**MODULE 10**

**LASER AND OPTICAL TECHNOLOGIES**

“Any sufficiently advanced technology is indistinguishable from magic.”

**Arthur Charles Clarke, an English science-fiction writer**



|  |  |
| --- | --- |
| **Learning points for Module 10:**  • **Reading:**  **Text 10A.** Light Beam at the Service of Humanity  **Text 19B.** How the Flash Tube and the Crystal Make a Laser Beam  **Text 10C.** Photonics. How light really works  • **Vocabulary:** Word Definitions, Collocations, The Opposites, Word Quiz.  • **Grammar**: Infinitives and Gerunds  •  **Speaking:** Speak about how lasers work and are used  **Learning aims:**  - to practice reading and speaking about laser and optical technologies;  - to learn and practise active vocabulary related to the topic of the module;  - to learn and practice how to use Infinitives and Gerunds; |  |

**Lead-in**

**1. *Match the words in A with their definitions in B. Use a dictionary if necessary.***

|  |  |
| --- | --- |
| 1. stimulated  2. radiation  3. acronym  4. emission  5. beam  6. amplification | a. energy in the form of heat or light that you cannot see and which can be very harmful  b. a word formed from the initial letters of other words  c. the increase in volume of a signal  d. a line of radiation or particles flowing in one direction  e. the act of sending out gases or other substances  f. made stronger or more active |

**2. *In groups answer the questions.***

1. What is a laser?
2. a device which produces a very narrow beam of light useful in many technologies
3. a process of optical amplification of light based on radiation emission
4. both *a* and *b*
5. What kind of word is the word ‘laser’?
6. acronym
7. shortening
8. contraction
9. Can you decode the word ‘laser’? (use the words from task 1)

L\_\_\_\_\_\_\_ A\_\_\_\_\_\_ by Stimulated E\_\_\_\_\_\_\_\_ of R\_\_\_\_\_\_\_\_ .

**3. *Study the pictures below. Which of the following words and phrases refer to ordinary light (1) and which to laser light (2)?***

Coherent; its intensity decreases with distance; highly monochromatic; it is not strictly monochromatic; less intense; travels in one direction; incoherent; highly intense; organized; concentrated; travels in all directions; disorganized.

|  |  |
| --- | --- |
| **1IMG_5435** | **2IMG_5436** |
| Ordinary light | disorganized, … |
| Laser light | organized, … |

**Reading. Part 1**

**4*. Read the text and check your answers to lead-in tasks.***

**Text 10 A**

**Light Beam at the Service of Humanity**

**Предпосылки к изобретению (invention preconditions)**. Lasers often remind us of science fiction films and novels. Long ago science fiction writers\* predicted the appearance of a mysterious fiery sword1, which would become an invincible weapon2. The idea of using lasers as death rays3 has also been employed by creators of such blockbusters as X-Men and Star Wars. And though the ray laser gun4 still remains science fiction, ​​putting a light beam at the service of humanity is embodied in myriads5 of other uses based on laser technology.

(2) The word "laser" stands for "light amplification by stimulated emission of radiation”. A laser, an optical device that strengthens light waves, represents an amazing and powerful light source. The difference between ordinary light and laser light is like the difference between the ripples6 in your bathtub and huge waves on the sea. Until the invention of the laser, the available light sources were generally neither monochromatic nor coherent7 and were of relatively low intensity. Lasers produce a well-directed, very intense beam which is *monochromatic, directional* and *coherent*.  *Monochromatic* means that all of the light produced by the laser is of a single wavelength.  *Directional* means that the beam of light has a very low divergence8.  Light from conventional sources, such as a light bulb or the sun, diverges, spreading in all directions.  The intensity may be large at the source, but it decreases rapidly as an observer9 moves away from the source. In contrast, the output of a laser has a very small divergence and can maintain high beam intensities over long ranges.  Thus, relatively low power lasers are able to project more energy at a single wavelength within a narrow beam than can be obtained from much more powerful conventional light sources. *Coherent* means that the waves of light are in phase with each other.  A light bulb produces many wavelengths, that’s why its light is *incoherent*.

(3) The first discoveries that eventually brought us lasers were made at the dawn of the 20th century. In 1917, Einstein laid the foundation for the laser when he introduced the concept of *stimulated emission*. In 1954, Russian physicists Nikolay Basov and Alexander Prokhorov working on the quantum oscillator10 created the first microwave generator, laser’s predecessor,11 and described the theory of its operation. At the same time, the idea how to generate stimulated emission at microwave frequencies was also developed independently by American physicist Charles Townes. He showed how this device, which was named a *maser*, could work. A decade later, in 1964, all three were awarded with the Nobel Prize in physics for their discoveries. In 1960, physicist from California Theodore Maiman demonstrated the first ruby12 laser, which was considered the first successful light laser. Other types of laser quickly followed: a gas laser and a semiconductor injection13 laser.

(4) Due to their remarkable properties lasers turned out to have all sorts of useful applications in different fields from communications to medicine. In science they are a great help in spectroscopy. They allow gigabytes of information to be recorded. They can be used to focus relatively low wattage power14 to such high intensity that it can be used to cut, heat or vaporize material. They have great applications aboard spacecraft. Laser beams allow us to measure distances with much greater accuracy than ever before. Laser-sighting devices15 are fitted to military and police rifles to help soldiers hit their targets. Light lasers can also be used as a defence16 against nuclear missiles17. Lasers may be of use in thermonuclear fusion reactors18. Medicine and surgery have been transformed thanks to highly accurate laser scalpels and [laser diagnostics](http://www.bbc.co.uk/news/uk-scotland-38058636). In the arts, lasers can provide fantastic displays of light.

(5) We are currently living in an era of intense development of lasers. New types of lasers (chemical, excimer, semiconductor, free electron) are introduced almost every year. New applications of lasers are constantly emerging. For example, not long ago archaeologists uncovered a new vast network of cities and roads in the thick jungles around the ancient Cambodian temple complex of Angkor Wat, implementing an aerial survey using Lidar (light detection and ranging). Lidar might also prove crucial in helping autonomous vehicles navigate. Lasers could have a huge impact on the world of computing. For example, a silicon laser computer chip promises faster data transfers. Laser developers say it could enable us to see people behind walls, detect underground infrastructure without digging holes, and develop navigation systems that do not rely on GPS.

*\*Herbert Wells in his novel “The War of the Worlds” in 1898 and Alexey Tolstoy*

*in “The hyperboloid of Engineer Garin” in 1927.*

**Vocabulary notes for text 10 A**

1 fiery sword огненный меч

2 invincible weapon непобедимое оружие

3 death rays лучи смерти

4 laser gun лазерная пушка

5 myriads (of) несметное число

6 ripples рябь, зыбь

7 coherent когерентный

8 divergence дивергенция, расхождение

9 observer наблюдатель

10 oscillator осциллятор, генератор

11 predecessor предшественник

12 ruby рубин

13 injection laser инжекционный лазер

14 wattage power мощность в ваттах

15 laser sighting лазерный прицел

16 defence защита, оборона

17 missiles ракеты

18 thermonuclear fusion термоядерный синтез

**5*. Find the words and word combinations in the text which have the following meanings.***

**§1**

1–verb – to make someone remember something;

2 – verb – to use a particular idea or method

3 – verb – to continue to be in the same state or condition

4 – verb –to express clearly or show the importance of an idea or principle

**§2**

5 – noun – the product of making larger or greater in amount or intensity

6 – noun – the result of sending something out (*e.g.* gas or heat)

7 – verb – to make stronger

8 – noun – the point from which something begins

9 **–** adverb – in relation to something else

10 – noun – a shining line of light

11 – “-ing” form of a verb – covering a large area

12 – verb – to go down to a lower level

13 – a phrase used when you are comparing objects or situations and saying that they are completely different

14 – the amount of something (energy, work, information) produced by a machine

15 – adverb – after a long time

16 – a verb phrase – to provide something (idea, principle) from which another thing can develop

17 – verb – to give someone a prize for something they have done

**§4, 5**

18 – a phrase meaning because of or thanks to

19 – adjective – unusual or surprising and therefore deserving attention

20 – verb – to have a particular result, especially one that you didn’t expect

21 – verb – to write something (*e.g.* information) down

|  |  |
| --- | --- |
| 22 – verb – to change into a vapour  23 – verb – to find the size, length or amount of something  24 – noun – the quality of being correct and true  25 – verb – to carry out  26 – verb phrase – to be of primary importance |  |

**6. *Read the text again and answer the following questions.***

1. Why can we say that lasers were predicted long before their invention?
2. What is a laser? What does the word ‘laser’ mean?
3. What kind of beam do lasers have?
4. What do we mean by the words ‘monochromatic, directional, and coherent’ speaking about laser light?
5. Why is light from the laser so concentrated?
6. Who proposed the theoretical possibility of the process that made lasers possible?
7. Who created the first microwave generator?
8. Who demonstrated the first successful light laser?
9. What laser types are mentioned in the text?
10. Do you agree with the author’s opinion that lasers have found myriads of useful applications. What examples do you think best prove this point?
11. What uses of lasers were you surprised to find out about while reading this text?
12. Can you think of an example of a laser device or technology that you have used or are using?

**7. *Read the statements and decide which of them are true (T) and which are false (F) according to text 10A. Explain why.***

1.The word ‘laser’ means microwave amplification by stimulated emission of radiation.

2. Laser was invented at the dawn of the 20th century.

3. Albert Einstein was the first inventor of a laser.

4. Laser came into existence only in the second half of the 20-th century.

5. Unfortunately most of the applications of a laser proved to be impossible to achieve in reality.

6.The use of lasers in thermonuclear fusion reactors is the question of the future.

7. Laser weapons are widely used by the military.

8. In medicine lasers can be used for various kinds of surgery.

9. There are few inventions that can compete with the invention of a laser.

10. Laser technology has a promising future.

**8. *Complete the sentences using the information from the text without looking into the text.***

1.The word laser is an acronym standing for …

2. Laser light is different from ordinary light in that it is …

3. Russian physicists Nikolay Basov and Alexander Prokhorov created … while working on …

4. In 1960, physicist from California Theodore Maiman demonstrated …

5. Lasers turned out to have myriads of uses, from … to …

6. In science lasers are a great help in…

7. Laser-sighting devices are fitted to … to help soldiers …

8. Today new applications of lasers are …

9. Not long ago archaeologists uncovered … using Lidar.

10. In computing lasers could have …

**9. *Complete the table of laser applications using information from text 10 A. Add any other applications you know of which are not included in the text.***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Military | Engineering | Communications | Medicine | Arts | Any other? |
| sighting devices | cutting materials |  |  |  |  |

**10. *Speak about lasers according to the following plan. Make use of the words and word combinations given below.***

1. The definition of a laser.

2. Laser light vs. ordinary light - a brief explanation.

3. How lasers were invented.

4. Lasers at the service of humanity.

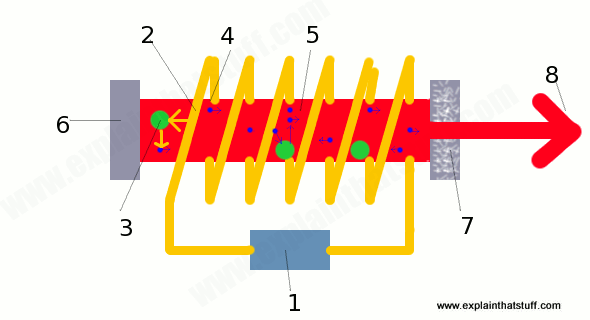
5. The future of laser technology.

*Light amplification, stimulated emission, radiation, laser beam, strengthen light waves, monochromatic, directional, coherent, lay foundation, create a maser, award the Nobel Prize, the first ruby laser, types of lasers, in different fields, measure distances, laser-sighting devices, surgery, new applications of lasers, prove crucial.*

**Reading. Part 2**

**11. *Read the description of the diagram below and match the words below with numbers 1-8 in the diagram.***

Photons, *partial1* mirror, ruby crystal, power source, atoms, laser beam, light *tube*2



You are looking at a red cylinder with a yellow zigzag tube *coiled3* around it. The red cylinder represents a ruby crystal and the yellow zigzag represents a tube of lighting. It coils around the ruby crystal and is connected to the power source in blue. When the laser is working, the light tube *flashes4* on and off, like a series of camera flashes. The grey disc to the left of the ruby crystal is a mirror and the one to the right of the crystal is a partial mirror, which means it *reflects5* part of the light (about 99%) but allows about 1% of the light to come through it to the right. The large green circles inside the crystal represent atoms and the small blue circles represent photons. The large red *arrow6* coming out of the right-hand side of the machine is a laser beam.

**12*. You are going to read about how a laser beam is made. Before you read the text put these notes into the best order.***

* escapingphotons form a powerful laser beam ( )
* atoms *absorb7* energy and give off a photon of light ( )
* the flashes *inject8*energy into the crystal in the form of photons ( )
* partial mirror lets some photons escape ( )
* electric supply makes the tube flash on/off (1)
* new photon hits an excited atom which emits two photons instead of one ( )
* a mirror reflects photons along inside of crystal ( )
* new photons travel inside crystal at the speed of light ( )

**13*. Now read the text and check your answers.***

**Text 10 B**

**How the Flash Tube and the Crystal Make a Laser Beam**

1. A high-voltage electric supply makes the tube flash on and off. Every time the tube flashes, it "pumps" energy into the ruby crystal. The flashes it makes inject energy into the crystal in the form of photons.  
2. Atoms in the ruby crystal (large green circles) *soak9* up this energy in a process called **absorption**. Atoms absorb energy when their electrons jump to a higher energy level. After a few milliseconds, the electrons return to their original energy level (ground state) by giving off a photon of light (small blue circles). This is called **spontaneous emission**.  
3. The photons that atoms give off *zoom10* up and down inside the ruby crystal, traveling at the speed of light.  
4. Every so often, one of these photons stimulates an already *excited11* atom. When this happens, the excited atom gives off a photon and we get our original photon back as well. This is called **stimulated emission**. Now one photon of light has produced two, so the light has been amplified (increased in strength). In other words, "**l**ight **a**mplification"(an increase in the amount of light) has been caused by "**s**timulated **e**mission of **r**adiation" (*hence12* the name "laser", because that's exactly how a laser works!)

5. A mirror at one end of the laser tube keeps the photons *bouncing13* back and forth inside the crystal.

6. A partial mirror at the other end of the tube bounces some photons back into the crystal but lets some escape.

7. The escaping photons form a very concentrated beam of powerful laser light.

**Vocabulary notes**

partial частичный, неполный

tube трубка

coil(ed) обматывать

flash вспыхивать, сверкать

reflect отражать

arrow стрела

absorb поглощать

inject вбрызгивать, вдувать

soak впитывать

zoom *зд.* двигаться

excited atom возбужденный атом

hence поэтому, следовательно

bounce подпрыгивать, отскакивать

**14. *Read the text in detail and choose the best option to complete the sentences according to the information from the text.***

1. The red cylinder in the diagram represents …

a. a power supply b. a laser beam c. a ruby crystal

2. When the laser is working the light tube …

a. highlights b. switches on c. flashes on and off

3) The partial mirror …

a. doesn’t allow the light to pass through b. reflects part of the light c. reflects all the light

4) The large red arrow coming out of the machine is …

a. a flow of atoms b. a laser beam c. a beam of ordinary light

5) When the tube flashes, it…

a. coils around the crystal b. makes the crystal flash on and off c. injects energy into the crystal

6) The photons that atoms give off …

a. zoom up and down inside the ruby crystal b. make the tube flash c. emit radiation

7) Light amplification is caused by …

a. spontaneous emission b. absorption c. stimulated emission

8) The photons that escape through the partial mirror …

a. heat the crystal b. form a concentrated beam of light c. constitute 99% of the light produced by a laser

**15. After reading speaking. *In pairs prepare to speak about a laser machine.***

Student A. Speak about the basic components of a laser machine.

Student B. Speak about how a laser machine works.

**Reading. Part 3**

**16. *Read the text and fill in the gaps with the words in boxes.***

**Text 10 C**

**Part 1. Photonics**

***particles / entire / visible and invisible / far-reaching / cure / suggested / controversial / confirmed / cutting-edge / wavelengths / explore***

**Photonics is the science and technology of generating, controlling, and detecting photons, which are particles of light. Photonics underpins technologies of daily life from smartphones to laptops, medical instruments and lighting technology. The 21st century will depend as much on photonics as the 20th century depended on electronics.**

Photonics is the science of light, it is the technology of generating, controlling, and detecting light waves and photons, which are 1. \_\_\_\_\_\_\_\_\_\_\_\_of light. The characteristics of the waves and photons can be used to 2. \_\_\_\_\_\_\_\_\_\_\_ the universe, to 3.\_\_\_\_\_\_\_\_\_\_\_\_ diseases, and even to solve crimes. Scientists have been studying light for hundreds of years. The colors of the rainbow are only a small part of the entire light wave range, called the electromagnetic spectrum. Photonics explores a wider variety of 4.\_\_\_\_\_\_\_\_\_\_\_ , from gamma rays to radio, including X-rays, UV and infrared light. It was only in the 17th century that Sir Isaac Newton showed that white light is made of different colors of light. At the beginning of the 20th century, Max Planck and later Albert Einstein 5.\_\_\_\_\_\_\_\_\_\_\_\_ that light was a wave as well as a particle, which was a very 6.\_\_\_\_\_\_\_\_\_\_\_\_\_ theory at the time. How can light be two completely different things at the same time? Experimentation later 7.\_\_\_\_\_\_\_\_\_\_\_\_\_ this duality in the nature of light.

The word *Photonics* appeared around 1960, when the laser was invented by Theodore Maiman. Even if we cannot see the 8.\_\_\_\_\_\_\_\_\_\_\_\_ electromagnetic spectrum, 9.\_\_\_\_\_\_\_\_\_\_\_\_ light waves are a part of our everyday life. Photonics is everywhere; in consumer electronics (barcode scanners, DVD players, remote TV control), telecommunications (internet), health (eye surgery, medical instruments), manufacturing industry (laser cutting and machining), defense and security (infrared camera, remote sensing), entertainment (holography, laser shows), etc.

All around the world, scientists, engineers and technicians perform 10.\_\_\_\_\_\_\_\_\_\_\_ research surrounding the field of Photonics. The science of light is also actively taught in classrooms and museums where teachers and educators share their passion for this field with young people and the general public. Photonics opens a world of unknown and 11. \_\_\_\_\_\_\_\_\_\_\_\_ possibilities limited only by a lack of imagination.

**Part 2. How Light Really Works**

***bouncing / solar panels****/* ***converted / incoming / absorbing / makes sense*** */* ***excited / reflecting*** */* ***photons / cells / photoelectric***

Once we understand how atoms take in and give out energy, the science of light 12. \_\_\_\_\_\_\_\_\_\_\_ in a very interesting new way. Think about mirrors, for example. When you look at a mirror and see your face reflected, what's actually going on? Light (maybe from a window) is hitting your face and 13. \_\_\_\_\_\_\_\_\_\_\_\_ into the mirror. Inside the mirror, atoms of silver (or another very reflective metal) are catching the 14. \_\_\_\_\_\_\_\_\_\_\_ light energy and becoming15. **\_\_\_\_\_\_\_\_\_\_\_**. That makes them unstable, so they throw out new 16. \_\_\_\_\_\_\_\_\_\_\_ of light that travel back out of the mirror towards you. In effect, the mirror is playing throw and catch with you using photons of light as the balls!

The same idea can help us explain things like photocopiers and 17. \_\_\_\_\_\_\_\_\_\_ (flat sheets of the chemical element silicon that turn sunlight into electricity). Have you ever wondered why solar panels look black even when they're in full sunlight? That's because they're 18. \_\_\_\_\_\_\_\_\_ back little or none of the light that falls on them and 19. \_\_\_\_\_\_\_\_\_\_ all the energy instead. (Things that are black absorb light, and reflect little or none, while things that are white reflect virtually all the light that falls on them, and absorb little or none. That's why it's best to wear white clothes on a hot day.) Where does the energy go in a solar panel if it's not reflected? If you shine sunlight onto the solar 20. \_\_\_\_\_\_\_\_\_\_\_ in a solar panel, the atoms of silicon in the cells catch the energy from the sunlight. Then, instead of producing new photons, they produce a flow of electricity instead through what's known as the 21.\_\_\_\_\_\_\_\_\_\_\_\_ (or photovoltaic) effect. In other words, the incoming solar energy (from the Sun) is 22. \_\_\_\_\_\_\_\_\_\_to outgoing electricity.

**17. *Read the text again and answer the following questions.***

1. What does photonics study?
2. What can the characteristics of waves and photons be used for?
3. What kind of waves does photonics explore?
4. What discoveries did the scientists of the past make while studying light?
5. What does ‘duality of light’ mean?
6. Why can we say that photonics is everywhere?
7. Do you agree with the opinion of the author that photonics is so important today?
8. What is actually going on when you look at a mirror?
9. Why do solar panels look black in full sunlight?
10. Why is it best to wear white clothes on a hot day?
11. What happens to the solar energy in a solar panel?
12. Do you think that making a career in Photonics is exciting and rewarding?

**18. Listening on the topic. *Listen to a short lecture about lasers and decide which of the following points below the speaker talks about.***

<https://www.youtube.com/watch?app=desktop&v=oUEbMjtWc-A>

**Useful words**

hallmark - клеймо, проба, признак

range finder - дальномер

vitreous humour - стекловидное тело

tour de force - проявление таланта, мастерства

xenon arc - (электрическая) дуга в атмосфере ксенона

flash lamp - импульсная лампа

the crests and troughs - точки подъёма и спада

resonant cavity - резонансная полость

avalanche - лавина

decay - распад

* The unique characteristics of laser light.
* How laser light is different from ordinary light
* How lasers are used in the military.
* How lasers are useful in eye surgery.
* How laser was invented.
* Different types of lasers.
* The operation of a ruby laser.
* How electronic transitions create stimulated emission.
* How the light becomes intensified and narrowed in wavelength inside a laser cavity.
* Innovations and improvements in laser technology.

**19. *Listen to the same lecture again, take notes and prepare to answer the questions.***

1. What examples does the speaker mention to prove his point that ‘much of our technology today depends on lasers’?
2. What technology does he say highlights all other applications of lasers?
3. What are the advantages of a laser scalpel?
4. What three characteristics of laser light does the author call ‘a tour de force of engineering’?
5. How are these three characteristics made?

**VOCABULARY**

**Module 10 Word List**

|  |  |
| --- | --- |
| **Text 10 A**   1. emission (n) 2. emit (v) 3. radiation (n) 4. amplification (n) 5. amplify (v) 6. stimulated () 7. coherent (adj) 8. remind (v) smth. 9. remain (v) 10. embody (v) 11. strengthen (v) 12. source (n) 13. relatively (adv) 14. beam (n) 15. spread (v) 16. decrease (v) 17. output (n) 18. remarkable (adj) 19. in contrast 20. eventually (adv) 21. lay (laid) foundation 22. award (v, n) 23. due to 24. turn (v) out 25. accuracy (n) 26. vaporize (v) 27. fit (v)/ be fitted to 28. measure (v) 29. prove crucial (v) 30. implement (v) | **Text 10 B**   1. photon (n) 2. represent (v) 3. reflect (v) 4. partial (adj) 5. circle (n) 6. absorb (v) 7. bounce (v) 8. absorption (n) 9. inject (v) 10. spontaneous (adj) 11. every so often (n) 12. increase (v, adj) 13. hence (adv) 14. back and forth (adv)   **Text 10 C**   1. underpin (v) 2. photonics (n) 3. far-reaching (adj) 4. cure (v) diseases 5. controversial (n) 6. confirm (v) 7. invisible (adj) 8. consumer (v) 9. particle (n) 10. lack (v, n) 11. make (v) sense (n) |

**1. *Look at the words below. Give their definitions and try to recall how they were used in text 8A.***

Emission, stimulate, radiation, beam, to embody, coherent, monochromatic, directional, laser, to strengthen, to measure, output, remarkable, relatively, vaporize, eventually, to award, accuracy, to be fitted, to implement.

**2. *Fill in the gaps with the words from Task 1 in the right form. The first letters are given. Translate the sentences into Russian.***

***Example:*** *A \_\_\_\_\_\_\_\_ microphone is the one that picks up sound from a specific area. → A directional microphone is the one that picks up sound from a specific area.*

1. If two or more waves have the same phase we call this light **c**\_\_\_\_\_\_\_\_\_\_\_.

2. All our laboratories are **f**\_\_\_\_\_\_\_\_\_ withcomputers and high-speed internet access. 3. Some people think that electromagnetic **r**\_\_\_\_\_\_\_\_\_ from our mobiles is harmful. 4. Climatologists say that the **e**\_\_\_\_\_\_\_\_\_\_ of greenhouse gases contributes to global warming. 5. Melatonin, a hormone involved in controlling our sleep, is **s**\_\_\_\_\_\_\_\_\_\_ by darkness. 6. You might feel ill but if you continue following the doctor’s recommendations you will get well **e**\_\_\_\_\_\_\_\_\_. 7. When a liquid changes form into gas we can say that it **v**\_\_\_\_\_\_\_\_\_\_. 8. The sky cleared up and a **b**\_\_\_\_\_\_\_\_\_ of sunlight shone in through the window. 9. If we don’t modernize, the **o**\_\_\_\_\_\_\_\_ from the factory will decrease. 10. Today it is **r**\_\_\_\_\_\_\_\_\_\_ easy to find any information thanks to the Internet. 11. The 20th century was **r**\_\_\_\_\_\_\_\_\_\_ for its inventions. 12. The Nobel Prizes are **a**\_\_\_\_\_\_\_\_\_\_  annually from a fund created for that purpose by the Swedish inventor and industrialist Alfred Bernhard Nobel. 13. A school’s success can be **m**\_\_\_\_\_\_\_\_ in terms of the number of pupils who got into university. 14. Scientists need to be very careful about the **a**\_\_\_\_\_\_\_\_\_\_ of their research results. 15. Reforms should be **i**\_\_\_\_\_\_\_\_\_ that will allow the company to stay competitive. 16. Our students’ ideas are **e**\_\_\_\_\_\_\_\_ in new classroom rules. 17. **M**\_\_\_\_\_\_\_\_ color refers to a color scheme that is comprised of variations of one color. 18. Exercising regularly is the best way to **s**\_\_\_\_\_\_\_\_ your immune system.

**3*. Match the words with numbers (1-10) with the words with letters (a-j) to make up word collocations. Explain the meaning of these expressions and try to recall how they were used in text 10A.***

|  |  |
| --- | --- |
| 1. to lay 2. to prove 3. to measure 4. light 5. stimulated 6. to decrease 7. conventional 8. to spread 9. remarkable 10. to vaporize | 1. crucial 2. amplification 3. emission 4. source 5. properties 6. foundation 7. distances 8. material 9. rapidly 10. in all directions |

**4. *Complete each sentence with the correct word to make up a word collocation from Exercise 3. Translate the sentences into Russian.***

1. Buying the works of his contemporary artists, Pavel Tretiakov laid the \_\_\_\_\_\_\_\_\_ for one of the world’s greatest collections of Russian paintings. 2. Learning the facts about how COVID-19 emerged may \_\_\_\_\_\_\_\_\_ crucial for preventing future outbreaks. 3. Before electricity was invented the \_\_\_\_\_\_\_\_\_ sources of light were candles or oil lamps. 4. The use of lasers to \_\_\_\_\_\_\_\_\_\_ distances is based on the principle of reflection of a laser beam. 5. One of the problems the inventors of a laser faced was how to create conditions for light \_\_\_\_\_\_\_\_\_\_ . 6. Stimulated \_\_\_\_\_\_\_\_ of radiation is the first and necessary condition for laser light generation, but it is not the only one. 7. Marketers know that the value of data \_\_\_\_\_\_\_\_\_ rapidly over time. 8. The fire was spreading out in all \_\_\_\_\_\_\_\_\_ because of the hot weather and strong wind. 9. The number of articles about new materials with some remarkable \_\_\_\_\_\_\_\_\_ has increased in the last years. 10. Processing of materials with a laser beam allows engineers to cut, drill, weld, and even \_\_\_\_\_\_\_\_\_ different materials.

**5. *Match the words with the correct definition or synonym of the word as it is used in text 8B.***

|  |  |
| --- | --- |
| 1. photon 2. a partial (mirror) 3. back and forth 4. power source 5. to emit 6. to reflect 7. to absorb 8. to bounce 9. concentrated 10. hence 11. to inject | a. to force (*e.g.* a vaccine) or place into   1. a unit of energy that carries light and has zero mass 2. the device that supplies energy 3. to return or throw back (*e.g*. light or sound) 4. so, thus 5. to move away from a surface 6. not complete, limited 7. to send out (*e.g.* light or gas) 8. to take a liquid in 9. focused 10. moving first in one direction and then in the opposite one |

**6. *Look at the words below. Try to recall how they were used in text 10B or think of your own example sentences with some of these words.***

Photons, mirror/partial mirror, power source, laser beam, light tube, to escape, ruby crystal, to reflect, to be connected to, to represent, to flash on and off, to absorb (a photon), to emit (a photon), to get excited, to inject.

***Example:*** *The photons* that atoms give off zoom up and down inside the ruby crystal, traveling at the speed of light.

**7*. Find the opposites.* *Match the words in column A with their opposites in column B. Example:*** *‘to evolve’ is the opposite of ‘to decrease, worsen’*

|  |  |
| --- | --- |
| A.   1. increase 2. absorb 3. stimulated emission 4. inside 5. output 6. get excited 7. flash on 8. inject (energy) 9. coherent 10. organized 11. strengthen 12. implement | B.   1. input 2. emit (energy) 3. disorganized 4. decrease 5. outside 6. incoherent 7. reflect 8. calm down 9. weaken 10. spontaneous emission 11. prevent, delay 12. flash off |

**8*. Rewrite each sentence replacing the italicized words by their opposites. Use the words in brackets so that the new sentence has the meaning opposite to the first sentence. Translate the sentences into Russian.***

***Example:*** The production *efficiency* is the result of good work. (bad). → The production *inefficiency* is the result of bad work.

1. Black surfaces *absorb* more light than other colours. (white) 2. In spring wild birds *increase* in number in Moscow region. (in autumn) 3. *Spontaneous* emission takes place without interaction with other photons. (when photon emission is triggered by other photons) 4. It is really warm *inside* on a winter morning. (cold) 5. A mouse and a keyboard are the examples of *input* devices. (a monitor and a printer) 6. For the system (such as an atom or a molecule) *to calm down* you need to make its energy level lower. (higher than the ground state). 7. If you want to take a picture when it is dark you should choose a ‘*flash on*’ mode. (in daylight) 8. Ordinary light unlike laser light is *incoherent* and *disorganized.* (laser light) 9. The committee agreed that it was necessary to *implement* the changes recommended in the report. 10. Our attention is *weakened* by stress. (mindfulness)

**9. *Complete the sentences with the correct form of the word in capitals at the end of each sentence.***

1. The name ‘laser’ stands for Light \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by stimulated emission of radiation. AMPLIFY 2. Many enjoy the mental \_\_\_\_\_\_\_\_\_\_\_ of a challenging job. STIMULATE 3. Words \_\_\_\_\_\_\_\_\_\_ thoughts and feelings. EMBODIMENT 4. Difficulties \_\_\_\_\_\_\_\_\_\_ the mind, as labour does the body. STRONG 5. Laws controlling the \_\_\_\_\_\_\_\_\_\_ of greenhouse gases should be made. EMIT 6. Truth is the \_\_\_\_\_\_\_\_\_\_ of all knowledge. FOUND 7. A cloud is a mass of \_\_\_\_\_\_\_\_\_\_ in the sky. VAPORIZE 8. A graphical \_\_\_\_\_\_\_\_\_ of the experiment results is required. REPRESENT 9. Do you think mobile phones emit \_\_\_\_\_\_\_\_ ? RADIATE 10. If a text is \_\_\_\_\_\_\_\_\_\_ , it means that it is well planned, clear and logical. COHERENCE

**10. *Read the text and fill in the gaps with the following words in the appropriate form.***

*Concentrated, coherence, weapon, monochromatic, stands for, emission, beam, to encode and transmit, sophisticated, represents, hence, to vaporize.*

In the «War of Worlds» written before the turn of the last century H. Wells told a fantastic story of how Martians almost invaded our Earth. Their 1\_\_\_\_\_\_\_\_\_\_\_\_\_ was a mysterious «sword of heat». Today Wells’ sword of heat has come to reality in the laser. The name 2\_\_\_\_\_\_\_\_\_\_\_\_\_\_ light amplification by stimulated 3\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of radiation.

Laser, one of the most 4\_\_\_\_\_\_\_\_\_\_\_\_\_\_ inventions of man, produces an intensive 5\_\_\_\_\_\_\_\_\_\_\_\_ of light of a very pure single colour. It 6\_\_\_\_\_\_\_\_\_\_\_\_\_ the fulfilment of one of the humankind’s oldest dreams of technology to provide a light beam intensive enough 7\_\_\_\_\_\_\_\_\_\_ the hardest materials. There are few materials which are not suited for laser processing, 8 \_\_\_\_\_\_\_\_\_ laser treatment of materials has become an important technique lately.

The laser’s most important potential may be its use in communications. We send and receive the data, video and other information, using lasers 9 \_\_\_\_\_\_\_\_\_\_\_ the data at rates 10 to 100 times faster than radio, because lasers can generate a very intense, 10\_\_\_\_\_\_\_\_\_\_\_, highly parallel and 11\_\_\_\_\_\_\_\_\_\_ beam and 12\_\_\_\_\_\_\_\_\_\_\_ is a very important property of laser light.

**11. *Work in groups. Choose 5-7 words from Module 10 Word list and prepare a short news story to tell your group using these words. Ask your listeners to note down the words while they listen to your story. Compare your lists.***

**12*. Summarize in English paying attention to linking expressions.***

**I.** Тема моего сообщения – изобретение, свойства и использование лазера. Я начну с рассказа об истории изобретения лазера, затем перейду к его свойствам, в-третьих расскажу о типах существующих лазеров и, наконец, рассмотрю практическое использование лазера в различных областях. Итак, кого можно однозначно считать изобретателем лазера? Точного ответа на этот вопрос нет. Тем не менее, можно упомянуть ряд имен ученых, внесших вклад в создание лазера. Более того, двух-трёх из них можно назвать отцами этого изобретения. Несмотря на то, что вначале казалось, что в основном лазер найдет применение в военной области, лазерная винтовка, по-видимому, останется изобретением фантастов. Что касается свойства лазера испускать чрезвычайно узкий луч света, то по этой причине он стал широко применяться во многих областях. С одной стороны, лазер используется в военной науке, с другой стороны, он применяется в медицине. В целом, нельзя переоценить роль лазера в компьютерной науке. Таким образом, можно видеть, что лазер имеет широкую сферу применения, от хирургических операций до устройств контроля скорости автомобилей. В заключение, хочу отметить, что то что «смертельные лучи» не стали реальностью, только к лучшему.

**II**. Понятие «фотоника» появилось в конце ХХ века и вошло в повседневную жизнь. Это оптоволоконные линии связи, плоские экраны телевизоров и компьютерных мониторов, смартфоны и многое другое. Лазерная связь имеет высокоe качествo, большую пропускную способность, строгую конфиденциальность. И лазеры, и оптоволоконная оптика стали жизненно важными компонентами многих отраслей промышленности. Когда они объединяются, их потенциал стремительно растет. Свет входит в один конец кабеля, отражается по гибкому (flexible) кабелю за счет (due to) полного внутреннего (internal) отражения и попадает в оптический приемник на другом. Лазер, используемый в волоконно-оптических телекоммуникационных системах, -это полупроводниковый лазер. В ходе многих исследований были накоплены новые знания о световых пучках, преобразования их энергии в другие виды энергии, получили мощное развитие такие научно-технические направления как квантовая электроника, волоконная оптика, квантовая оптика, физика и техника лазерной плазмы, передача информации по лазерному лучу, лазерно индуцированные термомеханические процессы, лазерная химия и многие другие. Были разработаны разнообразные источники световых пучков. Термин «фотоника» объединил все эти научно-технические направления.



**SPEAKING AND DISCUSSION**

**Which laser technology is the most important? *Use the cards below to prepare to describe your technology. Present your ideas in mini groups. Decide which three technologies are the most promising.***

**Student A’s Card. Weather regulation**

An international group of scientists have created a laser that can control lightning, changing its trajectory and attracting to the desired point.

To create a thunderstorm model, scientists used two flat parallel plates with an electric charge accumulated on them. When the charge reaches some value, a small lightning appears on the first plate and hits the section on the second. In the model, the researchers use laser-directed graphene particles. The laser beam heats the microparticles and creates a channel with a high permeability, through which an electric discharge begins to flow. During the experiment, physicists made the lightning move along a precise trajectory. According to experts, their discovery will help control the path of an electric discharge in air with great accuracy. Scientists believe that lightning control will be useful for weather control, in industry or medicine.

**Student B’s Card. In weapons**

The implementation of projects to develop laser weapons is extremely important to increase combat effectiveness. Tactical-level combat laser systems have recently been encountered only in science fiction stories. And nowadays they have already been created in practice. The practical tests of the laser complexes and the hypersonic aviation missile systems are being considered. Russian optics and highly sensitive optoelectronics in the creation of laser weapons are also of great importance. Protection from enemy weapons in Russia should be created before such types of weapons appear in other countries.

**Student C’s Card. In space**

Scientists have created an experimental laser installation that will be able to build lasers to protect the Earth from asteroids in the future. For pumping it uses the radiation of diode lasers, and in the discharge chamber, atoms of inert gases are used. They are transferred to an excited state in the plasma created by an electric discharge. Thus, a much more powerful and high-quality ray flux is formed. In the future on the basis of such lasers it will be possible to create global anti-asteroid protection systems as well as compact and powerful sources of coherent radiation for use in industry. In addition, the proposed combination of technologies makes it possible to create a compact laser capable of emitting continuous radiation with a power of up to several megawatts.

**Student D’s Card. In medicine**

Laser-based instruments are widely used in medicine. They are used in the treatment of cancer, removal of tumors of the vocal cords, brain surgery, plastic surgery, gynecology and oncology. Laser therapy causes less bleeding and damage to healthy tissue than standard surgical instruments and reduces the risk of infection. Surgical removal of tissue with a laser is a physical process like industrial laser drilling. Carbon dioxide lasers operating at 10.6 micrometers can burn tissue because infrared rays are strongly absorbed by water, which makes up the bulk of living cells. The laser beam cauterizes (прижигает) cuts, stopping bleeding in blood-rich tissues such as the gums (десны). Likewise, a laser with a wavelength of about one micrometer (neodymium YAG laser) can penetrate the eye, welding detached retina back into place, or cutting the inner membranes, which often become cloudy after cataract surgery. Less intense laser pulses can destroy abnormal blood vessels that propagate through the retina in diabetic patients, delaying the blindness often associated with the condition. Ophthalmologists surgically correct vision defects by removing tissue from the cornea by reshaping the transparent outer layer of the eye using intense ultraviolet pulses from excimer lasers.

**Grammar**

**infinitives and gerunds**

**The infinitive**

**Lead-in**

***Read the sentences below, explain their meaning or translate them into Russian paying attention to the highlighted words. In groups discuss the following questions.***

1. What are the highlighted words called? 2. What do they look like? 3. What is their meaning and role in a sentence? 3.Is there an equivalent verb form in Russian?

* Lasers are able to project more energy at a single wavelength within a narrow beam than can be obtained from much more powerful conventional light sources.
* The idea how to generate stimulated emission at microwave frequencies was also developed independently by American physicist Charles Townes.
* Due to their remarkable properties lasers turned out to have all sorts of useful applications.
* They allow gigabytes of information to be recorded. They can be used to focus relatively low wattage power to such high intensity that it can be used to cut, heat or vaporize material.
* Today lasers are helping us see into the past.
* Laser developers say it could enable us to see people behind walls, detect underground infrastructure without digging holes, and develop navigation systems that do not rely on GPS.

STUDY NOTE. **Infinitives** are forms like *to read, to write, to be used*. Unlike verb tenses (*e. g.* *he writes, they developed*) they do not show the actual times of actions, but refer to actions in a more general way. They are usually used with to, but there are some exceptions.

Infinitives have many functions. They can be used to add more information after certain verbs, adjectives and nouns; explain the reason or purpose; as subjects and complements.

**Examples:**

*I wanted to meet him. (after a verb to add more information)*

*He is too busy to help you. (after an adjective to add more information)*

*I went to university to get a degree. (to explain the purpose)*

*My dream is to travel. (as a complement)*

*There’s a great need to improve our service (after a noun to add more information)*

*To eat much sugar is bad for your health. (as a subject)*

**1*. Identify the infinitives and decide what they do in the sentences. Translate the sentences into Russian.***

1-add more information (after nouns, verbs, adjectives)

2-explain the reason or purpose of something

3-as subjects and complements

1. My brother went to university to study computing. 2. Who was the last to come? 3. He is too lazy to get up early. 4. Do you want to see this film? 5. He doesn`t seem to know the answer. 6. It was difficult to sell my car. 7. To read a lot is to know much. 8. This is a difficult question to answer. 9. I don`t know how to respond. 10. I`m going to see her tomorrow. 11. He borrowed some money to buy flowers. 12. To tell the truth, I`m too old to learn new tricks.

**2*. Translate into Russian paying attention to the functions of the infinitives.***

1.To build a number of new factories was one of the tasks of this project. 2.The aim of scientific stations in the Arctic was to see how the navigation period could be lengthened. 3.With the help of the new survey submarine the scientists plan to study underwater flora and soils. 4. To calculate the living standard of the people one also has to consider education expenditure among other expenses. 5.To speak English fluently is the aim of our students. 6.To speak English fluently it is necessary to practise regularly. 7.They are happy to be invited. 8. Here is a book to read. 9. We have a lot of questions to ask. 10. This is the rule to be remembered. 11. The spacecraft to be launched in a few days has been constructed in accordance with the most up-to-date principles. 12. To make light coherent we need to produce light waves of the same wavelength and the same frequency.

**STUDY NOTE.** Sometimes infinitives are used without ***to****.* They are called *bare* infinitives.

 after modal verbs: *Could you* ***answer*** *a few questions?*

 after the verbs to let, to make (to force), to need, to dare: *Weather changes often make cyclones appear. Let me* ***explain*** *the rule.*

Note! In passive voice make is followed by to-infinitive: *She was made to rewrite the essay.*

 after the verbs like: to see, to hear, to feel, to watch, to notice etc.: *I have never seen you look so happy.*

 after the expressions had better/ would rather: *You had better go there.*

 in the sentences beginning by why (not): *Why* ***tell*** *her the bad news?*

*Why not pay more in other shops?*

**3. *Decide which option in brackets is correct.***

1. She always makes him (do/to do) all she wants. 2. They may (arrive/to arrive) soon. 3. It is better (to leave /leave) than to stay. 4. I’d rather (walk/to walk) than take a car. 5. Why not (go/to go) there at once. 6. Will you (let/to let) me (ask/to ask) a few questions? 7. I didn’t hear you (to come in/ come in). 8. Let’s (go/to go) out tonight. 9. Can you (to help/help) me (to do/do) this work? 10. We’d better (go/to go) home as soon as possible. 11. Has anybody seen him (leave/to leave)? 12. I’d like (to go/go) on holiday in July. 13. She said she would never (tell/to tell) lies again. 14. People were made (to stay /stay) indoors during the lockdown.

***(If you want to learn about when ‘bare’ infinitives are used, watch a video following this link: https://youtu.be/TG6ZEJSrMyc)***

**4. *Complete the sentences with the bare or to-infinitive of the verbs in brackets.***

1. We had \_\_\_ (put on) our overcoats because it was cold. 2. How dare you\_\_\_ (call) me a liar? 3. They heard this girl \_\_\_ (cry out) with joy. 4. I would rather \_\_\_ (stay) at home today. 5. You look tired you had better\_\_\_ (go) home. 6. I was planning \_\_\_ (do) many things today. 7. Do not let us \_\_\_ (get worried). 8. What made you \_\_\_ (think) so? 9. He was made \_\_\_ (obey) the rules.10. I’d rather\_\_\_ (see) the cases myself. 11. Why not\_\_\_ (talk) with her yourself?

**The gerund**

**Lead-in**

***Read the sentences below, explain their meaning or translate them into Russian paying attention to the highlighted words. In groups discuss the following questions.***

1. What are the highlighted words called? 2. What do they look like? 3. What is their meaning and role in a sentence? 4. Is there an equivalent verb form in Russian?

* The idea of using lasers as death rays has also been employed.
* ​​Putting a light beam at the service of humanity is embodied in myriads of other uses based on laser technology.
* Producingmany wavelengths makes ordinary light incoherent.
* Implementing an aerial survey using Lidar (light detection and ranging) allowed archaeologists uncover a new vast network of cities and roads in the thick jungles around the ancient Cambodian temple complex of Angkor Wat.
* Lidar might also prove crucial in helping autonomous vehicles navigate.

**STUDY NOTE.** In the examples above **–ing** verb forms ‘act’ more like nouns and can be called ‘**gerunds**’.

***Compare****:* *The students are reading the explanation. (Participle)*

*Reading helps you develop your cognitive abilities .(Gerund*)

We use gerunds to add information after certain verbs; as objects; after prepositions, determiners, possessive pronouns\* instead of verbs; as subjects and compliments; to list activities; after certain common expressions. (*e.g. it is worth doing, no use doing etc…)*

*Examples:*

*We enjoy listening to his lectures. (object of a verb)*

*Are you still interested in dancing? (after a preposition)*

*Doing nothing is sure to get you into a difficult situation. (subject)*

*There’s no use trying to convince him. (special expression)*

*I hope you don’t mind my asking a question. (after my)*

**Note.** Add not before a gerund to make a negative statement.

*Not inviting him was a big mistake.*

\*Some grammars identify the use of a gerund after possessive adjectives, object pronouns or nouns as a *gerundial construction*.

**5*. Decide which usage of gerunds each group of examples illustrate? Match the uses (a-e) with the groups (I-V). Translate the sentences into Russian.***

1. Who`s going to do the cooking? 2. You ought to do some studying. 3. I did a bit of shopping this morning. 4. This is a good place to go fishing.
2. 5. I`m thinking of buying an electric toothbrush. 6. My brother is talking about starting a pop group. 7. We succeeded in finding the place. 8. My mum is fond of doing crosswords. 9. I am not good at drawing. 10. I`m used to walking. 11. I insist on having a rest. 12. I`m afraid of Sarah`s doing too much.
3. 13. On hearing the news, they left at once. 14. We like a hot drink before going to bed. 15. Can`t you help instead of just standing there? 16. You won`t pass the exams without doing any work. 17. You need a special tool for cutting glass. 18. When I studied for exams I stayed awake by drinking black coffee.
4. 19. Eating fast food is bad for you. 20. My favourite activity is reading. 21. Smoking isn`t allowed here. 22. Driving a car isn`t as comfortable as travelling by train.
5. 23. I hate packing. 24. I find reading difficult on a bus. 25. Have you finished writing the letter? 26. Barry suggested going for a walk. 27. I don`t mind waiting a few minutes. 28. Do you enjoy listening to music? 29. I`ve stopped watching television. 30. Our trip involved changing plains.
6. the gerund after prepositions
7. the gerund after verbs, nouns or adjectives
8. the gerund after do and go
9. the gerund after verb/adjective +preposition
10. the gerund as a subject or complement

**6. *Define the function of the gerund and translate the sentences into Russian.***

1.I remember your having objected to this schedule. 2. He entered the room without noticing her. 3.We were surprised at hearing his name among the sportsmen. 4.We know of all substances consisting of atoms. 5. We knew of glass having been invented some hundred years ago. 6. Every student knows of copper being one of the first metals used by man. 7. The possibility of ethylene being converted into aromatic hydrocarbons is slight. 8. Increasing the number of power stations in our country means improving living standards of people. 9. We know of the anti-spam filters being an effective protection from spam. 10. After checking the temperature twice he decided to change the conditions of the experiment. 11. We agreed to their adopting this system as being more economical.12. Heat may be produced by burning coal, gas or any other fuel. 13. After investigating many materials engineers selected aluminium for constructing this device. 14. By raising the cathode temperature we increase the number of emitted electrons. 15. The infection of your computer may lead to deleting crucial files and installing hidden programs on your computer.

**7. *Think of a suitable gerund used as a noun to complete the gaps in these sentences.***

***Example:*** *I don’t mind …… earlier. → I don’t mind leaving earlier*

1. ....... is usually the quickest way of getting from one city to another in Russia.

2. My job involves ……. in the evenings but not very often.

3. I gave up ……. fatty foods.

4. The student admitted ……. his smart phone in the exam.

5. I suggest ……. an alternate route if possible.

6. I really appreciated him ……. me to the airport.

7. I’m looking forward to ……. from you soon.

8. Would you mind ……. the window.

9. I've always avoided ……. things off till the last minute.

10. I consider……. them a letter explaining the situation.

(You can choose from: to send, to take a train, to work, to put, to eat, to open, to use, to hear, to take, to give a lift)

**Gerunds after prepositions**

**STUDY NOTE.** We always use gerunds after prepositions and phrasal verbs with prepositions.

*Example: Excuse me for interrupting you.*

*I’m looking forward to hearing from you.*

**8. *Read the sentences paying attention to the prepositions used with the verbs. Translate the sentences into Russian.***

1. If you want to *enquire about* enrolling on the course you should write an email to this address. 2. They seem *excited about* being here. 3. Luckily I have friends that I can *rely on* to help me in a difficult situation. 4. The delegation *insisted on* holding an immediate meeting. 5. He was *depressed about* being lonely and forgotten. 6. Though he *apologized for* not inviting me to his party I think he did it on purpose. 7. Most employees *approve of* our boss dealing with the crisis. 8. Nobody can be *blamed for* doing what he thinks is best. 9. My driving instructor *warned me against* driving without seatbelts. 10. They *informed us about* opening dozens of new underground stations in the near future.

**9. *Complete the sentences with the correct preposition and the gerund of the verbs in brackets.***

1. The possibility … … chemical energy into mechanical is evident. (to transform)

2. We insisted … … them favourable terms of payment. (to offer) 3. I think … … to the South in summer. (to go) 4. The engineer succeeded … … a very complex problem. (to solve) 5. He is involved … … a new alarm device. (to develop) 6. We object … their … new methods before the test is completed. (to introduce) 7. We discussed some methods … … new projects. (to finance). 8. He improved his report … … the end. (to change) 9. The final decision depends … their …the details of the project. (to submit) 10. I was surprised … his … in that experiment. (to take part) 11. He was disappointed … … the reason of the incident. (not to find out) 12. I`m afraid … … . (to be late) 13. There are different ways … … transportation problems. (to solve) 14. We have no intention … … air pollution equipment. (to order) 15. The customer informed the firm … the buyer`s … the goods. (to insure)

**10. *Complete each sentence by writing in the correct preposition and form of the verb given in the right column.***

|  |  |
| --- | --- |
| 1. The scientists succeeded …. the way for progress.  2. She doesn’t approve ……. in scandals.  3. He didn’t object …. .  4. They cannot prevent her…… here.  5. I was thinking at the time …… the place.  6. Why are you accusing her …… the documents?  7. I thanked him again …… me the car.  8. Unfortunately he persisted …… his ideas.  9. They dreamt …… rich fast.  10. They congratulate me …. from university.  11.Are you accusing me …...  12.The police suspect him …… the money. | 1. PAVE  2. BE INVOLVED  3. BE EXAMINED  4. GO  5. SELL  6. TAKE  7. LEND  8. EXPRESS  9. GET  10. GRADUATE  11. LIE  12. STEAL |

**11*. Choose the correct preposition.***

*Before/without* learning the details about Mount Hood, in Oregon, we had seen this beautiful picture. We thought*for/ by/ of* visiting this difficult place but decided that there was no point *in/at* going there *without* */ after/before* receiving information about this volcano. *After/ in/for* searching the Internet, we learned that volcano Hood was potentially active. But unofficially, Hood was considered calm and active tourism was developed there. We learned that there were three ski resorts. *For/at/by* going there, you need to take skis. *After/to*/*for* having visited this interesting place, we plan to invite friends, talk with them about travel and show photographs.

**CHOOSING BETWEEN AN INFINITIVE AND A GERUND**

**12. *Read the sentences below. Underline infinitives and gerunds and try to explain what the choice of either an infinitive or a gerund depends on in each example.***

1. In laser communications, also referred to as optical communications, light is used to transmit information.
2. The application of so called Laser Communication Terminals will allow drivers to avoid traffic jams.
3. LCTs are able to send important information on the fast lane.
4. More and more people enjoy watching laser light shows which are considered to be safer than fireworks.
5. He didn’t want to wear glassed and decided to have a laser vision correction eventually.
6. Due to their remarkable properties lasers turned out to have all sorts of useful applications.
7. Today engineers carry on designing new types of lasers and are sure of finding more useful applications for these lasers.
8. The surgeon insists on using a laser, which allows to perform more delicate operations.
9. The applications of LiDAR are numerous and have given us everything from tracking the speed of vehicles to recording the distance to the Moon.
10. Many years after developing maser, laser technology goes on having an increasing number of applications.

**STUDY NOTE.** **Gerunds** are often used in similar ways to **infinitives**. In a small number of cases it makes **no difference** whether we choose an infinitive or an –ing form:

*It began to rain = raining.*

*We have a good chance of making = to make a profit.*

**We use infinitives:**

-after certain nouns and adjectives: *I am* ***glad to meet*** *you.*

-after auxiliary verbs (modals): *I* ***can speak*** *English.*

-after many non-auxiliary verbs: *They* ***refused to take*** *part in the discussion.*

**We use gerunds**:

-after certain verbs: *They* ***discussed modernizing*** *the industrial process.*

-after all the verbs with prepositions including phrasal verbs: *She was accused* ***of telling*** *lies.*

-after some expressions: *It is* ***no use crying****.*

(For more explanation and examples watch a video using the link: <https://youtu.be/yDc2BUV9xis>)

**13*. Do you know which verbs and phrases are followed by infinitives and which are followed by gerunds? Make two lists and then check them using the table at the end of Grammar Section.***

Arrange, attempt, expect, fail, decide, expect, happen, hope, intend, manage, plan, pretend, promise, seem, tend, wait, wish, agree, appear, decide, demand, deserve, hesitate, learn, offer, prepare, refuse, start, want, would like, advise, appreciate,

apologise for, involve, insist on, enjoy, consider, carry on, excuse, forgive, involve,

mention, recommend, suggest, look forward, practise, report, can’t stand, can’t help, admit, anticipate, avoid, give up, delay, deny, discuss, complete, continue, escape, fancy, imagine, keep=continue, mean, mind, do not mind, risk, miss, , put off, object to, prevent, , it is worth, no point, give up.

**14. *Complete the sentences by choosing one of the options (a, b).***

1. They agreed not (*a. to speak b. speaking*) about the case. 2. They have arranged (*a. to stay b. staying*) at this hotel. 3. We’ve never attempted *(a. to pass b. passing*) this exam. 4. She could not put off (*a. to go b. going*) to her parents this time. 5. He didn’t expect (*a. to be involved b. being involved*). 6. He promised (*a. to walk b. walking*) in the park every day. 7. The scientist suggested (*a. submit b. submitting*) the student’s work for consideration. 8. Are you just pretending (*a. to take part b. taking part*) in this matter? 9. She admitted (*a. to tell b. telling*) lies. 10. Does your work involve (*a. meeting b. to meet)* a lot of people? 11. She can’t stand (*a. being contradicted b. to be contradicted).*12. He gave up (*a. playing b. to play*) cards. 13. Try to forget it. It isn’t worth (*a. worrying b. to worry*) about. 14. He used *(a. going b. to go)* to school in a car.15. They can’t help *(a. making b.to make*) a noise. 16. I didn’t feel like (*a. working b. to work*). 17. I am used (*a. to listening b. to listen*) to classical music.

**15. *Put the verbs in brackets into the infinitive or the gerund.***

1. A new laser promises (solve) the problem of achieving a laser fusion. 2. Our department invites all the students (take part) in the conference on the topic “Lasers and laser technology”. 3. I don’t mind (have) evening classes from time to time. 4. Why have you decided (go) to university? 5. My colleagues often complain about (have/work) overtime. 6. The speaker claims (be) an expert in the field of computing but I doubt that he really is. 7. Why everybody is blaming him for (lose) the match? It is not entirely his fault. 8. Some people don’t approve of (use) robots extensively because they are afraid of (lose) their jobs. 9. Our teacher told us (prepare) for a test but I don’t know how. 10. He was supposed (speak) for 15 minutes, 20 minutes passed and he is still keeping (talk). 11. Which would prefer (write) an essay or (deliver) a presentation? 12. The chairman asked the audience (not/make) so much noise. 13. When I was leaving my home town (go) to university I thought I would miss (see) my family and school friends. 14. The tutor didn’t recommend (spend) too much time on do) this assignment. 15. I’ve always wanted (live) in my own house. 16. What do you think of (go) to the cinema at the weekend? 17. Is there anything you enjoy (do) ?18. I regret (not /have) more time to go to the gym. 19. We expect lasers (find) more exciting applications in the near future. 20. Don’t forget (practise) regularly if you want (learn) (speak) English fluently.

**16. *Complete the sentences with the infinitive or the gerund of the verb in brackets.***

1. We hope \_\_\_\_\_\_\_ you soon. (see) 2. Are you looking forward to \_\_\_\_\_\_\_ a letter from the company? (receive) 3. Some people are opposed to \_\_\_\_\_\_\_ vaccinated. (get) 4. They’ve been waiting \_\_\_\_\_\_\_ for ages. (be noticed) 5. His parents persuaded him \_\_\_\_\_\_\_ university. (not/give up) 6. It takes some time to get used to \_\_\_\_\_ in such a big city as Moscow. (live) 7. Have you ever wanted \_\_\_\_\_\_\_ a second degree? (get) 8. In addition to \_\_\_\_\_\_\_ English it is really useful \_\_\_\_\_\_\_\_ a second foreign language. (learn) 9. It was very unfortunate that I forgot \_\_\_\_\_\_\_ an umbrella. (take) 10. The more we learn about the origin of the virus the closer we get to \_\_\_\_\_\_ a way to deal with it. (find out) 11. The key \_\_\_\_\_\_\_ success is to be positive. (achieve) 12. No one objected to \_\_\_\_\_\_\_ the meeting as soon as possible. (start) 13. Though he was doing well he decided \_\_\_\_\_\_\_ the course. (give up) 14. Watching his vlog is similar to \_\_\_\_\_ to all those destinations by yourself. (go) 15. The government suggested \_\_\_\_\_\_\_ new measures to protect people. (take) 16. You should continue \_\_\_\_\_\_\_ safer behaviours. (follow)

**17. *Complete the sentences choosing the correct form (an infinitive or a gerund) of the verb given.***

1. She gave up ***(study)*** many years before. 2. She decided not (***study)*** Arts. 3. If you know anything, don’t hesitate (***make)*** an appointment. 4. If you know anything, don’t neglect (***make)*** an appointment. 5. I don't mind your ***(take part)*** in the matter. 6. I want you (***take part)*** in the project. 7. The operation involves ***(open)*** the abscess. 8. During the operation the doctor needed ***(open)*** the abscess. 9. We must delay ***(decide)*** about this! 10. We must agree (***delay***) this! 11. On hot summers she refused (***go)*** to the beach with us. 12. She didn’t admit (***go)*** to the beach. 13. In the end, we decided (***start)*** this matter. 14. In the end, we put off (***start)*** this matter.

**18. *Fill in the gaps with the right form (an infinitive or a gerund) of the verbs in the box.***

|  |
| --- |
| play (2) see buy write visit do win take (2) work |

1. I enjoy ……. the guitar and ……. talented people. 2. He appreciates your ……. efforts to come. 3. Ann has just completed ……. her dissertation. 4. We're considering ……. the yacht. 5. Carry on ……. that, nothing will happen. 6. If we want to win the prize, that will mean ……. hard. 7. They hope ……. us next year. 8. We intend ……. this tender. 9. I'm learning ……. the guitar. 10. Did you manage ……. books in the library?

**19. *Make up sentences using gerunds or infinitives after some of these verbs. Write them on separate cards using gaps instead of the key words. Exchange your cards with other groups and do the gap filling exercise. Check your answers.***

Agree, decide, expect, fail, demand, hope, intend, learn, manage, need, neglect, offer, plan, prefer, prepare, pretend, promise, refuse, tend, wait, want, admit, anticipate, appreciate, avoid, give up, involve, delay, deny, enjoy, complete, consider, carry on, mean, mind, can’t stand, risk, miss, suggest, put off, look forward.

***20. Read this page from a computer games forum. (This is a simple way to understand gerunds and infinitives)***

Home>Forums>Gaming>Off-Topic

MikeSpeed: ⎨If you've ever thought of a gameplay which would be fun at high speeds, then this game might be of interest. You will stop playing any other games.

TheLastWinner:⎨ Have you ever won? How do you play?

MikeSpeed:⎨ Try to move through or attack walls that look out of place with their surroundings. Remember to move until it hits a wall.

MistyJJ: ⎨Try playing before you buy. You may try to test your single-player tactical skills or play the role of famous historical figures. You will never forget navigating within a scene in this game. It’s amusing!

MikeSpeed: ⎨You will remember playing this game. It’s very realistic!

Brain100: ⎨Recording and streaming games is a great way to share or upload your greatest gaming achievements. But what if this tool stops working? 

MikeSpeed: ⎨I’s best to use an external screen recorder.

 Brain100: ⎨It may be no way to stop that train. The brain also loves novelty, new experiences, and art, after all,! Stop to listen to music!

*21. Match the sentences with their meaning*s.

|  |  |
| --- | --- |
| **remember, forget**  1. Remember to move until it hits a wall  2. You will never forget navigating  **stop**  1. Stop to listen to music!  2. But what if this tool stops working?  **try**  1. Try to move through or attack walls.  2. Try playing before you buy. | a. past action/event  b. future action/event  a. to finish the action  b. to interrupt one action in order  to do something else  a. attempt, see if it succeeds (possible action)  b. experience, see if you can do it (action may not be possible) |

**STUDY NOTE.** After certain verbs we can use gerunds or infinitives with a difference in meaning.

Compare: *People* ***stopped buying*** *newspapers because all the news can be found on the Internet. (they no longer buy)*

*On his way home he* ***stopped to buy*** *a newspaper. (interrupt your action to do something else)*

***22. Compare the sentences in each pair. Try to explain the difference between them. Use the clues below to help you.***

1. I remember going to see my grandparents every summer when I was at school.

Remember to buy some bread on your way home. 2. Try drinking herbal tea before you go to bed. They tried to persuade their son not to smoke. 3. He never regretted getting married. I regret to tell you that our cooperation is over. 4. They finished reading and went on translating the article. After university he went on to become one of the leading professionals in his field. 5. They don’t allow smoking inside. My boss didn’t allow me to take a break. 6. We are used to working together. I used to live in the centre, but now I’m living in the country.

1. an infinitive suggests some kind of effort or difficulty is involved in action; a gerund means making a suggestion.
2. we use a gerund when we mean that the task needs to be done but don’t specify by whom; when we specify who has a task to do, we use a full infinitive form.
3. an infinitive used after this expression means that you did something regularly in the past, but no longer do it; a gerund is used after this expression with the meaning accustomed to doing something;
4. an infinitive refers to the future (something we are about to do); a gerund refers to the present or past

***(For more explanation and examples you can watch a video following the link:*** [***https://youtu.be/v2\_Qic03XFI***](https://youtu.be/v2_Qic03XFI)***)***

**23. *Put the verbs in brackets into the gerund or the infinitive. Explain the meaning or translate the sentences into Russian.***

1. We listened to this symphony last Wednesday. Do you remember \_\_\_\_\_\_\_\_\_(listen) to it? 2. Alex was very forgetful. He never remembered \_\_\_\_\_\_\_\_\_ (lock) the garage. 3. My sister forgot \_\_\_\_\_\_\_\_\_ (bring) the knives for our picnic: she left them on the kitchen table. 4.You must never forget \_\_\_\_\_\_\_\_\_ (say) please and thank you. 5. I didn’t know how to get to the university. That’s why I stopped \_\_\_\_\_\_\_\_\_ (ask) the way. 6. Everybody thinks that they all know that should be done. But the board still needs \_\_\_\_\_\_\_\_\_ (convince). 7. The company regretted \_\_\_\_\_\_\_\_\_ (cause) the customer inconvenience. 8. We plan \_\_\_\_\_\_\_\_\_ (go) abroad for our holidays this year. 9. The teacher doesn’t permit \_\_\_\_\_\_\_\_\_(talk) during the lessons. 10. I don’t remember \_\_\_\_\_\_\_\_\_ (he, say) something like that. 11. I recommend you \_\_\_\_\_\_\_\_\_ (consult) an expert. 12. I’ll stop \_\_\_\_\_\_\_\_\_ (lend) you money if you waste it on such things. 13. The airline regrets \_\_\_\_\_\_\_\_\_ (to announce) the cancellation of flight. 14. The windows need \_\_\_\_\_\_\_\_\_ (clean). 15. Could you please stop \_\_\_\_\_\_\_\_ (make) so much noise? 16. We didn’t have enough petrol to reach our destination so we had to stop \_\_\_\_\_\_\_\_ (fill) the car. 17. A master’s in French requires \_\_\_\_\_\_\_\_\_ (study) in a French-speaking country for one year. 18. On some occasion students at Cambridge are required \_\_\_\_\_\_\_\_\_\_\_ (wear) black gowns.

**COMPLEX INFINITIVE AND –ING FORMS**

**Lead-in**

***Which of the following words are the infinitives? why?***

To read; work; looking; to be writing; kept; to have missed out; answered; be treated

**STUDY NOTE.** Besides the ordinary (Simple) Infinitive *e.g.* *to prove, to live,* … there are also progressive, perfect and passive forms.

Compare:

*It is nice* ***to be sitting*** *here with you. (Progressive (continuous) infinitive – suggests that the action is continuing around the time we are talking about)*

*I meant* ***to have phoned****, but I forgot. He should* ***have finished*** *his work. (Perfect infinitive emphasizes that something happened before something else or refer to things that didn’t happen –unreal past)*

*There’s a lot of work* ***to be done****. (Passive infinitive has the meaning similar to passive tense forms)*

*Try* ***not to be*** *late (Negative simple infinitive)*

*He could* ***have been working*** *outside. (Perfect continuous)*

**24. *Find the infinitives in the following examples. Decide what forms they are.***

1. I was glad to answer their questions. 2. I was prepared to be asked questions. 3. I am sorry to have kept you waiting. 4. I might have left my phone at home. 5. It is quite common not to understand everything in lectures. 6. He doesn`t seem to be listening. 7. It seems to be raining outside. 8. I want to be treated with more consideration. 9. It is nice to have finished the work. 10. She must have been studying all night.

**STUDY NOTE**. The **perfect** infinitive is used to emphasize that the action expressed by the infinitive happened before the action expressed by the predicate of the sentence.

**25. *Rewrite these sentences using perfect infinitives.***

**Example:** *I am sorry I have interrupted you. →* I am sorry I **to have interrupted** you.

1. He expects he `ll have passed his exams by June. 2. I was glad I had done my homework. 3. It seemed that he had misunderstood me (He seemed…) 4. We were pleased we had written our tests well. 5. I am happy that I have met you. 6. I was upset because I had lost my wallet. 7. It seems that she `s forgotten about the appointment. (She seems…) 8. It is known that he has won the race. (He is known…) 9. I hope I`ll have finished writing the essay by that time. 10. She was sorry that she had left without saying good-by.

**26*. Use the appropriate form of the Infinitive in brackets.***

1) I’ m glad (to introduce) to you. 2) Her mood seemed (to change) for the worse. We had better not (to speak) to her now. 3) I’m sorry (to disappoint) you but I didn’t mean anything of the kind. 4) He is happy (to award) the Nobel Prize. 5) He was anxious (to take) the first place in competition. 6) The poem can easily (to memorize). 7) You should (to tell) me you were ill. 8) I didn’t expect (to ask) that question. 9) He must (to read) something funny; he is smiling all the time. 10) These are the letters (to answer).

**27. *Find gerunds in the following examples. What forms are they? Translate the sentences into Russian.***

1. She is angry about not having been invited. 2. She loves being admired. 3. Visiting people is nicer than being visited. 4. He was afraid of being seen by the police. 5. I don`t like the dog being shut up in the house. 6. My having said that made no difference. 7. The criminal’s having shot the policeman reacted against him. 8. I completely forgot having asked him to wait for me there. 9. He apologized for not having written the report on time. 10. I am surprised at not having been asked about it.

**STUDY NOTE.** Besides the ordinary (Simple) gerunds *e.g. living, doing*, there are also perfect and passive forms.

*Examples: She loves* ***being admired****. (Passive form)*

*My* ***having said*** *that made no difference. (Perfect form stresses that the action expressed by the gerund ‘having said’ precedes the action expressed by the main verb ‘made’)*.

*I am surprised at* ***not having been asked*** *about it. (Perfect passive form).*

**28*. Fill in the gaps using the appropriate gerund form. Explain their meanings or translate the sentences into Russian.***

*having seen - being spoken - -having allowed me –Combining - visiting -*

*having to* - *being corrected - being told*

1) The place is worth \_\_\_\_\_\_\_ . 2) Can you remember \_\_\_\_\_\_\_ the man before? 3) She was terrified of \_\_\_\_\_\_\_\_ speak to any­body, and even more, of \_\_\_\_\_\_\_\_ to. 4) After \_\_\_\_\_\_\_\_ by the teacher, the stu­dents' papers were returned to them. 5) I was surprised at my mother's \_\_\_\_\_\_\_\_\_ the journey. 6) On \_\_\_\_\_\_\_\_ the news, she turned pale. 7) \_\_\_\_\_\_\_\_\_ laser and thermonuclear reaction is a very interesting problem for the scientists in many countries.

***29. Read the sentences and explain the use of complex infinitives and gerunds. Translate the sentences.***

1. I’d like to be chosen for this role. 2. She regretted not having told us about the accident. 3. The computer should have been repaired last week. 4. You’d better be sleeping now. 5. He denied having been asked to prepare a presentation. 6. Being invited to take part in the conference made them feel good. 7. He can’t have done it on his own, he is not strong enough. 8. Everything's changed, but they forgot to send me the memo. 9. I can’t stand being asked my age. 10. She must have been sleeping all night.

**30. *Fill in the table below with more examples of different infinitive and gerund forms.***

|  |  |  |
| --- | --- | --- |
| **Infinitive** | Active | Passive |
| Simple | *to help,* | *to be helped,* |
| Continuous | *to be helping,* | *xxx* |
| Perfect | *to have helped,* | *to have been helped,* |
| Perfect continuous | *to have been helping,* | xxx |
| **Gerund** | Active | Passive |
| Simple | *writing,* | *being written,* |
| Perfect | *having written,* | *having been written,* |

**31. *Complete the sentences with the appropriate form of the gerund or the infinitive.***

1. Every athlete’s dream is (to choose) to take part in the Olympic games. 2. (go) to university changed many people’s lives. 3. He thinks that hackers might (steal) money from his bank accounts for months. 4. His countrymen congratulated him on (win) the race. 5. Nobody knew of his (send) to work in Africa. 6. Do you know someone who is not looking forward to (go) on holiday? 7. The citizens were warned about a new coronavirus strain (appear) in the country. 8. I can’t see our tutor. He seems (to leave) a few minutes ago. 9. The engineer denied (use) his colleagues’ ideas in his work. 10. I can’t find my key. I must (lose) it. 11. After (fail) the exam in January he was allowed to take it again in February. 12. Due to (be able to speak) French he found lots of job offers in France. 13. He doesn’t respond well to (ask) to do things. 14. Don’t disturb her. She seems (to study) for her exams. 15. At the end of his presentation the speaker said that he was glad (to cover) all the points of his talk. 16. Black paintings by Goya are completely different from his earlier works because of his (to paint) them when he was old and ill. 17. He was sacked because they suspected him of (lie) in order to get the job. 18. The flat looks so tidy. You must just (to clean) it. 19. I don’t like (to interrupt) when I’m working. 20. In addition to (lose) my phone, I realized that I had left my credit card at home.

**REFERENCE MATERIALS FOR GRAMMAR SECTION**

**1. Verbs followed by infinitives:**

*agree, appear, arrange, attempt, decide, expect, fail, demand, decide, deserve, expect, happen, hesitate, hope, intend, learn, manage, offer, plan, prepare, pretend, promise, refuse, seem, start, tend, wait, want, wish, would like.*

**2. Verbs followed by gerunds:** *admit, advise, anticipate, appreciate, avoid, apologise for, give up, involve, delay, insist on, deny, discuss, enjoy, complete, consider, continue, carry on, escape, excuse, fancy, forgive, imagine, involve, keep=continue, mention, mean, mind, do not mind, recommend, risk, miss, suggest, put off, look forward, object to, practise, prevent, report, it is worth, no point, can’t help, give up, can’t bear, can’t stand.*

**3. Verbs followed by gerunds or infinitives** (similar meaning)

*continue, hate, like, love, neglect, prefer, propose*

**4. Verbs followed by gerunds or infinitives** (different meanings)

*begin, stop, remember, forget, regret, need*

**Some verbs and prepositions where the gerund acts as a prepositional indirect object:**

|  |  |  |
| --- | --- | --- |
| *accuse of*  *approve of*  *dream of*  *think of*  *suspect of* | *congratulate on*  *depend on*  *feel like*  *insist on*  *look forward* | *object to*  *persist in*  *prevent from*  *succeed in*  *thank for* |

**Verbs + Gerunds or Infinitives**

**Verbs followed by a gerund or to infinitive with little or no change in meaning:**

**Example**: *It started to rain. / It started raining.*

***begin continue hate like love prefer propose start***

**Different meanings**

**Verbs followed by gerunds or infinitives** (different meanings)

*stop, remember, try*

**More verbs followed by gerund or infinitive with change in meaning:**

*forget regret, need*

***forget* *+ -ing form:***

*They forgot working for this company****.***( They forgot that you had done it)

***forget* *+ to*:**

*They forgot to post the letter.*(They forgot that they needed to post the letter.)

***need* *+ to*:**

*He needs to wash his car. (*It is necessary to do.)

***need*** ***+ -ing form:***

*The car needs washing.* (Passive meaning. The car needs to be washed.)

***regret* *+ to*:**

*We regret to inform you that your house has been robbed****.*** (We wish we didn’t tell you bad news.) It is quite formal. The speakers regret about what they are going to say.)

***regret + -ing form:***

*She regretted being late for the party.* (To look back to an action that took place in the past)

**COMPLEX INFINITIVES and GERUNDS**

Different forms of the gerund and the infinitive

The gerund and the infinitive can be used in the following forms:

**Infinitive**

|  |  |
| --- | --- |
| Infinitive | (to) do |
| continuous infinitive | (to) be doing |
| perfect infinitive | (to) have done |
| perfect continuous infinitive | (to) have been doing |
| passive infinitive | (to) be done |
| perfect passive infinitive | (to) have been done |

|  |  |
| --- | --- |
| Gerund | Doing |
| perfect gerund | having done |
| passive gerund | being done |
| perfect passive gerund | having been done |

**INDEPENDENT FURTHER STUDY**

**Pronunciation**

**Words commonly mispronounced**

**STUDY NOTE.** Some two-syllable words in English have the same form of the verb and the noun. The stress is on the first syllable when the word is a noun and the second syllable when it is a verb**.**

**Example:** *His record was minus 2 miles.-. As a result, we recorded several discussions between her and the manager*

Here are some of the most common such words:

conduct **conflict** contest decrease suspect desert import **increase** insult transfer permit present progress protest transport record reject reprint subject upset

**1*. Read the sentences. Underline the stressed syllable in the words from the list above.***

1. During conflict economic policy typically deteriorates.2. The measures conflicted with the existing criminal law and procedure of the country. 3. They haven’t voted for increases in military spending. 4. Over time economic growth fuelled by innovations in science and technology can increase social cohesion and stability in the community. 5. To conduct a decent advertising campaign, you need a lot of money.6. As far as his conduct is concerned he deserves praise. 7. Both horses contested the race. 8. To enter the contest you must fill in a application. 9. There has been a steady decrease of temperature. 10. These changes will decrease our expenses. 11. This area of the country is mostly desert. 12. His courage deserted him. 13. It was a serious and dull subject. 14. He was subjected to severe criticism. 15. He made a present to his wife. 16. The prizes were presented.

**Gerund/infinitive**

**Do not confuse!**

***Used to + Infinitive****:* e.g. *When a child I used to eat a big breakfast.*

Expresses repetitive actions in the past. Has only one past tense, doesn’t have other tenses.

***Be used to + Gerund or Noun***: e.g. *I’m used to hearing about his achievements.*

Means that you are accustomed to something, and so it seems normal.

**2*. Choose the correct answer. Translate the sentences.***

1. I never used…. TV. (to watch/to watching) 2. It’s different for you. You are used…. (to walk/to walking) 3. I’m not used …. on the left. (to driving/ to drive) 4. You should tidy the room? Yes, I am used ….it myself. (to tidy/to tidying) 5. Did you use …. newspapers at this kiosk? (to buying/to buy) 6. I am used …. lunch myself. (to cook/ to cooking) 7. Did they use ….to this house and …. by the fireplace? (to come ….and sit/to coming … and sitting)

**3*. Complete the sentences choosing some of the options.***

1. Could you please stop (a. making, b. to make) so much noise? 2. Does your work involve (a. meeting, b. to meet) a lot of people? 3. I considered (a. taking, b. to take) the job. 4. The batteries of this radio need (a. changing, b. to change). 5. Do you think the grass needs (a. cutting, b. to cut). 6. She can’t stand (a. being contradicted, b. to be contradicted).7. He gave up (a. playing, b. to play) cards.8. Try to forget it . It isn’t worth (a. worrying, b. to worry) about. 9. He used (a. going, b. to go) to school in a car.10. They can’t help (a. making, b. to make) a noise. 11. I didn’t feel like (a. working, b. to work). 12 I am used (a. to listening, b. to listen) to classical music.

**4. *Rewrite the following sentences using gerunds.***

***Example***: Employees must do their tasks carefully. The boss insists on ***the employees’ doing*** their tasks carefully.

1. The teacher allows his students to put off the work. The teacher doesn’t mind ……

2. My cousin got my e-mail although I had addressed it wrongly. He got my e-mail in spite of ……

3. Did you give me back the book I lent you. I can’t remember…….

4.The woman said that I could open the window. She didn’t mind……

5. My father doesn’t like me to stay out late at night. My father doesn’t like……

6. I’m sure she asked you not to phone after 11.p.m. Have you forgotten……?

**5. *Correct the mistakes.***

1) They congratulate him of arriving. 2) He succeeded of passing exams.

3) The innocent was accused on setting fire to a house. 4) This person persists in spreading false information. 5) He didn't object in his ideas being used.

6) The speaker insisted on the last thesis. 7) They thanked me at taking part in the matter. 8) She said that the case depended on her attending.

9) I feel like to sleep. 10) He got an idea of working for a global company.

**STUDY NOTE.** to-infinitive or gerund:

The verbs ADVISE, RECOMMEND, ALLOW, PERMIT, FORBID, REQUIRE

are followed by –ing forms if there is no object. If there is an object, we use an infinitive. Passive infinitives are also common:

*They* ***advised making*** *the requests for entry visas well in advance in order to facilitate the process.*

*They* ***advised delegations to make*** *their requests for entry visas well in advance in order to facilitate the process.*

(We were advised to make our requests.)

***6. Complete the sentences with the correct forms of the words in brackets.***

1.The administrator advised (check) the "Advanced Settings" option.2. The lecturer recommended us (buy) a few books that might help. 3. In many countries, they don't allow (smoke) in public places. 4. The rules do not permit tenants (keep) pets on the premises. 5. The authorities forbade (enter) the park because of the pandemic. 6. The project required us (work) closely with other schools. 7. We were required (complete) the form.8. The university doesn’t allow (smoke) on the campus. 9. If you visit my country, I recommend (see) the cities of the Golden Ring.

**7*. Complete the sentences with the forms from the box. Then complete the table with the forms.***

*to be loved to have learned to see to love* *to be listening have forgotten*

1) They were happy …….about the discovery of this scientist.

2) Nobody likes …….competitors at conferences.

3) Andrew pretended …….to music.

4) He must …….her.

5) It is wonderful …….and……..

*have been found to defrost to be made to be taking* *to have been working*

6) He asked me not to forget …….the refrigerator.

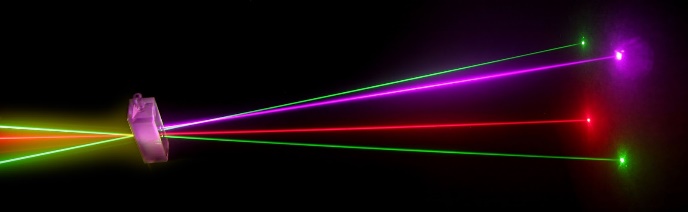
7) This manuscript could very well …….in Syria.

8) One of the earliest optical instruments ever …….was the humble pair of spectacles.

9) She seems …….all night. She looks tired.

10) The tailor wants …….measurements now.

**CHECK YOURSELF**



**1. Laser Quiz.**

1. Laser is a device for producing …

1. spontaneous radiation
2. scattered radiation
3. stimulated radiation

2. Laser light is intense because …

1. It has a few photons that are not in phase
2. It has a very large number of photons that are in phase
3. It has a very large number of photons that are not in phase

3. Commonly used Laser in MB-Computer printers is …

1. He-Ne Gas
2. ruby
3. semiconductor

4. Laser light is different from others because …

1. it is coherent
2. it is intensive
3. it is fast

5. The **strength of early lasers** was measured in … which was a measure of how many razor blades a laser beam could penetrate.

1. amperes
2. gillettes
3. **therm**al units

6. Scientists are experimenting with huge lasers that **are designed to reproduce conditions** …

1. at CERN's Large Hadron Collider
2. on the surface of the sun
3. during the eruption of a volcano

7. Lasers are classified by … of the light pulses they use.

1. the amount of output power
2. the power consumption
3. by the brightness of their beams

8. Lasers have had military applications the most common of which is not …

1. weapons used that rely on laser-targeting
2. defence systems
3. laser guns

9. Laser lights **can’t be seen in space** because …

1. the colours of the beams are not bright enough
2. because they are too far away
3. they do not consist of any matter

10. These are used for bloodless surgery

1. anesthetic
2. lasers
3. fibre-optics

**2. *Five out of ten sentences below contain mistakes. Correct these mistakes.***

1. Einstein proposed the theoretical possibility of the process that made lasers possible.

2. The key feature of a laser technology is that the amplification makes light that is very well defined, unlike ordinary light from such sources as the sun or a lamp.

3. Laser light consists of many wavelengths, with all the waves moving in one direction.

4. Light from conventional sources, such as a light bulb or the sun, diverges, spreading in all directions.

5. In 1964, Nicolay Basov and Alexander Prokhorov were awarded the Nobel Prize for their fundamental research in quantum electronics which led to the development of maser.

6.In 1954, the physicist from California, Theodore H. Maiman, created the first gas laser.

7. Today's laser and all of its applications are the result of an individual's efforts.

8. As it was suggested by science-fiction writers lasers most useful application is a laser gun.

9. Due to their remarkable properties lasers turned out to have all sorts of useful applications in different fields.

10. Lasers can be classified into five types based on their application.

**3. Word quiz. *Repeat the words given in vocabulary section.* *Guess the word using the definition and the first letter of the word. Think of your own sentences with these words.***

1. To find the size, length or amount, using standard units (meters, inches etc.)

**m**\_\_\_\_\_\_\_\_\_ 2. A word made up from the first letters of the name of something.

**a**\_\_\_\_\_\_\_\_\_\_ 3. An increase in the effect or strength of something. **a**\_\_\_\_\_\_\_\_\_\_

4. A gas or other substance sent into the air. **e**\_\_\_\_\_\_\_\_\_\_\_ 5. Put a substance through a special process in order to change its condition, *e.g.* liquid into gas. **v**\_\_\_\_\_\_\_\_\_ 6. To represent a quality or an idea. **e**\_\_\_\_\_\_\_\_\_\_\_

7. To make someone remember something. **r**\_\_\_\_\_\_\_\_\_ 8. To make stronger. **s**\_\_\_\_\_\_\_\_\_\_ 9. The point from which something begins. **s**\_\_\_\_\_\_\_\_\_ 10. As compared with other things the synonym of *fairly*. **r**\_\_\_\_\_\_\_\_\_\_11. The amount of something (energy, work, information) produced by a machine. **o**\_\_\_\_\_\_\_\_\_\_

12. A prepositional phrase meaning because of or thanks to. **d**\_\_\_\_\_ \_\_ 13. Worthy of being noticed especially as being uncommon or extraordinary. **r**\_\_\_\_\_\_\_\_\_\_ 14. To write something (*e.g.* information) down. **r**\_\_\_\_\_\_\_\_\_ 15. A phrase used when you are comparing objects or situations and saying that they are completely different. **i**\_\_ **c**\_\_\_\_\_\_ 16. The quality of being correct and true. **a**\_\_\_\_\_\_\_\_\_17. To turn out to be of primary importance. **p**\_\_\_\_\_\_\_ **c**\_\_\_\_\_\_\_ 8. To use a particular idea or method. **e**\_\_\_\_\_\_\_\_\_\_ 19. To continue to be. **r**\_\_\_\_\_\_\_\_\_ 20. To fulfill or put into effect, carry out. **i**\_\_\_\_\_\_\_\_\_\_

**4*. Fill in the gaps using the words from the table. Retell these mini- texts using the words as prompts.***

*emission, vaporize, fields, treat, accuracy, amplification, beams, measure, engineering, sighting*

**I.** The word “laser” stands for light \_\_\_1\_\_\_\_ of stimulated e\_\_\_\_2\_\_\_\_ of radiation. Laser \_\_\_3\_\_\_ can heat, melt or \_\_\_4\_\_\_\_ materials and also to \_\_\_\_5\_\_\_\_ and align structures. Lasers are used in different \_\_\_6\_\_\_: medicine, military, \_\_\_7\_\_\_ and arts. For example, in medicine they are used to \_\_\_8\_\_\_ damaged tissue or in eye operations where high \_\_\_9\_\_\_ is essential. In the military field they are used as \_\_\_ 10\_\_\_ devices to identify targets.

*amplify, directional, semiconductor, defence, frequency, devices, beams, solid, missiles, recording*

**II.** Lasers are \_\_\_1\_\_\_ which \_\_\_2\_\_\_ light and produce \_\_\_3\_\_\_\_ of light.

Light produced by lasers is very intense and \_\_\_4\_\_\_\_\_ and pure in colour.

There are different types of lasers: \_\_\_\_5\_\_\_ state lasers, gas, liquid and \_\_\_\_6\_\_\_\_ . Once it was believed that they could be used as death rays, but they are actually used as \_\_\_\_7\_\_\_\_against nuclear \_\_\_8\_\_\_\_ . Laser light can carry many information channels because of its high \_\_\_\_9\_\_\_\_ . Lasers can also be used for information \_\_\_\_10\_\_\_\_\_ and reading.

**5. *Match the sentences with the technology names. Match the pictures with sentences.***

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. 2. 3. 4.   |  |  |  |  | | --- | --- | --- | --- | | [Optical Fiber Network Represents World Wide Web And Communicatio Stock Photo](http://www.freedigitalphotos.net/images/optical-fiber-network-represents-world-wide-web-and-communicatio-photo-p329229) | [Singapore - Aug 8 ,2017 : Laser Show At Night In Singapore Stock Photo](http://www.freedigitalphotos.net/images/singapore---aug-8-2017--laser-show-at-night-in-singapore-photo-p574668) | [Cds With Mono Colors - Silver Stock Photo](http://www.freedigitalphotos.net/images/Textures_g330-Cds_With_Mono_Colors__Silver_p165573.html) | [https://upload.wikimedia.org/wikipedia/commons/thumb/e/e7/Laser_Pointers.jpg/300px-Laser_Pointers.jpg](https://en.wikipedia.org/wiki/File:Laser_Pointers.jpg) | | [Plasma Cutting For Workpieces Stock Photo](http://www.freedigitalphotos.net/images/plasma-cutting-for-workpieces-photo-p573700) | [Dental Stock Photo](http://www.freedigitalphotos.net/images/dental-photo-p224157) | [Hand Holding Barcode Scanner Stock Photo](http://www.freedigitalphotos.net/images/Retail_and_sales_g195-Hand_Holding_Barcode_Scanner_p97120.html) |  |   5. 6. 7. |  |

a) Laser Pointers; b) DVD and CD Players; c) Laser Light Shows and Holography; d) Surgery; e) Fiber Optical Communication; f) Barcode Scanner; g) Laser Cutting Machines

1) James Bond has demonstrated laser cutting in 1964 in Ian Flemings "Goldfinger". Laser systems for cutting paper, panels of wood, textiles, plastics or metal foils use laser optical output power of up to a few hundred watts. This power level is sufficient to vaporize these materials. In sheet metal processing, laser cutting machines are standard equipment and have laser power of up to 7 Kilowatts. They can cut anything from sheet metal — from single pieces to small and medium batch sizes. The machines are easily programmed using the CAD-files of the desired part and do not require any other tool besides the laser cutting head which operates without contact and wear. With more than a million watts per square centimeter in the focal area of the laser beam, it melts and partially vaporizes the metal resulting in a needle-like hole reaching tens of millimeters deep into the material.

What the movie producers missed: To cut metal efficiently you need a nozzle to blow away the melted metal. Without the nozzle and cutting gas you would witness another standard laser process: welding.

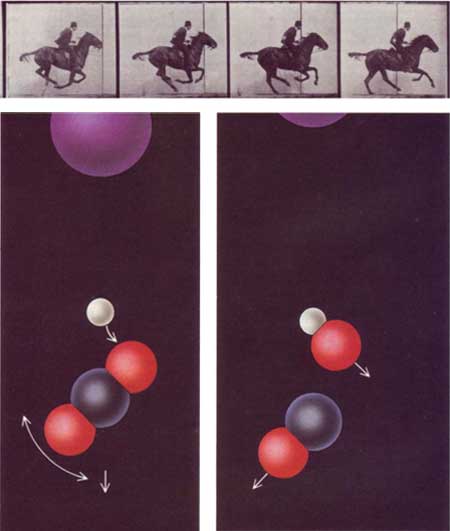


A laser quickly cuts parts with many features and shapes from a piece of steel sheet metal. The finished parts feature clean, smooth edges.

The pictures taken by Eadweard Muybridge in 1872 of a trotting horse enabled him to capture it flying through the air. The camera's shutter speed for such a visible object was appropriately set at a thousandth of a second. For atoms and molecules the time and length scales are vastly different—the atom dimension is about 0.1 nm and atoms move in matter's transformations at speeds as large as a few kilometers in one second.

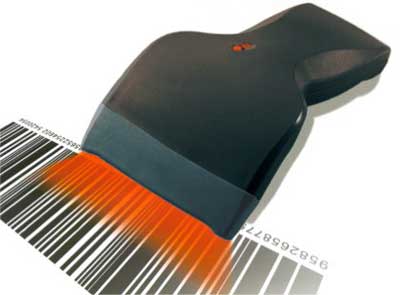
With the invention of lasers, and their mode-locking, bursts of light could be produced with femtosecond duration, a millionth of a billionth of a second. With these stroboscopic pulses shined on a beam of isolated molecules it was possible to witness the motion of atoms as one substance changes to another. The shutter speed was nearly ten orders of magnitude faster than that of Muybridge's camera.

In 1999, Ahmed Zewail of Caltech was awarded the Nobel Prize for developing the field of femtochemistry. On such a time scale one is able to observe in real time the transition states of atoms in motion and uncover the fundamental elementary processes of matter's transformations. It is also feasible to control the outcome of reactions. Currently, the generation of attosecond pulses and the plethora of theoretical and experimental advances in femtoscience represent frontiers of research in atomic, molecular, and biological sciences.



The trotting of a horse captured by a camera, first taken in 1872, and the atoms' motion in the course of a transformation first made in 1987 by laser stroboscopy.

2) These scanners use a laser beam that is scanned back and forth so rapidly that it appears as a line to the human eye. In 1974, the first public laser was introduced in the BarCode scanner found at supermarkets. BarCode scanners use a laser beam that is scanned back and forth so rapidly that it appears as a line to the human eye. A photodiode measures the intensity of the light reflected back from the black and white BarCode pattern, generating a signal that is used to measure the widths of the bars and spaces in the BarCode.



A 10-pack of Wrigley's chewing gum was the first product logged in a grocery store by a BarCode scanner, on June 26th 1974.

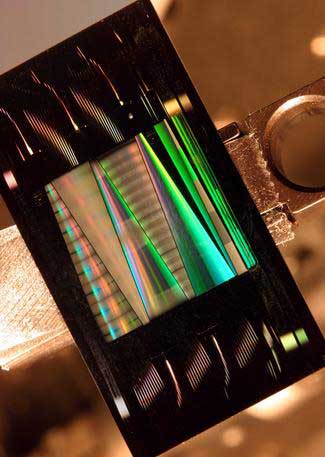
3) These simple, pocket-sized lasers are used to highlight important areas during presentations.

4) These simple, pocket-sized lasers are used to highlight important areas during presentations, and first became available in the 1980s. A red pointer is simply a battery-powered laser diode, which produces light when electricity passes through it. The now popular green laser pointer includes a special crystal that doubles the frequency of an infrared laser into the visible part of the spectrum. They appear so bright because the human eye is most sensitive to green light.



Laser pointers are typically used in business or educational presentations.

Photolithography is the process of using light to print patterns onto a surface or silicon wafer, and is the main technique for micro structuring of electronic devices (such as semiconductors) found in computer chips. Current lithography relies on laser light in the deep ultraviolet produced from an excimer laser. The smallest feature that can be produced with photolithography is related to the wavelength of the light, which led to the adoption of excimer lasers for the light source, as they can produce large amounts of light at very short wavelengths.

Computer chip manufacturers are in continual pursuit of smaller, faster, and more efficient semiconductors. The benefit of being tiny is pretty simple: finer lines mean more transistors can be packed onto the same chip. The more transistors on a chip, the faster it can make your Facebook and World of Warcraft!

Holographic structures can be lithographically scribed and etched onto silicon chips.

The laser acts as a precise disc-reading mechanism. The laserdisc player, introduced in 1978, was the first mass-market consumer product to include a laser. Although this format never really caught on, the compact disc (CD), introduced in 1982, became the audio format of choice. The CD player became the first laser-equipped device readily found in the home. The laser acts as a precise disc-reading mechanism. Its beam of light is reflected off information stored on the disc in a series of tiny pits. The reflected light strikes a photodetector, which converts the information into digital 1s and 0s that is further processed into an audio signal. CD-ROMS use the same technology to store digital data other than audio.

A laser beam shines on the grooves of the CD; the reflected light patterns are then read by an optical device that converts these patterns into little pieces of data called bits. The bits are assembled into the bytes that can in turn represent just about any kind of data imaginable, for example, images or sounds.

5) The first use of a laser in medicine occurred in the early 1960s, when physicians used a laser on a human for the first time, by *destroying* a *retinal* eye *tumo*r with a ruby laser.

6) Both lasers and fiber optics have independently become vital components of many industries.

7) Laser shows produce visual displays by using beam effects; either by switching a stationary beam on and off or by creating dynamic beam effects.

**GRAMMAR**

**6. *Open the brackets using either infinitive or gerund.***

1) He deliberately neglected (to mention) the fact that we could get into a serious trouble. 2) My farther offered (to give) them a lift. 3) I prefer (to go) by train to flying. 4) She was beginning (to work). 5) We tend (to have) cold winters and dry summers. 6) I wish (to make) an appointment. 7) She admitted (to get into trouble). 8) I can't put off (to see) the manager any longer. 9) I suggested (to prepare) the talk in advance.10) They certainly deserved (to win) that game. 11) I don't mind aquatic turtles (to live) in the house. 12) They anticipate (to have) a lot of sales. 13) I appreciate your (to do) well. 14) He promised not (to involve) us in this matter. 15) It is always a risk (to go) on a safari. 16) I recommend (write) your feelings down on paper. 17) Neil denies (to steal) the car. 18) I enjoy (to meet) people. 19) He's just completed (to write) his 17th novel. 20) We're considering (to sell) the house. 21) If we want to catch the train, that will mean (to leave) the house earlier. 22) I avoid (go) to the forest. 23) There were a lot of shoppers waiting (to enter) the store. 24) He failed (to arrive) on time. 25) I demand (to see) the manager. 26) I look forward (to hear) from you. 27) If you need anything, don’t hesitate (to call) me. 28) They hope (to visit) us next year.

**7*. Complete the sentences by choosing one of the options (a, b).***

1) At 5 p.m. that day, the doctors were just beginning (a. to prepare; b. preparing) for the operation. 2)I’m used (a. to hear; b. to hearing) about his achievements. 3) I used (a.to play; to playing) volleyball at that time. 4) You have no experience (to account; b. in accounting). 5) He is used (a.to meeting; to meet) her every day. 6) I cannot explain my anxiety about (a.to fly; b. flying) 7) I’m looking forward (a.to meeting; b. to meet) you. 8) I forgot (a. working; b. to work) for this company. 9) Jack went cold: he completely forgot (a. to call; b. calling) the director. 10) She apologized and said that she regretted (a. being late; b. to be late) for classes. 11) The apartment needed (a. to renovate; b. renovating). 12) We regret (a.to inform; b. informing) you that your house has been sold.

**8. *Complete the sentences with the bare or to-infinitive of the verbs in brackets.***

1. We had \_\_\_ (put on) our overcoats because it was cold. 2. How dare you\_\_\_ (call) me a liar? 3. They heard this girl \_\_\_ (cry out) with joy. 4. I would rather \_\_\_ (stay) at home today. 5. You look tired you had better\_\_\_ (go) home. 6. I was planning \_\_\_ (do) many things today. 7. Do not let us \_\_\_ (get worried). 8. What made you \_\_\_ (think) so? 9. He was made \_\_\_ (obey) the rules. 10. Why not\_\_\_ (talk) with her yourself?

**9*. The infinitive. Choose the right answer. Translate the sentences.***

1. He didn’t want to join the conversation. So he pretended …

a. to read b. to be reading c. to have read

2. I cannot go with you to the cinema today. I’m sorry not … about it earlier.

a. to tell b. to have told c. to be told

3. Look at him. He is smiling. He seems … the film.

a. to enjoy b. to be enjoying c. to have enjoyed

4. This exercise is so easy. It may … by a fifth-grade pupil.

a. do b. be doing c. be done

5. Don’t call her. She worked all night. She may still …

a. sleep b. be sleeping c. have slept

6. That guy is still in the corridor. He seems … over an hour.

a. to wait b. to waiting c. to have been waiting

7. It is important … someone who cares about other people’s feelings.

a. to find b. to be finding c. to have found

8. I’m so hungry. Is dinner ready? It should … long ago.

a. be cooking b. be cooked c. have been cooked

9. This picture looks really old. It must … more than a century ago.

a. be painted b. has been painted c. have been painted

10. It is better to have loved and lost than never … at all.

a. to love b. to be loved c. to have loved

**10. *Translate into Russian using infinitives in different functions.***

1. Передавать сигналы с помощью лазера гораздо быстрее, чем обычными радио волнами. 2. Цель данного исследования показать преимущества компьютеров нового поколения. 3.Необходимо понимать, какие преимущества даст широкое применение лазера в медицине. 4. После неудачных опытов было решено отложить (put off) попытки использовать лазер для контроля термоядерной реакции. 5. Проекты использования лазера в космосе достаточно перспективны (promising). 6. Чтобы описать к-л изобретение, необходимо знать историю его появления. 7. История изобретения лазера слишком интересная, чтобы говорить о ней так кратко (briefly).

**MODULE 10 PROGRESS TEST**

**Grammar*. Decide which answer a, b or c best fits into each gap.***

1) In 1954 Soviet scientists were starting \_\_\_\_\_\_\_\_\_ a molecular generator (maser).

|  |  |  |
| --- | --- | --- |
| a. to create | b. creating | c. being created |

2) We regret \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_you that your house has been sold.

|  |  |  |
| --- | --- | --- |
| a. being informed you | b. informing | c. to inform |

3) You should never forget \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_your hands before eating.

|  |  |  |
| --- | --- | --- |
| a. wash | b. to wash | c. washing |

4) They deserved \_\_\_\_\_\_\_\_\_the greatest minds of all times.

|  |  |  |  |
| --- | --- | --- | --- |
| a. that they call | b. being called | c. to be called | c. to be called |

5) Colleagues remembered A.M. Prokhorov’s \_\_\_\_\_\_\_\_\_from one scientific field to others.

|  |  |  |
| --- | --- | --- |
| a. to switch | b. being switched | c. switching |

6) They forgot \_\_\_\_\_\_\_\_\_ for this company. It was long time ago.

|  |  |  |
| --- | --- | --- |
| a. to work | b. work | c working |

7) They denied the time of encyclopedic scientists \_\_\_\_\_\_\_\_\_into eternity.

|  |  |  |
| --- | --- | --- |
| a. having sunk | b. sank | c. being sunk |

8) They refused \_\_\_\_\_\_\_\_\_ in the matter.

|  |  |  |
| --- | --- | --- |
| a. be involved | b. being involved | c. to be involved |

9) It’s impossible to solve problems without \_\_\_\_\_\_\_\_\_the advanced achievements.

|  |  |  |
| --- | --- | --- |
| a. using | b. to use | c. being using |

10) It’s possible now to avoid \_\_\_\_\_\_\_\_\_mistakes in extremely complicated thermodynamic computations.

|  |  |  |
| --- | --- | --- |
| a. to make | b. making | c. to have made |

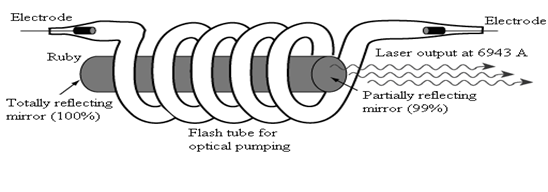
11) This client insists \_\_\_\_\_\_\_\_\_false information.

|  |  |  |
| --- | --- | --- |
| a. on receiving | b. to receive | c. receiving |

12) On examining the car before \_\_\_\_\_\_\_\_\_on a long journey the driver can be sure that he will get to his destination without accidents.

|  |  |  |
| --- | --- | --- |
| a. starting | b. having started | c. to start |

**Vocabulary. *Decide which answer a, b or c best fits into each gap.***

******

Lasers are devices which make large groups of *1\_\_\_\_\_\_\_\_\_* focus into a beam, but getting from a randomly moving photon generated from an electron to a nice *2\_\_\_\_\_\_\_\_\_\_* is no easy task.   
But wait, how do we get atoms *3\_\_\_\_\_\_\_\_* in the first place? The answer is flash tubes. These tubes act as a "pump" to start driving the atoms in our lasing medium. They *4\_\_\_\_\_\_\_\_* extremely intense bursts of light in very short amounts of time, and this full spectrum light energizes the laser medium. As stated before, now that we have energized electrons, we can get photons! Once the laser medium begins emittin*g* photons, they need to be *5\_\_\_\_\_\_\_\_\_\_* and lined up in order to establish our beam.   
Most simple lasers have the same basic structure; the inside of a laser consists of a cylinder of some medium that can be *6\_\_\_\_\_\_\_\_\_\_* (such as a gas like helium or neon in a gas laser, or a crystal like ruby). This cylinder is surrounded by a 7\_\_\_\_\_\_\_\_\_\_ *,* and has a 100% reflectivity mirror at one end to keep the photons *8\_\_\_\_\_\_\_\_\_\_* the tube. The other end of the tube, the end that is actually emitting our beam, is capped with a *9\_\_\_\_\_\_\_\_\_* mirror. This mirror allows photons to travel through it if they are moving in the right direction, but *10\_\_\_\_\_\_\_\_* the photons if they aren't. In some cases, a photon may travel back and forth billions of times before it leaves the medium.

1. a. atoms b. molecules c. photons

2. a. signal b. flash c. beam

3. a. excited b. nervous c. stressed

4. a. excite b. inject c. emit

5. a. concentrated b. collected c. coordinated

6. a. motivated b. electrified c. energized

7. a. coils b. flash tube c. wire

8. a. back and forth b. outside c. inside

9. a. particular b. partial c. reflecting

10. a. reflects b. absorbs c. emits