business. The market for laser systems represents around 2,5 % of the world **machine tool** market. Which country is the biggest producer and **consumer** of lasers? Japan, naturally: Japan produced 46 % of world's lasers in 1989, while figures for Europe and the USA were 32 % and 22 %. Japan is building 1200 to 2000 of carbon oxide (CO); lasers per year of which some 95 % are over 500 W power and 80 % of them are used for cutting operations. Europe is the second largest user and the third largest producer. In 1990 Europe's market for lasers was $128 million, of which Germany consumed about $51 million, and Italy – $12 million. The

Germany met 90 % of its demands through **domestic** producers. Growth rate of the European market **is estimated** at 10 to 15 % per year. In future the main trend **influencing** the industry will be laser source prices. The prices are dropping. There appear lasers of modular construction. The **complexity** of laser machines is rising. Multi-axes systems are in more use now. Recently 7-axis CNC laser machining center has been introduced. In addition to X, Y and Z axes, there are two **rotary axes**, A and C, and two more linear axes, U and V, to give a trepanning (прорезать большие отверстия) motion to the laser.

TASKS:

1. Answer the following questions to the text:

1. What can you say about laser technology in the last decade? 2. What is the beginning of big business? 3. Which country is the biggest producer and consumer of lasers? 4. What is the growth rate of laser using and producing in the European countries? 5. What is the future of laser technology? 6. In what spheres is the laser used mostly?

2. Make an abstract of the text.

Text 5
Lasers Today and Tomorrow

LEARN THE WORDS:

to prevent – препятствовать
to travel – двигаться
narrow – узкий
intense – интенсивный
to spread – распространять(ся)
a partial mirror – полупрозрачное зеркало
a power supply – источник питания
to approach – приближаться, достигать
to foresee (foresaw; foreseen) – предвидеть
to employ – использовать
to carry – передавать

The laser has become a multipurpose tool. It has caused a real revolution in technology. Atoms emit rays of different length which **prevents** the forming of an intense beam of light. The laser forces its atoms to emit rays having the same length and **travelling** in the same direction. The result is a **narrow**, extremely **intense** beam of light that **spreads** out very little and is therefore able to travel very great distances. The most common laser is the helium-neon laser in the laser tube, there being 10 per cent helium gas and 90 % neon gas. At the end of the tube there is a mirror, and at the other end there is **a partial mirror**. The electrons get energy from **a power supply** and become "excited", giving off energy as light. This light is reflected by the mirror at one end of the tube. It can only escape through the partial mirror at the other end of the tube. The first laser having been built in 1960, scientists developed several types of lasers which make use of luminescent crystals, luminescent glass, a mixture of various gases and finally semiconductors. Having been developed at the Lebedev Institute of Physics in 1962, semiconductor quantum generators occupy a special place among the optical generators. While the size of a ruby crystal laser comes to tens of centimeters and that of a gas generator is about a meter long, a semiconductor laser is a few tens of a millimeter long, the density of its radiation being hundreds of thousands of times greater than that, of the best ruby lasers. But the most interesting thing about semiconductor lasers is that they are able to transform electric energy directly into light wave energy. They perform it with an efficiency **approaching** 100 % as compared with a maximum of about 1 % of other lasers, this property of semiconductor lasers opening up new possibilities of producing extremely economical sources of light. But it is in the field of communication that the laser will find its most extensive application in future. Scientists **foresee** the day when a single laser beam will be **employed to carry** simultaneously millions of telephone conversations or a thousand of television programmes. It will serve for fast communications across continents, under the sea, between the Earth and spaceships and between men travelling in space. The potential importance of these applications continues to stimulate new development in the laser field.

TASKS:

1. Answer the following questions to the text:

1. What is a laser? 2. What is a function of a laser? 3. What beam of light does a laser produce? 4. When was the first laser built? 5. What types of quantum generators did scientists develop after 1960? 6. What type of laser is the most common at present? 7. Where will a laser find the most extensive applications in future?

2. Make an abstract of the text.

Text 6
The Use of Lasers

LEARN THE WORDS:

a structure – структура
a property – свойство
a condition – условие
a compound – компонент
to remove impurities – удалять примеси
a cardboard – картон
precision – точность
to vaporize – испарять
to retool – переоборудовать
to sharpen – точить
an acetylene torch – ацетиленовая горелка
a warehouse – склад
a fabric – ткань
dull – тупой
a diode – диод
a microchip – микрочип
mining – рудник, шахта
a shaft – вал
approximately – приблизительно

optical fiber – оптическое волокно
to booster – усиливать
to expose laser light – подвергать действию лазерного луча
to strew the laser light – посыпать лазерный луч
an interference pattern – интерференционный узор
to diffract – преломлять
near-sighted condition – близорукость
a tumor – опухоль
a tissue – ткань
a missile guidance system – система наведения ракет
a target – цель
a satellite – спутник
a warhead – боеголовка
a turnable dye laser – поворотный лазер на красителе
an isotope – изотоп

Lasers have revolutionized many fields such as science research, manufacturing, communication, photography, medicine and military applications.

Science Research

Lasers have transformed chemistry research. Scientists use lasers to study the **structure** of atoms and molecules. They also use them to determine how their **properties** change under different **conditions**. Scientists can make new **compounds**, break down elements and **remove impurities** from compounds.

Manufacturing

Manufacturers of large equipment, computer chips, plastics and **cardboard** have all seen the changes that lasers have brought to their different industries.

Manufacturers of large equipment use lasers for **precision** drilling and cutting by **vaporizing** the unwanted material (ex. where the hole is). This technique is used for hard materials such as steel and diamonds. There is less waste by-products when using lasers because it vaporizes the material. This saves companies time and money because they do not have

retool the machine or to have tools **sharpened**. It has also made it safer for the workers because they can be in a separate room out of the danger. These lasers can do precision welding. It does not make the metal hot like a conventional **acetylene torch** therefore it does not weaken metal.

Warehouses where plastic, cardboard and heavy **fabrics** are produced use lasers to cut quickly and accurately through the sheets of materials. This cuts down on the cost of manufacturing because a laser never gets **dull**.

Computer manufacturers use lasers to treat semiconductor chips. They also use the laser to do precision welding in glass tubes such as resistors, **diodes**, transistors and many other **microchips**. This has enabled computer companies to **decrease** the size of the computer and increase the processing speed of the computer.

Mining

Another area in industry where lasers are used is **mining**. They use the laser to precision **digging** and drilling. Mine safety people use lasers to test **shafts** in the mine for cracks. The laser shoots the beams in all directions and from that a computer can tell the size, shape, and if there are any cracks in the tunnel or digging area. This is a very valuable tool because it cuts down on the chance of an accident.

Communication

The laser has revolutionized communication. Because of the high frequency of laser light it can carry **approximately** 1000 times the TV channels as carried by microwaves. This makes lasers the ideal tool for space communication. Lasers are now being used for communication on earth such as telephones and computer systems. This is made possible by low-loss **optical fibers** also known as fiber optics. With use of fiber optics, signals can be sent up to 100 kilometers before you need a signal **booster** compared to the current system where you needed a signal booster every 1.5 kilometers.

Photography

Lasers can produce a type of three-dimensional image called holograms. Holograms are made by **exposing laser light** to a piece of film.

The object that is being holographed **strews the laser light**. The piece of film being holographed is also being exposed to light coming directly from the laser this is the reference beam. These two beams of laser light become disharmonious with one another because they are traveling from different paths. The film then records the **interference pattern**, between the two light beams, which is the hologram. To view the hologram you simply pass a beam of light through the film and it **diffracts** due to the interference pattern on the film and reproduces the original image.

Medicine

Lasers have advanced medicine in so many different ways from eye surgery to plastic surgery. Doctors are always finding new ways that lasers can be used to make procedures easier to perform and to shorten the length of the procedure and easier on the patient in terms of recovery time.

Many private companies are using lasers to correct vision problems. Lasik (Laser-In-Situ Keratomileusis) is the most common technique for correcting the **near-sighted condition**. The procedure takes about five to ten minutes per eye depending upon how bad the eyesight of the person is. If the surgery is successful you should not have to wear glasses again for the treated condition.

Doctors who perform plastic surgery find the laser very helpful in many different areas. They can now remove a tattoo by simply burning it off with a laser. Although this procedure is relatively painful, the pain does not last long. When doing plastic surgery the doctors will use laser to cut into or underneath the skin. As the doctor cuts the capillaries the laser automatically seals the blood flow preventing blood loss making for a cleaner surgery. The benefit to using lasers in this instance is time savings.

Lasers can easily vaporize surface **tumors**. Surgeons also use them for cutting many of the human organs instead of a scalpel because they can make a more precise cut in the **tissue** around affected area. The laser will not damage the tissue surrounding the cut.

Dentists use lasers to burn out diseased parts of teeth. This is a lot quicker and less painful then drilling the tooth. It also does a much cleaner job and is easier for the dentist to fill afterwards.

Military

The military is main use for lasers is for their **missile guidance systems**. These systems currently need someone close to the **target** with a laser beam to point at the target to guide the missile to it. They have already started the construction of **satellites** that will be able to do this job from space. The United States is proposing to use lasers as an anti-missile system. The laser would send a concentrated beam of laser light at a missile and destroy the missile in the air. The military and the United States government have already started testing laser beams that will be able to destroy spy satellites.

The laser is instrumental in the making of nuclear **warheads**. Using the **turnable dye laser**, scientists are now able to selectively excite atoms or molecules which in return has opened up more successful ways to separate **isotopes** in the construction of nuclear warheads.

TASKS:

1. **Make an annotation to the text.**
2. **Make an abstract of the text.**

Text 7
Optical Technology

LEARN THE WORDS:
optical fiber – оптическое волокно
a wire – провод
a cable – кабель
capacity – производительность
performance – (здесь) работа
reliability – надежность
virtually – фактически
a conductor – проводник
silicon – кремний
a pulse of light – импульс света

amplification – усиление
a circuit – цепь
simultaneously – одновременно
surface – поверхность
versatile – многофункциональный

One of the most interesting developments in telecommunication is the rapid progress of optical communication where optical fibers are replacing conventional telephone wires and cables. Just as digital technologies greatly improved the telephone system, optical communication promises a considerable increase in capacity, quality, performance and reliability of the global telecommunication network. New technologies such as optical fibers will increase the speed of telecommunication and provide new, specialized information service. Voice, computer data, even video images, will be increasingly integrated into a single digital communication network capable of processing and transmitting virtually any kind of information.

It is a result of combining two technologies: the laser, first demonstrated in 1960, and the fabrication 10 years later of ultra-thin silicon fibres which can serve as lightwave conductors. With the further development of very efficient lasers plus continually improved techniques to produce thin silica fibres of incredible transparency, optical systems can transmit pulses of light as far as 135 kilometers without the need for amplification or regeneration. At present high-capacity optical transmission systems are being installed between many major US cities at a rapid rate. The system most widely used now operates at 147 megabits per second and accommodates 6 000 circuits over a single pair of glass fibres (one for each direction of transmission).

This system will soon be improved to operate at 1.7 gigabits per second and handle 24 000 telephone channels simultaneously. A revolution in information storage is underway with optical disk technology.

The first digital optical disks were produced in 1982 as compact disks for music. They were further developed as a storage medium for computers. The disks are made of plastics coated with aluminium. The information is recorded by using a powerful laser to imprint bubbles on the surface of the disk. A less powerful laser reads back the pictures, sound or information. An optical disk is almost indestructible and can store about 1000 times more information than a plastic disk of the same size. One CD-ROM disk (650 MB) can replace 300 000 pages of text (about 500 floppies), which represents a lot of savings in databases.

The future of optical storage is called DVD (digital versatile disk). A DVD-ROM can hold up to 17 GB, about 25 times an ordinary CD-ROM. For this reason, it can store a large amount of multimedia software and complete full-screen Hollywood movies in different languages. However, DVD-ROMs are "read-only" devices. To avoid this limitation, companies also produce DVD rewritable drives. Besides, it is reported that an optical equivalent of a transistor has been produced and intensive research on optical electronic computers is underway at a number of US companies as well as in countries around the world.

It is found that optical technology is cost-effective and versatile. It finds new applications every day – from connecting communication equipment or computers within the same building or room to long distance transcontinental, transoceanic and space communications.

TASKS:

1. Give English equivalents:

обычные телефонные провода и кабели, цифровые технологии, надежность, объединять в одно целое, проводник световых волн, усиление, устанавливать, развивать, представлять собой, оптико-электронный компьютер, рентабельный.

2. Give Russian equivalents:

capacity, computer data, transmitting information, ultra-thin silicon fibres, incredible transparency, regeneration, an optical disk technology, coated, a database, multimedia software, rewritable drive, cost-effective, application.

3. Match up:

optical	conductors
conventional	bubbles
silicon	medium
lightwave	communication
storage	software
to imprint	telephone wires and cables
multimedia	fibres

4. Fill in the blanks:

1.7 gigabits, digital communication network, cost-effective and versatile, high-capacity optical transmission systems, transistor, digital technologies, coated, information storage.

1. Just as … greatly improved the telephone system, optical communication promises a considerable increase in capacity, quality, performance and reliability.

2. Voice, computer data, even video images will be increasingly integrated into a single … .

3. At present … are being installed between many major US cities at rapid rate.

4. This system will soon be improved to operate at … per second.

5. A revolution in … is underway with optical disk technology.

6. The disks are made of plastics … with aluminium.

7. It is reported that an optical equivalent of a … has been produced.

8. It is found that optical technology is … .

5. Put in the right proposition:

1. You communicate with your computer … the keyboard.

2. The instruction manuals … most software applications contain a section describing the functions … each key.

3. The mouse works … sliding it around (ball down) … a flat surface.

4. You will see the arrow … your screen moving … unison.

5. That's the only part the computer pays attention … .

6. Your computer is not complete … the monitor.

7. The sharpness … the picture depends … the number and size … these pixels.

8. Some … the controls … the monitor change the size and position … the image.

9. Windows includes a number … screen savers.

10. The drives can read and write … floppy diskettes.

11. The amount and variety … material you can access … CD-ROM is amazing.

12. If a diver wants to know an accurate depth he is down, he must set water type he is… .

13. If a diver wants to know how long he has been down, he can see this … the display.

14. Before he descends, the diver sets the time … ascend.

15. Optical communication promises a considerable increase … capacity, quality, performance and reliability … the global telecommunication network.

16. The system most widely used now operates … 147 megabits (thousand bits) per second.

17. The first digital optical disks were produced … 1982 as compact disks … music.

18. The information is recorded … using a powerful laser to imprint bubbles … the surface … the disk.

6. Put the verbs into the correct tense form:

a. In the nearest future digital communication network (to allow) to process and transmit voice, computer data and video images.

b. Invention of the laser and thin silicon fibres (to make) it possible to transmit pulses of light without amplification and regeneration.

c. New high-capacity optical transmission systems (to operate) between many major US cities.

d. Another revolution (to concern) optical disk technology.

e. An optical disk (to be) capable of storing about 1000 times more information than a plastic disk of the same size.

7. Answer the following questions:

1. Which is one of the most interesting developments in telecommunication nowadays?
2. What does optical communication promise?
3. What are the capabilities of optical fibers?
4. What are the perspectives of optical fibers?
5. Why is the system developing rapidly now?
6. What are the advantages of using compact discs?
7. How much information can a DVD-ROM hold?
8. Where can optical technology be used?

Text 8
Peaceful Atoms

LEARN THE WORDS:

atomic energy – атомная энергия
fissioned nucleus – расщепленное ядро
fuel – топливо
a radioactive source – радиоактивный источник
a nuclear installation – ядерная установка
to recharge – перезаряжать
thermonuclear – термоядерный
fusion – плавление, сплав
an inexhaustible source – неисчерпаемый источник
annihilation – уничтожение

Achievements in studying atom structure have opened up new, practically unlimited possibilities to humanity for further mastering nature's forces. The discovery of **atomic energy** provides as profound effect for the benefit of civilization as the discovery of fire and electricity. After having recovered from the shock of unimaginable horror of the explosion of the atomic bomb over Hiroshima people asked scientists how soon they would be able to apply the immense power of **fissioned nucleus** to peaceful purposes. Many problems had to be solved: the main one was that of "braking" the released neutrons efficiently so that the chain reaction could be controlled. The "classical" solution of this question is conducting the heat generated by the fission process out of the reactor, making it boil water and forcing the resulting steam to drive turbines which, in their turn, drive electric generators. It is a way which works well although it is still rather expensive. It is to be noted that the first power station fed by atomic **fuels** which was also the world's first atomic power station started working in Obninsk, near Moscow, in 1954. Its capacity was 5 000 kilowatts. Thirty years later in the Soviet Union there were already 13 atomic power stations with the total capacity of over 21 million kilowatts. At the same time with large atomic stations smaller mobile electricity producing units have been created based on the discovery of **radioactive sources** – isotopes. Mobile **nuclear installation** may be carried by rail and then by transporters to the out-of-the-way regions even in areas having no roads. Such a station according to estimates can operate without being **recharged** for two years. Today scientists are looking for new more efficient nuclear process of producing energy. But it was only lately that the physicists understood that the process of producing tremendous energy by stars, including our Sun, was the very process they were looking for. Now we know that this **thermonuclear** process is called **fusion** and it takes place at fantastically high temperatures. It can be done only by imitating on the Earth the process that makes the Sun shine. There are many difficult problems to overcome before thermonuclear power station based on this process can become a reality, but the problem of fuel supply is the least of them: the oceans of the Earth are practically an **inexhaustible source** of **deuterium** which plays the decisive part in the fusion process and its extraction from sea water is neither complicated nor expensive. In short, peaceful uses of atomic energy are vast – but we must stop using it on weapons of mass **annihilation**.

TASK:

Answer the questions:

1. What possibilities have the achievements in the study of atom structure opened up?
2. What question did people ask scientists after the explosion of the first atomic bomb?
3. What was the main problem in applying the immense power of fissioned nucleus to peaceful purposes?
4. When and where did the first atomic power station start working?
5. What was its capacity?
6. Why are mobile nuclear installations convenient?
7. How long can they operate without being recharged?
8. What thermonuclear process takes place at fantastically high temperatures?
9. What element plays the decisive part in fusion process?
10. What can this element be extracted from?

Text 9
The Electro-Ionizing Laser

LEARN THE WORDS:
correct – правильный
to list – перечислять
to process – обрабатывать
tremendous – огромный
capabilities – возможности
to sound – звучать
carbon dioxide – двуокись углерода
to weld – сваривать
pulse duration – продолжительность импульса
nearly – почти

The 20th century was often called the age of the atom, the age of polymers or the space age. It would be equally **correct** to call it the age of the laser.

It is impossible **to list** all the jobs the laser can do. It has become a part of our life being used in various industries, medicine, biology, etc. It should be mentioned that all the methods we know of **processing** materials with the laser were suggested not long ago. Physicists knew of the **tremendous capabilities** of the laser beam, but they could not be realized until the laser of adequate capacity was developed. To make a laser device really useful the radiation intensity had to be increased (since capacity determines productivity) and high beam efficiency created.

Creating a highly effective laser device is still one of the main problems of quantum electronics. In a gas laser device all one has to do in order to increase the capacity is to increase the volume and the pressure of gas. This **sounds** simple, but the doing of it is not.

The best results were achieved with electro-ionizing laser devices (EILs) operating on **carbon dioxide**. They have found a wide field of application. EILs of some 10-kilowatt capacity can **weld** and cut metal; pulse EILs with radiation energy of 10 kilojoules and a **pulse duration** can heat plasma to **nearly** thermonuclear temperatures.

TASKS:

1. **Complete the sentences according to the text.**

1. The list of jobs the laser can do is...
   a) limited;
   b) very short;
   c) so long that it is impossible to name all of them.
2. The laser productivity is determined by...
   a) radiation intensity;
   b) the volume of gas in a laser tube;
   c) the size.
3. One of the main problems of quantum electronics is...
   a) creating a very small laser device;
   b) creating a laser device which would operate in various conditions;
   c) creating a highly effective laser device.

2. Fill in the gaps with the words from the list below:

1. One cannot ... all the jobs which the laser can do.
2. Scientists say that the ... of the laser are tremendous.
3. The laser is widely used for ... and ... metals.
4. The gas lasers operating on … ... has found a wide field of application.

Text 10
Laser – Technology for the Future

LEARN THE WORDS:

to pierce – прокалывать
hard substance – твердая материя
a diamond – алмаз
accuracy – точность
precisely – точно
a skin blemish – дефект кожи

Lasers are devices which produce pure intense beams of light or radiation. When they were first invented in 1960 nobody quite knew what to do with them. At that time they were called "a solution waiting for a problem". The beam of a laser can be focused very precisely which means that it can be used in tasks as simple as cutting cloth and piercing leather, and as delicate and sensitive as destroying a single cell of living tissue. The strength of the laser is such that it can pierce very hard substances such as diamonds and metals.

Laser's accuracy as a means of measurement has helped scientists to calculate the speed of light more precisely than ever before, and with the help of laser reflectors placed on the Moon by American astronauts to determine its exact distance from the Earth.

Surgeons performing operations have found the laser to be also a surgical knife. Skin blemishes can also be removed by means of a laser.

There are suggestions that laser beams may replace cables in telecommunications. One of the most interesting uses is in the world of newspapers. The Los Angeles "Times" is "written" by a helium/neon laser.

Finally, a whole new area of optics is being opened by lasers.

TASKS:

1. Find Russian equivalents:

1. A device	a. Решение
2. A beam	b. Прибор
3. A solution	c. Сила
4. Strength	d. Точность
5. Leather	e. Луч
6. A diamond	f. Измерение
7. Accuracy	g. Кожа (животных)
8. Measurement	h. Средства
9. Distance	i. Алмаз
10. A knife	j. Нож
11. Means	k. Расстояние
12. A blemish	l. Повреждение, пятно

2. Translate the verbs and give their three forms:

to be, to know, to mean, to write, to find.

3. Choose the correct variant:

1. The laser _________ pierce even diamonds and metals.

a) was;

b) can;

c) has;

d) were.

2. The beam of a laser can also __________ cables in telecommunications.

a) mean;

b) determine;

c) use;

d) replace.

3. Laser _________ a new area of optics.

a) opens;

b) knows;

c) removes;

d) helps.

4. ___________ use the laser as a surgical knife.

a) area;

b) helium;

c) diamonds;

d) surgeons.

4. Choose the correct variant of translation:

1. Laser's accuracy as a means of measurement has helped scientists to calculate the speed of light.

a) Учёные точно подсчитали скорость света с помощью лазера.

b) Такое средство измерения, как лазер, помогло учёным вычислить скорость света.

c) Точность лазера как средства измерения помогла учёным вычислить скорость света.

2. One of the most interesting uses of the laser is in the world of newspapers.

a) Одним из наиболее интересных путей использования лазера является его использование в газетном мире.

b) Лазер вызвал большой интерес в мире газет.

c) Использование лазера в газетном мире весьма интересно.

Text 11
Albert Einstein

LEARN THE WORDS:
age – возраст
among – среди
contribution – вклад
to equal – равняться
relativity – относительность
an equation – уравнение
to establish – устанавливать
to solve – решать (проблему)

Albert Einstein, a well-known German physicist and mathematician, was born in Germany on March 14, 1879. His unusual ability to mathematics and physics began to show itself at a technical school in Zurich. At the **age** of 21, after four years of university study, Albert Einstein got a job as a clerk in an office. But already in 1905 he made revolutionary discoveries in science. He published three papers in the field of physics and mathematics. In the first he explained the photoelectric effect by means of Plank's quantum theory. The second paper developed a mathematical theory of Brownian motion. He presented his third paper on "Special Theory of **Relativity**" to a physical journal. Einstein expressed his theory in the **equation** $E = mc^2$, roughly that energy **equals** mass times the square of the speed of light. All over the world scientists read the work with great surprise. Few physicists understood its importance at that time. Everybody wanted to know as much as possible about the author. In which institute did he teach? In what laboratory did he do his research? Einstein's fame **among** scientists grew slowly but surely. For a few years he lived in Prague where he worked as a professor. When he came to Prague, he often told his students: "I shall always try to help you. If you have a problem, come to me with it, we shall **solve** it together". He liked questions and answered them at once, for there were no simple or foolish questions for him. He spoke much with his students about scientific problems and his new ideas. His advice to students was "Don't take easy problems". In 1921 Einstein got the Nobel Prize in physics not for the theory relativity but for a logical explanation of the photoelectric effect.

After the Great October Socialist Revolution in Russia Einstein became a true friend of the young Socialist Republic. He **establish**ed scientific contacts with his colleagues in Soviet Russia. In 1922 he became a foreign member of the Russian Academy of Sciences for his outstanding c**ontributions** to physics and mathematics. On March 14, 1979 by UNESCO decision all people throughout the world celebrated the birth centenary of the great 20th century scientist.

NOTES: Albert Einstein – Альберт Эйнштейн (1879 – 1955); Zurich – Цюрих (город в Швейцарии); Plank – Макс Планк (1858 – 1947), выдающийся немецкий физик; Brownian motion – броуновское движение; Brown – Роберт Броун (1773 – 1858), шотландский ботаник; Prague – Прага.

TASKS:

1. Answer the questions:

1. What was Einstein? 2. When and where was he born? 3. What discoveries did Einstein make in 1905? 4. In what equation did he express his theory of relativity? 5. Did many scientists of that time understand the importance of his discovery? 6. What prize did Einstein get in 1921? 7. What anniversary did people throughout the world celebrate in 1979?

2. Speak about Albert Einstein and his contribution to the science.

UNIT II
NANOTECHNOLOGY

ENTRY TEST

1. Nanotechnology is…

a) a method of substance manipulation at the atomic and molecular level;

b) a method of metal treatment;

c) a method of working with tiny objects.

2. Whom did the idea of creating ROSNANO belong to?

a) D. Medvedev;

b) V. Putin.

3. What flower gave its name to the nanopolymer?

a) a rose;

b) a lotus;

c) a camomile.

4. What is the achievement in nanomedicine?

a) nanorobots;

b) a nanocapsule;

c) a nanolaser.

5. What is measured in nanometers?

a) atoms;

b) molecules;

c) viruses.

6. One nanometer is…

a) one billionth of a meter;

b) one millionth of a meter;

c) one trillionth of a meter.

7. The first scientist who used a nanometer as a unit of measurement was…

a) R. Feynman;

b) E. Ruska;

c) A. Einstein.

8. The nanomaterial with the illusion effect is…

a) a grapheme;
b) a fullerene;
c) a colloid.

9. What is the useful data volume recorded from the DNA with the help of nanotechnology?

a) 2 megabits;
b) 5,2 megabits;
c) 5,2 megabytes.

10. Which scientist was the first to introduce the notion of nanotechnology?

a) Norio Taniguchi;
b) Richard Feynman;
c) Albert Fert.

11. What kind of machine is there in the nanotechnology world?

a) a nanoautomobile;
b) a nanorobot;
c) a nanoplane.

12. What animal uses nanotechnology to move?

a) a fly;
b) a gecko;
c) a jelly fish.

13. Which of these people is against the nanotechnology development?

a) Papa Benedict XVI;
b) Prince Charles;
c) Kim-Chen In.

14. What material can prevent bleeding?

a) bandage;
b) glue;
c) plaster.

15. What covering can protect the surface from getting dirty?

a) Ultra-Ever Dry;
b) AntiFog;
c) astrohim.

Text 1
What is Nanotechnology?

LEARN THE WORDS:
nanotechnology – нанотехнология
atomic – атомный
molecular – молекулярный
a structure – структура
a nanometre – нанометр
self-assembly – самосборка
application – применение
biomaterials – биоматериалы

Nanotechnology is the study of manipulating matter on an **atomic** and **molecular** scale. Generally, nanotechnology deals with **structures** sized between 1 to 100 **nanometre** in at least one dimension, and involves developing materials or devices within that size.

Nanotechnology is very diverse, ranging from conventional device physics to completely new approaches based upon molecular **self-assembly**, from developing new materials with dimensions on the nanoscale to investigating whether we can directly control matter on the atomic scale.

There is much debate on the future implications of nanotechnology. Nanotechnology may be able to create many new materials and devices with a vast range of **applications**, such as in medicine, electronics, **biomaterials** and energy production. On the other hand, nanotechnology raises many of the same issues as any new technology, including concerns about the toxicity and environmental impact of nanomaterials and their potential effects on global economics, as well as speculation about various doomsday scenarios. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

Key features in this field are:

• combining different sciences and technologies;
• enhanced or new properties;

• new applications;

• all at very small dimensions;

• and we now have sophisticated tools to build, characterize and utilize structures at the nanoscale, across a breadth of disciplines;

• but we must also be aware of possible consequences.

TASKS:

1. Answer the questions:

1. What is nanotechnology?
2. What does nanotechnology deal with?
3. What are implications of nanotechnology?
4. What are the key features of nanotechnology?

2. Make a summary of the text.

Text 2
History of Nanotechnology

LEARN THE WORDS:

a physicist – физик

an atom – атом

a molecule – молекула

processing – обработка

separation – разделение

consolidation – затвердевание

the scanning tunneling microscope (STM) – сканирующий туннельный микроскоп

a carbon nanotube – углеродная нанотрубка

a property – свойство

synthesis – синтез

a semiconductor nanocrystal – полупроводниковый нанокристалл

the atomic force microscope (AFM) – атомный силовой микроскоп

a nanoparticle – наночастицы

quantum dots – квантовая точка

The first use of the concepts found in "nano-technology" (but pre-dating use of that name) was in "There's Plenty of Room at the Bottom", a talk given by **physicist** Richard Feynman at an American Physical Society meeting at California Institute of Technology on December 29, 1959. Feynman described a process by which the ability to manipulate individual **atoms** and **molecules** might be developed, using one set of precise tools to build and operate another proportionally smaller set, and so on down to the needed scale. The term "nanotechnology" was defined by Tokyo University of Science Professor Norio Taniguchi in a 1974 paper as follows: "'Nano-technology' mainly consists of the **processing, separation, consolidation**, and deformation of materials by one atom or by one molecule." In the 1980s the basic idea of this definition was explored in much more depth by Dr. K. Eric Drexler, who promoted the technological significance of nano-scale phenomena and devices and the term acquired its current sense. *Engines of Creation* is considered the first book on the topic of nanotechnology. Nanotechnology and nanoscience got started in the early 1980s with two major developments; the birth of cluster science and the invention of **the scanning tunneling microscope (STM)**. This development led to the discovery of fullerenes in 1985 and **carbon nanotubes** a few years later. In another development, the **synthesis** and **properties** of **semiconductor nanocrystals** was studied; this led to a fast increasing number of metal and metal oxide **nanoparticles** and **quantum dots**. **The atomic force microscope (AFM)** was invented six years after the STM was invented. In 2000 the United States National Nanotechnology Initiative was founded to coordinate Federal nanotechnology research and development and is evaluated by the President's Council of Advisors on Science and Technology.

TASKS:

1. Say whether the following statements are true or false:

1. The term "nanotechnology" was first defined by physicist Richard Feynman in the USA.

2. The term "nanotechnology" acquired its current sense in the 1980s.

3. The birth of cluster science and the invention of the scanning tunneling microscope prompted the start of nanoscience.

4. The study of the synthesis and properties of semiconductor nanocrystal led to the discovery of fullerenes and carbon nanotubes.

5. The canning tunneling microscope was invented six years earlier than the atomic force microscope.

2. Answer the questions:

1. When was the first use of the concepts found in nanotechnology?
2. What process did Richard Feynman describe?
3. When was the term "nanotechnology" defined?
4. What does the term mean?
5. When did the term "nanotechnology" acquire its current sense?
6. When did nanotechnology and nanoscience get started?
7. What were other developments?

3. Make an abstract of the text.

Text 3
How Big?

LEARN THE WORDS:
a component – компонент
a nanoscale – наноуровень
measurement – измерение
length – длина
comparison – сравнение
an inch – дюйм
a property – свойство
assembly – сборочный

Nanotechnology deals with the very smallest components of our world – atoms and molecules. Trying to understand just how small the nanoscale is can be very difficult for people.

A nanometer is a unit of measurement for length just as you have with meters and centimeters. A nanometer is one billionth of a meter, 0.000000001 or 10^{-9} meters. For comparison, a human hair is about 60 – 80 000 nanometers wide.

The word *nano* comes from the Greek word for "dwarf".

The term *nanoscale* is used to refer to objects with dimensions on the order of 1 – 100 nanometers (nm).

To understand how small a nanometer is, we typically compare the nanoscale to objects that we know how big or small they are. Here are some examples:

- a human hair is about 60 000 – 80 000 nm wide;
- a fingernail grows 1 nm per second;
- a DNA molecule is 2 – 3 nm in wide;
- a 2 meter person is 6 feet 6 inches tall or 2 billion nanometers.

Another way to help in the understanding of the minuteness of a nanometer is to examine objects on a size scale.

Scientists have discovered that materials at small dimension have small particles, thin films, etc. and can have significantly different properties than the same materials at larger scale. There are thus endless possibilities for improved devices, structures and materials if we can understand these differences and learn how to control the assembly of small structures.

Why is small good?

- faster;
- lighter;
- can get into small spaces;
- cheaper;
- more energy efficient;
- less waste products and uses less energy and materials to produce;
- different properties at very small scale.

TASK:

Read the following text once without a dictionary. Try to catch the main ideas. Retell the text briefly in English.

Text 4
What is Nanostructure?

LEARN THE WORDS:
a nanostructure – наноструктура
a nanoscale – наноуровень
a nanotexture – нанотекстура
thickness – плотность
a nanotube – нанотрубка
a diameter – диаметр
spatial – пространственный
ultrafine – ультрадисперсный
a micrometer – микрометр

A **nanostructure** is an object of intermediate size between microscopic and molecular structures.

In describing nanostructures it is necessary to differentiate between the number of dimensions on the **nanoscale**. **Nanotextured** surfaces have one dimension on the nanoscale, i. e. only the **thickness** of the surface of an object is between 0.1 and 100 nm. **Nanotubes** have two dimensions on the nanoscale, i. e. the **diameter** of the tube is between 0.1 and 100 nm; its length could be much greater. Finally, spherical nanoparticles have three dimensions on the nanoscale, i. e. the particle is between 0.1 and 100 nm in each **spatial** dimension. The terms nanoparticles and **ultrafine** particles (UFP) often are used synonymously although UFP can reach into the **micrometre** range. The term *nanostructure* is often used when referring to magnetic technology.

Ordinary objects are absolutely huge measured on what scientists call the nanoscale:

- Atom: ~0.1 nanometers.
- Atoms in a molecule: ~0.15 nanometers apart.
- DNA double-helix: ~2 nanometers in diameter.
- Typical protein: ~10 nanometers long.
- Computer transistor (switch): ~100 – 200 nanometers wide.

- Typical bacteria: ~200 nanometers long.
- Human hair: 50 000 – 100 000 nanometers in diameter.
- One piece of paper: ~100 000 nanometers thick.
- Girl 1.2 m (4 ft) tall: ~1200 million nanometers tall.
- Man 2 m (6.5 ft) tall ~ 2000 million nanometers tall.
- Empire State Building: 381 m (1250 ft) tall: ~381 000 million nanometers tall.

Can you figure out how tall you are in nanometers?

TASKS:

1. Answer the questions:

1. What is a nanostructure?
2. What dimension do nanotextured surfaces have?
3. What dimension do nanotubes have?
4. What dimension do nanoparticles surfaces have?

2. Make a summary to the text.

Text 5
Nanoparticles

LEARN THE WORDS:
coarse – крупный
fine – мелкий
a nanometer – нанометр
dimension – измерение
to exhibit size-related properties – показывать свойства, связанные с размером
bulk – сыпучий
a nanocluster – нанокластер
dimension – измерение
nanopowder – нанопорошок
an agglomerate – агломерат
a single-domain ultrafine particle – однодоменная ультрадисперсная частица

In nanotechnology a particle is defined as a small object that behaves as a whole unit with respect to its transport and properties. Particles are further classified according to diameter. **Coarse** particles cover a range between 10 000 and 2 500 nanometers. **Fine** particles are sized between 2 500 and 100 nanometers. **Ultrafine** particles, or nanoparticles are sized between 1 and 100 nanometers. The reason for this double name of the same object is that, during the 1970 – 80s, when the first thorough fundamental studies with "nanoparticles" were underway in the USA (by Granqvist and Buhrman) and Japan (within an ERATO Project), they were called "ultrafine particles" (UFP). However, during the 1990s before the National Nanotechnology Initiative was launched in the USA, the new name "nanoparticle" had become fashionable. Nanoparticles may or may not **exhibit size-related properties** that differ significantly from those observed in fine particles or **bulk materials**. Although the size of most molecules would fit into the above outline, individual molecules are usually not referred to as nanoparticles.

Nanoclusters have at least one **dimension** between 1 and 10 nanometers and a narrow size distribution. **Nanopowders** are **agglomerates** of ultrafine particles, nanoparticles, or nanoclusters. Nanometer-sized single crystals, or **single-domain ultrafine particles**, are often referred to as nanocrystals.

Nanoparticle research is currently an area of intense scientific interest due to a wide variety of potential applications in biomedical, optical and electronic fields.

TASKS:

1. Answer the questions:

1. How is a particle in nanotechnology defined?
2. How are they classified?
3. When was the new name "nanoparticle" introduced?
4. What is nanopowder?

2. Make an abstract of the text.

Text 6
Nanorobots

LEARN THE WORDS:
a nanomachine – наномашина
a sensor – датчик
approximately – приблизительно
a sample – образец
a cancer cell – раковая клетка
detection of toxic chemicals – обнаружение токсических химикатов
measurement – измерение
a buckyball – фуллерен
precision – точность
an apparatus – аппарат, инструмент

Nanorobotics is the emerging technology field creating machines or robots whose components are at or close to the scale of a nanometer (10^{-9} meters). More specifically, nanorobotics refers to the nanotechnology engineering discipline of designing and building nanorobots, with devices ranging in size from 0.1 – 10 micrometers and constructed of nanoscale or molecular components.

Nanomachines are largely in the research-and-development phase, but some primitive molecular machines have been tested. An example is **a sensor** having a switch approximately 1.5 nanometers across, capable of counting specific molecules in a chemical **sample**. The first useful applications of nanomachines might be in medical technology, which could be used to identify and destroy **cancer cells**. Another potential application is the **detection of toxic chemicals**, and the **measurement** of their concentrations, in the environment. Rice University has demonstrated a single-molecule car developed by a chemical process and including **buckyballs** for wheels. It is actuated by controlling the environmental temperature and by positioning a scanning tunneling microscope tip.

Another definition is a robot that allows **precision** interactions with nanoscale objects or can manipulate with nanoscale resolution. Such devices are more related to microscopy or scanning probe microscopy, instead of the description of nanorobots as molecular machine. Following the microscopy definition even a large **apparatus** such as an atomic force microscope can be considered a nanorobotic instrument when configured to perform nanomanipulation. For this perspective, macroscale robots or microrobots that can move with nanoscale precision can also be considered nanorobots.

TASKS:

1. Answer the questions:

1. What is nanorobotics?
2. Where can the first useful applications of nanomachines take place?
3. Where can a nanomachine potentially be applied?
4. What devices are considered to be nanorobotic?

2. Make an abstract of the text.

Text 7
Nanotechnology in Everyday Life

LEARN THE WORDS:
wrinkle-free – немнущийся
to iron – гладить
to soak up – впитывать
inescapable – неизбежный
to grab – хватать
to rely on – основываться на

From the clothes and sunglasses you wear to computer hard drives and even cleaning products, nanotechnology – often inspired by the natural world – plays a big part in the manufacture of many familiar products

You're going on holiday. Off the plane and checked into your hotel, you take the **wrinkle-free** shirt you packed so you wouldn't have to do any

ironing. Poolside, you relax listening to summery tunes on your MP3 player before taking a plunge into the cool refreshing water.

As you **soak up** the sun, nanotechnology is probably the furthest thing from your mind. Yet throughout every step of your trip you've unknowingly encountered it. From the nanoparticles that coated the surface of your plane to the way the hotel pool was cleaned, nanotechnology was there.

Nanotechnology is an **inescapable** part of modern everyday life, both on holiday and at home. "There are things we've been using for a long time which contain nanosize components, like the lasers in DVD and CD players," – says Milo Shaffer, head of the London Centre for Nanotechnology. Yet most of the time it goes unnoticed. "On the whole people aren't very aware of the nanotechnology all around them," – Shaffer explains.

So if you stretch out an arm you'll almost certainly be able **to grab** something that employs nanotechnology.

Whether in your office, home or while sunning yourself on holiday, it is impossible not to encounter technology based on the manipulation of the very small. Many technologies in the modern world **rely on** nanostructures, often inspired by evolution in the natural world.

TASK:

Read the text and tell the group how nanotechnology helps you in everyday life.

Text 8
What is the Current State of Use of Nanoscience and Nanotechnology?

LEARN THE WORDS:
nanoscience – нанонаука
chemistry – химия
medicine – медицина
surface friction – поверхностное трение

wear resistance – износостойкость
adhesion – склеивание, сцепление, спайка
a nanoscale – наноуровень
a drug – лекарство
a fibre – волокно
a dye – краситель
a storage – хранилище
a tyre – шина, покрышка
a coating – покрытие
stiffness – жесткость
to glare – сверкать, сиять
a pane – панель
a cell – клетка

Current knowledge in **nanoscience** comes from developments in **chemistry**, physics, life sciences, **medicine** and engineering. Nanotechnology is under active development or already in practical use in several areas.

In materials science nanoparticles allow for the making of products with new mechanical properties, including **surface friction, wear resistance** and **adhesion**. The smallest components of a computer chip are on a **nanoscale**.

In biology and medicine nanomaterials are used to improve **drug** design and targeting. Others are being developed for analytical and instrumental applications.

Consumer products such as cosmetics, sunscreens, **fibres**, textiles, **dyes** and paints already contain nanoparticles.

In electronic engineering nanotechnologies are used for instance to design smaller, faster and less consuming data **storage** devices.

Optical devices such as microscopes have also benefited from nanotechnology.

What are the uses of nanoparticles in consumer products?

Nanoparticles can increase **tyre** adhesion to the road.

Nanoparticles can contribute to stronger, lighter, cleaner and "smarter" **surfaces** and systems. They are already being used to produce scratchproof eyeglasses, crack-resistant paints, anti-graffiti **coatings** for walls, transparent sunscreens etc.

They can be used to increase the safety of cars, for instance, by increasing tyre adhesion to the road, improving the **stiffness** of the car body or preventing **glare** or condensation on displays and **panes**.

They can also improve food safety and packaging.

Moreover, they are used in a wide variety of ways in biology and medicine, for example in drugs targeting specific organs or **cells**.

TASKS:

1. **Make up 7 – 8 questions to the text.**

2. **Make an abstract of the text.**

Text 9
Nanotechnology: What Will It Mean

LEARN THE WORDS:

to emerge – зарождаться, возникать, появляться
a fleet – (здесь) парк
to eliminate – устранять
cancer – рак
to heal – лечить
to cure – излечивать
pollution – загрязнение
a pollutant – загрязнитель
a submicron range – субмикронный диапазон

Nanotechnology will make us healthy and wealthy though not necessarily wise. In a few decades, this **emerging** manufacturing technology will let us inexpensively arrange atoms and molecules in most of the ways permitted by physical law. It will let us make supercomputers that fit on the head of a pin and **fleets** of medical nanorobots smaller than a human cell able **to eliminate cancer**, infections, clogged arteries and even old age. People will look back on this era with the same feelings we have toward medieval times – when technology was primitive and almost everyone lived in poverty and died young.

Besides computers billions of times more powerful than today's, and new medical capabilities that will **heal** and **cure** in cases that are now viewed as utterly hopeless, this new and very precise way of fabricating products will also **eliminate the pollution** from current manufacturing methods. Molecular manufacturing will make exactly what it is supposed to make, no more and no less, and therefore won't make **pollutants.**

When nanotechnology pioneer Eric Drexler first dared to publish this vision back in the early 1980s, the response was skeptical, at best. It seemed too good to be true, and many scientists pronounced the whole thing impossible. But the laws of physics care little for either our hopes or our fears, and subsequent analysis kept returning the same answer: it will take time, but it is not only possible but almost unavoidable.

The progress of technology around the world has already given us more precise, less expensive manufacturing technologies that can make an unprecedented diversity of new products. Nowhere is this more evident than in computer hardware: computational power has increased exponentially while the finest feature sizes have steadily shrunk into the deep **submicron range**.

TASK:

Make a summary to the text.

Text 10
Environment and Nanotechnology

LEARN THE WORDS:

to determine – определять
expediency – целесообразность
deliberation – размышление
to split – расщеплять
nanopollution – нанозагрязнение

wastes – отходы
to penetrate – проникать
appropriate – соответствующий
a chemical reaction – химическая реакция
a catalyst – катализатор
hazardous – опасный
to desalinate – опреснять
fossil – окаменелый
to eliminate – уменьшать
to enhance – усиливать

Science often faces with the problem of the balance of priorities. What are the benefits of a certain research for the technical progress? What conditions of the environment are best for people, for native vegetation and animals and for maintaining usability of the land? How do you balance costs, economic benefits and environmental impacts? How do you **determine** acceptable levels of risk?

Human priorities are linked strongly, on the one hand, with economic and political **expediencies** and, on the other hand, with ethics. All of the above questions are difficult and their relevance is obvious.

The environmental implications of nanotechnology are the possible effects that the use of nanotechnology and nanomaterials and devices can have on the environment. As nanotechnology is a new field there is a great **deliberations** regarding to what extent industrial and commercial use of nanotechnology will affect ecosystems and organisms.

The matter can be **split** into two aspects: the contribution to improvement of the environment (as a potential innovations), and the possibly novel type of pollution that application of nanotechnology might cause.

Nanopollution is a genetic name for all the **wastes** generated by nanodevices or during the nanomaterials manufacturing process. This kind of wastes can float in the air and might easily **penetrate** into animal and plant cells causing unknown effects. Most human-made nanoparticles do not appear in nature, so living organisms may not have **appropriate** means to deal with nanowaste. This is probably one of the serious challenges nanotechnology deals with.

The term *green nanotechnology* is used to describe the development of clean technologies employing to minimize potential environmental and human health risks associated with the manufacture and use of nanotechnology products and to encourage replacement of existing products with new nanoproducts that are more environmentally friendly throughout their lifecycle.

In addition to making nanomaterials and products with less impact to the environment, green nanotechnology also means using nanotechnology to make current manufacturing processes for non-nano materials and products more environmentally friendly. For example, nanoscale membranes can help separate desired **chemical reaction** products from waste materials. Nanoscale **catalysts** can make chemical reactions more efficient and less wasteful. Sensors at the nanoscale can form a part of process control systems, working with nano-enabled information systems. Using alternative energy systems, made possible by nanotechnology, is another way to "green" manufacturing processes.

The second goal of "green" nanotechnology involves developing products that benefit the environment either directly or indirectly. Nanomaterials or products directly can clean **hazardous** waste sites, **desalinate** water, treat pollutants or sense and monitor environmental pollutants. Indirectly, lightweight nanocomposites for automobiles and other means of transportation could save fuel and reduce materials used for production; nanotechnology-enabled fuel cells and light-emitting diodes (LEDs) could reduce pollution from energy generation and help conserve **fossil** fuels; self-cleaning nanoscale surface coatings could reduce or **eliminate** many cleaning chemicals used in regular maintenance routines; and **enhanced** battery life could lead to less material use and less waste. "Green" nanotechnology takes a broad systems view of nanomaterials and products, ensuring that unforeseen consequences are minimized and that impacts are anticipated throughout the full life cycle.

TASKS:

1. Find the following word combinations in the text:

новый тип загрязнения
воздействие на окружающую среду
сталкиваться с проблемой
условия природной среды
экономические прибыли
предопределить приемлемые уровни
поддержание пригодности
прочно связаны
политическая целесообразность
уместность очевидна
вклад в улучшение среды
проникать в клетки
подвергая неизвестному воздействию
подходящие средства
серьёзные вызовы
безопасные для окружающей среды
менее отходный
участки с опасными отходами
опреснять воду
экономить топливо
непредсказуемые последствия

2. Answer the following questions according to the text.

1. What kind of questions does the science often face with?
2. What are human priorities linked strongly with?
3. What kind of deliberations is arisen concerning the environmental impact of nanotechnology?
4. What two aspects can this matter be split into?
5. What is the effect of nanopollution?

6. What is one of the most serious challenges nanotechnology deals with?

7. What are the goals of "green" nanotechnology?

3. Give all possible variants and translate them into Russian:

precise (observation, measurements, values)

to consider (a problem, data, the results)

to receive (a degree, a diploma, a medal, news, education, one's training, an award, a prize, a letter, a telegram)

to obtain (data, information, evidence, knowledge, a result)

to make (calculations, a conclusion, a contribution to, a discovery, an experiment, an investigation, measurements, a mistake, observations, a suggestion, a summary, analyses)

to do (experimental work, exercises, research in smth, theoretical studies on)

to gain (knowledge, recognition, experience)

4. Match English participles with Russian equivalents:

a) released	1) видоизмененный
b) reduced	2) отобранный
c) selected	3) примененный
d) developed	4) произведенный
e) planted	5) высвобожденный
f) cleaned	6) поглощенный
g) absorbed	7) посаженный
h) suggested	8) очищенный
i) generated	9) предложенный
j) applied	10) развитый
k) modified	11) сокращенный

5. In pairs, discuss the possible effects of environmental implications of nanotechnology. Give examples for and against using nanotechnology from environmental point of view. Make use of the following linking words:

- *to start with / first of all / firstly*
- *secondly*
- *at first sight*
- *apparently*
- *the greatest advantage / disadvantage*
- *however / yet*
- *what is more / moreover*
- *on the one hand / on the other hand*
- *in my opinion / view*
- *personally I believe*
- *I feel strongly that*
- *I am concerned*
- *according to / with reference to*
- *therefore / thus / as a result / as a consequence*
- *in fact / actually / as a matter of fact*
- *finally*
- *to sum up*

SUPPLEMENTARY READING

The History of the Laser

It is one of the best examples of how technology can go from the science of the future to everyday use in a short period of time. Faith Lapidus and Steve Ember tell us about the history and many uses for the laser.

Laser is short for Light Amplification by Stimulated Emission of Radiation. The idea behind lasers is complex. Just how complex? Consider that it took the mind of Albert Einstein to discover the physics behind the laser.

Theodore Maiman succeeded in building the first working laser in nineteen sixty. Mr. Maiman worked at Hughes Research Laboratories in Malibu, California.

A laser fires a light beam. Before the laser, scientists developed a similar device: a maser which stands for Microwave Amplification by Stimulated Emission of Radiation. A maser is basically a microwave version of the laser. Microwaves are a form of electromagnetic radiation similar to, but shorter than, radio waves.

In the nineteen fifties, researchers in the United States and Russia independently developed the technology that made both masers and lasers possible. Charles Townes was a professor at the Massachusetts Institute of Technology in Cambridge, Massachusetts. He and his students developed the first maser.

Russians Nickolay Basov and Aleksandr Prokhorov did their research in Moscow. Their work led to technology important to lasers and masers. The three men received the Nobel Prize in Physics in nineteen sixty-four.

Industry put lasers to work almost immediately after they were invented in nineteen sixty. But weapons were not first on the list.

The first medical operation using a laser took place the year following its invention. Doctors Charles Campbell and Charles Koester used a laser to remove a tumor from a patient's eye at Columbia-Presbyterian Hospital in New York City. Since then, doctors have used lasers to cut and remove tissue safely with little risk of infections.

Since nineteen seventy-four, the public has had direct experience with lasers – at the grocery store checkout line. Laser barcode scanners have changed how stores record almost everything.

Air Scanning Tunneling Microscope

The scanning tunneling microscope (STM) has developed into an imaging method with diverse possibilities for real-space imaging on a scale that extends to atomic dimensions. The interaction that is monitored in STM is the tunneling current between a metallic tip and a conducting substrate, which are in very close proximity but not actually in physical contact. It is quantum mechanical tunneling that permits the electrons to tunnel through the potential barrier, which they could not surmount according to the classical laws of physics. In this model, the probability of tunneling is exponentially dependent upon the distance of separation between the tip and surface: the tunneling current is therefore a very sensitive probe of this separation. Another great advantage of a STM is that it may allow the characterization and identification of individual atoms and may lead to the manipulation of materials at the atomic scale. One of the principal reasons for building this air STM is to be able to study two-dimensional materials such as graphene and T1S2. Due to the electronic properties of these materials it has been of great interest to explore their use in electronic device applications such as FETs.

Because of the reactivity that many surfaces, such as Si have in ambient conditions, the use of an ultra-high vacuum (UHV) system with pressures $< 10^{-9}$ torr is necessary to study those surfaces with a STM. However, since only materials that are unreactive in ambient conditions will be studied, it was sufficient to design and assemble an air STM in order to characterize materials such us graphene, which do not have to be constrained to an UHV environment. One of the principal advantages of using an air STM rather than an UHV-STM is the significant time reduction in transferring and preparing a sample for imaging. While it can take up to two or three days to prepare a sample for imaging in UHV, a sample can be prepared for imaging in ambient conditions in just a few minutes. Also, an air STM is relatively cheap and involves a simple design, which ameliorates maintenance procedures.

Due to the proximity between the tip and the sample (~ 5A), main considerations in the design for this air STM were the vibration and noise isolation of the entire system, the coarse and fine approach of the tip probe to the sample, and the electrical wiring connections. Electronic equipment from RHK Technology was used to control the STM.

Nanotechnology Primer: Graphene – Properties, Uses and Applications

Existing forms of carbon basically consist of sheets of graphene, either bonded on top of each other to form a solid material like the graphite in your pencil or rolled up into carbon nanotubes (think of a single-walled carbon nanotube as a graphene cylinder) or folded into fullerenes. The reason nanotechnology researchers are so excited is that graphene and other two-dimensional crystals – it's called 2D because it extends in only two dimensions: length and width; as the material is only one atom thick, the third dimension, height, is considered to be zero – open up a whole new class of materials with novel electronic, optical and mechanical properties. Early experiments with graphene have revealed some fascinating phenomena that excite researchers working towards molecular electronics. For instance, it was found that graphene remains capable of conducting electricity even at the limit of nominally zero carrier concentration because the electrons don't seem to slow down or localize. The electrons moving around carbon atoms interact with the periodic potential of grapheme's honeycomb lattice, which gives rise to new quasiparticles that have lost their mass, or "rest mass" (so-called *massless Dirac fermions*). That means that graphene never stops conducting. It was also found that they travel far faster than electrons in other semiconductors. Graphene is undoubtedly emerging as one of the most promising nanomaterials because of its unique combination of superb properties, which opens a way for its exploitation in a wide spectrum of applications ranging from electronics to optics, sensors, and biodevices.

Graphene-based nanomaterials have many promising applications in numerous areas.

Energy graphene-based nanomaterials have many promising Applications in energy-related areas. Just some recent examples: graphene improves both energy capacity and charge rate in rechargeable batteries; activated graphene makes superior supercapacitors for energy storage; graphene electrodes may lead to a promising approach for making solar cells that are inexpensive, lightweight and flexible; and multifunctional graphene mats are promising substrates for catalytic systems.

Sensors functionalized graphene holds exceptional promise for biological and chemical sensors. Already researchers have shown that the distinctive 2D structure of graphene oxide (GO), combined with its superpermeability to water molecules, leads to sensing devices with an unprecedented speed.

Nanoelectronics. Some of the most promising applications of graphene are in electronics (as transistors and interconnects), detectors (as sensor elements) and thermal management (as lateral heat spreaders). The first graphene field-effect transistors (FETs) – with both bottom and top gates – have already been demonstrated. At the same time, for any transistor to be useful for analog communication or digital applications, the level of the electronic low-frequency noise has to be decreased to an acceptable level (graphene transistors can work without much noise). Transistors on the basis of graphene are considered to be potential successors for the some silicon components currently in use. Due to the fact that an electron can move faster through graphene than through silicon, the material shows potential to enable terahertz computing.

Coatings. Coating objects with graphene can serve different purposes. For instance, researchers have now shown that it is possible to use graphene sheets to create a superhydrophobic coating material that shows stable superhydrophobicity under both static as well as dynamic (droplet impact) conditions, thereby forming extremely water repelling structures. Research findings also have established graphene as the world's thinnest known coating for protecting metals against corrosion. It was found that graphene, whether made directly on copper or nickel or transferred onto another metal, provides protection against corrosion. Another novel coating application is the the fabrication of polymeric AFM probes covered by monolayer graphene to improving AFM probe performance.

Nanotechnology is Getting Closer to 3D-Nanoprinting

Fabrication of three-dimensional (3D) objects through direct deposition of functional materials – also called additive manufacturing – has been a subject of intense study in the area of macroscale manufacturing for several decades. These 3D-printing techniques are reaching a stage where desired products and structures can be made independent of the complexity of their shapes – even bioprinting tissue is now in the realm of the possible. Applying 3D-printing concepts to nanotechnology could bring similar advantages to nanofabrication – speed, less waste, economic viability – than it is expected to bring to manufacturing technologies. In addition, pre-patterned micro- or nanostructures could be used as substrates, allowing researchers to realize unprecedented manufacturing flexibility, functionality and complexity at the nanoscale. Researchers in Korea have now shown that nanoscale 3D-objects such as free-standing nanowalls can be constructed by an additive manufacturing scheme. Even without the motion of the substrate, nanojets are spontaneously laid down and piled to yield nanowalls. The team, led by Ho-Young Kim, a professor at Seoul National University, explain their findings.

"Electrospinning that produces polymer nanojets is a relatively simple and inexpensive method to yield nanoscale fibers, but the fiber streams are so chaotic that control of individual fibers has been considered almost impossible," – Kim explains. – "In our recent work, we have shown that an electrospun polymer solution jet, which tends to become unstable as traveling in the air due to Coulombic repulsion, can be stably focused onto a thin metal electrode line". Kim and his team also elucidated the fundamental electromechanical mechanism that enables the spontaneous stacking of a nanofiber onto itself to provide a physical basis behind this novel nanofabrication process. In this novel method, a thin metal line on an insulating plate strongly focuses the electrical field, thus the whipping instability of the electrical nanojets is suppressed.

The construction of a free-standing nanowall is the most fundamental step to achieve 3D-nanoprinting. This process is so attractive because it needs only a power supply and a linear stage to build free-standing nanowalls after drawing metal microlines, all of which can be conducted under normal laboratory conditions. Kim points out that this technique has a significant economic advantage as compared to conventional nanomanufacturing processes used to build nanowalls such as DRIE (deep reactive ion etching).

"Full 3D-control of an electrospun nanojet would possibly revolutionize the current nanofabrication technology, which we aim to achieve in the long run," – says Kim. – "However, we believe that such great achievement cannot be made with a single step. Further development for the precise control of the nanojet could realize full 3D-nanofabrication".

Nanomaterials with 2D-Nanostructures (Nanolayers)

2D-nanostructures are structures like layers, having large (near 1 μm) sizes on two coordinate axes and nanometer size on third axe.

Lateral AlGaAs – Superlattice

Abundant new physics was brought about by the invention of the superlattice (SL) concept and its subsequent realization through molecular beam epitaxy (MBE) of layered semiconductor structures with atomic precision. The formation of minibands isolated by minigaps in the vertical SL direction ensues from the coupling between adjacent quantum wells. In order to reduce the dimensionality of the system, electrons are confined in one direction to a quantum well, and a lateral periodic potential modulation may additionally be imposed from the surface of the sample with, for example, lithographically defined top gates. As in the conventional vertical SL geometry, an artificial band structure derives from the reduced width of the Brillouin zone and zone folding. Magnetotransport offers an excellent tool for the study of the resulting band structure in these laterally modulated two-dimensional systems (2DES), since oscillations in the magnetoresistance provide immediate information on the area encircled by closed electron orbits at the Fermi energy EF. Such experimental evidence for an artificial band structure is sparse. Only very recently, using two-dimensional modulation, unambiguous proof of two different closed electron orbits was achieved. This lack of evidence may be related to the inherent inadequacy of lateral modulation schemes in producing concurrently a high quality 2DES and a sufficiently short period and large amplitude modulation to guarantee the occupation of only few, well-isolated minibands.

We use a new concept to fabricate lateral SLs based on the cleaved edge overgrowth technique, that overcomes the limitations of previous geometries by periodically modulating the material composition *directly adjacent* to the 2DES. In this way, both the period and the modulation strength can be tailored with unprecedented precision by MBE growth. In a first MBE step, an undoped SL with lattice constant d = 100 nm of 30 periods of 50 nm GaAs and 50 nm Al0.32Ga0.68As is grown between two n-GaAs contacts, that act as source and drain. In a second MBE step, the sample is cleaved *in situ* and immediately thereafter overgrown by a 30 nm undoped GaAs layer, a 100 nm AlAs barrier, and an n-GaAs gate applying a positive gate voltage with respect to source and drain a 2DES is induced at the GaAs/AlAs heterointerface. The finite overlap of the electron wave function with the SL causes a modulation of the electron density ns in x direction with a strength that depends on the GaAs layer thickness. For our sample this variation of the density, integrated over the z direction, exceeds 10 %, as determined by a self-consistent 2D-Poisson/Schrödinger calculation.

How Do You Make a Nanomachine?

A machine is something with moving wheels, gears and levers that can do useful jobs for us, but how do you make moving parts from something as tiny as a molecule? Just imagine trying to build a clock from gears that are millions of times smaller than usual!

It turns out there is a way to do it. Some molecules are regularly shaped and symmetrical so they have no overall positive or negative charges. Other molecules are not symmetrical, which means they have slightly more positive charge at one end and slightly more negative charge at the other. These are called polar molecules and water is the best known example. Water sticks to a lot of things and cleans them well because it has a positive pole at one end and a negative pole at the other. We can use this idea to make a molecular machine.

Suppose you take a molecule made from a ring of atoms that has a slightly positive charge in one place. Now thread it over another molecule made from a rod of atoms, which has slightly negative charges at its two ends. The positive ring will pull toward one of the negative charges so the ring will lift upward. Now add some energy and you can make the ring move back down, toward the other negative charge. In this way, you can make the ring shunt back and forth or up and down, a bit like a nanoscopic elevator! By extending this idea, we can gradually make more complex machines with parts that shuffle back and forth, move around one another, or even rotate like tiny electric motors.

Ingenious ideas like this were developed by three brilliant scientists who won the Nobel Prize in Chemistry in 2016.

Nanotechnology Products: Real World Applications of Nanotechnology

The consumer world is exploding with "nanotechnology enhanced" products. Consumer products is an area where the experts are saying the most immediate nanotechnology impacts will be made and recognized by the majority of people in the world. Currently there are numerous products on the market that are the result of nanotechnology.

For the sporting enthusiast we have tennis balls that last longer, tennis rackets that are stronger, golf balls that fly straighter, nano ski wax that is easier to apply and more effective than standard wax, and bowling balls that are harder; and these products are just scratching the surface. These products all use nanostructured materials to give them enhanced performance.

Speaking of scratching the surface, we also have nano car wax that fills in those tiny cracks more effectively and gives you a shinier vehicle. There are also nanoproducts available to keep your eyewear and other optical devices cleaner, dryer, and more durable.

In the clothing world, we have pants that repel water and won't stain shirts and shoe inserts that keep you cool in the summer and warm in the winter, and nanosocks that don't "stink" due to the inclusion of nanotech materials (nanosized sliver particles). Nanoceramic coatings are being utilized on photo quality picture paper to deliver sharper, higher quality "homemade" digital photo reproductions on your ink jet printer. How about that DVD you watched last night? Any idea how big the features on that now ubiquitous product are? DVD "bumps" to store information are 320 nanometers wide.

The world of electronics has been using many of the key methods shared by other nanotechnology disciplines for many years. As an example, think of the evolution of the video game. Nanotechnology has enabled arcade size video games of yesteryear like Pong, Frogger, and PacMan to be replaced with very sophisticated home Playstations, X-Boxes and Game Cubes that play "life like" Madden 2005, Grand Theft Auto and Halo 2 video games.

There are also a tremendous amount of other electronic applications out there that are affecting our everyday lives. Just take a trip to your local electronics mega-store and you will see a multitude of these including: faster and more powerful computers, palm pilots (blackberries), flash drives, digital cameras and displays cell phones, LCDs, LEDs, MP3s, electronic ink displays, thin film batteries and flexible electronics to name a few. All of these applications are possible and affordable due to the ability to work effectively and efficiently at the nanoscale.

The biotech world also has many real world applications currently in use or under development that are, or will be, affecting our quality of life. Bandages embedded with silver nanoparticles are coming of age in the wound healing arena. And we now have drug delivery via a patch. A variety of time release thin films are now utilized on implantations into the human body (for example screws, joints, and stents) and these films are affecting the long term effectiveness of these devices. Respiration monitors utilizing nanomaterials have been developed that are many times more sensitive than previous state of the art technology. Man-made skin is a nanofabricated network and is presently in use for skin graft applications. Some other nanotechnology applications which are currently under development in the biotech world are diabetic insulin biocapsules, pharmaceuticals utilizing "bucky ball" technology to selectively deliver drugs and cancer therapies using targeted radioactive biocapsules.

The world around us is filled with applications that nanotechnology makes possible. Don't believe it? Look around! You won't have to look far before these applications become evident to you. Nanotechnology is influencing the development of a wide variety of very diverse fields; among these are electronics, biotechnology, and consumer applications. From tennis balls to bandages to palm pilots, nanotechnology is making a significant impact on the jobs we work at and the products that we enjoy.

The Future of Nanotechnology: Nanodream or Nano-Nightmare?

Engineers the world over are raving about nanotechnology. This is what scientists at one of America's premier research institutions, the Los Alamos National Laboratory, have to say: "The new concepts of nanotechnology are so broad and pervasive, that they will influence every area of technology and science, in ways that are surely unpredictable.... The total societal impact of nanotechnology is expected to be greater than the combined influences that the silicon integrated circuit, medical imaging, computer-aided engineering and man-made polymers have had in this century." That's a pretty amazing claim: 21st-century nanotechnology will be more important than all the greatest technologies of the 20th century put together!

Nanotechnology sounds like a world of great promise, but there are controversial issues too that must be considered and resolved. Some people have raised concerns that nanoscale organisms or machines could harm human life or the environment. One problem is that tiny particles can be extremely toxic to the human body. No one really knows what harmful effect new nanomaterials or substances could have. Chemical pesticides were not considered harmful when they were first used in the early decades of the 20th century; it wasn't until the 1960s and 1970s that their potentially harmful effects were properly understood. Could the same happen with nanotechnology?

The ultimate nanonightmare, the problem of "gray goo", was first highlighted by Eric Drexler. What happens if well-meaning humans create nanobots that run riot through the biosphere, gobbling up all living things and leaving behind nothing but a chewed-up mass of "gray goo"? Drexler later backed away from that claim. But critics of nanotechnology still argue humans shouldn't meddle with worlds they don't understand, but if we took that argument to its logical conclusion, we'd have no inventions at all – no medicines, no transportation, no agriculture and no education – and we'd still be living in the Stone Age. The real question is whether the promise of nanotechnology is greater than any potential risks that go with it. And that will determine whether our nanofuture becomes dream or nightmare.

Solid-State Lasers

Solid-state lasers use a crystalline or glass rod which is "doped" with ions that provide the required energy states. For example, the first working laser was a ruby laser, made from ruby (chromium-doped corundum). The population inversion is actually maintained in the dopant. These materials are pumped optically using a shorter wavelength than the lasing wavelength, often from a flashtube or from another laser. The usage of the term "solid-state" in laser physics is narrower than in typical use. Semiconductor lasers (laser diodes) are typically *not* referred to as solid-state lasers.

Neodymium is a common dopant in various solid-state laser crystals, including yttrium orthovanadate ($Nd:YVO_4$), yttrium lithium fluoride (Nd:YLF) and yttrium aluminium garnet (Nd:YAG). All these lasers can produce high powers in the infrared spectrum at 1064 nm. They are used for cutting, welding and marking of metals and other materials, and also in spectroscopy and for pumping dye lasers. These lasers are also commonly frequency doubled, tripled or quadrupled to produce 532 nm (green, visible), 355 nm and 266 nm (UV) beams, respectively. Frequency-doubled diode-pumped solid-state (DPSS) lasers are used to make bright green laser pointers.

Ytterbium, holmium, thulium, and erbium are other common "dopants" in solid-state lasers. Ytterbium is used in crystals such as Yb:YAG, Yb:KGW, Yb:KYW, Yb:SYS, Yb:BOYS, $Yb:CaF_2$, typically operating around 1020 – 1050 nm. They are potentially very efficient and high powered due to a small quantum defect. Extremely high powers in ultrashort pulses can be achieved with Yb:YAG. Holmium-doped YAG crystals emit at 2097 nm and form an efficient laser operating at infrared wavelengths strongly absorbed by water-bearing tissues. The Ho-YAG is usually operated in a pulsed mode, and passed through optical fiber surgical devices to resurface joints, remove rot from teeth, vaporize cancers, and pulverize kidney and gall stones.

Titanium-doped sapphire (Ti:sapphire) produces a highly tunable infrared laser, commonly used for spectroscopy. It is also notable for use as a mode-locked laser producing ultrashort pulses of extremely high peak power.

Thermal limitations in solid-state lasers arise from unconverted pump power that heats the medium. This heat, when coupled with a high thermo-optic coefficient (dn/dT) can cause thermal lensing and reduce the quantum efficiency. Diode-pumped thin disk lasers overcome these issues by having a gain medium that is much thinner than the diameter of the pump beam. This allows for a more uniform temperature in the material. Thin disk lasers have been shown to produce beams of up to one kilowatt.

Fiber Laser

Solid-state lasers or laser amplifiers where the light is guided due to the total internal reflection in a single mode optical fiber are instead called fiber lasers. Guiding of light allows extremely long gain regions providing good cooling conditions; fibers have high surface area to volume ratio which allows efficient cooling. In addition, the fiber's waveguiding properties tend to reduce thermal distortion of the beam. Erbium and ytterbium ions are common active species in such lasers.

Quite often, the fiber laser is designed as a double-clad fiber. This type of fiber consists of a fiber core, an inner cladding and an outer cladding. The index of the three concentric layers is chosen so that the fiber core acts as a single-mode fiber for the laser emission while the outer cladding acts as a highly multimode core for the pump laser. This lets the pump propagate a large amount of power into and through the active inner core region, while still having a high numerical aperture (NA) to have easy launching conditions.

Pump light can be used more efficiently by creating a fiber disk laser or a stack of such lasers.

Fiber lasers have a fundamental limit in that the intensity of the light in the fiber cannot be so high that optical nonlinearities induced by the local electric field strength can become dominant and prevent laser operation and/or lead to the material destruction of the fiber. This effect is called photodarkening. In bulk laser materials, the cooling is not so efficient, and it is difficult to separate the effects of photodarkening from the thermal effects, but the experiments in fibers show that the photodarkening can be attributed to the formation of long-living color centers.

Lasers As Weapons

Lasers of all but the lowest powers can potentially be used as incapacitating weapons, through their ability to produce temporary or permanent vision loss in varying degrees when aimed at the eyes. The degree, character, and duration of vision impairment caused by eye exposure to laser light varies with the power of the laser, the wavelength(s), the collimation of the beam, the exact orientation of the beam, and the duration of exposure. Lasers of even a fraction of a watt in power can produce immediate, permanent vision loss under certain conditions, making such lasers potential non-lethal but incapacitating weapons. The extreme handicap that laser-induced blindness represents makes the use of lasers even as non-lethal weapons morally controversial, and weapons designed to cause blindness have been banned by the Protocol on Blinding Laser Weapons. Incidents of pilots being exposed to lasers while flying have prompted aviation authorities to implement special procedures to deal with such hazards.

Laser weapons capable of directly damaging or destroying a target in combat are still in the experimental stage. The general idea of laser-beam weaponry is to hit a target with a train of brief pulses of light. The rapid evaporation and expansion of the surface causes shockwaves that damage the target. The power needed to project a high-powered laser beam of this kind is beyond the limit of current mobile power technology, thus favoring chemically powered gas dynamic lasers. Example experimental systems include MIRACL and the Tactical High Energy Laser.

Throughout the 2000s, the United States Air Force worked on the Boeing YAL-1, an airborne laser mounted in a Boeing 747. It was intended to be used to shoot down incoming ballistic missiles over enemy territory. In March 2009 Northrop Grumman claimed that its engineers in Redondo Beach had successfully built and tested an electrically powered solid state laser capable of producing a 100-kilowatt beam, powerful enough to destroy an airplane. According to Brian Strickland, manager for the United States Army's Joint High Power Solid State Laser program, an electrically powered laser is capable of being mounted in an aircraft, ship or other vehicle because it requires much less space for its supporting equipment than a chemical laser. However, the source of such a large electrical power in a mobile application remained unclear. Ultimately, the project was deemed to be infeasible, and was cancelled in December 2011, with the Boeing YAL-1 prototype being stored and eventually dismantled.

The United States Navy is developing a laser weapon referred to as the Laser Weapon System or LaWS.

Laser Safety

Even the first laser was recognized as being potentially dangerous. Theodore Maiman characterized the first laser as having a power of one "Gillette" as it could burn through one Gillette razor blade. Today, it is accepted that even low-power lasers with only a few milliwatts of output power can be hazardous to human eyesight when the beam hits the eye directly or after reflection from a shiny surface. At wavelengths which the cornea and the lens can focus well, the coherence and low divergence of laser light means that it can be focused by the eye into an extremely small spot on the retina, resulting in localized burning and permanent damage in seconds or even less time.

Lasers are usually labeled with a safety class number, which identifies how dangerous the laser is:

- Class 1 is inherently safe, usually because the light is contained in an enclosure, for example in CD players.

- Class 2 is safe during normal use; the blink reflex of the eye will prevent damage. Usually up to 1 mW power, for example laser pointers.
- Class 3R (formerly IIIa) lasers are usually up to 5 mW and involve a small risk of eye damage within the time of the blink reflex. Staring into such a beam for several seconds is likely to cause damage to a spot on the retina.
- Class 3B can cause immediate eye damage upon exposure.
- Class 4 lasers can burn skin, and in some cases, even scattered light can cause eye and/or skin damage. Many industrial and scientific lasers are in this class.

The indicated powers are for visible-light, continuous-wave lasers. For pulsed lasers and invisible wavelengths, other power limits apply. People working with class 3B and class 4 lasers can protect their eyes with safety goggles which are designed to absorb light of a particular wavelength.

Infrared lasers with wavelengths longer than about 1.4 micrometers are often referred to as "eye-safe", because the cornea tends to absorb light at these wavelengths, protecting the retina from damage. The label "eye-safe" can be misleading, however, as it applies only to relatively low power continuous wave beams; a high power or Q-switched laser at these wavelengths can burn the cornea, causing severe eye damage, and even moderate power lasers can injure the eye.

Medical Laser Use

Lasers in medicine have a variety of uses. The real attraction in this industry (and it's not the only attraction, or the only industry!) is the delivery of light energy with incredible precision to almost anywhere in the human body. By directing focussed laser beams onto tissue you can efficiently but gently coagulate tumours, activate medicines and make non-contact incisions.

The primary uses of lasers in medicine begin with the obvious: as a cutting tool – a laser scalpel – with minute precision in cutting.

Optical Coherence Tomography is another medical use of lasers: mapping below the surface of human tissue by penetrating the material and bouncing back when the laser hits a sub-surface element, creating a clearer and safer image than x-rays. This can be used to see changes in the bone protein chemistry that couldn't be detected through other, more traditional techniques (like x-rays).

Lasers can be used to activate medicines too. For the treatment of skin cancers, photodynamic therapy is used, combined with a light-sensitive drug. The laser activates the medicine injected into the cancer cells and destroys them.

LASIK (Laser Assisted Stromal In-situ Keratomileusis) is another use for lasers in medicine: a pulsed laser beam gently reshapes the surface of the cornea to correct vision impairments. Lasers can also be used to remove cataracts and remove unwanted scars, tattoos, pigmentation of the skin and excessive hair through precision surgery.

As well as cutting, medical lasers can weld too. Used to reattach retinas and close incisions by fusing the skin together, lasers really are a multipurpose tool in the medical industry!

Computing, Printing and Communications with Lasers

Because lasers travel so fast (at the speed of light!), they make an ideal method of communication and information processing and retrieval. Combined with fibre optic cables, laser communication is almost instantaneous and large chunks of data can be transported quickly and with minimal space usage.

Printers increasingly use laser technology. Standard, on-paper printers and copiers use laser technology, but more impressively, so do 3D printers. 3D printers work by creating a 3D solid object from a digital file, layer by layer. Two methods for completing this technologically impressive feat are Selective Laser Sintering, where material is melted to form layers, and curing a photo-reactive resin with a UV laser one layer at a time. Both of these utilise lasers.

Quantum Information Processing is another method of laser use in computing and technology, using the quantum properties of light to send information that is "quantum encrypted" and guaranteed to be secure by the laws of physics. The method of doing this is quite incredible, and was thought up in the 1980s.

Packets of light (photons) are sent through an optical fibre with the information encoded in the light packet's polarization. The receiver measures the polarization of this light to retrieve the message encoded within. Because of the properties of quantum mechanics, it would be impossible for anyone to have heard or read the information within the light packet. This technology, already incredible, will only get better as further advancements are made in the construction of quantum computers and fibre optic cable systems, utilising the properties of quantum mechanics in computer processing.

The barcode scanner was another technological advancement in the use of lasers. Back in 1974, the first publicly introduced laser was the barcode scanner in supermarkets. Barcode scanners use a laser beam that scans back and forth so quickly that it appears to the naked eye as a line. Within the scanner a photodiode measures the intensity of the light being reflected back from the black and white pattern and generates a signal that measures the widths of the black bars and white spaces.

An Encyclopedia of a Tiny Crystal

Scientists have discovered that a laser beam can be effectively used to record alphanumeric data and sound on crystals. According Russian researchers a method for recording information on crystals by means of a laser has already been developed, but advanced technologies are needed to make it commercially applicable.

At present researchers are looking for the most suitable chemical compounds to be used as data storages and trying to determine optimum recording conditions. Theoretically, the entire "Great Soviet Encyclopedia" can be recorded on a single tiny crystal.

As far back as 1845 Michael Faradey discovered that a light beam reverses its polarization as it passes through a magnetized crystal Scientists of our day have used this phenomenon to identify crystalline materials capable of storing information. Lasers have been successfully employed to record information on and read it off.

No ideal data storage crystal has yet been found, but it is obvious now that the future of computer engineering lies in lasers and optoelectronics. As paper gave way to magnetic tape, so the latter is to be replaced by tiny crystals.

The Future of Lasers

When it comes to the future of science and technology we can never say for certain what will happen. But lasers show every sign of continuing its unique, creative and important role. Nicholas Bigelow, Lee A. DuBridge Professor of Physics and Optics at the University of Rochester coined it well when he said "The laser is so special because it allows us to harness light in a unique way", "Light is the carrier of the fundamental force that shapes the world as we know it". Being of such importance, the laser will continue to be at the forefront of technological advancements in all fields. We're certainly looking forward to those relating to our specialism. The fibre laser being the first of many!

Judging by the technological advancements already made in the last 55 years, laser research will continue and open the fields of medicine, manufacturing and technology to further new and exciting uses of lasers.

On one hand, the continuously higher requirements for technology and material processing and the emergency of new applications for the laser motivate the development of new systems, but on the other, advanced lasers like the "paser" and "LASIK" are paving the way to new applications for lasers. The only conclusion for certain is that lasers will continue to play a significant role in our daily lives, becoming more prevalent as future applications for this technology emerge. Take, for instance, our F1. The technology utilised here was originally designed for fast communications, but now can be used to cut through solid sheets of steel!

GRAMMAR SUPPLY

ИНФИНИТИВ (The Infinitive)

(Глагол + существительное)

Categories	Active	Passive
Simple	to print	to be printed
Progressive	to be printing	–
Perfect	to have printed	to have been printed
Perfect Progressive	to have been printing	–

Употребление инфинитива

Инфинитивы групп Simple и Progressive выражают действие, одновременное с действием главного глагола, причем форма Progressive выражает процесс.

Jane was sad to learn the truth.

He must be working now.

Инфинитивы группы Perfect выражают любое прошедшее действие независимо от его характера.

Kate regretted to have told it.

Инфинитив Perfect Progressive показывает, что действие началось раньше действия главного глагола, длится параллельно с ним и, возможно, будет длиться далее.

They seem to have been walking the whole day.

Функции инфинитива

1. Подлежащее: To live is to learn.
2. Часть составного именного сказуемого: His task was to help them.
3. Дополнение: He promised to come in time.
4. Определение: I've got much work to do.
5. Обстоятельство:
   - цели: She took a taxi to be in time.
   - следствия: Your tea is too hot to drink it now.

Инфинитив без частицы ‘to’

Употребляется после:

1) модальных глаголов: *We must be in time*;

2) глаголов чувственного восприятия (to see, to feel, to touch, to hear и др.): *We saw him come.*

NB: если глаголы to see и to feel употребляются в косвенном значении, частица to употребляется: *I feel it to be true*;

3) глаголов принуждения: to make, to have. *I had him take the money*;

4) глагола to let: *Let me go*;

5) после структур (had better, would rather, would sooner, nothing but, cannot but): *She does nothing but sleep*;

6) в вопросах, начинающихся с why: Why not ask him about it;

7) после глагола to help инфинитив может употребляться как с ‘to’, так и без: *Help me (to) do it.*

NB: данное правило действует только для активного залога!

Объектный падеж с инфинитивом
(Complex Object)

Употребляется после глаголов:

1) чувственного восприятия: *We heard him speak about it*;

2) умственной деятельности (to think, to believe, to suppose, to consider и др.): *We believed him to be honest*.

NB: после глаголов to think, to consider, to find глагол to be может опускаться: *She finds him handsome*;

3) желания и намерения (to want, to wish, to desire): *I want you to be careful*;

4) эмоций (to like, to love, to hate): *She hates him to shout at her*;

5) принуждения: *I can’t make him obey us*;

6) провозглашения (to announce, to declare, to report): *He was reported to be missing*.

Субъектная конструкция с инфинитивом
(Complex Subject)

В пассивном залоге употребляется после глаголов:

1) чувственного восприятия: *He was seen to take the money*;
2) умственной деятельности: *He is thought to be kind*;
3) to make, to say, to report, to find, to prove, to turn out: *He is said to be in town.*

В активном залоге после глаголов to seem, to appear, to happen, to chance: *He seems to have forgotten about it*.

После выражений to be (un)likely, to be sure: *He is likely to come.*

Exercises

1. Translate from Russian into English:

1. Nick preferred to do anything but work.
2. You must do it at once.
3. He is likely to know her address.
4. Nina seems to know English well.
5. They were asked to come earlier.
6. The text is easy enough for you to understand.
7. I'm sorry to have interrupted you.
8. We didn't expect their team to win the game.
9. She was absent yesterday. She may have been ill.
10. Mr. Walter went to see who was there.

2. Insert "to" where required:

1. We should allow him … come next week.
2. Most people supposed him … be a liar.
3. Don't let us … waste time.
4. You ought not … sit up alone.
5. I'd rather … see the cases myself.
6. There are hundred things … be done.

7. I like to hear her … sing.
8. Why not … make him a doctor, like his father.
9. He was seen … leave the house.
10. She heard her name call.

3. Change clauses for infinitive constructions:

Example: He is so old that he cannot skate. — He is too old to skate.

1. The problem is so difficult that it is impossible to solve it.
2. The box is so heavy that nobody can carry it.
3. The baby is so little that it cannot walk.
4. He is so weak that he cannot lift this weight.
5. She is so busy that she cannot talk with you.
6. She was so inattentive that she did not notice the mistake.
7. The rule was so difficult that they did not understand it.
8. He was so stupid that he did not see the joke.
9. She has got so fat that she cannot wear this dress now.
10. The accident was so terrible that I don't want to talk about it.
11. They were so empty-headed that they could not learn asingle thing.
12. The window was so dirty that they could not see through it.
13. She was so foolish that she could not understand my explanation.
14. I have very little wool: it won't make a sweater.

ГЕРУНДИЙ (the Gerund)

(Глагол + существительное)

Reading is useful

Читать полезно. Чтение полезно.

Categories	Active	Passive
Simple	reading	being read
Perfect	having read	having been read

Характеристики герундия как существительного

1. Выполняет те же функции:
   - подлежащее: *Smoking is harmful*;
   - дополнение: *I remember* (что?) *seeing you somewhere*;
   - часть составного сказуемого: *Peter's hobby* (что делать?) *is seeing all new films*;
   - определение: *There is a chance* (какой?) *of catching the train*;
   - обстоятельство: *After reading the letter I put it into the drawer*. (в функции обстоятельства сочетается с предлогами).

2. Как и существительное, может:
   - сочетаться с предлогами: *On coming in I recognized him*;
   - определяться притяжательным местоимением: *Excuse my interrupting you*;
   - определяться существительным в притяжательном падеже: *I insist on John's staying with us*.

Характеристики герундия как глагола

1. Может иметь прямое дополнение: *His hobby is writing letters.*
2. Может быть определен наречием: *She went on walking fast.*

Употребление герундия

1. Простой герундий (Simple) выражает действие, одновременное с действием главного глагола.

	will become	
He	becomes	rich by working hard.
	became	

2. Перфектный герундий (Perfect) выражает действие, произошедшее до действия главного глагола.

	will regret	
I	regret	after having said these words.
	regretted	

NB: с глаголами типа to remember, to forget, to excuse, to forgive, to thank, с предлогами on, after, without может употребляться простой герундий.

Речевые образцы с герундием

1. To be worth doing smth. – Стоит что-то сделать. The book is worth reading. – Книгу стоит почитать.
2. There is no stopping him. – Его не остановить.
3. Would you mind + Gerund – Вы не возражаете, если… . Would you mind my leaving? – Вы не возражаете, если я уйду?
4. Can't help doing smth – Не могу не… I can't help thinking about it. – Я не могу не думать об этом.
5. Need + Gerund. The grass needs cutting. – Траву нужно скосить.

Грамматическое значение предлогов с герундием

In – одновременность = when, while + Participle I

In leaving my room he paused at my desk. – Покидая комнату, он задержался у моего стола.

On – сразу после.

On entering the room he saw a lot of people. – Войдя в комнату, он увидел много людей.

After – через некоторое время после.

After leaving school he became a student of VSU. – Окончив школу, он стал студентом ВлГУ.

Before – до, перед.

Before saying think of what you are going to say. – Думай перед тем как сказать.

Without – без, не.

Without working you can't live. – Без работы не проживешь.

By – отвечает на вопросы: как? при помощи чего?

He earned money by writing novels. – Он зарабатывал деньги написанием книг.

Through – посредством, благодаря.

Through reading we can learn much. – Благодаря чтению мы можем многое узнать.

Besides – кроме того, что (дополняющее значение).

Besides being a good specialist she is also a good housewife. – Являясь хорошим специалистом, она также хорошая домохозяйка.

Except – кроме (исключающее значение).

She can do everything except cooking. – Она умеет делать все, кроме приготовления пищи.

In spite of – несмотря на (despite).

In spite of being lazy he is one of the best students in the group. – Несмотря на то, что он лентяй, он один из лучших студентов в группе.

Instead of – вместо того, чтобы.

Instead of working you sit with your arms folded. – Вместо того чтобы работать, ты сидишь сложа руки.

For – для того чтобы.

For being respected you should respect others. – Для того чтобы тебя уважали, уважай других.

Глаголы, после которых употребляется только герундий

To enjoy
To finish
To dislike
To go on
To give up
To depend on
To rely on
To insist on
To object to
To hear of
To think of
To thank for
To prevent from
To look forward to
To be fond of
To be sure of
To be surprised at
To be interested in
To be afraid of
Can't stand
Don't mind

С некоторыми глаголами употребляется как инфинитив, так и герундий без разницы в значении:

To begin/to start
To like
To love
to hate
to prefer
to continue

Некоторые глаголы в сочетании с инфинитивом или герундием имеют разные значения

Сравните:

Инфинитив	Герундий
	To remember/to forget
I remember to post the letter Я помню, что мне нужно отправить письмо.	I remember posting the letter. Я помню, как я отправлял письмо.
	To like, to hate, to prefer
I like to swim. Я люблю плавать (время от времени).	I like swimming. Я люблю плавание (вообще).
	To stop
I stopped to buy a newspaper. Я остановился, чтобы купить газету.	I stopped buying newspapers. Я прекратил покупать газеты.
	To go on
On graduating from school he went on to work. Окончив школу он пошел работать.	He went on working though his father objected to it. Он продолжал работать, несмотря на то что его отец возражал.
	To be afraid
I am afraid to ask such questions. Я боюсь задавать такие вопросы (не имею смелости).	I am afraid of being asked such questions. Я боюсь, что мне зададут такие вопросы (боюсь, что что-то может случиться).

Exercises

1. State the syntactic function of the gerund:

1. Repairing cars is his business.
2. Have you finished writing?
3. Taking a cold shower in the morning is very healthy.
4. I am fond of skiing, but my sister prefers skating.
5. The teacher said, "Go on translating, George".
6. He gave up smoking when he was 30.
7. He doesn't mind his staying with his friend's family.
8. The new film is worth seeing.
9. She prefers living alone.
10. They stopped chattering when she entered.

2. Use the gerund or the infinitive:

1. I started (write) my letter this afternoon.
2. She promised (go) to the doctor.
3. (Travel) by air is interesting.
4. She enjoys (cook) Indian meals.
5. Would you mind (open) the window?
6. I'm looking forward to (see) my parents again.
7. Peter gave up (learn) Chinese.
8. Sasha stopped (read) the advertisement.
9. Alison likes (sit) at home and (read) the books in the evening.
10. She kept on (tell) lies.

3. Use the required form of the gerund:

1. She tried to avoid (to speak) to.
   a) having spoken;
   b) being spoken;
   c) speaking.
2. The doctor insisted on (to send) the sick man to hospital.
   a) sending;
   b) being sent;
   c) having sent.

3. He is good at (to repair) cars.
   a) being repaired;
   b) repairing;
   c) having been repaired.
4. The problem is not worth (to discuss).
   a) having discussed;
   b) being discussed;
   c) discussing.
5. Do you mind him (to examine) by a heart specialist?
   a) being examined;
   b) having examined;
   c) examining.

4. Translate into English:

1. Он думает однажды поехать в Америку.
2. Она любила танцевать, когда была молодой.
3. Он поблагодарил меня за звонок.
4. Она согласилась погостить у них летом.
5. Она удивилась, получив от него письмо.
6. Он был заинтересован в сотрудничестве с этой фирмой.
7. Она ждала с нетерпением, когда получит визу.
8. Я настаиваю на том, чтобы помочь ей.
9. Она простила его за то, что он не писал ей.
10. Он не может не рассказать эту историю.

ПРИЧАСТИЕ (The Participle)

(Глагол + прилагательное)

Participle I

Categories	Active	Passive
Simple	using	being used
Perfect	having used	having been used

Функции причастия 1

1. Определение: The boy riding a bike is my friends' son. – Мальчик, катающийся на велосипеде, – сын моих друзей.

2. Обстоятельство: Having parked the car he went home. – Припарковав машину, он пошел домой.

Употребление простого причастия

Простое причастие (Simple) выражает действие, одновременное с действием главного глагола. *Example:* Reading a newspaper she fell asleep.

Перфектный герундий выражает действие, произошедшее до действия главного глагола. *Example:* Having bought the flat he began to do repairs.

Объектный падеж с причастием 1
(Complex Object with PI)

Употребляется после глаголов типа to feel, to see, to hear, to watch.

Example: I heard them discussing the problem.

Participle II

V3 или V (ed): taken, proved.

Функции причастия 2

1. Определение: The mail delivered this morning is very important. – Корреспонденция, доставленная сегодня утром, очень важна.

2. Обстоятельство: Offered this job he was very happy. – Когда ему предложили эту работу, он был очень счастлив.

Объектный падеж с причастием 2
(Complex object with PII)

Означает, что действие совершается не лицом, выраженным подлежащим, а кем-то другим. *Example*: He wants to have his car washed. Он хочет, чтобы его машину помыли. Но: He wants to wash his car (т. е. сам).

Exercises

1. Translate into English:

1. She had her hair done yesterday.
2. I must get my TV repaired.
3. The sun having risen, we continued our way.
4. I saw him running.
5. I remembered him locking the door.
6. She was heard singing in the corridor.
7. He wanted this work done quickly.

2. Find out if the sentences are correct or wrong:

1. The man walked slowly as if hiding from somebody.
2. Be careful when cross the street.
3. While walking our dog we found a wallet full of money.
4. When come home I ran into my old school friend.
5. I like to fall asleep listening to classical music.
6. My brother watching TV when doing his homework.
7. Playing the guitar well he joined a rock band.
8. When looking through my family photos I often feel happy.

3. Correct the errors:

1. She heard her name call.
2. I was kept to wait in the hall for an hour.
3. They were seen crossed the street.
4. We want to have our piano to tune.
5. We'll have the house to paint.
6. I saw the girl to dance in the hall.

CONCLUSION

Отражая специфику специальностей 12.03.05 «Лазерная техника и лазерные технологии» и 28.03.01 «Нанотехнологии и микросистемная техника», учебное пособие будет способствовать повышению общего профессионального уровня студентов, а также поможет приобрести навыки, необходимые для изучения англоязычной профессиональной литературы, что поможет учащимся ориентироваться в значительных потоках технической информации.

Материал и упражнения пособия построены на материале, который обучающимся близок и интересен в силу выбранного направления, что способствует большей заинтересованности в изучении научной лексики на английском языке. Работа с пособием позволит не только усовершенствовать знание английского языка, но и позволит частично повторить и узнать новое по выбранному направлению обучения.

Кроме этого пособие призвано:

- способствовать углублению и закреплению знаний, полученных студентами на лекциях и в ходе самоподготовки;
- развивать у студентов способность к творческому, самостоятельному анализу учебной и нормативной литературы на английском языке;
- вырабатывать умение систематизировать и обобщать усвоенный англоязычный материал, критически оценивать его;
- формировать и укреплять навыки практического применения своих знаний, аргументированного, логического и грамотного изложения своих мыслей на английском языке.

Материалы пособия дают возможность частично использовать его и в процессе преподавания студентам других специальностей технического профиля.

LIST OF RECOMMENDED MATERIALS

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APPENDIXES

Appendix 1

Аннотация (Summary) – это краткое изложение содержания статьи (доклада, заметки) с целью дать возможность понять читателю, стоит ли знакомиться с текстом более подробно. Аннотация отражает тематику текста и основную мысль автора. Обычный объем аннотации составляет 5 – 6 строк.

Структура аннотации:

1) название работы (статьи, доклада), фамилия и инициалы автора, выходные данные оригинала, (т. е. название журнала или монографии, год издания, том, номер и т. д.);

2) формулировка темы работы (текста, статьи, доклада);

3) краткое содержание статьи (доклада), составленное из простых предложений, связанных по определенным правилам.

Если аннотация составляется на английском языке, то допускаются только безличные предложения со сказуемым в страдательном залоге, как правило, в форме Present или Past Simple, иногда в Present Perfect Passive Voice.

Чаще всего используются следующие клише:

…is/are discussed (described, mentioned)…	…обсуждаются (описываются, упоминаются)…
…is/are considered (outlined)…	…рассматриваются…
…is/are presented (shown)…	… представлены, показаны…
…is/are studied (investigated, examined)…	…исследуются…
…is/are obtained (found, established)…	…получены (обнаружены, установлены)…
A (short) description is given to …	Кратко описаны…
A (thorough) study is made of …	Тщательно исследованы…
Particular (special) attention is given (paid) to …	Особое внимание уделено …

Иногда используются конкретизирующие наречия и сочетания, такие как:

accurately (carefully) – тщательно, внимательно

thoroughly, in detail – подробно, детально

clearly – четко, ясно

fully – во всей полноте и т. д.

Для формулировки темы работы (статьи) можно использовать сказуемое в Present Active Voice. Например: The text deals with (studies) …

Далее придаточные предложения должны быть преобразованы в причастные или инфинитивные конструкции, а примеры и иллюстрации любого вида исключены.

Appendix 2

Реферат (Abstract) – это конспективное описание оригинального произведения (текста, статьи, доклада или монографии), передающее его основной смысл. В реферате кратко и четко излагаются все основные положения оригинала. Как правило, объем реферата составляет 1/3 оригинала.

Реферат не предполагает выводов или комментариев составителя, допускаются только выводы автора оригинала, если таковые есть.

По структуре реферат напоминает развернутую аннотацию с употреблением речевых **клише**:

The title of the article is… – Название статьи…
The article is about… – Эта статья о…
The article is devoted to… – Статья посвящена…
The text tells of… – В тексте рассказывается о…
At the beginning of the text… – В начале текста…
The article begins with the description of… – Статья начинается с описания…

The author describes – описывает
(автор) touches upon – затрагивает
explains – объясняет
enumerates – перечисляет
characterizes – характеризует
mentions – упоминает
points out – указывает на
analyses – анализирует
shows – показывает
defines – определяет
underlines – подчеркивает
notes – отмечает
passes on to – переходит к
states – констатирует

Then (next, after that, further) – затем, далее

In conclusion the author… – в заключении автор…

At the end of the text the author sums it all up by saying… – В конце текста автор суммирует все вышесказанное, говоря…

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