Module 10 *LASER*

SPEAKING

- Ask and answer questions to find out missing information
- Speak about real and imaginary conditions
- Speak about future applications of laser

LISTENING

- Listen to part of a lecture on laser properties

READING

- Read about laser applications
- Read about laser timeline
- Read about laser history
- Read about pioneers in laser research
- Read about laser future applications

WRITING

- Write a paragraph about hypothetical situations
- Write a paragraph about accidents involving laser

VIDEO CONTENT

- Laser used to reveal Mayan ruins
- Laser history
- 5 ways laser will be used in the future

Grammar

- Conditionals Types 0- 1-2-3
- Conjunctions to introduce conditionals: IF, UNLESS, IN CASE, PROVIDING/ PROVIDED (THAT), AS/ SO LONG AS
- Inversions in conditionals: SHOULD (YOU), HAD (YOU)
- Phrases with AT

Word formation:
Essential vocabulary

amplify, v	construct, v	groundbreaking, adj	pave (the way), v	scale, n	trigger, v
as long as, conj	employ, v	increasingly, adv	propose, v	semiconductor, n	unless, conj
award, v	expand, v	matter, n	provided/ providing, conj	stand for, v	via, prep
beam, n	fibre/ fiber, n	measure, v	ray, n	sync, v	wavelength, n
condition, n	fine, adj	melt, v	reveal, v	tiny, adj	weld, v

Lesson 1 LASERS EVERYWHERE

1 Look at the pictures and match a conventional device with its laser equivalent.

What are their functions?

E. G. [a] and [b] are both used for **measuring** distances/ to **measure** distances.

a

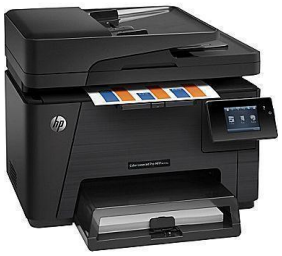
b

c

d

e

f



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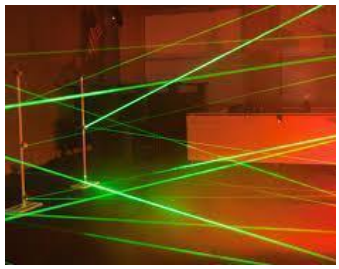

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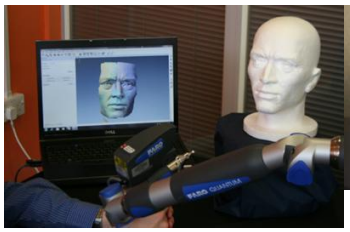
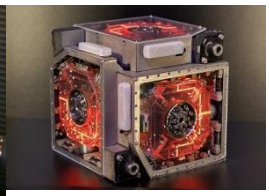
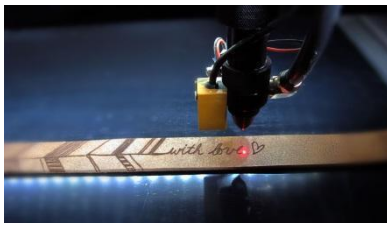
What advantages do laser devices have? (cheaper; faster; more accurate; more efficient etc)

What other laser devices do you know?







3D laser scanning; laser barcode scanner; laser cutting; laser drilling; laser engraving; laser gyroscope; laser intruder alarm; laser lighting display; laser measure; laser pointer; laser printer; laser rangefinder; laser speed gun; laser sight; laser welding; lidar

2 *Fill in the gaps with the names of laser devices from the box above.

_____ (Light Detection and Ranging) is a remote sensing method used to examine the surface of the Earth.
Laser _____ is a manufacturing technique to join two or more pieces of material (usually metal) together using a laser beam.
Laser _____ *is* a device on a firearm that uses a laser to take a precise aim.
*Laser*____ ___ is a handheld device used by the road police to measure the velocity of a vehicle.
*Laser*_____ an instrument for finding the distance of an object from the observer.

3 *Find the English equivalents.

Дальномер; лазерная указка; лазерный прицел; лазерная сварка; резка лазером; лазерная гравировка; сканер штрих-кода; лазерное шоу.

4 Which of these statements are true about laser?

a. It is a machine that makes an amplified, single-colour source of light.
b. It is a high-frequency radio wave.
c. It was predicted in science fiction novels.
d. It was developed by William Roentgen.
e. It ***stands for*** (means) "light amplification by stimulated emission of radiation".
f. It stands for "light absorption in solid environment of ruby".

5 Answer the questions and do the reading task.

1. Some people say that laser is more present in our life than a wheel. Do you agree with this? Name the spheres where laser is used.

2. Read the texts below and match the paragraphs to the headings. Note! One paragraph is extra

~~Information Technology~~		Manufacturing	Measurement and analysis
Medicine	Military	Scientific research	Telecommunications

semiconductor, n – полупроводник, полупроводниковый	**increasingly**, adv все чаще
fibre (fiber), n – волокно	**melt**, v – плавить, расплавлять
via, prep – через, посредством	**employ**, v – использовать
amplifier, n – усилитель	**measure**, v – измерять
amplify, v – усиливать, увеличивать	**tiny**, adj – крошечный; миниатюрный
fine, adj – тонкий, мелкий	**matter**, n – материя
beam, n – луч, пучок лучей	**reveal**, v – выявлять, обнаруживать
	scale, n – масштаб

Information Technology

One of the application of lasers is in optical storage devices (e.g. CD and DVD players), in which a focused beam from a **semiconductor** laser, less than 1 mm wide, scans and reads the disc surface. Other everyday uses include barcode readers, laser printers and laser pointers. Over the past 25 years the publishing and newsprint industries have been revolutionised by the use of lasers, which have replaced traditional "hot metal" printing.

_____

Another large application is in **fibre**-optic communications. Broadband* depends on the transmission of light pulses along optical fibres, which are generated and sent **via** lasers. This is made possible by fibre **amplifiers**, which are an important component in long-distance fibre links.

* широкополосная сеть

_____

Lasers can deliver concentrated energy in the form of **fine** controllable light **beam**s, so doctors soon took advantage of them to perform micro-surgery, which involves less pain and scarring*, lower blood loss and shorter recovery time in hospital. One of the most frequent uses of lasers is in eye surgery to treat disease and, **increasingly**, improve bad eyesight.

* образование шрамов

_____

Lasers can deliver enough power to heat and **melt** metal joints, and so are used for welding, as well as for cutting. When controlled by a computer, a laser can cut complex designs into a material such as wood or paper, as is increasingly being seen in furniture and other home goods.

_____

Lasers have long been used by the military for range-finding, but now even estate agents* **employ** laser tape measures. Because lasers can be modified to produce specific wavelengths**, they are used to analyse chemical and physical structure, and so are used in factory quality control and to monitor environmental pollutants remotely. Lasers can be used for a type of measurement called interferometry which can **measure tiny** changes in distance.

*риелторы

** длина волны

_____

Without lasers, many recent discoveries would never have been made. Lasers interact with **matter** at the quantum level in very specific ways and so are important tools in research. They can be used to follow chemical reactions and **reveal** structure at the atomic and molecular **scale**. Increasingly, life scientists are employing lasers in new types of microscopy designed to highlight cellular* structures.

*клеточные

6 Read the texts again and answer the questions.

a) Which method was used in printing industry before laser?
b) In what form is signal transmitted in fibre-optic cables?
c) What are the advantages of laser surgery over the traditional technology?
d) What manufacturing processes can be performed using laser?
e) How can lasers be useful for environmental protection?
f) How is laser used in science?
g) What are the main properties of laser?

7 Match the synonyms.

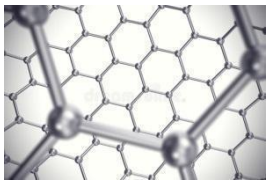
1. amplify 2. employ 3. fine 4. matter 5. measure 6. melt 7. reveal 8. semi- 9. via

a) use b) show c) soften d) calculate e) thin f) substance g) using h) make bigger i) half

8 Fill in the gaps with the suitable words from Ex. 5.

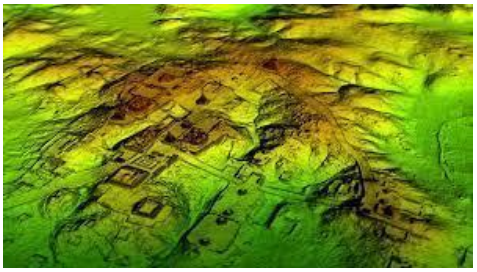
1. All m_____ is made up of t___ particles called atoms.
2. Conventional commercial lasers can m____ a metal by a depth of 2 mm per pulse.
3. One of the main benefits of laser w_____ is that it offers a high level of accuracy.
4. Transistors are devices that can a_____ a weak signal in a circuit.
5. Class IV lasers are e_____ for surgery, cutting, drilling, and micromachining.
6. Microf_____ diameter is larger than 0.2 micron, but not larger than 10 microns.
7. 3D maps created from aircraft-mounted lasers are helping to r_____ historic secrets.

9 Study the phrases with the preposition AT and translate the Russian phrases.

at quantum level at atomic scale at [this] speed at [this] temperature at [this] pressure		*На низком уровне;* *при комнатной температуре;* *на высокой скорости;* *при повышенном давлении;*

10 Watch the video about another use of lasers and answer the questions
https://www.youtube.com/watch?v=zXa_aDbwvM4

1 Which branch of science had profited from the use of lasers?
a) astronomy b) georaphy c) archeology
2 In which part of the world did the experiment take place?
a) Central America b) South Africa c) Western Australia
3 What technology did they use?
a) LiDAR b) RADAR c) X-Ray



4 How did scientists survey the archeological site?
a) from under the sea b) from air c) from the ground
5 How many objects were discovered?
a) around sixty thousand b) around six hundred c) around eight hundred
6 What is the area of the land they mapped?
a) 80000 sq mi b) 8000 sq mi c) 800 sq mi

11 Read the text and give examples of laser technology in your life

LIFE WITHOUT LASERS?

If you were offered $1000 to go an entire day without interacting with lasers, do you think you could do it? What if you also couldn't use anything that had been built with the help of lasers? Doesn't sound too hard, does it? Think again. If you lead a normal life and use some of the modern *amenities* (comforts) around us, you inevitably come into contact with products that were created with or contain a laser. "How can this be?" you might ask. "I don't see any laser beams flashing around me. I don't hit an 'ON' button on a laser every day." But if you stop and think about all the uses lasers have, you'll be pretty surprised.... (By Mark Bronski)

CONDITIONALS

тип	значение	часть с if (условие)	главная часть (результат)	перевод на русский
Zero 0	100% истинно	present (simple, continuous, perfect)	present (simple, continuous, perfect)	настоящее время
		If you *heat* water,	it *boils*.	
First 1st	вероятное действие в будущем	present (simple, continuous, perfect)	future simple	будущее время (обе части)
		If you *keep* trying,	you *will succeed*.	
Second 2nd	маловероятное или воображаемое действие в настоящем	past simple	would V	с использованием частицы бы
		If I *were* a magician, If I *had* superpowers	I *would make* everyone happy.	
Third 3rd	невозможное действие в прошедшем	past perfect	would have V3	с использованием частицы бы
		If your parents *had* not *met*,	you *would* not *have been* born.	

12 Identify the types of conditionals in the text in Ex. 11.

13 Match the two halves to make a proverb or a famous quote. Identify the type of the conditional.

1) If I hadn't been a writer,	a. you won't have to remember anything. (*M. Twain*)
2) If there were no bad people,	b. there would be no good lawyers. *(Ch. Dickens)*
3) If wishes were horses,	c. beggars would ride. (*proverb*)
4) If you do right,	d. I would still plant my apple tree. (*M. Luther*)
5) If you do wrong,	e. you'll get what you always got.
6) If you do what you always did,	f. no one will remember.
7) If you tell the truth,	g. no one will forget.
8) Even if I knew that tomorrow the world would go to pieces,	h. I should have been a gardener. (*A. Chekhov*)

FOCUS on Conditional Type 1

14 Use the verbs in Conditional Type 1 to fill in the gaps and choose the statements you agree with.

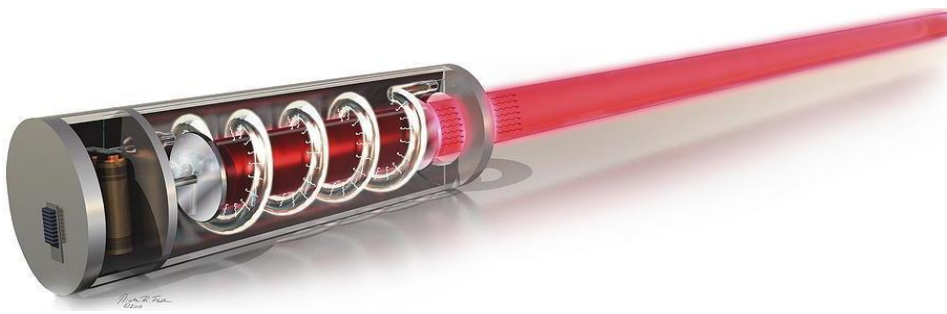
1. If all computers suddenly *disappear*, our world *will adapt* quickly.
2. If the Internet _____(collapse), every aspect our lives _____(be affected).
3. If a limitless source of energy _____(be found), it _____ (solve) all global problems.
4. If renewable power sources _____ (be used), electricity _____ (be) cheaper.
5. If we _____ (not use) plastic bags, there _____(be) much less rubbish.
6. I _____(feel) comfortable if I _____(have) to go a whole day without my smartphone.
7. The humanity _____(not survive) if all electronic devices _____(disappear).
8. There _____(not be) any road accidents if robotic cars _____(take over).
9. People _____(spend) their free time more productively if there _____(be) no social networks.
10. People _____ (not have to) do dangerous jobs when robots _____ (become) more affordable.

Alternatives to IF:

unless – если только не	Do not operate this device **unless** you are 100% confident.
in case – в случае если;	Read the manual again **in case** you missed something.
providing/ provided (that) – при условии, что	The mechanism will keep working **provided** there is enough fuel.
as/ so long as – если	**As long as** there's life, there will be hope.

15 Fill in the gaps with the appropriate conjunction.

1. You will need backup _____ something goes wrong.
a. in case b. provided
2. We won't believe you _____ you give us proof .
a. as long as b. unless
3. _____ as the car is regularly maintained, you will not have any problems.
a. in case b. as long
4. Personal protection equipment won't help _____ you wear it.
a. unless b. providing
5. E-books will be popular as _____ they are free.
a. long as b. provided that
6. They will fund the project _____ they find it safe.
a. provided b. unless
6. The production technology will be refined _____ it will not involve extra expenses.
a. unless b. providing
7. Bubbles of air will expand if you heat them, _____ the pressure remains constant.
a. as long as b. unless

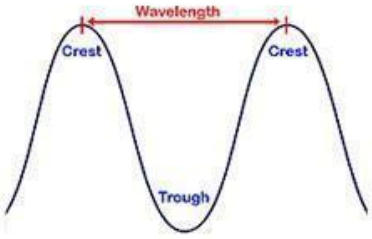


Lesson 2 HOW LASER WORKS

16 Listen and choose the correct laser property in each column.
https://www.youtube.com/watch?v=L3bB26kX4QY

1	2	3
• monochromatic	• adherent	• collected
• monodramatic	• coherent	• collimated
• monogramatic	• inherent	• contaminated

17 Listen again and choose the correct option in each statement. Match them with the laser properties.

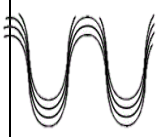
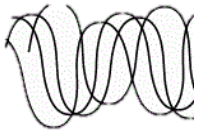
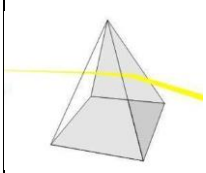
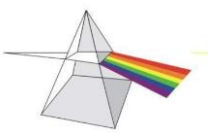


wavelength, n = the distance between two points of the same phase
ray, n = beam
sync, n = to be **in phase** = synchronize
crest, n = top, peak
trough, n [trɒf] = the lowest point of a wave

1. The *white light/ laser light* is composed of all of the wavelengths of light that we can see.
2. The *white light/ laser light* is composed of only one wavelength of light.
3. The *laser/ ordinary light* rays are far apart.
4. The *laser/ ordinary light* rays don't spread out but instead remain parallel to each other.
5. All the rays in a *laser/ ordinary light* beam are in phase, which means that their crests and troughs sync up.
6. The crests and troughs of the rays in a *laser/ ordinary light* beam do not sync.

18 Match the labels to the illustrations. Which of them show laser light?

coherent/ collimated/ incoherent/ monochromatic/ non-collimated/ polychromatic

					
a	b	c	d	e	f

19 Read the text about how laser works and choose the correct alternative in each case.

To make a laser all you need to do is give a big *collection/ connection* of atoms enough energy so they're *exciting/ excited* and ready to *emit/ exit* light. *Once/ Since* one of them *spontaneously/ simultaneously* emits a *proton/ photon*, it'll *motivate/ stimulate* some of the others to do so and you get a nice cascade of illumination. But instead of letting all the light *enter/ escape*, it's more powerful to *trap/ hide* it between two *mirrors/ glass walls* and let it bounce back and forth through the atoms. All that passing light will *simulate/ stimulate* them to emit even more light. And *as long as/ unless* you keep on re-exciting the atoms they're happy to go on emitting light *forever/ finally*.

Watch the video (till 0:26) and check your answers.

20 Work in pairs. Ask and answer questions to fill in the missing information.

STUDENT B Worksheet is on Page 27

E.G. What does laser stand for?

(It stands for) light amplification by stimulated emission of radiation.

STUDENT A

The term *laser* is an acronym for_____.

Astronauts on the Apollo 11 space mission in 1969 used a laser to measure _____.

Despite some lasers being hotter than the surface of the sun, they can be used to cool atoms when combined with a magnetic field.

In 1974 lasers were used commercially for the first time in supermarket barcode scanners.

Laser "*tweezers*" can be used to manipulate _____.

Laser tag was developed as a training program for the U.S. army in the 1970s.

You need _____ common laser pointers to move a *coin*.

The strength of early lasers was measured in "gillettes," the amount of power required to burn through one Gilette *razor blade.*

The capacity of the world's most powerful laser is equal to _____.

GRAMMAR Focus on Conditional Type 2

21 Which of these statements describe an UNREAL condition?

1. If our cars could fly, our city roads would be less crowded.
2. When driverless cars become widely available, road accidents will disappear.
3. If you were given a choice of any car, what car would it be?
4. The air in the cities would be much cleaner if everyone rode electric cars.
5. Electric cars will be more popular if they cost less.

22 Choose the correct option and fill in the gaps to formulate the rules for Conditional Type 2

Conditional Type 2 refers to a *hypothetical/real* or *likely/ unlikely* condition and its probable *cause/ result.*

Conditional Type 2 is --*/ not* based on the actual situation.

In Conditional Type 2 sentences, the time is *now/ any time/ past*.

FORM: IF (condition) + _____*Simple*,

(result) _____ + *infinitive*.

23 Use the verbs in Conditional Type 2 to fill in the gaps in the statements.

What **would** life **be** like if we **didn't have** lasers?

1. If doctors _____ (use) conventional tools, eye surgery _____(be) impossible.
2. If there _____ (be) no lasers in medicine, many surgeries _____(take) much longer.
3. If we _____ (not have) laser surgery, patients _____ (feel) more pain.
4. Recovery time in hospitals _____(be) longer, if laser microsurgery _____(not exist).
5. If laser _____(not interact) with matter, it _____ (not be used) as a research tool.
6. Archeologists _____ (not be able) to discover hidden objects if they _____ (not use) LiDAR.
7. If they _____(be) no barcode scanners, shopping _____ (take) much longer.
8. If we _____ (use) mechanical tools instead of laser, we _____ (not be able) to cut complex shapes.
9. If laser _____ (not produce) fine, controllable beams, microstructure _____ (not be revealed).
10. Printing _____(take) much longer if we _____(not have) laser printers.

24 Think of some common object or phenomenon (or ask your teacher for inspiration) and imagine what our life would be like without it. Let your groupmates guess what it is.

If we didn't have (…)

If we didn't have this, our shopping **would take** much longer.

If we didn't have this, some medical manipulations **would be** more painful.

If we didn't have this, we **wouldn't be able to** create complex designs in mass production.

25 Write a paragraph about life without a common object or phenomenon. Use your ideas from Ex. 24. Remember the rules of paragraph writing.

Start with a topical sentence.

E.G. *If all lasers suddenly disappeared, our lives would not be affected much.*

or

E.G. *Our lives would be much different if we didn't have lasers.*

Add supporting sentences. Choose the ones that support your point.

- *Many efficient manufacturing techniques would be impossible, such as laser cutting, welding and drilling.*
- *Lasers have changed modern medicine enabling advanced eye surgery and microsurgery.*
- *Alternative manufacturing methods would be used, such as waterjet cutting or 3D printing.*
- *Laser has made a major contribution to science having become an important research instrument.*
- *Laser surgeries are not dominant in medicine and could be replaced.*
- *Laser pointers do more harm than good.*

Add the linking phrases to make your writing more cohesive.

First of all/ First and foremost/ To begin with

Also/ Besides/ In addition (to this)/ Apart from this/ Moreover

Last but not least/ Finally

Write the concluding sentence summarizing your arguments or restating the topical sentence.

- *We would be able to survive without lasers in spite of their usefulness to us now.*
- *Lasers are playing such an important part in every sphere of our life that it would be impossible to imagine our world without them.*

Use the linking phrases for conclusion

In a word/ in brief/ briefly

In conclusion/ in the end/ on the whole

Thus/ to conclude/ to summarize/ to sum up/ in summary

26 Work in pairs. Ask and answer questions.

1. If you decide to eat out, which restaurant or cafe will you go to?
2. How will you feel tomorrow if you run 5 km today?
3. If you didn't get any homework, how would you feel?
4. If you had more free time, how would you spend it?
5. If you have a day off on Saturdays, will you study more?
6. What will you do if you see someone cheating?
7. If your phone breaks tomorrow, what will you do?
8. What medicine will you take if you catch a cold next week?
9. What would your teacher say if you were always late?
10. When will you go to bed if you are really tired tonight?
11. Who will you ask for help if you have a problem?
12. Would you ask your groupmates for help if you had a problem in class?

Lesson 3 PROBLEMS AND SOLUTIONS

27 Answer the questions before watching the video.
https://www.youtube.com/watch?v=JFThNvfKHck (from 0:50)

1. Who laid the foundation for the science of laser?
a. Isaac Newton b. Nicola Tesla c. Albert Einstein
2. When was the first laser constructed?
a. 1920s b.1960s c. 1980s
3. Laser was invented …
a. for a specific practical purpose b. without a definite practical purpose

28 Watch the video and match the personality with the achievement.

award, v – присуждать, награждать

beam, n **–** луч

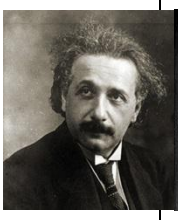
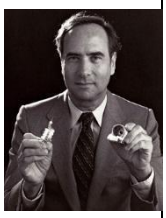
pave the way – подготовить почву

propose, v предлагать

construction, v – сооружение, изготовление

groundbreaking, adj – революционный прорывной

trigger, v – инициировать, дать начало

					
	Albert Einstein	Charles Townes	Nikolai Basov	Alexander Prokhorov	Theodore Maiman
constructed the first working laser					
described the basics of stimulated emission					
laid down the basis of quantum electronics					
was **awarded** the Nobel prize in physics					

29 Translate these sentences from the History of Laser video into Russian.

- A **beam** of light needs eight minutes and nineteen seconds to reach the Earth.
- The man who **paved the way** was Albert Einstein.
- By pure logic Einstein **proposed** that there had to be an until then unknown type of light emission that would allow us to control the characteristics of light to a degree that was not dreamt possible before.
- Four years later in 1921 he was **awarded** the Nobel Prize for Physics for his **groundbreaking** theories about light.
- One day Townes would study physics and his fundamental work in the field of quantum electronics enabled the **construction** of the very first masers and lasers.
- The laser was a **groundbreaking** technology that would find applications in every sector of modern life and activity. It was an invention that **triggered** innovations itself.

Theodore Maiman

- People still did not quite know what Maiman's new invention could be used for: "an invention searching for an application" was the scornful opinion even in the technical press.

30 This Laser Timeline contains 7 factual mistakes. Can you find them all?

1917	Albert Einstein lays the foundations for laser technology when he predicts the phenomenon of "Simulated Emission," which is fundamental to the operation of all lasers.
1939	Valentin Fabrikant theorizes the use of stimulated emission to amplify radiation.
1950	Charles Townes, Nikolay Basov, and Albert Einstein develop the quantum theory of stimulated emission and demonstrate stimulated emission of microwaves. They later receive the Nobel Prize in Physics for this groundbreaking work.
1959	Columbia University graduate student Gordon Gould proposes that stimulated emission can be used to amplify light. He describes an optical resonator that can create a narrow beam of coherent light, and calls it a LASER for "Laser Amplification by Stimulated Emission of Radiation".
1960	Theodore Maiman builds the first working prototype of a laser at Hughes Research Laboratories in Malibu, California. This laser uses synthetic ruby as the active medium and emits a deep green beam of light with a wavelength of 694.3 nm. The first application for the ruby laser was for military range finders and is still used commercially for drilling holes in diamond because of its high peak power.
1964	The Calcium Dioxide (CO_2) laser is developed by Kumar Patel at AT&T Bell Labs. The CO_2 laser has much higher cost and lower efficiency than the ruby laser. These factors have made it the most popular laser type for more than 50 years/

31 *Read the texts about laser pioneers and choose the correct synonyms to the words in bold. Think of the suitable title for each story. *Prepare one of the texts for retelling.

_____

Townes sent a short paper to the leading journal Physical Review but at the time of his trip to England he had not yet written a **thorough** theoretical description of what he had done. Therefore, he was **astounded** when a Soviet physicist named Alexander Prokhorov, speaking excellent English, **preceded** him in the conference by delivering a paper describing the theory of an ammonia maser, exactly the device Townes had used. Townes had never met Prokhorov before and did not dream at that moment that he would **eventually** share a Nobel Prize with him and his student Nikolai Basov for the development of lasers. After Prokhorov had finished his report Townes stood up and **announced**, "Well, that is very interesting, and we have one of these working." He then described his recent work with an ammonia maser.	detailed or correct? happy or surprised? was before or after? at first or at last? said or asked?

_____

It was the Russian physicist V. A. Fabrikant who first had the **vision** to propose the concept of a laser in 1940. Fabrikant stated the principles of a laser in a doctoral dissertation of 1939, and in 1951 he obtained for his work an "author's certificate". He not only **elaborated** the theory but he was the first to observe experimentally the amplification of optical radiation using a mixture of mercury vapor and hydrogen. He was a true **pioneer**. Maiman (the American who built the first laser in 1960) thought Fabrikant should have received the Nobel Prize instead of Basov, Prokhorov, and Townes. He said that when the Nobel Committee chose the trio over Fabrikant they "did not do their homework. It would have made more sense to **recognize** the Russian physicist Fabricant."	= character or idea? = corrected or developed? = leader or hero? = to honour or to understand?

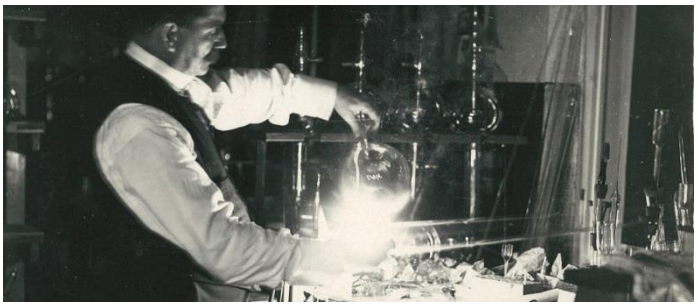
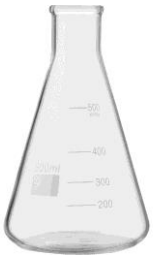
_____

In the 1950s Prokhorov's lab at the Lebedev Physics Institute was doing rather **conventional** research which did not seem to be leading toward anything exciting. Prokhorov decided it was necessary to move in a different direction, to start working on induced radiation of gases. His assistants in the lab did not wish to do so, as they were working on their dissertations and did not want **disruption**. Prokhorov gave them a month to rethink their positions. When they **refused**, he went through the laboratory with a hammer and **destroyed** the instruments that were necessary for their current research. He then brought in new instruments and instructed the assistants to work on what he told them. There was a **tremendous** scandal, half of the researchers left, but the remaining ones followed Prokhorov on the work that eventually resulted in a Nobel Prize.	= usual or innovative? = help or pause? = said yes or no? = broke or fixed? = big or small?

GRAMMAR Focus on Conditional Type 3

32 What accidents caused the inventions below? Match the pictures from the two sets.

 **1**	 **2**	 **3**
 **4**	 **5**	**1. vulcanized rubber** **2. safety glass** **3. Velcro** **4. X-ray** **5. microwave oven**

 **a**		 **b**
 **c**	 **d**	 **e**

Watch the video https://www.youtube.com/watch?v=JL9URxJA6r4 (from 3:58 to 9:14) and check your answers.

33 Fill in the gaps in the statements below.

1. _____ would not have been invented if Percy Spencer hadn't put a chocolate bar in his pocket.
2. _____ would not have been developed if a stove (heating apparatus) in Charles Goodyear's laboratory had been cold.
3. _____ would not have been developed if George de Mestral had not loved dogs.
4. _____ would not have discovered this phenomenon if he had been working in a well-lit room.
5. _____ would not have been developed if Edouard Benedictus, a French chemist, had had better coordination.

GRAMMAR Focus on Conditional Type 3

34 Use the statements from Ex. 33 to formulate the rules for Conditional Type 3.

Conditional Type 3 describes a *hypothetical/ realistic* situation in the *past/ present*.
The reality is *the same as/ the opposite to* what the sentence expresses.
FORM
IF (condition) _____ Perfect (_____+ V3)
(result) WOULD + _____ + _____

35 Use the verbs in Conditional Type 3 to fill in the gaps in the statements.

1. If people _____ (see) the potential applications for laser, they _____ (recognize) the value of this invention.
2. If Townes, Prokhorov and Basov _____ (not receive) the Nobel Prize, Valentin Fabrikant _____ (receive) it.
3. If Alexander Prokhorov _____ (not destroy) his assistants' equipment, they _____(not focus) on the new research.
4. If Einstein _____ (not describe) stimulated emission, laser _____ (not be developed).
5. Archeologists _____ (not discover) the ancient Mayan ruins if they _____ (not use) LiDAR.
6. :Leonardo da Vinci _____ (build) the first automobile if he _____ (have) access to the modern technologies.
7. Ada Lovelace created something that _____ (become) the first computer program if Charles Babbage _____ (build) his machine.

36* Read the stories and write a report on how one (or more) of these accidents could have been prevented. Use Conditional Type 3.

1. A student at Los Alamos National Laboratory suffered permanent vision loss when he looked directly into the target chamber of a laser experiment without safety eyewear. As a result of the injury, all scientific work at the lab was shut down for several weeks.

2. Ross Vanderpool, a 13-year-old teenager from Indiana, lost sight in his left eye after playing with a laser pointer. His friend brought him the toy as a present from Italy. Thinking it was just a toy Ross shone the green beam into a mirror and looked at it. He didn't know it was so dangerous.

3. In September 2004, an experienced laser experimenter at Argonne National Laboratory, suffering from a slight eye infection, raised his protective eyewear momentarily to rub his eye. At that moment, he saw a bright flash, and afterward the vision in his left eye was cloudy. A polarizer on his optical bench (which was not blocked properly) had reflected the laser beam into his eye. All laser operations at the laboratory were stopped for several weeks and an extensive investigation was conducted of the entire laser safety program.

4. Michael Brandon Smith was standing in his driveway one afternoon, beer in one hand and laser pointer in the other. Bored, he decided to see if the pocket-sized novelty could reach the helicopter passing overhead. A short time later, police were knocking on Smith's door. Not long after that, Smith was sentenced to two months of house arrest and two years' probation. The helicopter was a St. Louis police transport responding to a burglary call; it had to divert when the laser pointer temporarily disoriented its occupants.

Lesson 4 LASER IN FUTURE

37 Fill in the gaps with the suitable words.

LASER = l _ _ _ _ a _ _ _ _ _ _ _ _ _ _ _ _ by s _ _ _ _ _ _ _ _ _ e _ _ _ _ _ _ _ of r _ _ _ _ _ _ _ _

A laser beam is 1) m _ _ _ _ _ _ _ _ _ _ _ _ _; 2) c_ _ _ _ _ _ _; 3) c _ _ _ _ _ _ _ _ _

38 a How can laser be used in the following situations? Discuss in pairs.

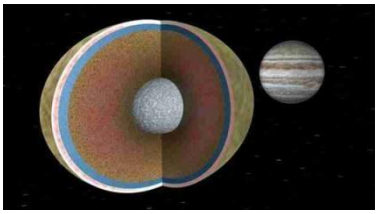
To use lasers for …

Laser scanners to save …

To create …

To transmit …

To … … in Jupiter's core



38 b Watch the video about the future use of lasers and fill in the gaps in the headings

38 c *Watch the video again and fill in the gaps in the projects' descriptions

	Description
5	A device with two lasers: one makes a _____ _____ in your vein, the other _____ ___ the wound*. * *рана*
4	Laser scanner compares the reference and the actual model to find the _____ pieces
3	_____ laser light joins together _____ _____ into strings
2	A high-powered laser creates a dense string of ____ _____. A second laser could follow this pathway without losing _____
1	_____ high-powered lasers evaporated the hardest material on Earth – _____ _____

39 In groups of three, read one text each and find answers to the questions below. Present the project to your group.

TEXT 1

1. What current problem is this concept designed to solve?

2. What extra benefits will the laser technology bring?

3. What prevents this project from being realized?

In the mid-1990s the laser joined in a useful working partnership with the computer, but the laser still only reads, writes, and memorizes for the computer. Some scientists think the laser could go further and bring about a serious change in the way the computer is designed. The computer itself consists of wires, chips, connections, and other parts through which electrical signals flow. Experts point out that in the larger supercomputers sometimes too many pieces of information try to get to the same place at the same time. Due to the limitations of the machine parts themselves, the information bits can only move so fast. As a result, bottlenecks* form. These are like miniature traffic jams, only with bits of data instead of cars. The laser might be able to eliminate such bottlenecks by using light instead of electricity to process the information. A laser beam could carry millions of signals without once touching a physical connection. Thus bottlenecks would be eliminated and much more information could flow through the computer. Many technical problems need to be worked out before such an optical computer can be built. But researchers around the world are presently trying to solve these problems. (1216)

*bottleneck бутылочное горлышко, узкое место

Assess the projects on a 1 to 5 scale using the table.

	Project 1	Project 2	Project 3
Importance			
Practicability			
Cost-effectiveness			

TEXT 2

1. What current problem is this concept designed to solve?
2. What extra benefits will the laser technology bring?
3. What prevents this project from being realized?

Most nuclear scientists believe that in the future nuclear power will be supplied by fusion: a nuclear reaction in which two atoms are combined. One great benefit of controlling fusion for energy production is that the process is relatively clean and safe. All that is needed for fuel is a small amount of hydrogen. In addition, the process does not leak dangerous radiation.

But starting a fusion reaction requires an enormous initial force. Many scientists think that "laser chains" can supply that force. A laser chain consists of several laser amplifiers over a hundred feet long, which intensify the power of laser beams. The high-powered beams are directed at a tiny fuel pellet* from all sides at once. This causes an explosion powerful enough to trigger a fusion reaction.

Experiments with lasers and fusion began in the late 1960s, but progress was slow for a long time. A major breakthrough occurred in 2001 when researchers from Japan and the UK succeeded in using a laser beam to compress a ball-like pellet of nuclear fuel. The beam, which generated temperatures of 10 million degrees centigrade, focused on the pellet, creating enormous pressure—about 10 million times that of Earth's atmosphere. The pressure caused the pellet to implode (collapse inward) and release energy. (1190)

* fuel pellet топливная таблетка

Assess the projects on a 1 to 5 scale using the table.

	Project 1	Project 2	Project 3
Importance			
Practicability			
Cost-effectiveness			

TEXT 3

1. What current problem is this concept designed to solve?
2. What extra benefits will the laser technology bring?
3. What prevents this project from being realized?

The population of the world continues to grow rapidly, and more people create a demand for more energy. Today's major sources of energy are water power; the burning of coal, gas, and oil; and nuclear reactors. But all these methods may not be enough to supply the energy needs of the future.

The laser promises to open up new and seemingly endless stores of energy for humanity's use: the solar-powered satellite. The satellite will be rocketed into a special orbital position where it will always stay above a certain fixed point on Earth's surface. Once in position the satellite will begin gathering energy from sunlight. The energy will power a large laser that will direct a beam back to Earth where a receiver will collect the beam and convert it into electricity. If enough of these satellites can be put into orbit, a large share of Earth's energy needs will be met.

Some people worry that such a beam might be aimed in the wrong direction and cause death and destruction. As a matter of fact, the military has considered this method for making beam weapons. But ways will be found to adjust the power of the beam so that it will not do any damage. The time and money it will take to get these satellites orbiting will be worthwhile because sunlight is free. And because the sun is expected to shine for several billion more years, sunlight is also nearly inexhaustible*. (1376)

inexhaustible неисчерпаемый

Assess the projects on a 1 to 5 scale using the table.

	Project 1	Project 2	Project 3
Importance			
Practicability			
Cost-effectiveness			

CONSOLIDATION

1 Translate the word combinations into English using the Active Vocabulary.

Аббревиатура означает

В наномасштабе

Все более сложный

Крошечные частички материи

Оптоволоконный провод

Полупроводниковый лазер

Прорывная технология

Связь посредством

Тонкая настройка

Выявлять дефекты

Дать начало инновациям

Изготовить первый лазер

Измерять мельчайшие изменения

Измерять расстояние

Использовать лазерную сварку

Подготовить почву для революции в промышленности

Предложить новую теорию

При условии, что будут применяться новые технологии

Присудить Нобелевскую премию

Проектировать лазерные устройства

Расплавлять металл

Усиливать сигнал

2 Identify the conditional type. *Translate the sentences into Russian.

	1. If I had bought $100 in bitcoin in 2010, it would have been worth $194,000,000 in 2018.
	2. If the signal is too small, it will be amplified before connecting
	3. We would all be safer and happier if all cars were autonomous.

	4. If a self-driving cars causes an accident, who will be responsible?
	5. If decisions about cars were rational, there would be a lot fewer SUVs on the road and.
	6. If we could fly from our office, the trip to the airport would only take 8 minutes.
	7. If laser had not been invented, many scientific discoveries would never have happened.
	8. If robots take over most jobs, what will be the purpose of humans?

3 Match the two halves of the sentences. Determine the conditional type. *Translate into Russian.

If inexpensive lasers hadn't been constructed,	you would have felt much more pain.
If laser wasn't used in surgical operations,	a new era of laser machining would not have started.
If laser had not been used during the surgery,	recovery time would be longer.
If you decide against the laser surgery,	complex design furniture would be more expensive.
If laser couldn't reveal molecular structure,	it may take you longer to recover.
If the signal is transmitted via fiber-optic cables,	many scientific discoveries wouldn't have occurred.
If laser machining didn't become so widespread,	it will travel very fast.

4 Transform the sentences below into one sentence with a condition.

1. There are no supersonic passenger planes, so we travel slowly.

If there were supersonic passenger planes, we would travel faster.

2. AI is not developed enough, so it is difficult to communicate with robots.

If AI …… .

3. George Devol met Joe Engelberger, so Unimate robotic arm took off (became a success).

If Devol …….. .

4. We don't have flying cars and our roads are terribly crowded.

If we …… .

5. Laser was invented and many scientific discoveries happened.

If laser …….. .

6. There are not many electric cars, so the air in the cities is not very clean.

If …… .

7. We travel slowly because there are no supersonic passenger planes.

We would travel faster if there were supersonic passenger planes.

8. There are so many road accidents because we don't have self-driving cars.

There …… .

9. People don't have to perform dangerous jobs, because there are industrial robots.

People …….. .

10. Many scientific discoveries happened because laser was invented.

Many …… .

5 Transform the sentences using the alternatives to IF.

As long as • in case • provided that • unless

1. The experiment will continue if there is enough funding.

2. The students will not enjoy the class if they don't find the subject interesting.

3. Don't start a full time job if you don't need money badly.

4. You can do the assignment if you have a Moodle account.

5. If I don't procrastinate, I will finish my PhD thesis this year.

6. If you are interested in languages, you could get a degree in linguistics at Bauman university.

7. We will receive the research funding, if we meet all the criteria.

6 How much do you know about laser?

1. What does LASER stand for?

2. What are the main properties of laser light?

3. Who are the key figures in laser development?

4. What are the main components of a laser device?

20 Work in pairs. Ask and answer questions to fill in the missing information.

STUDENT A Worksheet is on Page 10

STUDENT B

The term *laser* is an acronym for _____.

The world's most powerful laser has the power equivalent to that of a hydrogen bomb.

The strength of early lasers was measured in _____.

Laser "*tweezers*" can be employed to manipulate single atoms.

Lasers were used commercially for the first time in supermarket barcode scanners in ____ (year).

The Apollo 11 astronauts measured the distance between Earth and the moon using a laser in 1969.

_____ was developed as a training program for the U.S. army in the 1970s.

Lasers can be used to cool atoms when combined with _____.

Lasers can be used to push an object! But you need at least 30 billion common laser pointers to move a *coin*

LASER VOCABULARY

absorbance поглощающая способность

amplification factor коэффициент усиления

angle of incidence угол падения

AR coating (anti-reflection coatings) противоотражающее покрытие

attenuation ослабление излучения

axis, optical axis ось, оптическая ось

bandwidth диапазон частот

beam quality качество пучка

brightness яркость

coherent light, coherent radiation когерентное излучение

collimated light коллимированный, направленный свет

convergence сведение

crest вершина волны

CW (continuous wavefront) непрерывное излучение

divergence расходимость, расхождение (пучка)

DOF (depth of focus) глубина фокусировки

duty cycle продолжительность включения, период включения

flux поток

focus главный фокус

focal point фокальная точка лазера

frequency частота

gain лазерное усиление

ground state основное состояние (напр. электрона)

HAZ (heat-affected zone) зона теплового воздействия

heat sink теплоотвод

incident light падающий свет

maser мазер, квантовый генератор СВЧ

mode режим излучения

optical density оптическая плотность

output power выходная мощность

population inversion инверсия заселенности

pumping накачка, возбуждение

pulse energy энергия импульса

pulsewidth длительность импульса

Q-switch переключатель добротности

repetition rate частота повторения импульсов лазера

resolution разрешающая способность

stability стабильность частоты

trough впадина волны

wall-plug efficiency степень преобразования электрической энергии в оптическую

laser components компоненты лазера

beam delivery system система переноса лучей

beam bender устройство отклонения луча

cavity резонатор

cold mirror интерференционное зеркало

dispersive mirror диспергирующее зеркало

flashlamp импульсная лампа

gain medium активное вещество/ среда лазера

laser rod стержень активного вещества лазера

optical resonator оптический резонатор

oscillator лазерный генератор

pump source генератор накачки

types of laser типы лазеров

axial-flow laser лазер с аксиальной прокачкой

CO2 laser углекислый лазер, лазер на диоксиде углерода

continuous wave laser (CWL) лазер с непрерывной накачкой

dye laser лазер на красителе

gas-discharge laser газоразрядный лазер

free electron laser лазер на свободных электронах

He-Ne gas laser гелий-неоновый лазер

ion laser ионный газовый лазер

liquid laser жидкостный лазер

pulsed laser импульсный лазер

semiconductor laser полупроводниковый лазер

solid-state laser твердотельный лазер