КАЗАНСКИЙ ФЕДЕРАЛЬНЫЙ УНИВЕРСИТЕТ

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SUPPLEMENTARY READING AND QUIZZES

Учебно-практическое пособие по английскому языку
для студентов Института физики

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Сигачева Н.А., Исмагилова Г.К. Supplementary Reading and Quizzes: учебно-практическое пособие по английскому языку
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Данное пособие посвящается выдающимся ученым Института физики К(П)ФУ и предназначено для студентов, обучающихся по направлениям: 03.04.03 «Радиофизика» и 03.04.02 «Физика», и содержит материалы, дополняющие основной курс английского языка. Пособие может быть использовано как для аудиторной, так и для самостоятельной работы студентов.

Предисловие

Настоящее учебно-практическое пособие посвящается выдающимся ученым Казанской школы физиков К(П)ФУ и предназначено для занятий со студентами 1-2 курсов Института физики Казанского (Приволжского) федерального университета, которые обучаются по направлениям 03.04.03 «Радиофизика» и 03.04.02 «Физика». Основной целью данного пособия является повышение уровня владения профессиональным иностранным языком, достигнутого на предыдущей ступени образования. В задачу данного пособия входит совершенствование навыков и умений студентов самостоятельно работать с научными текстами на английском языке с целью получения профессиональной информации.

Основным критерием при отборе материалов является информативная ценность аутентичных специализированных текстов и их соответствие направлению профессиональной подготовки студентов. Тексты для пособия отобраны из Интернет-источников по профилю обучения студентов. В отдельных случаях тексты подвергались адаптации и сокращению.

Настоящее пособие состоит из 2 частей:

1. Supplementary Reading.
2. Quizzes, lexical games, definition games, crosswords.

Первая часть включает в себя 10 аутентичных текстов, соответствующих направлению подготовки студентов. К каждому тексту прилагается ряд заданий, направленных на совершенствование языковых навыков, связанных с профессиональной деятельностью. Подготовка к чтению текста начинается с изучения и закрепления лексики. Задания к тексту направлены на то, чтобы достичь полного и точного понимания текста. Контроль понимания осуществляется через продуктивные, творческие задания, которые способствуют усвоению и запоминанию специальных терминов в таких областях как физика и радиофизика. Предложенные в учебно-практическом пособии письменные задания направлены на отработку навыков перевода и позволяют совершенствовать возможности письменной профессиональной коммуникации.

Вторая часть пособия содержит викторины, лексические игры, кроссворды, предназначенные для самостоятельной работы студентов с целью расширения профессионального кругозора.

Приложение включает глоссарий терминов по физике ***Glossary of Physics Terms.***

Contents

UNIT I. SUPPLEMENTARY READING

Text 1. Outstanding physicists of Kazan Federal University

Read the text and translate it.

Yevgeny Konstantinovich Zavoisky

September 28, 1907 – October 9, 1976

Zavoisky was born in 1907 in Mogilyov-Podolsk, a town in the south of Russian Empire (now in Vinnytsia oblast, Ukraine). His father Konstantin Ivanovich was a military doctor and mother Elizaveta Nikolaevna was trained as a teacher. In 1910, Zavoisky family moved to Kazan – a major Russian university city – for the sake of better education and well-being of their five children. There, Konstantin Ivanovich obtained a respectable job and a large apartment, which he equipped with equipment and books for home experiments with his children. Yevgeny, in particular, was keen to electromagnetism.

Evgeny Zavoisky is a scientist famous all over the world. In 1933-1947 he headed the Department of Experimental Physics of Kazan State University. While working in Kazan Zavoisky discovered the phenomena of electron paramagnetic resonance. He investigated paramagnetic relaxation in condensed media using the method of resonant absorption by a radio-frequency substance with a frequency of

100 MHz and the method of modulating a constant magnetic field, and he was able to observe the absorption peaks of the microwave field in anhydrous chromium chloride, in manganese and copper sulfates and in other paramagnetic salts. The linear dependence of the intensity of a constant magnetic field on the frequency of the oscillating microwave field was shown in his works, as well as the inverse dependence of the paramagnetic susceptibility (magnitude of the effect) on temperature. This discovery gave rise to various explorations both in Kazan University and in the whole world.

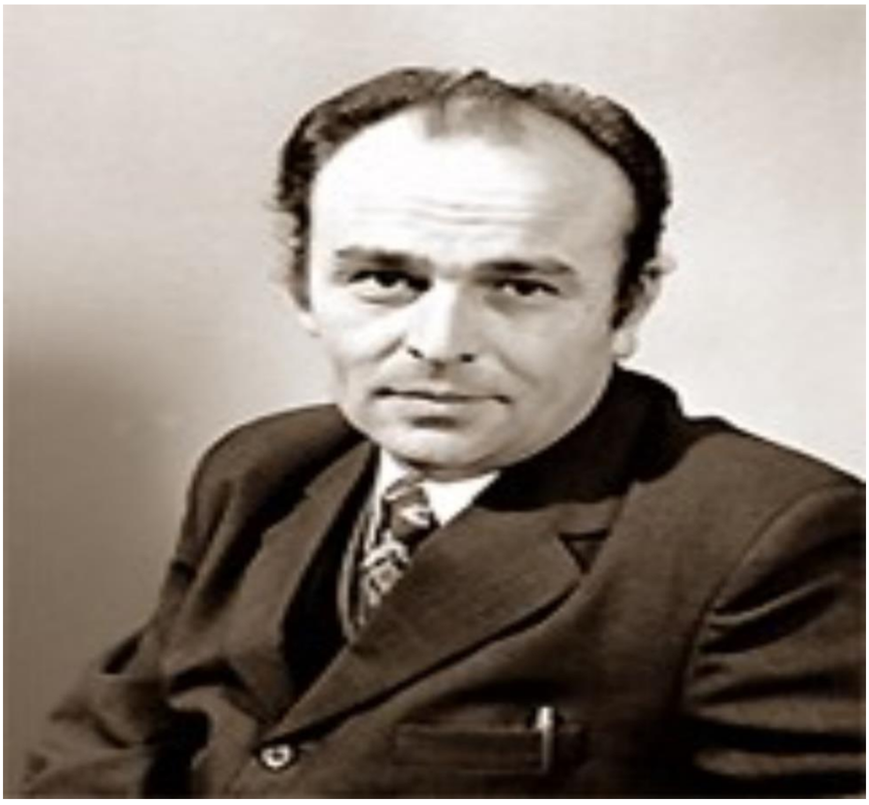
Semen Alexandrovich Altshuler

September 24, 1911 – January 24, 1983

Altshuler was born in 1911 in Vitebsk, now a city in Belarus, near the border with Russia. He finished school in Nizhny Novgorod and later moved to Kazan, where he spent most of his life. In 1928, he entered the physics faculty of the Kazan University aiming to study theoretical physics. He graduated in 1932 and obtained a post-graduate scholarship, but had to change university due to the scholarship rules. He moved to Moscow to study with Igor Tamm whom he admired for his books on electricity and magnetism. In 1934, Altshuler and Tamm published a famous article which predicted the existence of the magnetic moment of neutron and correctly estimated its value and sign. This idea was so unusual then that even Niels Bohr who visited Moscow in 1934 could not accept it.

In 1934, Altshuler was recalled to Kazan by Evgeny Zavoisky who offered him a position of lecturer and a chair of the theoretical physics group. In Kazan, Altshuler closely collaborated with Zavoisky in his search for nuclear magnetic resonance and electron paramagnetic resonance. One indication of this collaboration was a paper published during the World War II with the names of Zavoisky, Altshuler and Kozyrev – Altshuler was absent at the time, serving in the Soviet army during the war, between 1941–1946, yet his ideas were valued by his group.

The problem laboratory of radiospectroscopy was opened at Kazan University on the 7th of March, 1957. Its first scientific supervisor was S. A. Altshuler. The main task of the problem laboratory was to deploy extensive experimental and theoretical studies of the EPR spectra and paramagnetic relaxation in ionic crystals as soon as possible. The fifties of XX century is the period of rapid development of quantum electronics. The first lasers were created, and the investigations of lasers were perspective. So, in 1962 a problem laboratory of quantum electronics was created. These laboratories actively cooperated and continuously interacted.



Maksut Mukhamedzyanovich Zaripov

8 сентября 1929 — 24 декабря 2016

Place of birth: Podolsk, Podolsk district, Moscow province, RSFSR. Kazan University: assistant, senior lecturer, docent, in 1955-1957. He was a deputy Dean of the faculty of physics and mathematics, in 1968-1971- the dean of the faculty of physics, founder and first head (1963-1971) of the department of quantum electronics and radiospectroscopy, then professor of the department until 2009.

Since 1971 he moved to the main work in the Kazan Institute of physics and technology (KIPT) of the Kazan branch of the Academy of Sciences of the USSR: head of the laboratory of electronic paramagnetic resonance (1971-1988), Director (1972-1988), the manager of the laboratory of solid state physics (1988-1993), 1993 chief researcher.

He established the communication mechanisms of ion-ligand in the paramagnetic complexes on a microscopic level. Together with the staff of his laboratory, he discovered the effect of recrystallization of the surface layer of the implanted semiconductor under the action of a powerful laser pulse, which was the basis for the creation of a new technology for manufacturing semiconductor devices.

Therefore, on the 1st of February, 1963, the Department of Quantum Electronics and Radiospectroscopy was organized for the training of specialists in the field of magnetic resonance and laser physics. It was headed by professor M. M. Zaripov, a well-known theoretician in the field of EPR and the student S.A. Altshuler. Altshuler and Zaripov found a lot of talented experimenters and engineers, who were able to build EPR and NMR spectrometers. Also a new building was constructed in order to place the equipment for crystal growing there. Soon mechanical and glass-blowing workshops were organized.

On the basis of the Department of Quantum Electronic and Radiospectroscopy both theoretical research and experiments were carried. The scientists worked on such topics, as theoretical study of the EPR spectra of the iron group, EPR and relaxation of rare-earth ions, electron-nuclear double resonance and EPR and optical spectroscopy of exchange-coupled pairs.

Altshuler formed a research group of experimentalists under the leadership of M.A. Teplov (F.L. Aukhadeev, V. A. Grevtsev, V.M. Fadeev, I. S. Konov, M. S. Tagirov, A. G. Volodin, A.V. Duglav and others), which quickly took the leading position in the world in studies of nuclear resonance in rare-earth paramagnets. Theoretical interpretation of the results involved physicists-theorists L.K. Aminov, B.I. Kochelaev, B.Z. Malkin, M.V. Eremin, D.N. Terpilovsky. Some of them are still working at the department, such as the head of the department M.S. Tagirov, A.V. Duglav, B.I. Kochelaev B.Z. Malkin, M.V. Eremin.

In particular, in the 1950s-1970s, the collectives on experimental and theoretical study of the Electron paramagnetic resonance spectra of the iron group worked actively (M.M. Zaripov, V.G. Stepanov, Yu. E. Polsky, G.K. Chirkin, M.L. Falin, V.S. Kropotov and others.). L.Ya. Shekun, I.N. Kurkin, A.A. Antipin, V.I. Shlenkin, M.V. Eremin, R.Yu. Abdulsabirov and others worked on the study of Electron spin resonance and the relaxation of rare-earth ions. Yu.E. Polsky, Yu.F. Mitrofanov, M.L. Falin investigated an electron-nuclear double resonance. R.M. Valishev, M.M. Zaripov, R.L. Garifullina, N.S. Altshuler, M.V. Eremin, R. Kirmze and others worked on the study of Electron paramagnetic resonance and optical spectroscopy of exchange-coupled pairs. About 100 natural and artificial crystals were studied, of which ten were recommended for use in quantum electronics devices. Later on five of them were created masers - quantum paramagnetic amplifiers. In the future, the masers (quantum paramagnetic amplifiers) were created based on five of them.

In the 1960s, in the Laboratory of Magnetic Radiospectroscopy, the research group of experimenters (F.L. Aukhadeev, V.A. Grevtsev, V.M. Fadeev, I.S. Konov, M.S. Tagirov, A.G. Volodin, A.V. Duglav and others) was formed under the leadership of M.A. Teplov. This group quickly took the leading position in the world in nuclear resonance studies in rare-earth paramagnets. The theoretical results were interpreted by physicists L.K. Aminov, B.I. Kochelaev, B.Z. Malkin, M.V. Eremin, D..N Terpilovsky.

In the 1960s, the group (B.I. Kochelaev, A.Kh. Khasanov, R.M. Valishev, A.V. Duglav, J.G. Nazarov) was formed to study the Mandelstam-Brillouin scattering of light under the magnetic resonance saturation conditions. The staff of the group created a unique complex of scientific and measuring equipment. This complex made it possible to make a wide study of the nonequilibrium properties of paramagnetic ionic crystals by traditional and newly developed experimental Electron paramagnetic resonance methods using electromagnetic, radio-frequency, optical, sound, pulsed magnetic and thermal fields.

The next important stage in the development of magnetic resonance is the publication of the first book on paramagnetic resonance. This "encyclopedia" of Electron paramagnetic resonance was written by Altshuler and Kozyrev about 1958. It was translated into foreign languages. In 1972 the second edition was published.

For all these years, in the laboratory of magnetic radiospectroscopy, nearly 50 candidates of science were trained, 14 of whom became doctors of science and have students. These people became academicians of the Academy of Sciences of the Russian Academy of Sciences and corresponding members of the Academy of Sciences of the Republic of Tatarstan. They head most of the departments, laboratories and scientific institutes of Kazan and other cities of our country.

Over the years, scientists of the Kazan University took an active part in the publication of collections "Radiospectroscopy of a solid body" (Moscow: Atomizdat, 1967) and "Problems of magnetic resonance" (Moscow: Nauka, 1978).

From the second half of the 20th century in Kazan, the largest scientific center for radio spectroscopy, All-Union conferences on radio spectroscopy and low temperatures were held periodically.

Nowadays the department and laboratory are one of the leading scientific subdivisions of Kazan University and have a deserved authority in the world and national scientific communities. There are numerous scientific contacts and student exchanges with many foreign universities and organizations, such as Kamerlingh Onnes laboratory of Leiden University, Swiss Federal Institute of Technology in

Zurich, The French National Center for Scientific Research, Low Temperature Laboratory of Kanazawa University, etc.

Adapted from: https://en.wikipedia.org/wiki/Yevgeny_Zavoisky, https://en.wikipedia.org/wiki/Semen_Altshuler, http://www.kfti.knc.ru/about-institute/zaripov.php

Tasks

1. Write out key words from the text.
2. Title the paragraphs.
3. Use the key words of the text to make up the outline of the text.
4. Make up 5 questions to the text.
5. Write out the main idea of the text. Be ready to speak about it.
6. Give the summary of the text.
7. Retell the text.
8. Write an essay on the topic discussed.

Text 2. New method heats up ultrasonic approach to treating tumors

Vocabulary

1. tumor [ˈtjuːmə] опухоль
2. ultrasonic [ʌltrəˈsɒnɪk] ультразвуковой
3. treatment [ˈtriːtmənt] лечение
4. transducer [trænzˈdjuːsər] преобразователь
5. concave [ˈkɒŋˈkeɪv] вогнутый
6. pressure [ˈpreʃər] давление
7. cavity [ˈkævɪti] резонатор
8. tight [taɪt] плотный
9. equation [ɪˈkweɪʃən] уравнение
10. fluid [ˈfluːɪd] жидкость
11. wavelength [ˈweɪvleŋθ] длина волны
12. sufficient [səˈfɪʃnt] достаточный
13. incorporate [ɪnˈkɔːpərɪt] включать (в состав чего-либо)

14. compressible [kəmˈpresəbl] сжимаемый

15. focal region [ˈfəʊkəl] [ˈriːdʒən] фокальная область

16. intensity [ɪnˈtensɪti] интенсивность

Read the text and translate it.

1. High-intensity focused ultrasound (HIFU) is a breakthrough therapeutic technique used to treat tumors. The principle of this noninvasive, targeted treatment is much like that of focusing sunlight through a lens, using an ultrasonic transducer like a convex lens to concentrate ultrasound into a small focal region. In an article appearing this week in the *Journal of Applied Physics*, a multi-institutional team of researchers in China have now designed a semi-enclosed, spherical cavity transducer for potential application in HIFU that can generate a steady, standing-wave field with a subwavelength-scale focal region and extremely high ultrasound intensity.

2. HIFU concentrates ultrasonic energy into a focal region by using an ultrasonic transducer, which converts electrical signals into sound waves, to raise the temperature within the tumor to above 65 C, killing cells without damaging the surrounding tissue. This therapeutic precision is dependent on the size of the focal region and the intensity of focused ultrasound generated by the transducer.

3. The size of the focal region generated by the spherical cavity transducer was about 50 to 70 percent of the millimeter-scale wavelength, and the pressure amplitude gain over three orders of magnitude. In contrast, the size of the focal region generated by a traditional concave spherical transducer is about 10 times the wavelength, and the pressure amplitude gain is generally lower than 200. The level of intensity channeled through a tighter focal region produced by the new transducer design could be a significant improvement in HIFU for targeted cancer treatments.

The numerical simulations modeling the focused fields is key to providing the detailed information needed to estimate the performance of ultrasonic transducers used in HIFU therapy. The lattice Boltzmann method (LBM) modeling the team used is a novel mesoscopic simulation method born at the end of 20th century. While it is different than either the traditional macroscopic flow equation or the microscopic molecular dynamics simulation (MDS), it takes the advantages of both. The LBM can describe some complex flows that might be difficult to model using traditional computational fluid dynamics approaches.

"The size of the focal region generated by conventional spherical concave transducers is restricted by acoustic diffraction to usually the order of the ultrasound wavelength, but this does not meet the needs of more sophisticated treatments," said Dong Zhang, a researcher at the Institute of Acoustics in China. "Because it is crucial to reduce the size of the focal region while supplying sufficient ultrasonic energy, we were prompted to design a new kind of ultrasonic transducer."

Traditional acoustic simulation approaches are generally based on the numerical solutions of wave equations. These approaches can provide approximate simulations of the acoustic field, but do not incorporate the physical flow details, and cannot easily handle boundaries with complex geometric structure. In addition, these traditional methods are computationally expensive.

Realizing the full potential of this new tool and applications requires some additional focused research.

"We are working to improve the measuring technique in cases of high pressure and to build a non-isothermal and compressible LBM model based on a complex lattice to capture the details of acoustic field and describe the accompanying acoustic nonlinearity more accurately," Zhang said. "Also, considering that acoustic cavitation is inevitable under extreme pressure conditions, we want to build a multiphase LBM model to study bubble dynamics, and further investigate the cavitations' and collapse jetting."

The potential applications are not limited to just HIFU therapy. For example, some unique physical phenomena could be observed and investigated under the extreme pressure conditions provided by this device.

"We designed the spherical cavity transducer, a device that has a novel but simple structure, and could generate both the subwavelength-scale focal region and extremely high ultrasonic intensity," Zhang said.

In addition, while the LBM is widely used in fluid dynamic simulations and rarely in acoustic fields, it provides a novel but promising tool to simulate complicated acoustic fields.

Adapted from: https://bioengineer.org/new-method-heats-up-ultrasonic-approach-to-treating-tumors/

Tasks

1. What is the main idea of the text? Choose the correct answer:

a) Article appearing in the journal of Applied Physics.

b) Creation of a high-intensity focused ultrasound, which used to treat tumors.

c) The size of the focal region generated by conventional spherical concave transducers.

2. Mark true (T) or false (F) sentences.

a) HIFU is used to treat tumors

b) Spherical cavity transducer can generate extremely low ultrasound intensity.

c) LBM is a novel mesoscopic simulation method born at the end of 20th century.

d) The size of the focal region is about 5 times the wavelength, and the pressure amplitude gain is generally lower than 100.

e) The potential applications are limited to just HIFU therapy .

3. In what paragraph is it written that ultrasonic transducer kill cells without damaging the surrounding tissue?

a) 1; b) 2; c) 3.

4. Put the names of the paragraphs in the correct order.

1) new therapeutic technique used to treat tumors
2) using an ultrasonic transducer in HIFU
3) description of HIFU

a) 1, 2, 3; b) 3, 2, 1; c) 2, 1, 3.

5. Choose the correct answer.

Where is HIFU being used?

a) in proctology

b) in gynecology

c) in oncology

6. Choose the correct translation of the sentence.

High-intensity focused ultrasound (HIFU) is a breakthrough therapeutic technique used to treat tumors.

a) Высокоинтенсивный сфокусированный ультразвук (HIFU) - это прорывная терапевтическая методика, применяемая для лечения опухолей.

b) Высокоэффективный сфокусированный ультразвук (HIFU) - это прорывная терапевтическая методика, применяемая для лечения полипов.

c) Высокоточный сфокусированный ультразвук (HIFU) - это прорывная терапевтическая методика, применяемая для лечения язв.

7. Match the words and their translations.

A	B
1. tumor 2. transducer 3. cavity 4. pressure 5. lattice	a) резонатор b) давление c) преобразователь d) решетка e) опухоль

8. Complete the sentence.

In contrast, the size of the focal region generated by a traditional concave spherical transducer is about …

a) 15 times the wavelength, and the pressure amplitude gain is generally above than 100.

b)10 times the wavelength, and the pressure amplitude gain is generally lower than 200

c) 20 times the wavelength, and the pressure amplitude gain is generally lower than 200.

9. Choose the sentence with a correct word order.

a) Realizing the full potential of this new tool and applications requires some additional focused research.

b) Additional focused research requires some realizing the full potential of this new tool and applications.

c) Some additional focused research requires of this new tool and applications realizing the full potential.

Extra tasks

1. Write out key words from the text.
2. Title the paragraphs.
3. Use the key words of the text to make up the outline of the text.
4. Make up 5 questions to the text.
5. Write out the main idea of the text. Be ready to speak about it.
6. Give the summary of the text.
7. Retell the text.
8. Write an essay on the topic discussed.

Text 3. How to outwit noise in quantum communication

Vocabulary

1. quantum communication [ˈkwɑːntəm][kəˌmjuːnɪˈkeɪʃn] квантовая связь
2. pulse [pʌls] импульс
3. tap-proof data [tæp pruːf] [ˈdeɪtə] защищенные от кражи данные
4. contaminating [kənˈtæməˌnetɪŋ] загрязняющие
5. immune [ɪˈmjuːn] невосприимчивый
6. quantum oscillator [ˈkwɑːntəm] [ˈɑːsɪleɪtər] квантовый генератор
7. photon [ˈfoʊtɑːn] фотон
8. superconducting qubit [ˈsuːpərkənˌdəktɪŋ] [ˈkjubɪt] сверхпроводящий кубит
9. circuit [ˈsɜːrkɪt] цепь
10. superposition [ˌsuːpəˈpoʊz] суперпозиция
11. obstacles [ˈɑːbstəkəlz] препятствие, помеха
12. microwave oscillator [ˈmaɪkrəweɪv] [ˈɑːsɪleɪtər] СВЧ генератор
13. mediator [ˈmiːdieɪtər] медиатор, посредник

14. waveguide [ˈweɪvgaɪd] волновод

15. detrimental [ˌdetrɪˈmentl] приносящий убыток

16. calculations [ˌkælkjəˈleɪʃənz] расчеты

Read the text and translate it.

1. How to reliably transfer quantum information when the connecting channels are impacted by detrimental noise? Scientists at the University of Innsbruck and TU Wien (Vienna) have presented new solutions to this problem. Nowadays we communicate via radio signals and send electrical pulses through long cables. This could change soon, however: Scientists have been working intensely on developing methods for quantum information transfer. This would enable tap-proof data transfer or, one day, even the linking of quantum computers.

2. Quantum information transfer requires reliable information transfer from one quantum system to the other, which is extremely difficult to achieve. Independently, two research teams – one at the University of Innsbruck and the other at TU Wien (Vienna) - have now developed a new quantum communication protocol. This protocol enables reliable quantum communication even under the presence of contaminating noise. Both research groups work with the same basic concept: To make the protocol immune to the noise, they add an additional element, a so-called quantum oscillator, at both ends of the quantum channel.

Reliable data transfer

3. Scientists have conducted quantum communication experiments for a long time. "Researchers presented a quantum teleportation protocol already in the 1990s. It permits transferring the state of one quantum system to another by using optical photons," says Benoit Vermersch, Postdoc in Peter Zoller's group at the University of Innsbruck. This works also over great distances but one has to accept that a lot of the photons are lost and only a tiny fraction reaches the detector.

"Our goal was to find a way to reliably transfer a quantum state from one place to the other without having to do it several times to make it work," explains Peter Rabl from the Atominstitut, TU Wien.

Superconducting qubits, in particular, are promising elements for future quantum technologies. They are tiny circuits that can assume two different states at the same time. Contrary to conventional light switches that can be either turned on or turned off, the laws of quantum physics allow a qubit to assume any combination of these states, which is called quantum superposition.

To transfer this quantum state from one superconducting qubit to another requires microwave photons, which are already used for classic signal transfer. Reliably transferring quantum information via a microwave regime has been considered impossible as the constant thermal noise completely superposes the weaker quantum signal.

New transfer protocol

The two research groups have now shown that these obstacles are not impossible to overcome as previously assumed. In collaboration with teams from Harvard and Yale (USA) they have been able to develop a transfer protocol that is immune to the inevitable noise.

"Our approach is to add another quantum system – a microwave oscillator – as a mediator at both ends of the protocol to couple the qubits instead of coupling them directly to the microwave channel or waveguide," explains Rabl.

"We cannot prevent the thermal noise that develops in the quantum channel," says Benoit Vermersch. "What is important is that this noise affects both oscillators on both ends in the same way. Therefore, we are able to exactly separate the detrimental effect of the noise from the weaker quantum signal through precise coupling to the waveguide."

"According to our calculations, we may connect qubits over several hundred meters with this protocol," says Peter Rabl. "We would still have to cool the channels but in the long term it will be technologically feasible to link buildings or even cities in a quantum physical manner via microwave channels."

Adapted from: **https://phys.org/news/2017-03-outwit-noise-quantum.html**

Tasks

1. What is the main idea of the text? Choose the correct answer.

a) Theoretical calculations of quantum systems allow providing more simple construction of quantum generators.

b) Two scientific groups developed a quantum protocol that can transmit information without contaminating noise.

c) Quantum oscillator is a necessary element to make the protocol immune to the noise.

2. Mark true (T) or false (F) sentences.

a) Nowadays we communicate via sending electrical pulses through vacuum.

b) First quantum teleportation protocol permitted transferring the state of one quantum system to another by using optical photons.

c) Superconducting qubits are absolutely useless elements for future quantum technologies.

d) Superconducting qubits are tiny circuits that can assume two different states at the same time.

e) To transfer quantum state from one superconducting qubit to another requires magnetic fields.

3. In what paragraph is it written that protocol enables reliable quantum communication even under the presence of contaminating noise?

a) 1; b) 2; c) 3.

4. Put the names of the paragraphs in the correct order.

1) Quantum communication protocol

2) The transfer of quantum information in the near future

3) Quantum teleportation protocol

a) 1, 2, 3; b) 3, 1, 2; c) 2, 1, 3.

5. Choose the correct answer.

What is quantum superposition?

a) Any combination of two states at the same time

b) Only one of two states at the same time

c) The birth and annihilation of quantum states

6. Choose the correct translation of the sentence.

Reliably transferring quantum information via a microwave regime has been considered impossible as the constant thermal noise completely superposes the weaker quantum signal.

a) Надежная передача квантовой информации через микроволновый режим всегда была легко осуществима, поскольку постоянный тепловой шум очень мал по сравнению с квантовым сигналом.

b) Надежная передача квантовой информации через микроволновый режим считалась возможной, поскольку постоянный тепловой шум полностью отсутствовал на фоне квантового сигнала.

c) Надежная передача квантовой информации через микроволновый режим считалась невозможной, поскольку постоянный тепловой шум полностью перекрывал более слабый квантовый сигнал.

7. Match the words and their translations.

A	**B**
1. to transfer 2. immune 3. to affect 4. to prevent 5. feasible	a) влиять b) перевести c) осуществимый d) невосприимчивый e) предотвращать

8. Complete the sentence.

We would still have to cool the channels but in the long term it will be technologically feasible to link buildings or even cities in a quantum physical manner via …

a) space

b) microwave channels

c) waveguides

9. Choose the sentence with the correct word order.

a) This protocol enables reliable quantum communication even under the presence of contaminating noise.

b) This protocol enables reliable quantum noise even under the presence of contaminating communication.

c) This protocol enables reliable contaminating noise even under the presence of quantum communication.

Extra tasks

1. Write out key words from the text.
2. Title the paragraphs.
3. Use the key words of the text to make up the outline of the text.
4. Make up 5 questions to the text.
5. Write out the main idea of the text. Be ready to speak about it.
6. Give the summary of the text.
7. Retell the text.
8. Write an essay on the topic discussed.

Text 4. Physicists reveal experimental verification of a key source of fast reconnection of magnetic fields

Vocabulary

1. magnetic reconnection [mægˈnetɪk] [riːkəˈnɛkʃən] магнитное перезамыкание
2. solar flares [ˈsəʊlər] [fleər] солнечные вспышки
3. northern lights [ˈnɔːðən] [laɪt] северное сияние
4. accurate predictions [ˈækjərət] [prɪˈdɪkʃən] точные прогнозы
5. damaging [ˈdæmɪdʒɪŋ] повреждающий, вредящий
6. space weather [speɪs] [ˈweðə(r)] космическая погода
7. atomic nuclei [əˈtɒmɪk] [ˈnjuː.kli.əs] атомные ядра
8. converge [kənˈvɜːdʒ] сходиться, сближать, слиться
9. snap apart [snæp] [əˈpɑːt] разрываться

10.pressure [ˈpreʃə(r)] давление

11.magnetic field lines [mægˈnetɪk] [fiːld] [laɪn] магнитные силовые линии

12.electric current [ɪˈlektrɪk] [ˈkʌrənt] электрический ток

13.plasma [ˈplæzmə] ионизованный газ

14.balance [ˈbæləns] уравновешивать

15.accelerate [əkˈseləreɪt] ускорять

Read the text and translate it.

1. Magnetic reconnection, a universal process that triggers solar flares and northern lights and can disrupt cell phone service and fusion experiments, occurs much faster than theory says that it should. Now researchers at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) and Germany's Max Planck Institute of Plasma Physics have discovered a source of the speed-up in a common form of reconnection. Their findings could lead to more accurate predictions of damaging space weather and improved fusion experiments.

2. Reconnection occurs when the magnetic field lines in plasma—the collection of atoms and charged electrons and atomic nuclei, or ions, that make up 99 percent of the visible universe—converge and forcefully snap apart. Electrons that exert a varying degree of pressure form an important part of this process as reconnection takes place.

3. The research team found that variation in the electron pressure develops along the magnetic field lines in the region undergoing reconnection. This variation balances and keeps a strong electric current inside the plasma from growing out of control and halting the reconnection process. It is this balancing act that makes possible fast reconnection. "The main issue we addressed is how reconnection can take place so quickly," said Will Fox, lead author of a paper that detailed the findings in March in the journal Physical Review Letters. "Here we've shown experimentally how electron pressure accelerates the process."

The physics team built a picture of the gradient and other parameters of reconnection from research conducted on the Magnetic Reconnection Experiment

(MRX) at PPPL, the leading laboratory device for studying reconnection. The findings marked the first experimental confirmation of predictions made by earlier simulations performed by other researchers of the behavior of ions and electrons during reconnection. "The experiments demonstrate how the plasma can sustain a large electric field while preventing a large electric current from building up and halting the reconnection process," said Fox.

Among potential applications of the results:

- Predictions of space storms. Magnetic reconnection in the magnetosphere, the magnetic field that surrounds the Earth, can set off geomagnetic "substorms" that disable communications and global positioning satellites (GPS) and disrupt electrical grids. Improved understanding of fast reconnection can help locate regions where the process triggering storms is ready to take place.
- Mitigation of the impact. Advanced warning of reconnection and the disruptions that may follow can lead to steps to protect sensitive satellite systems and electric grids.
- Improvement of fusion facility performance. The process observed in MRX likely plays a key role in producing what are called "sawtooth" instabilities that can halt fusion reactions. Understanding the process could open the door to controlling it and limiting such instabilities. "How sawtooth happens so fast has been a mystery that this research helps to explain," said Fox. "In fact, it was computer simulations of sawtooth crashes that first linked electron pressure to the source of fast reconnection."

Adapted from: https://phys.org/news/2017-03-physicists-reveal-experimental-verification-key.html

Tasks

1. What is the main idea of the text? Choose the correct answer.

a) Researchers have discovered a source of fast reconnection

b) Will Fox is lead author of a paper in the « Physical Review Letters » journal

c) Magnetic reconnection can disrupt cell phone service.

2. Mark true (T) or false (F) sentences.

a) Reconnection occurs when the magnetic field lines in plasma converge and forcefully snap apart.

b) The collection of atoms and charged electrons and atomic nuclei, or ions, is 99 percent of the visible universe.

c) Electrons don't participate in this process.

d) The variation in the electron pressure develops along the electric current lines.

e) This variation balances and keeps a strong electric current inside the plasma.

3. In what paragraph is it written that this variation balances and keeps a strong electric current inside the plasma?

a) 1; b) 2; c) 3.

4. Put the names of the paragraphs in the correct order.

1) The balancing act

2) The magnetic field lines in plasma

3) Magnetic reconnection

a) 1, 2, 3; b) 2, 1, 3; c) 3, 2, 1.

5. Choose the correct answer to the given question.

Along which lines does the variation in electron pressure develop?

a) The magnetic field lines

b) The electric field lines

c) Along the electric current lines

6. Choose the correct translation of the sentence.

Reconnection occurs when the magnetic field lines in plasma—the collection of atoms and charged electrons and atomic nuclei, or ions, that make up 99 percent of the visible universe—converge and forcefully snap apart.

a) Перезамыкание происходит, когда совокупность атомов, заряженных электронов и атомных ядер или ионов начинают составлять 99 процентов видимой Вселенной.

b) Перезамыкание происходит, когда линии магнитного поля в плазме - совокупность атомов, заряженных электронов и атомных ядер или ионов, составляющих 99 процентов видимой Вселенной, - сходятся и сильно разрываются.

c) Перезамыкание не происходит, поскольку совокупность атомов, заряженных электронов и атомных ядер или ионов не составляют 99 процентов видимой Вселенной.

7. Match the words and their translations.

A	B
1.universal	a) вариация
2.universe	b) вселенная
3.variation	c) предсказания
4.predictions	d) универсальный
5.percent	e) процент

8. Complete the sentence.

The collection of atoms and charged electrons and atomic nuclei, or ions, is…

a) 99 percent of the visible universe.

b) 9,9 percent of the visible universe.

c) 0,99 percent of the visible universe.

9. Choose the sentence with the correct word order.

a) Their findings could lead to more accurate predictions of damaging space weather and improved fusion experiments.

b) Could lead to more accurate predictions their findings of damaging space weather and improved fusion experiments.

c) Their findings lead could predictions more accurate to of weather damaging space and fusion experiments improved.

Extra tasks

1. Write out key words from the text.

2. Title the paragraphs.

3. Use the key words of the text to make up the outline of the text.

4. Make up 5 questions to the text.

5. Write out the main idea of the text. Be ready to speak about it.

6. Give the summary of the text.

7. Retell the text.

8. Write an essay on the topic discussed.

Text 5. NASA observations reshape basic plasma wave physics

Vocabulary

1. trap heat [træp hɪːt] ловушка тепла
2. wave [weɪv] волна
3. spacecraft [ˈspeɪskræft] космический корабль
4. precise [prɪˈsaɪs] точный
5. separation [sepəˈreɪʃn] разделение
6. density [densətɪ] плотность
7. end up [end ʌp] в конечном итоге
8. jockey [ˈdʒɑːkɪ] жокей
9.keep up [ˈkɪːp ʌp] поддерживать
10. comprehensive [ˌkɑːmprɪˈhensɪv] всеобъемлющий
11. fusion [ˈfjuːʒn] слияние
12. confine [kənˈfaɪn] удерживать
13. inefficient [ˌɪnɪˈfɪʃnt] неэффективный
14. outpouring [ˈaʊtpɔːrɪŋ] излияние
15. quasar [ˈkweɪzɑːr] квазар

Read the text and translate it.

1. When NASA's Magnetospheric Multiscale—or MMS—mission was launched, the scientists knew it would answer questions fundamental to the nature of our universe—and MMS hasn't disappointed. A new finding, presented in a paper in

Nature Communications, provides observational proof of a 50-year-old theory and reshapes the basic understanding of a type of wave in space known as a kinetic Alfvén wave. The results, which reveal unexpected, small-scale complexities in the wave, are also applicable to nuclear fusion techniques, which rely on minimizing the existence of such waves inside the equipment to trap heat efficiently. Kinetic Alfvén waves have long been suspected to be energy transporters in plasmas—a fundamental state of matter composed of charged particles—throughout the universe. But it wasn't until now, with the help of MMS, that scientists have been able to take a closer look at the microphysics of the waves on the relatively small scales where the energy transfer actually happens. "This is the first time we've been able to see this energy transfer directly," said Dan Gershman, lead author and MMS scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, and the University of Maryland in College Park. "We're seeing a more detailed picture of Alfvén waves than anyone's been able to get before."

2. The waves could be studied on a small scale for the first time because of the unique design of the MMS spacecraft. MMS's four spacecraft fly in a compact 3-D pyramid formation, with just four miles between them—closer than ever achieved before and small enough to fit between two wave peaks. Having multiple spacecraft allowed the scientists to measure precise details about the wave, such as how fast it moved and in what direction it travelled. Previous multi-spacecraft missions flew at much larger separations, which didn't allow them to see the small scales—much like trying to measure the thickness of a piece of paper with a yardstick. MMS's tight flying formation, however, allowed the spacecraft to investigate the shorter wavelengths of kinetic Alfvén waves, instead of glossing over the small-scale effects. "It's only at these small scales that the waves are able to transfer energy, which is why it's so important to study them," Gershman said. As kinetic Alfvén waves move through a plasma, electrons traveling at the right speed get trapped in the weak spots of the wave's magnetic field. Because the field is stronger on either side of such spots, the electrons bounce back and forth as if bordered by two walls, in what is known as a magnetic mirror in the wave. As a result, the electrons aren't distributed evenly

throughout: Some areas have a higher density of electrons, and other pockets are left with fewer electrons. Other electrons, which travel too fast or too slow to ride the wave, end up passing energy back and forth with the wave as they jockey to keep up. The wave's ability to trap particles was predicted more than 50 years ago but hadn't been directly captured with such comprehensive measurements until now. The new results also showed a much higher rate of trapping than expected. This method of trapping particles also has applications in nuclear fusion technology. Nuclear reactors use magnetic fields to confine plasma in order to extract energy. Current methods are highly inefficient as they require large amounts of energy to power the magnetic field and keep the plasma hot. The new results may offer a better understanding of one process that transports energy through plasma. "We can produce, with some effort, these waves in the laboratory to study, but the wave is much smaller than it is in space," said Stewart Prager, plasma scientist at the Princeton Plasma Physics Laboratory in Princeton, New Jersey. "In space, they can measure finer properties that are hard to measure in the laboratory."

3. This work may also teach us more about our sun. Some scientists think kinetic Alfvén waves are key to how the solar wind—the constant outpouring of solar particles that sweeps out into space—is heated to extreme temperatures. The new results provide insight on how that process might work. Throughout the universe, kinetic Alfvén waves are ubiquitous across magnetic environments, and are even expected to be in the extra-galactic jets of quasars. By studying our near-Earth environment, NASA missions like MMS can make use of a unique, nearby laboratory to understand the physics of magnetic fields across the universe.

Adapted from: http://phys.org/news/2017-03-nasa-reshape-basic-plasma-physics.html

Tasks

1. What is the main idea of the text? Choose the correct answer.

a) The main idea of the text is how does the energy transportation goes through Alfvén waves.

b) The main idea of the text is explanation of solar system device.

c) The main idea of the text is describing the method of magnetic resonance and ir appliance.

2. Mark true (T) or false (F) sentences.

a) The wave's ability to trap particles was predicted more than 50 years ago.

b) Russian Space Agency launched MMS mission.

c) Alfvén waves are overall across magnetic environments.

d) In space, they can measure finer properties that are hard to measure in the laboratory.

e) NASA missions like MMS cannot make use of a unique, nearby laboratory to understand the physics of magnetic fields across the universe.

3. In what paragraphs is it written that this work could also teach us more about sun?

a)1; b) 2; c) 3.

4. Put the names of paragraphs in the correct order.

1. Alfvén waves
2. NASA's Magnetospheric Multiscale
3. Studing universe

a) 1, 2, 3; b) 3, 2, 1; c) 2, 1, 3.

5. Choose the correct answer to the given question.

What can the Alfvén waves theory explain?

a) how the solar wind—the constant outpouring of solar particles that sweeps out into space—is heated to extreme temperatures.

b) how the universe works

c) how quantum mechanics mixed with the classical theory

6. Choose the correct translation of the given sentence.

The wave's ability to trap particles was predicted more than 50 years ago but hadn't been directly captured with such comprehensive measurements until now.

a) Способность волны улавливать частицы была предсказана более 50 лет назад, но до сих пор не было таких всеобъемлющих измерений.

b) Способность волны улавливать частицы была предсказана более 50 лет назад, и сразу же после этого были проведены измерения измерений.

c) Способность волны улавливать частицы была предсказана более 50 лет назад, но до сих пор не было таких простых объяснений.

7. Match the words and their translations.

A	B
1. wave 2. confine 3. fusion 4. density 5. outpouring	a) слияние b) удерживать c) плотность d) волна e) излияние

8. Complete the sentence.

The new results may offer a better …

a) constant outpouring of solar particles

b) understanding of one process that transports energy through a plasma

c) reactors use magnetic fields to confine plasma in order to extract energy

9. Choose the sentence with correct word order.

a) The waves could be studied on a small scale because of the unique design of the MMS spacecraft for the first time.

b) The waves could be studied on a small scale for the first time because of the unique design of the spacecraft MMS.

c) The waves could be studied on a small scale for the first time because of the unique design of the MMS spacecraft

Extra tasks

1. Write out key words from the text.
2. Title the paragraphs.
3. Use the key words of the text to make up the outline of the text.
4. Make up 5 questions to the text.

5. Write out the main idea of the text. Be ready to speak about it.

6. Give the summary of the text.

7. Retell the text.

8. Write an essay on the topic discussed.

Text 6. A led-based device for imaging radiation induced skin damage

Vocabulary

1. eradicate [ɪˈrædɪkeɪt] искоренять
2. irritation [ɪrɪˈteɪʃn] раздражение
3. blistering [ˈblɪstərɪŋ] вызывающий волдыри
4. evaluation [ɪˌvælјuˈeɪʃn] оценка
5. oncology [ɒŋˈkɒlədʒɪ] онкология
6. toxicity level [tɒkˈsɪsɪtɪ levl] степень токсичности
7. radiation therapy [ˌreɪdɪˈeɪʃn ˈθɛrəpɪ] лучевая терапия
8. reflected light [rɪˈflektɪd laɪt] отраженный свет
9. non-invasive [ˌnɒn-ɪnˈveɪsɪv] бескровный, неинвазивный
10. scattering [ˈskætərɪŋ] рассеивание
11. oxygen saturation [ˈɒksɪdʒ(ə)n ˌsætʃəˈreɪʃn] насыщение кислородом
12. cell [sel] клетка
13. necrosis [neˈkroʊsɪs] некроз, омертвение
14. lotions [ˈləʊʃ(ə)n] лосьон
15. shrinking [ˈʃrɪŋkɪŋ] сокращение
16. desquamation [ˌdeskəˈmeɪʃn] десквамация, шелушение
17. superficially [ˌsuːpəˈfɪʃ(ə)lɪ] поверхностно

Read the text and translate it.

1. To eradicate any cancer cells that may potentially remain after surgery or chemotherapy, many breast cancer patients also undergo radiation therapy. All patients experience unfortunate side effects including skin irritation, and sometimes peeling and blistering. Patients can also develop permanent discoloration of the skin

and thickening of the breast tissue months, or even years, after treatment. There is currently no method to predict the severity of these acute and late effects, and even current evaluation of these effects are based on subjective scoring.

2. Researchers at the Beckman Laser Institute (BLI) and Medical Clinic, and the Department of Radiation Oncology at the University of California, Irvine are testing a new imaging device developed by start-up, Modulated Imaging Inc. (Irvine, CA). One of these studies is designed to monitor, quantify, and hopefully one day predict skin toxicity levels induced by radiation therapy. Anaïs Leproux, a post-doctoral researcher at BLI and lead author of the paper, will report the work at the OSA Biophotonics Congress: Optics in the Life Sciences meeting, held 2-5 April in San Diego, California, USA.

3. "We use visible and near-infrared light at very low power and project it onto the breast," said Leproux. "We are trying to characterize the skin damage during radiation therapy, especially for the treatment of breast cancer." Using their new imaging technique, the project is aimed at using precision measurements to characterize skin toxicity of tissue exposed to radiation. By tracking these measurements throughout treatment, Leproux and her team hope to better understand the factors involved in skin damage and, hopefully, how to predict acute and late toxicities.

"The toxicity is basically the skin damage, a side effect from the radiation," said Leproux. "There are a wide range of side effects that we're observing; erythema, hyperpigmentation, discoloration, dry or wet desquamation. Necrosis can happen but is less common."

Erythema is the formal name for superficial reddening of the skin, and desquamation is skin peeling. Thickening of the skin is a common late side effect.

"The light is shined onto the breast tissue. When interacting with the skin; the light is scattered and some is absorbed," said Leproux. "The reflected light is detected by a camera. Basically, you're measuring the absorption and the scattering properties of the tissue." More specifically, she and her group use eight different wavelengths of visible and near-infrared light from LEDs, measuring how much of each energy is absorbed by the skin. This provides them with a quantitative values indicative of skin health.

To generate these values accurately, the light from the LEDs is modulated spatially, imparting distinct patterns with a digital micro-mirror device within the instrument. Formally, this functional imaging technique is called Spatial Frequency Domain Imaging, or SFDI.

"Since we use several wavelengths of light, we perform spectroscopy and obtain the content of melanin, tissue hemoglobin, in the de-oxygenated and oxygenated state, from which we can calculate the total blood volume and oxygen saturation in the tissue," Leproux said. "We measure superficially, about three to five millimeters deep."

This non-invasive look at just those few millimeters can reveal a lot about the changes radiation induces. Also, because they use a projector technology, they measure over large areas (about 20 cm by 20 cm) without scanning.

"We're hoping that we can see skin thickening in the scattering parameters we're looking at," she said. "We think that the radiation induces a remodeling of the collagen in the skin, which should be seen as a change in the scattering parameter."

The group did address concerns raised by physicians that the imaging itself exposes the skin to additional radiation, and calculated how their low power device compares to sun exposure. "Ten measurements with our device roughly corresponds to two seconds in the sun," Leproux said.

Although results are still in their infancy, they show great potential, successfully identifying distinctly different trends in melanin and oxygen saturation over the treatment time.

Along with aiming to one day predict a patient's reactions to radiation therapy, the group hopes to optimize the device in other ways along the way, perhaps helping to guide the development of better lotions to treat these side effects as well as shrinking the size of the instrument itself.

"We could optimize the current instrument in order to have shorter measurements with a cheaper device. That's something we'll look into," said Leproux.

Adapted from: http://medical.electronicspecifier.com/optomedical/led-ba...-detects-skin-damage

Tasks

1. What is the main idea of the text? Choose the correct answer.

a) The conference on oncology took place in California.

b) New device to estimate toxicity level of radiation therapy is being developed.

c) Infra-red absorption spectra of crystal gave unusual result.

2. Mark true (T) or false (F) sentences.

a) The scientist is trying to characterize the skin damage after massage.

b) Necrosis often happens as a side effect of radiation therapy.

c) The measurements which are carrying are superficial, about three to five millimeters deep.

d) The main aim of the scientist is to predict a patient's reactions to radiation therapy.

e) The investigation is over, the best result has been already achieved.

3. In what paragraph is it written that light of low power is used for diagnostic?

a) 1; b) 2; c) 3.

4. Put the names of the paragraphs in the correct order.

1) Device for prediction of skin toxicity is being invented.

2) How it is supposed to work.

3) Side effects of radiation therapy can’t be predicted now

a) 1, 2, 3; b) 3, 1, 2; c) 3, 2, 1.

5. Choose the correct answer to the given question.

How do the scientists estimate the strength of device’s radiation?

a) Its strength is equivalent to two seconds in the sun.

b) Its strength is equivalent to the therapy.

c) Its strength is equivalent to mobile phone radiation.

6. Choose the correct translation of the sentence.

Using their new imaging technique, the project is aimed at using precision measurements to characterize skin toxicity of tissue exposed to radiation.

a) Используя новую технику визуализации, данный проект имеет своей целью применение точных измерений, чтобы характеризовать токсичность кожи в области тканей, подвергшихся воздействию радиации

b) Используя новую технику изобразительного искусства, этот проект нацелен на характеристику токсичности ткани.

c) Использование новой техники изображения нацеливает проект на измерение токсичности лекарственных средств.

7. Match the words and their translations.

A	B
1. damage	a) поверхностный
2. near infra-red	b) дать количественную оценку
3. exposure	c) ближний инфракрасный
4. superficial	d) ущерб
5. to quantify	e) воздействие

8. Complete the sentence.

The reflected light is detected by ….

a) Geiger counter.

b) a camera.

c) synchronous detector.

9. Choose the sentence with the correct word order.

a) We could optimize the current instrument in order to have shorter measurements with a cheaper device.

b) We could optimize the instrument current in order to have shorter measurements with a cheaper device.

c) We could optimize the current instrument in order to shorter with measurements have a cheaper device.

Extra tasks

1. Write out key words from the text.

2. Title the paragraphs.

3. Use the key words of the text to make up the outline of the text.

4. Make up 5 questions to the text.

5. Write out the main idea of the text. Be ready to speak about it.

6. Give the summary of the text.

7. Retell the text.

8. Write an essay on the topic discussed.

Text 7. Researchers control soft robots using magnetic fields

Vocabulary

1. researchers [ˈrisərʧərz] исследователи
2. magnetic fields [mæɡˈnetɪk] [fɪːldz] магнитные поля
3. self-assembling [sɛlf-əˈsɛmblɪŋ] самосборщик
4. technique [tekˈnɪk] техника
5. device [dɪˈvaɪs] устройство
6. microparticles [ˈmaɪkrəʊ ˈpɑːtɪklz] микрочастицы
7. potential [pəʊˈtɛnʃəl] потенциал
8. measuring [ˈmɛʒərɪŋ] измерение
9. performance [pəˈfɔːməns] представление
10. tube [ˈ tjuːb] труба
11. manipulate [məˈnɪpjʊleɪt] манипулировать
12. muscle [ˈmʌsl] мускул
13. chains [`ʧeɪnz] цепи
14. aligning [a`laɪgnɪŋ] выравнивание

Read the text and translate it.

1. A team of engineering researchers has made a fundamental advance in controlling so-called soft robots, using magnetic fields to remotely manipulate microparticle chains embedded in soft robotic devices. The researchers have already created several devices that make use of the new technique.

2. "By putting these self-assembling chains into soft robots, we are able to have them perform more complex functions while still retaining relatively simple designs,"

says Joe Tracy, an associate professor of materials science and engineering at North Carolina State University and corresponding author of a paper on the work. "Possible applications for these devices range from remotely triggered pumps for drug delivery to the development of remotely deployable structures."

3. The new technique builds on previous work in the field of self-assembling, magnetically actuated composites by Tracy and Orlin Velev, the INVISTA Professor of Chemical and Biomolecular Engineering at NC State.

For this study, the researchers introduced iron microparticles into a liquid polymer mixture and then applied a magnetic field to induce the microparticles to form parallel chains. The mixture was then dried, leaving behind an elastic polymer thin film embedded with the aligned chains of magnetic particles.

"The chains allow us to manipulate the polymer remotely as a soft robot by controlling a magnetic field that affects the chains of magnetic particles," Tracy says.

Specifically, the direction of the magnetic field and its strength can be varied. The chains of iron microparticles respond by aligning themselves and the surrounding polymer in the same direction as the applied magnetic field.

Using this technique, the researchers have created three kinds of soft robots. One device is a cantilever that can lift up to 50 times its own weight. The second device is an accordion-like structure that expands and contracts, mimicking the behavior of muscle. The third device is a tube that is designed to function as a peristaltic pump – a compressed section travels down the length of the tube, much like someone squeezing out the last bit of toothpaste by running their finger along the tube.

"We're now working to improve both the control and the power of these devices, to advance the potential of soft robotics," Tracy says.The researchers have also developed a metric for assessing the performance of magnetic lifters, such as the cantilever device.

"We do this by measuring the amount of weight being lifted and taking into account both the mass of particles in the lifter and the strength of the magnetic field being applied," says Ben Evans, co-author of the paper and an associate professor of physics at Elon University. "We think this is a useful tool for researchers in this area who want to find an empirical way to compare the performance of different devices."

Adapted from: http://robotglobe.org/control-soft-robots-using-magnetic-fields/

Tasks

1. What is the main idea of the text? Choose the correct answer.

a) A team of engineering researchers from Kazan Federal University invented a method of detected superconductivity by nuclear magnetic resonance.

b) A team of engineering researchers from North Carolina State University created a three types of soft robots from magnetic microparticles using magnetic fields.

c) A team of engineering researchers from Harvard University created two types of solid robots from magnetic nanoparticles using electric fields.

2. Mark true (T) or false(F) sentences.

a) Magnetic microparticles line up in parallel chains due to the electric field.

b) Researchers are work in NC State University.

c) A team of engineering researchers created two types of soft robots.

d) One of types of created soft robots is like an eagle.

e) One device is a cantilever that can lift up to 50 times its own weight.

3. In what paragraph is it written about types of soft robots?

a) 6; b)3; c)5.

4. Put the names of paragraphs in the correct order.

1 Potential of soft robotics

2 Types of soft robots

3 Varied of magnetic field

a) 1, 2, 3; b) 3, 2, 1; c) 2, 1, 3.

5. Choose the correct answer to the given question.

What is the second soft robot?

a) The second device is an accordion-like structure that expands and contracts, mimicking the behavior of muscle.

b) The second type of created soft robots is like an eagle.

c) Researchers created only one soft robot.

6. Choose the correct translation of the given sentence.

The chains of iron microparticles respond by aligning themselves and the surrounding polymer in the same direction as the applied magnetic field.

a) Цепи микрочастиц железа состоят из полимеров, выстроенных по направлению приложенного магнитного поля.

b) Цепи микрочастиц железа не реагируют на магнитное поле, не позволяя выравниваться окружающим полимерам в том же направлении, что и приложенное магнитное поле.

c) Цепи микрочастиц железа реагируют, выравнивая себя и окружающий полимер в том же направлении, что и приложенное магнитное поле.

7. Match the words and their translations.

A	B
1. muscle	a) типы
2. aligning	b) цепь
3. soft	c) мускул
4. types	d) мягкий
5. chain	e) выравнивание

8. Complete the sentence.

For this study, the researchers introduced iron microparticles into a liquid polymer mixture and …

a) … then applied a magnetic field to induce the microparticles to form parallel chains.

b) then applied a electric field to induce the microparticles to form parallel chains.

c) then applied a electric field to induce the microparticles to form perpendicular chains.

9. Choose the sentence with correct word order.

a) Can be strength of the specifically direction field magnetic and varied the its.

b) Magnetic strength varied direction the specifically of the field and its can be.

c) Specifically, the direction of the magnetic field and its strength can be varied.

Extra tasks

1. Write out key words from the text.
2. Title the paragraphs.
3. Use the key words of the text to make up the outline of the text.
4. Make up 5 questions to the text.
5. Write out the main idea of the text. Be ready to speak about it.
6. Give the summary of the text.
7. Retell the text.
8. Write an essay on the topic discussed.

Text 8. Space station crew cultivates crystals for drug development

Vocabulary

1. protein [ˈprəʊtiːn] белок
2. structure [ˈstrʌktʃə(r)] структура/состав
3. disease [dɪˈzɪːz] болезнь
4. investigation [ɪnˌvestɪˈgeɪʃn] расследование/исследование
5. grow [grəʊ] расти
6. buoyancy-induce [ˈbɔɪənsɪ -ɪnˈdjuːs] вызывать плавучесть
7. purification [ˌpjʊərɪfɪˈkeɪʃən] очистка
8. microgravity growth [ˌmaɪkrəʊˈgravətɪ grəʊθ] выращивание в условиях микрогравитации
9. involvement [ɪnˈvɒlvmənt] участие
10. molecule [ˈmɒlɪkjuːl] молекула
11. precise [prɪˈsaɪs] точный
12. diffraction [dɪˈfrækʃən] дифракция
13. distinguish [dɪˈstɪŋgwɪʃ] выделить
14. aggregate [ˈægrɪgət] совокупный/агрегатный
15. counterpart [ˈkaʊntəpɑːt] коллега

Read the text and translate it.

1. Crew members aboard the International Space Station will begin conducting research this week to improve the way we grow crystals on Earth. The information gained from the experiments could speed up the process for drug development, benefiting humans around the world.

2. Proteins serve an important role within the human body. Without them, the body wouldn't be able to regulate, repair or protect itself. Many proteins are too small to be studied even under a microscope, and must be crystallized in order to determine their 3-D structures. These structures tell researchers how a single protein functions and its involvement in the development of disease. Once modeled, drug developers can use the structure to develop a specific drug to interact with the protein, a process called structure-based drug design.

3. Two investigations, The Effect of Macromolecular Transport on Microgravity Protein Crystallization (LMM Biophysics 1) and Growth Rate Dispersion as a Predictive Indicator for Biological Crystal Samples Where Quality Can be Improved with Microgravity Growth (LMM Biophysics 3), will study the formation of these crystals, looking at why microgravity-grown crystals often are of higher quality than Earth-grown, and which crystals may benefit from being grown in space.

Researchers know that crystals grown in space often contain fewer imperfections than those grown on Earth, but the reasoning behind that phenomenon isn't crystal clear. A widely accepted theory in the crystallography community is that the crystals are of higher quality because they grow slower in microgravity due to a lack of buoyancy-induced convection. The only way these protein molecules move in microgravity is by random diffusion, a process that is much slower than movement on Earth.

Another less-explored theory is that a higher level of purification can be achieved in microgravity. A pure crystal may contain thousands of copies of a single protein. Once crystals are returned to Earth and exposed to an X-Ray beam, the X-ray diffraction pattern can be used to mathematically mcounterpartap a protein's structure.

"When you purify proteins to grow crystals, the protein molecules tend to stick to each other in a random fashion," said Lawrence DeLucas, LMM Biophysics 1 primary investigator. "These protein aggregates can then incorporate into the growing crystals causing defects, disturbing the protein alignment, which then reduces the crystal's X-ray diffraction quality."

The theory states that in microgravity, a dimer, or two proteins stuck together, will move much slower than a monomer, or a single protein, giving aggregates less opportunity to incorporate into the crystal.
"You're selecting out for predominantly monomer growth, and minimizing the amount of aggregates that are incorporated into the crystal because they move so much more slowly," said DeLucas.

The LMM Biophysics 1 investigation will put these two theories to the test, to try to understand the reason(s) microgravity-grown crystals are often of superior quality and size compared to their Earth-grown counterparts. Improved X-ray diffraction data results in a more precise protein structure and thereby enhancing our understanding of the protein's biological function and future drug discovery.

As LMM Biophysics 1 studies why space-grown crystals are of higher quality than Earth-grown crystals, LMM Biophysics 3 will take a look at which crystals may benefit from crystallization in space. Research has found that only some proteins crystallized in space benefit from microgravity growth. The shape and surface of the protein that makes up a crystal defines its potential for success in microgravity.

"Some proteins are like building blocks," said Edward Snell, LMM Biophysics 3 primary investigator. "It's very easy to stack them. Those are the ones that won't benefit from microgravity. Others are like jelly beans. When you try and build a nice array of them on the ground, they want to roll away and not be ordered. Those are the ones that benefit from microgravity. What we're trying to do is distinguish the blocks from the jelly beans."

Understanding how different proteins crystallize in microgravity will give researchers a deeper view into how these proteins function, and help to determine which crystals should be transported to the space station for growth. "We're maximizing the use of a scarce resource, and making sure that every crystal we put up there benefits the scientists on the ground," said Snell. These crystals could be used in drug development and disease research around the world.

Adapted from: http://phys.org/news/2017-03-space-station-crew-cultivates-crystals.html

Tasks

1. What is the main idea of the text? Choose the correct answer.

a) Scientists investigate the growth of proteins in microgravity to improve medicine

b) Crew members aboard the International Space Station will begin conducting research this week to improve the way we grow crystals on Earth.

c) Proteins serve an important role within the human body.

2. Mark true (T) or false (F) sentences.

a) Researchers know that crystals grown on Earth often contain fewer imperfections than those grown in space.

b) All structures which grown in space tell researchers how a single protein functions and its involvement in the development of disease.

c) A pure crystal may contain thousands of copies of a single protein.

d) Understanding how different proteins crystallize in microgravity will give researchers a deeper view into how these proteins function, and help to determine which crystals should be transported to the space station for growth.

e) These crystals couldn't be used in drug development and disease research around the world.

3. In what paragraphs is it written that microgravity-grown crystals often are of higher quality than Earth-grown?

a)1; b) 2; c) 3.

4. Put the names of paragraphs in the correct order.

1. Structure of protein

2. Benefit of research

3 Microgravity-grown crystals

a) 1, 2, 3; b) 3, 2, 1; c) 2, 1, 3.

5. Choose the correct answer to the given question.

What do researchers know about growing crystals in space?

a) Nothing

b Researchers know that crystals grown in space often contain fewer imperfections than those grown on Earth, but the reasoning behind that phenomenon isn't crystal clear.

c) Crystals grown in space have a completely different structure

6. Choose the correct translation of the given sentence.

When you purify proteins to grow crystals, the protein molecules tend to stick to each other in a random fashion

a) Когда вы берете чистый белок, то молекулы белка случайным образом перемешиваются

b) При очистке белка, молекулы белка имеют тенденцию отталкиваться друг от друга

c) При очистке белков для выращивания кристаллов молекулы белка склонны слипаться друг с другом случайным образом.

7. Match the words and their translations.

A	B
1. benefit	a) сообщество
2. space-grown	b) выгода
3. community	c) движение
4. researchers	d) выращенный в космосе
5. movement	e) исследователи

8. Complete the sentence.

As LMM Biophysics 1 studies why space-grown crystals are of higher quality than...

a) Earth-grown crystals

b) the crystals of Mars

c) LMM Biophysics 0

9. Choose the sentence with correct word order.

a) Another less-explored theory is that a higher level of purification can be achieved in microgravity.

b) Another less-explored can be achieve theory of purification is that a higher level in microgravity.

c) Another of purification theory is that a higher level can be achieved in less-explored microgravity.

Extra tasks

1. Write out key words from the text.
2. Title the paragraphs.
3. Use the key words of the text to make up the outline of the text.
4. Make up 5 questions to the text.
5. Write out the main idea of the text. Be ready to speak about it.
6. Give the summary of the text.
7. Retell the text.
8. Write an essay on the topic discussed.

Text 9. Consider 3D microstructures for Mechatronics technology

Vocabulary

1. struggle [strʌgl] пытаться изо всех сил
2. apparent [əˈpærənt] очевидный
3. interconnect [ˌɪntəkəˈnekt] связывать
4. plating [pleɪtɪŋ] покрытие металлическими пластинами (*процесс*)
5. aspect ratio [ˈæspekt ˈreɪʃɪəʊ] соотношение сторон, пропорции
6. semiconductor [ˌsemɪkənˈdʌktər] полупроводник
7. doughnut [ˈdəʊnʌt] пончик
8. flat washer [flæt ˈwɒʃər] плоская шайба
9. sub-micron [sʌb ˈmaɪkrɒn] сверхтонкий
10. adhere [ədˈhɪər] присоединяться
11. rigid [ˈrɪdʒɪd] жёсткий
12. substrate [ˈsʌbstreɪt] основание

13. alumina [əˈljuːmɪnə] окись алюминия

Read the text and translate it.

1. 3D microstructures are electro-mechanical devices that bridge the gap between conventional manufacturing techniques and MEMS technology. As the drive to build smaller and more complex electro-mechanical devices or micro-devices continues, design engineers struggle to bridge the gap between conventional micromachining techniques such as laser, water jet, micro-EDM, micro-milling and Micro Electro Mechanical Systems (MEMS). Specifically, design engineers are discovering that many products now in the design stage are too small to be built with these manufacturing techniques, and are not candidates for the MEMS technology because of size, cost, or material limitations. The problem is apparent for both the mechanical and electronic interconnects portion of micro-devices and affects many application areas including medical, optical, space-based and semiconductor manufacturing equipment. This process should be considered in the early stages of design and can be a powerful new tool for those who are responsible for designing miniature and micro-devices. The technology supports feature sizes from 5 μm minimum to 150 μm maximum in thickness, and 30 to 1 aspect ratios.

2.Typically, "three-dimensional (3D) micros" are defined by dimensional relationships where the aspect ratio (height divided by the minimum feature width) is greater than one. Structures with aspect ratios of one or less than one are considered planar. They are usually, but not always, metallic structures with precisely controlled X, Y, and Z dimensions that may range from 0.002 mm to 0.500 mm. Depending on the application, the structure could be as simple as a doughnut-shaped flat washer or as complex as a multi-planed, magnetically actuated control device. If a structure is large enough to be formed by conventional machine-tool technology it is not considered a 3D micro-device. Also, MEMS, silicon-based devices with sub-micron dimensions and embedded electronics, are not considered 3D micro-devices.

3. 3D Micros are manufactured in several forms. They can be free standing structures, or sheets of linked structures that can be singulated, structures that are

adhered to rigid substrates, (such as glass or alumina) or structures that adhere to flexible substrates (such as metal foils or plastics).

Adapted from: https://www.therobotreport.com/consider-3d-microstructures-for-mechatronics-technology

Tasks

1. What is the main idea of the text? Choose the correct answer.

a) Engineers struggle to bridge the gap between conventional micromachining techniques and Micro Electro Mechanical Systems.

b) Structures with aspect ratios of one or less than one are considered planar.

c) The technology supports feature sizes from 5 μm minimum to 150 μm maximum in thickness, and 30 to 1 aspect ratios.

2. Mark true (T) or false(F) sentences.

a) Design engineers are discovering that many products now in the design stage are too tough to be built with these manufacturing techniques.

b) If a structure is large enough to be formed by conventional machine-tool technology it is not considered a 3D micro-device.

c) 3D Micros are produced in one form.

d) 3D microstructures are polyelectrolytes.

e) Structures with aspect ratios of one or less than one are considered small.

3. In what paragraphs are the sizes of micro-devices described?

a)1; b) 2; c) 3.

4. Put the names of paragraphs in the correct order.

1. Discussion of device sizes and forms
2. Used materials for creating a device
3. The problem of creating micro-devices

a) 1, 3, 2; b) 3, 1, 2; c) 2, 1, 3.

5. Choose the correct answer to the given question.

What is the aspect ratio is rightly for «three-dimensional (3D) micros»?

a) greater than one

b) less than one

c) one

6. Choose the correct translation of the given sentence.

Depending on the application, the structure could be as simple as a doughnut-shaped flat washer or as complex as a multi-planed, magnetically actuated control device.

1. В зависимости от приложения, структура может быть простой как плоская шайба в форме пончика или сложной как многоплановое, управляющее устройство, приводимое в действие с помощью магнита.
2. В зависимости от применения конструкция может быть такой же простой, как плоская шайба в форме пончика или сложная, как многоплановое магнитоуправляемое управляющее устройство.
3. В зависимости от применения конструкция может быть такой же простой, как плоская шайба в форме пончика или сложной как многоплановое управляющее устройство, приводимое в действие с помощью магнита.

7. Match the words and their translations.

A	B
a) semiconductor	1) фольга
b) dimension	2) промежуток
c) gap	3) обычный
d) foils	4) величина
e) conventional	5) полупроводник

8. Complete the sentence.

The problem is apparent for both the mechanical and electronic interconnects portion of micro-devices and affects many application areas including ………

1) economic, social and other types of areas.
2) medical, optical, space-based and semiconductor manufacturing equipment.
3) free standing structures, or sheets of linked structures that can be singulated, structures that are adhered to rigid substrates, (such as glass or alumina) or structures.

9. Choose the sentence with correct word order.

1) Specifically, design engineers are discovering that many products now in the design stage are too small to be built with these manufacturing techniques, and are not candidates for the MEMS technology because of size, cost, or material limitations **2)** As the drive to build smaller and electro-mechanical devices more complex or micro-devices continues, design engineers struggle to bridge the gap between conventional micromachining techniques such as laser, water jet, micro-EDM, micro-milling and Micro Electro Mechanical Systems (MEMS). **3)** Structures with aspect ratios of one or less than one considered are planar. They are usually, but not always, metallic structures with precisely controlled X, Y, and Z dimensions that may range from 0.002 mm to 0.500 mm.

Extra tasks

1. Write out key words from the text.
2. Title the paragraphs.
3. Use the key words of the text to make up the outline of the text.
4. Make up 5 questions to the text.
5. Write out the main idea of the text. Be ready to speak about it.
6. Give the summary of the text.
7. Retell the text.
8. Write an essay on the topic discussed.

Text 10. Ultrashort light pulses for fast 'lightwave' computers

Vocabulary

1. compressed sensing [kəmˈprest] [ˈsensɪŋ] сжатое считывание
2. computational technique [kɒmpjuˈteɪʃənl] [tɛkˈniːk] вычислительная техника
3. light sensor [lʌɪt] [ˈsɛnsə]световой датчик
4. researchers[rɪˈsɜːtʃəz] исследователи
5. spectrum [ˈspɛktrəm] спектр
6. exposure [ɪkˈspəʊʒə] воздействие
7. image acquisition[ˈɪmɪdʒ] [ˌakwɪˈzɪʃ(ə)n]получение изображения
8. pixel [ˈpɪks(ə)l] пиксель
9. wavelength[ˈweɪvlɛŋ(k)θ] длина волны

10. prospects [prəˈspekts] перспективы

11.aspect [ˈaspɛkt] аспект

12. lens [lenz] линза

13. sensors[ˈsensəz] датчик

14. environments [ɪnˈvaɪərənmənts] окружающая среда

Read the text and translate it.

1. Compressed sensing is an exciting new computational technique for extracting large amounts of information from a signal. In one high-profile demonstration, for instance, researchers at Rice University built a camera that could produce 2-D images using only a single light sensor rather than the millions of light sensors found in a commodity camera.

2. But using compressed sensing for image acquisition is inefficient: That "single-pixel camera" needed thousands of exposures to produce a reasonably clear image. Reporting their results in the journal IEEE Transactions on Computational Imaging, researchers from the MIT Media Lab now describe a new technique that makes image acquisition using compressed sensing 50 times as efficient. In the case of the single-pixel camera, it could get the number of exposures down from thousands to dozens.

3. One intriguing aspect of compressed-sensing imaging systems is that, unlike conventional cameras, they don't require lenses. That could make them useful in harsh environments or in applications that use wavelengths of light outside the visible spectrum. Getting rid of the lens opens new prospects for the design of imaging systems.

Adapted from: http://altlab.org/d/m/jpralves/newsletters/2017/101/

Tasks

1. What is the main idea of the text? Choose the correct answer.

a) Creation of a new type compressed sensing camera

b) Creation compressed sensing camera

c) Use wavelengths of light

2. Mark true (T) or false (F) sentences.

a) Researchers at Rice University built a camera atom.

b) New technique that makes image acquisition using compressed sensing 10 times as inefficient.

c) This camera could produce 3-D images.

d) Single-pixel camera cannot be used without lenses.

e) Compressed sensing camera useful in in applications that use wavelengths of light outside the visible spectrum.

3. In what paragraph is it written that single-pixel camera can be used without lenses?

a) 1; b) 2; c) 3.

4. Put the names of the paragraphs in the correct order.

1) Advantage of new technology

2) New type single-pixel camera

3) Compressed sensing

a) 1, 2, 3; b) 3, 2, 1; c) 2, 1, 3.

5. Choose the correct answer to the given question.

What is the drawback of a one-pixel imaging system?

a) needed thousands of exposures to produce a reasonably clear image

b) Camera doesn't require lenses

c) High cost

6. Choose the correct translation of the sentence.

That could make them useful in harsh environments or in applications that use wavelengths of light outside the visible spectrum.

a) Это может сделать их полезными в суровых условиях или в приложениях, использующих длины волн света вне видимого спектра.

b) Это может стать суровым условием в приложениях, использующих длины волн света вне видимого спектра.

c) Это может сделать их полезными в суровых условиях или в приложениях, использующих частоты волн света вне слышимого спектра.

7. Match the words and their translations.

A	B
1. sensor	a) производить
2. Compress	b) окружающая среда
3. image	c) изображение
4. environment	d) сжатие
5. produce	e) датчик

8. Complete the sentence.

Researchers from the MIT Media Lab now describe a new technique that makes image acquisition …

a) using compressed sensing 50 times as efficient

b) using compressed sensing 50 times as inefficient

c) using compressed sensing 50 billion times as inefficient

9. Choose the sentence with the correct word order.

a) One intriguing aspect of compressed-sensing imaging systems is that, unlike conventional cameras, they don't require lenses

b) Compressed is sensing an exciting computational new technique for extracting large amounts of from a signal information

c) Getting rid of the lens new for the design prospects systems of imaging systems opens.

Extra tasks

1. Write out key words from the text.
2. Title the paragraphs.
3. Use the key words of the text to make up the outline of the text.
4. Make up 5 questions to the text.
5. Write out the main idea of the text. Be ready to speak about it.
6. Give the summary of the text.
7. Retell the text.

8. Write an essay on the topic discussed.

TEST

Fill in the gap with an appropriate word.

1. A detector underneath reads the varying intensity of ________ coming through and sends a signal that draws an image on a computer screen

a) electrons

b) X-ray

c) protons

2. "We are working to improve the measuring technique in cases of high pressure and to build a non-isothermal and compressible LBM model based on a complex lattice to capture the details of ______ field and describe the accompanying acoustic nonlinearity more accurately," Zhang said.

a) magnetic

b) electric

c) acoustic

3. To make the protocol immune to the noise, they add an additional element, a so-called _______________, at both ends of the quantum channel.

a) quantum oscillator

b) mediator

c) microwave oscillator

4. The research team found that ________ in the electron pressure develops along the magnetic field lines in the region undergoing reconnection.

a) variation

b) balancing act

c) electron pressure

5. "It's only at these small scales that the waves are able________, which is why it's so important to study them," Gershman said.

a) to trap energy

b) to transfer energy

c) scatter energy

6. Since we use_________________, we perform spectroscopy and obtain the content of melanin, tissue hemoglobin, in the de-oxygenated and oxygenated state, from which we can calculate the total blood volume and oxygen saturation in the tissue.

a) radiation therapy

b) expensive equipment

c) several wavelengths of light

7. Possible applications for these devices range from remotely triggered pumps for _______________ to the development of remotely deployable structures.

a) magnetic fields

b) drug delivery

c) behavior of muscle

8. The investigation ____________ will put these two theories to the test, to try to understand the reason(s) microgravity-grown crystals are often of superior quality and size compared to their Earth-grown counterparts.

a) LMM Biophysics 3

b) LMM Biophysics 1

c) proteins

9. If a structure is large enough to be formed by conventional …….technology it is not considered a 3D micro-device.

1) modern

2) radio technical

3) machine-tool

10. **Fill in the gap with an appropriate word.**

Needed ______________to produce a reasonably clear image.

a) thousands of exposures

b) compensation motion blur

c) four of exposures

UNIT II. QUIZZES, LEXICAL GAMES, DEFENITION GAMES, CROSSWORDS

QUIZZES

Quiz 1

Choose a, b or c

1. What particles can be arranged in an orderly manner in a conductor?
a) electrons
b) ions
c) electrons, ions and other charged particles.

2. Electric current is…
a) the directed motion of a charged body.
b) any motion of charged particles in a conductor.
c) the ordered motion of charged particles.

3. What makes free charged particles in the conductor to move in an orderly manner?
a) thermal motion of crystal lattice ions.
b) electric field inside the conductor.
c) magnetic field of the earth.

4. The role of the current source is…
a) to heat the conductor.
b) the source of electrical charges.
c) to create and maintain an electric field.

5. The number of free electrons in the crystal lattice of metals is …
a) much larger than the number of ions.
b) always less than the number of ions.
c) equal to the number of ions.

6. How can we reveal the presence of an electric current in the circuit?
a) observing the motion of free charged particles.
b) according to the actions of electric current.
c) if the circuit is closed with a key, then there is a current in the circuit.

7. Which of the actions of the electric current is always observed?
a) magnetic
b) thermal
c) chemical

8. What direction is taken as the direction of the current?
a) direction of positive charges motion
b) direction of negative charges motion
c) the choice of direction depends on the specific conditions

Quiz 2

Choose a, b or c

1. Elementary particle with the smallest negative electric charge is…
a) proton b) electron c) neutron

2. What kind of interaction does not exist in nature?

a) strong 2) average 3) low

3. What is the fermion's statistics?

a) Bose-Einstein b) Maxwell c) Fermi-Dirac

4. By what principle are two or more identical fermions not simultaneously located in the same quantum state?

a) superposition principle b) The Pauli Principle c)Uncertainty Principle

5. The unit of electrical conductivity is…

a) Ohms b) Siemens c) Amps

6. What is the non-system unit of Angstrom (meters) measure?

a) 10^{13} b) 10^{-13} c) 10^{-10}

7. What is the type of «glow discharge»?

a) independent b) dependent c) arbitrary

Quiz 3

Choose a, b or c

1. Who is a founder of quantum mechanics?

a) Max Plank.
b) Albert Einstein.
c) Hendrik Lorentz.
d) Niels Bohr.

2. This scientist is commonly known as the one who has formulated four fundamental equations of electromagnetism theory.

a) Michael Faraday.
b) Andre-Marie Ampere.
c) Hendrik Lorentz.
d) James Clerk Maxwell.

3. He has been awarded a Nobel Prize for explanation of photoelectric effect.

a) Erwin Schrodinger.
b) Werner Heisenberg.
c) Albert Einstein.
d) Max Plank.

4. These three famous laws of motions called "Newton's laws" are the foundation for classical mechanics. Match each law to its mathematical expression.

Law	Formula
I. In an inertial frame of reference, an object either remains at rest or continues to move at a constant velocity, unless acted upon by a force.	A. **F**=*m***a**.

II. In an inertial reference frame, the vector sum of the forces **F** on an object is equal to the mass *m* of that body multiplied by the acceleration **a** of the object: $\mathbf{F} = m\mathbf{a}$.	B. $\sum \mathbf{F} = 0$.
III. When one body exerts a force on a second body, the second body simultaneously exerts a force equal in magnitude and opposite in direction on the first body.	C. $\mathbf{F}_{\mathrm{ab}} = -\mathbf{F}_{\mathrm{ba}}$.

5. **Gauss's law also known as Gauss's flux theorem states that:**
   a) The net electric flux through any hypothetical closed surface is equal to 1/ε times the net electric charge within that closed surface.
   b) Every point mass attracts every single other point mass by a force pointing along the line intersecting both points. The force is proportional to the product of the two masses and inversely proportional to the square of the distance between them.
   c) The potential difference (voltage) across and ideal conductor is proportional to the current through it.
6. **Light is…**
   a) particle
   b) wave
   c) both particle and wave.
7. **A quant of light is called…**
   a) boson
   b) fermion
   c) photon
8. **Sadie Carnot, a famous French engineer, had first formulated this fundamental principle of nature in his monograph "Reflections on the Motive Power of Fire". What principle is it?**
   a) the law of conservation of energy
   b) the second law of thermodynamics
   c) the law of conservation of impulse

9. **Which fundamental interaction is responsible for such forces as friction and reaction force?**
   a) strong gravitation
   b) electromagnetic gravitation
   c) weak gravitation

10. **The magnitude of the light speed is:**
   a) 300 000 m/s.
   b) 300 m/s.
   c) 10000 km/h.

Quiz 4

Choose a, b or c

1. First observation of gravitational waves was made on …

a) 14/09/15
b) 14/09/15
c) 11/02/16

2. This scientist got first fluid helium.

a) Kamerlingh Onnes
b) Kapitsa P.L.
c) Bunkov Yi. M.

3. Moscow Institute of Physics and Technology was founded in …

a) 1971
b) 1961
c) 1951

4. Who proved that the light pressure exists?

a) Maxwell
b) Lebedev P.N.
c) Einstein

5. Who is considered as the founder of EPR (Electron Paramagnetic Resonance)

a) Zavoisky Ye. K.
b) Felix Bloch
c) Altshuler S.A.

6. Do magnetic charges exist?

a) Yes b) No

7. Who discovered the phenomenon of electromagnetic induction and when?

a) Maxwell, 1831
b) Faraday, 1851
c) Faraday, 1831
d) Maxwell, 19th century

8. The angle between two atoms of hydrogen in molecule of water is ...

a) 104,5
b) 100,5
c) 121,5

9. The age of Sun.

a) 4,5 billion years
b) 5,5 billion years
c) 4,5 million years

10. How many planets are in Solar system?

a) 9
b) 8
c) 7

Quiz 5

Choose a, b or c.

1. **The main objective of the kinematics is …**

a) to establish the cause of the motion of bodies
b) to study the conditions of equilibrium of bodies
c) to determine the body's position in space at any given time

2. A material point is...

a) a body, which is conventionally assumed to be stationary
b) a body that moves with constant speed
c) a body, whose dimensions can be neglected in these conditions

3. What is called moving?

a) a body`s way
b) a vector connecting start and end points of the trajectory of motion of a body over a given period of time
c) length of the trajectory

4. Body weight is...

a) the force with which the Earth attracts the body
b) the force with which a body due to earth's gravity acts on the support or suspension, fixed relative to him

5. What is called a mathematical pendulum?

a) a physical body performing vibrations
b) a body, whose point of suspension is above the center of gravity
c) a material point suspended by a weightless inextensible thread

6. What is the amplitude?

a) the number of complete oscillations per unit time
b) the largest deviation of the vibrating point from its equilibrium position
c) the displacement of the vibrating point from the equilibrium position

7.What is called the center of mass (center of gravity)?

a) the geometric center of the body
b) pivot point
c) the point at which the gravity force is applied

8. What is called the moment of force?

a) the shortest distance from the axis of rotation to the line of action of the force
b) the magnitude of the force multiplied by the shoulder
c) the ratio of the power module to shoulder

Quiz 6

Choose a, b, c or d.

Astronomy

1. How many moons does the Mars have?

a)1, b) 2, c) 3, d) 4

2. The heaviest element formed in the core of a star is …?

a)Iron, b) Uranium, c) Plutonium, d) Lithium

3. When did the Pluto lose its planetary status?

a)2006, b) 2011, c) 2012, d) 2003

4. What planet has only soviet robots on its surface?

a)The Venu,s b) The Mercury, c) The Titan, d) The Mars

5. How many planets of the Solar System don't technically orbit the Sun?

a)1, b) 2, c) 3, d) 4

Atomic science

6. When did Fukushima accident happen?

a)2009, b) 2010, c) 2011, d) 2012

7. Which country has detonated the most powerful nuclear weapon?

a) The USA, b)the USSR, c)China, d)France

8. What journal invented the symbol of the doomsday clock?

a) The Times b) National Geographic, c) Physics Review, d) Bulletin of the atomic scientists

9. The date of Hiroshima and Nagasaki bombing is …?

a) April, b) May, c) August, d) September of 1945

10. The largest nuclear power facility in the world is located in …?

a) China, b) the USA, c) Canada, d) France

Quiz 7

Choose a, b, c or d.

Nobel Prize

1. When did Albert Einstein get his Nobel Prize?

a)1901, b) 1912, c)1921, d)1927

2. How many people have received the award twice?

a)1, b) 4, c) 11, d) 13

3. How many laureates have voluntarily declined the award?

a) 0, b)1, c) 2, d) 3

4. When did the first award ceremony happen?

a)1896, b) 1899, c) 1901, d) 1921

5. Which award is often described as "the Nobel prize of mathematics"?

a)The Fields medal, b)The Research medal, c)The Mathematics meda, d) The Nobel prize medal

Quiz 8

Choose a, b, c or d.

1) ESD stands for ...

a) electro sensitive devices
b) electrostatic discharge
c) electrostatic devices
d) electrostatic distance

2) Component (primarily electrical) can be damaged by…

a) static charges
b) charges
c) changes
d) battery

3) Static charges which be build up on people, tools, and other materials:

a) conductors
b) non-conductors or semiconductors
c) non of the above

4) Static electricity is generated and stored on the surface of …

a) conductive matieral
b) metal
c) heavy metal
d) non-conductive materials

5) Human hands, air, and glass store high …

a) positive charges
b) negative charges
c) neither negative or positive
d) non of the above

6) Plastics store large charges of … electricity.

a) negative
b) positive
c) neither negative or positive
d) all of the above

7) The voltage and current requirements for microelectronic devices are of a very ... magnitude

a) high
b) medium
c) low
d) all of the above

8) The devices damaged by static electricity are known as …

a) electrostatic-sensitive light
b) electrostatic-sensitive dare
c) electrostatic-sensitive diode
d) electrostatic-sensitive devices

9) The voltage required for damage electro sensitive devices is about …

a) 200V
b) 400V
c) 800V
d) 1600V

Quiz 9
Voltage and Current

Choose a, b, c or d

1.The unit for voltage is the ___ and the symbol for voltage is ___.

a) joule, V
b) coulomb, J
c) volt, Q
d) volt, V

2.___ make electric current possible.

a) protons
b) neutrons
c) shells
d) free electrons

3.The ___ represents a negative charge in an atom.

a) electron
b) proton
c) neutron
d) none of the above

4.All resistors can be placed into one of two main categories: ___ or ___.

a) carbon film, metal film
b) fixed, variable
c) wire wound, carbon-composition
d) insulator, semiconductor

5.Voltage is _________.

a) the opposition to the flow of current
b) the movement of free electrons
c) the force that exists between charged particles
d) the force that causes water to flow

6.The unit for resistance is the ___ and the symbol for resistance is ___.

a) ampere, R
b) ohm, R
c) volt, Q
d) ohm, J

7. Which resistive component is designed to be temperature sensitive?

a) thermistor
b) rheostat
c) potentiometer
d) photoconductive cell

8.The negative and positive charge symbols are assigned (in that order) to the:

a) proton and electron
b) electron and proton
c) atom and nucleus
d) electron and element

9. A voltmeter is used:

a) to measure current
b) in series with the circuit
c) in parallel with the circuit
d) to measure coulombs

10.If the current in a circuit equals 0 A, it is likely that the …

a) voltage is too high
b) resistance is too low
c) circuit has a short

d) circuit is open

Quiz 10

Choose the correct answer

1.Which part of an atom has no electrical charge?

a) electron
b) neutron
c) proton
d) all of the above

2.Which voltage source converts chemical energy to electrical energy?

a) electrical generator
b) battery
c) solar cell
d) electronic power supply

3.If 40 C of charge flow past a point in 20 s, what is the current?

a) 2 A
b) 0.5 A
c) 20 A
d) 40 A

4.The term used to designate electrical pressure is:

a) voltage
b) current
c) resistance
d) conductance

5. Which electronics material opposes the movement of free electrons?

a) conductor
b) insulator
c) semiconductor
d) element

6. A basic electric circuit is made up of the following components …

a) a load, a resistor, and a conductive path for current
b) a voltage source, a load, and a conductive path for current
c) a voltage source, a conductive path for current, and a battery
d) a conductive path for current, a battery, and a copper wire

7.A multimeter measures only voltage.

a) true
b) false

8. A conductor will not carry current.

a) true
b) false

9.Charges of the same polarity tend to attract one another.

a) true
b) false

10.All conductors have some resistance.

a) true
b) false

11.Resistance is the pressure that causes current to flow.
a) true
b) false

12.The potential difference between two points is called voltage.
a) true
b) false

13.An open circuit allows current to flow.
a) true
b) false

14.Switches are used to open and close paths for current.
a) true
b) false

15.Carbon is a semiconductor.
a) true
b) false

Quiz 11

Choose a, b or c

1. **When did Ewald Georg find that charge could be stored by connecting a high voltage electrostatic generator by a wire to a volume of water in a glass jar?**
   a) In October 1745
   b) in January 1744
   c) In March 1746
2. **When did physicist Pieter van Musschenbroek invent the Leyden jar?**
   a) In 1747
   b) in 1746
   c) in 1749
3. **In what unit of measurement capacity is measured?**
   a) Coulomb
   b) Farad / meter
   c) Farads
4. **What does the simplest capacitor look like?**
   a) two parallel plates and insulator
   b) water in a glass jar
   c) Ceramic capacitors
5. **How did Daniel Gralath increase the battery capacity?**
   a) He increased the volume of water in the jar
   b) He connected low-voltage electrostatic generator
   c) He combined several jars in parallel "battery"
6. **How are capacitors usually classified?**
   a) depending on the type of dielectric they contain

b) depending on capacity
c) depending on the manufacturer

7. **Until what time was the Leiden jar used?**
   a) Until 1850s
   b) Until 1900S
   c) Until 1800s
8. **How were the early capacitors called?**
   a) condensers
   b) batteries
   c) electronic capacitors
9. **Why is the Leyden jar so called?**
   a) Because he was helped by a man with Leyden by a surname
   b) Because Musschenbroek worked in Leyden university
   c) Because his father was Leyden by name

Quiz 12

Choose a, b or c

1. **What is physics?**
   a) a science
   b) a disease
   c) a journal
2. **What is the best way to understand the physical world?**
   a) try to become smarter, reading books and watching movies
   b) to observe it, to model its behavior, to test the success or failure of these models
   c) play with friends, have fun and go to parties
3. **What does electrostatics study?**
   a) character of the charge that moves, and set the stage of consideration of a non-moving charge
   b) animal world and relations between its various representatives
   c) the nature of charge that is not moving, and set the stage for a consideration of moving charge
4. **What materials did Greek scientists use in the first electrostatics experiments?**
   a) iron
   b) amber
   c) tin
5. **What is ampere?**
   a) name of the famous singer
   b) energy of one electron
   c) a flow rate of 1 C/s
6. **What provides an electromotive force?**
   a) any device that maintains a potential difference
   b) wooden and plastic pipes
   c) objects from glass

7. **What is emf measured in?**
   a) in volts
   b) in ampere
   c) in Farad
8. **What is called resistance?**
   a) the tendency for certain materials to slow the passage of electrons
   b) the force with which one charge acts on the other
   c) dipole electric field energy
9. **What is an electrical circuit?**
   a) circuit in which there is no electric field
   b) any path that allows electrons to flow
   c) an imaginary thread of electrons and protons
10. **What is an ideal capacitor characterized by?**
   a) by constant value amperage , which is measured in amperes
   b) by constant value, capacitance, which is measured in farads
   c) by constant value voltage , which is measured in volts

Quiz 13

Choose a, b or c

1. Is the ability to store electric charge called …?
a) capacitance
b) resistor
c) ammeter
2. Capacitance is measured in …
a) ampere
b) coulomb
c) farad
3. … is the study of matter and energy and the interactions between them.
a) physics
b) chemistry
c) history
4. What is measured by the electric field?
a) E = F/q
b) E=mc^2
c) E=(mV^2)/2
5. How are the lines of electric field go?
a) from positive to negative
b) from negative to positive
c) both
6) The directed movement of charged particles is …
a) electric current
b) potential
c) resistance
7. Ohm's law

a) I = q/t
b)R = pl/S
c) I = U/R
8. A resistor whose resistance value may be varied is …
a) a conductor
b) a rheostat
c) velocity
9. How is the voltage when connected in parallel formulated?
a) $U_0=U_1+U_2$
b) $U_0=U_1-U_2$
c) $U_0=U_1=U_2$
10. How can we formulate the current in a series connection?
a) $I_0=I_1+I_2$
b) $I_0=I_1=I_2$
c) $I_0=I_1*I_2$

Quiz 14

Choose a, b or c
1. What is a capacitor used to?
a) to supply voltage
b) to increase the voltage output
c) to store energy.
2. What is capacitance measured in?
a) Farads
b) Coulomb
c) Farad / meter.
3. What loop is oscillating?
a) RC-circuit
b) LC-circuit
c) RLC-circuit
4. What elements are included in an RLC circuit?
a) EMF, resistor, inductor
b) capacitor, resistor, inductor
c) capacitor, resistor, ammeter
5. Semiconductors that contain donor atoms and free electrons are known as…
a) n-type
b) p-type
c) p-n- type
6. The material, which occupies an intermediate position between conductors and insulators is …
a) semimetal
b) semiconductor
c) superconductor
7. Impurity atoms that generate "holes" are called ...

a) acceptors
b) donors
c) valency
8. The metal which is more effective in the conductors, but too expensive to be broadly used is …
a) gold
b) cuprum
c) silver
9. Who invented the first capacitor?
a) Ewald Georg von Kleist
b) The Dutch physicist Pieter van Musschenbroek
c) both (independently)
10. What material newly opened is successfully used in supercapacitors?
a) cuprum
b) grafen
c) brass

Quiz 15

Choose a, b or c
1.Who discovered superconductivity?
a) H. Kamerling-Onnes
b) A.Einstein
c) B. Wayne
2. In what year was superconductivity discovered?
a) 1679
b) 1975
c) 1911
3. Electrical conductivity...
a) is proportional to the electrical resistivity R
b) depends on the resistance as R2
c) inversely proportional to electrical resistance
4. The phenomenon of superconductivity is observed …
a) at very high electrical resistance
b) at zero electrical resistance
c) at any value of electrical resistance
5. The critical temperature of the transition of the conductor to the superconducting state is…
a) temperature above which the superconductivity effect is observed
b) temperature below which the superconductivity effect is observed
c) temperature at which the transition to the superconducting state occurs.
6.The first superconductors are …
a) metals
b) dielectrics
c) semiconductors
7. The first theory of superconductivity was created by …

a) Bednorets and Mueller
b) Bardeen, Cooper and Schriefer
c) Ginzburg and Landau

8. High-temperature superconductivity (HTSC) has been experimentally detected at …

a) 1987
b) 1890
c) 2001

9.The superconducting state of the conductor can be destroyed by …

a) magnetic field
b) high temperature
c) low temperature

10) The idea of the possibility of high-temperature superconductivity is put forward in London at …

a) 1950
b) 2016
c) 1812

Quiz 16

Choose a, b, c or d

1. Semiconductors have ... conductivity.

a) electron substituted c) electron hole
b) full d) incomplete

2. ... increases conductivity of the semiconductor.

a) Arsenic c) Thermal agitation
b) Impurity d) Chemical valence

3. Impurity atoms that generate "holes" are called...

a) holes c) impurities
b) acceptors d) valency

4. Semiconductors that contain ... and free electrons are known as n-type semiconductors.

a) donor atoms c) impurities
b) electron hole d) electron bonds

5. An atom of silicon has a chemical valency...

a) 2 c) 7
b) 5 d) 4

6. What type of conductivity do pure semiconductors have?

a) electron and hole c) only electronic
b) only hole d) it is not known yet

7. Which group element should be introduced into a semiconductor belonging to group IV in order to obtain n-type conductivity in it?

a) V c) II
b) IV d) III

8. A semiconductor crystal with an electron-hole transition possessing one-sided conductivity is …

a) a transistor c) a resistor
b) a photo resistor d) a diode

9. Acceptor impurities are ...

a) ... impurities, with the addition of which the number of free electrons increases.

b) ... the predominant conductivity of the p-type or n-type, obtained in semiconductors by the addition of certain impurities.

c) ... the interaction of neighboring atoms, caused by the reversal of electrons around a pair of atoms.

d) ... impurities, due to the addition of which there is a lack of electrons to form covalent bonds between the atoms of the semiconductor and the impurity atoms.

10. A semiconductor is a substance that …

a) does not conduct all electric charges

b) is able to skip only half of the electric charges

c) conducts electric charges worse than a conductor, but better than a dielectric

d) has special properties of electrical conductivity

Quiz 17

Choose a, b or c

1. Fusion is…

a) an interrupted part between something.

b) the union of two different objects into one whole.

c) getting rid of the liquid.

2. Substances are ...

a) things inside the object.

b) a kind of matter that has a rest mass and possesses certain properties.

c) atoms and molecules.

3. Nucleus is…

a) a part of the atom, which has a positive electric charge; almost all of its mass is concentrated in it.

b) the lightest part of the atom.

c) an unstable material particle entering the of an atom is devoid of electric charge.

4. Beta ray is…

a) radiation of nuclei of helium atoms.

b) energetic electromagnetic ray in the form of photons.

c) a charged particle (electron or positron) emitted as a result of beta decay.

5. Isotope is…

a) the most common chemical element.

b) an atom of a chemical element that differs from another atom of the same element by atomic weight.

c) a rare metal.

6. Atom is…

a) the smallest particle of a chemical element, consisting of a nucleus and electrons.

b) a particle with the smallest mass.

c) an object consisting of molecules.

7. Energy is…
a) a characteristic of matter.
b) the ability of matter to heat up.
c) the ability of material systems to perform work when their condition changes.
8. Radioactivity is…
a) a change in the state of matter.
b) decay, decomposition of atomic nuclei of some chemical elements, accompanied by active radiation.
c) the transformation of one substance into another with the release of heat.
9. Neutron is…
a) an unstable material particle entering the nucleus of an atom is devoid of electric charge.
b) a positively charged particle.
c) the fastest particle in an atom.
10. Physic is…
a) the science about the planet.
b) the science of the simplest and most general laws of nature, matter, its structure and movement.
c) the science about everything.

Quiz 18

Answer the questions

1. What is superconductivity?
2. At what temperature does helium become a superconductor?
3. What is C° equivalent of absolute zero?
4. When superconductive was discovered?
5. What is the practical use of superconductor?
6. Why liquid nitrogen is more convenient than liquid helium?
7. Why most researchers were skeptical about superconductive above 373 K?
8. What did Paul Chu say about higher-temperature observations?
9. What criteria did he put forward for superconductivity?
10. What temperature of superconductivity is the record for today?

Quiz № 19

Answer the questions

1. What is ampere?
2. What materials did Greek scientists use in the first electrostatics experiments?
3. What does electrostatics study?
4. What is the nature of electric field?
5. What does direct current refer to?
6. What provides an electromotive force?
7. What is emf measured in?
8. What current is produced in batteries?
9. What is measured in cycles per second?
10. What is called resistance?

11. What does the resistance of a material depend on?
12. What materials are called superconductors?
13. What is an electrical circuit?
14. What doubles the current?
15. What type of resistor is a rheostat?
16. What is a rheostat used for?
17. What is the function of the switch?
18. Who invented the first capacitor?
19. How did Daniel Gralath increase the battery capacity?
20. What happens if the battery is removed?

Quiz № 20

Answer the questions

1. What is one of the most important effects used in electronics?
2. What is the ability to store an electrical charge?
3. What is a capacitor?
4. What separated the capacitor plates?
5. What is the plate capacitor with an excess of electrons?
6. What is the plate capacitor with a small number of electrons?
7. In what case, will the capacitor retain the charge?
8. Who found that charge could be stored by connecting a high-voltage electrostatic generator by a wire to the volume of water in a glass jar?
9. Who invented the Leyden jar?
10. When a Leyden jar was used?
11. How did they used to call capacitors?
12. What are the units of capacity measurement?
13. Where are electronic capacitors used?
14. What substance was a certain type of capacitor called after?
15. What types of capacitors are usually used?
16. What happens if the battery is removed?
17. How did Daniel Gralath increase the battery capacity?
18. What is an ideal capacitor characterized by?
19. What is the formula for the energy of a charged capacitor?
20. What is the ratio of capacity to volume (or mass) of the dielectric?

Quiz № 21

Answer the questions

1. What is a capacitor used for?
2. How do we sometimes call the voltage decrease?
3. What is a semiconductor?
4. What does the capacity of a capacitor depend on?
5. What is an ideal capacitor characterized by?
6. What material is used for supercapacitor?
7. What event created a demand for standard capacitors?

8. What is another word for a “capacitor”?
9. What is another word for a “supercapacitor”?
10. What is the difference between n-type and p-type semiconductors?
11. Which loop is oscillating?
12. What elements does the resonant circuit have?
13. Where are the conductors used?
14. How to get a superconductor?
15. What material is the most conductive?
16. Who discovered the phenomenon of superconductivity?
17. Are the diodes and transistors semiconductors?
18. What types of transistors do you know?
19. What type of semiconductor is silicon lattice with boron?
20. Is air an insulator?

Quiz № 22

Answer the questions

1. What is a capacitor?
2. What are capacity units?
3. Name all types of capacitors, please.
4. By what formula do we calculate the energy of the indicator?
5. What is called the specific capacitance of the capacitor?
6. What are ways of connecting capacitors?
7. What is rated voltage (Nominal)?
8. What is electrical insulation resistance of the capacitor?
9. Do you know any forms of condensers?
10. What do you need oil DC capacitors for?

Quiz № 23

Answer the questions

1. When light bends as it enters a different medium the process is known as …
2. What type of lens is a magnifying glass?
3. In what units is electric resistance typically measured?
4. A person who studies physics is known as a …?
5. Metal expands when it is heated and when it is cooled it …?
6. What is the first name of the famous scientist who gave us Newton’s three laws of motion?
7. What state of the art computer technology is used to train pilots when wanting to copy the experience of flying an aircraft?
8. In what units is electric power typically measured?
9. The most recognized model of how the universe started to exist is known as …?
10. Who is the Hubble Space Telescope named after?
11. The wire inside an electric bulb is known as …?
12. In what country theoretical physicist James Maxwell was born?
13. Does infrared light have too long or short wavelength to be visible for humans?

14. What kind of eclipse do we have when the moon is between the sun and the earth?
15. Is it true or false that iron is attracted by magnets?
16. What is the earth's primary source of energy**?**
17. Do conductors have a high or low resistance?
18. In what units is electric current typically measured?
19. What scientist is well known for his theory of relativity?
20. In what galaxy is Earth located?

Quiz № 24

Answer the questions

1. Why does the snow creak under the feet?
2. Who has done the experiments from the Leaning tower of Pisa?
3. How does a rainbow set called?
4. How does the phenomenon of self-mixing called?
5. What word is the name of the French physicist and unit of pressure at the same time?
6. What science studies inanimate (not live) nature.
7. Why is the vapor more damaging and painful for skin than boiling water?
8. Why do the wet fingers freeze to metal things in winter?
9. Why do we use heavy chains, which touch the ground, for liquid transportation?
10. How do we call a stick that revolves around the axis?

Quiz 25

Answer the questions

1. The problem of Kapitsa. A tin is tied by the tail of a dog. How fast should the dog run so that the rumble couldn't be heard?
2. The scuba diver lost his orientation under the water. How can he determine where the top is, and where is the bottom?
3. Who can travel around the world staying in the same corner?

Quiz 26

Answer the questions

1. In what gases does temperature cease to exert pressure?
2. What is the type of current that naturally results from the continued turning of a coil (e.g., an electromagnet) in a fixed magnetic field; the type of current in your house?
3. What was earlier thought to be the smallest component of matter; now thought to be simply the smallest unit of an element.
4. What is the type of current in which the charge flows continually in one direction; the type of current in handheld electronics?
5. What is temperature increment of the Kelvin, or absolute, scale of temperature; formerly called degree Kelvin?

6. What is solid-state device having medium resistivity used to transmit and amplify electronic signals
7. What is rating, stated in ohms, the ability of a nonconductor (dielectric) to store charge when there is a difference in potential between its opposite surfaces
8. A transformer is used …
9. What types of capacitors are usually used?
10. What is capacitance measured in?
11. How does temperature affect the resistance of its own semiconductor?
12. What is the bound state of two electrons interacting via a phonon?
13. What are carriers of free charges in metals?
14. In which year is superconductivity theoretically justified?
15. What is the main difficulty in obtaining superconductors?
16. What is the field of application of superconductivity?
17. Who discovered superconductivity?
18. What temperature, when cooled makes the material superconducting
19. What is low temperature for superconductivity?
20. What is high temperature for superconductivity?

LEXICAL GAMES

Make up a word from letters

Lexical Game № 1

1. t e n o p i a t l
2. t l o a v g e
3. o e l e r c i m c i n c t r o s
4. q u i e t o p t i e n a l
5. o z e l e i e p c r i t i t c y
6. m a r o r e f t e g n m i s
7. v e i d g e n r e c
8. c u d t i n i n o
9. t e g n a m t i z a i t o i n
10. u c r i c t i

Lexical Game № 2

Make up a word from letters

1. C i p y s s h
2. Y e r e g n
3. A r e c h g
4. O u n n t r e
5. M g i n s a m t e
6. R p e s s r e u
7. M p a e s r e o t
8. E t n n o w
9. E y t i t i s n n
10. S e i u r n v e

Lexical Game № 3

Make up a word from letters

1. y n s e t i n t i
2. t e v o c l i y
3. d y i e n t s
4. h r c g e a
5. n a c r c e e l i o t
6. l o t s c l i r a o
7. a i l d v t y i
8. s t r m a e e e u n m t
9. t t s e a
10. s v i o i i d n
11. p b a s n r t o o i
12. l m u l o c e e
13. e m t n e l e
14. f n t i u c n
15. n t o e l c e r
16. q t a e u n i o

Lexical Game № 4

Make up a word from letters

1. t l i o a b r
2. p e l i s m u
3. r t e h y o f o b l o b y i i p t r a
4. i f i y t n i
5. r e n e u s i v
6. t s i o s p s r p u e n I c l e r i n p p i
7. n o i c l a e c t e r a
8. t a m e n c i g   l i f e d
9. e u s n c l u
10. m a h l n i t a i o n

Lexical Game № 5

Make up a word from letters

1. n e l t c e r o
2. s u n u l e c
3. t o n r o p
4. l e e l m u c o
5. g a h e r c
6. r e e r s u s p
7. m e p t e e t r a r u
8. m u l o v e
9. s o o n t e c a n i d
10. c a m u v u

Lexical Game № 6

Find the scientists

Names:

1. P _ _ _ _ _
2. N _ _ _ _ _
3. A _ _ _ _ _ _ _ _ _

4. M _ _ _ _ _
5. F _ _ _ _ _ _
6. P _ _ _ _ _
7. V_ _ _ _
8. L _ _ _

DEFINITION GAMES

Definition game № 1

Match the following terms with definitions and translate them into Russian

Terms	Definitions
1.Anode 2. Antiparticle 3. Humidity 4. Sublimation 5. Degeneracy 6. Galvanometer 7. Crystallization 8. Capacity 9. Friction 10. Oscilloscope	A. The amount of water vapor present in the air. B. When an energy level corresponds to two or more different measurable states of a quantum system. C. A particle with the same mass but with opposite physical charge D. An electromechanical instrument for detecting and indicating electric current. E. A process by which a solid forms F. An electrode through which conventional current flows into a polarized electrical device G. The change from solid to gas without passing through the liquid phase H. The amount of energy that the storage system of a power plant can hold I. A type of electronic test instrument that allows observation of varying signal voltages J. The force resisting the relative motion of solid surfaces.

Definition game № 2

Match the following terms with definitions and translate them into Russian

Terms	Definitions
a. Galvanometer b. Constant current c. Maxwell's equations d. Voltage e. Electrolyte	1.A physical quantity whose value is equal to the work of an effective electric field (which includes an external field) performed during the transfer of a single test charge.

f. The Biot-Savart-Laplace law g. Zone theory h. Electrical resistance i. Ohm`s law j. Weber (Wb)	2.Physical quantity characterizing the properties of the conductor to prevent the passage of electric current. 3.A highly sensitive device that allows you to measure the strength of small permanent electric currents. 4.The unit of measurement of magnetic flux in the International System of Units. 5.Electric current, which in the course of time does not vary in magnitude and direction. 6.An empirical physical law that determines the relationship between the electromotive force of a source (or electrical voltage) with the current flowing in the conductor and the resistance of the conductor. 7.A physical law for determining the vector of induction of a magnetic field generated by a constant electric current 8.Quantum mechanics of the motion of electrons in a solid. 9.A system of equations in differential or integral form describing the electromagnetic field and its relation to electric charges and currents in vacuum and continuous media. 10.A substance that conducts an electric current due to dissociation into ions, which occurs in solutions and melts, or the motion of ions in the crystalline lattices of solid electrolytes.

Definition game № 3

Match word combinations

1. Free 2. Various 3. Optical 4. Vacuum-ultraviolet 5. Time-depend 6. Local 7. Ionizing 8. Special 9. Accurate 10. Appropriate	a) Resolution b) Conditions c) Wavelengths d) Agent e) Refractive f) Attention g) Electrons h) Experiment i) States j) Quantities

Definition game № 4

Match the following terms with definitions and translate them into Russian

Terms	Definitions
1. Mol 2. Molar mass 3. Amount of heat 4. Isothermal process 5. Dew point temperature 6. Molecule 7. Tensile strength 8. Relative humidity	a)part of the internal energy, which is transmitted by the heat exchange b)the temperature at which the vapor becomes saturated c)the amount of substance that contains as many molecules, how many of them contained in 0,012 kg of carbon d)the process occurring in the gas at the same temperature e)the mass of one mole of a substance f)the ratio of the absolute humidity to the amount of water vapor required to saturate 1 m3 of air at a given temperature g)minimum mechanical strain that leads to destruction h)the smallest particle of this substance that retains physical and chemical properties of this substance

Definition game № 5

Match the following terms with definitions and translate them into Russian

Terms	Definitions
1. parallel circuit 2. series circuit 3. insulator 4. generator 5. static electricity	A. Nonconductor; material that impedes passage of electric charge B. Device used to convert mechanical energy into electrical current

	C. Electric charge resting on an object D. Connection of electrical components in such a way that current can branch in multiple directions, one through each component in parallel E. Connection of electrical components in such a way that the same current flows through each component

Definition game № 6

Match the following terms with definitions and translate them into Russian

Terms	Definitions
1. Capacitor 2. Leyden jar 3. Battery 4. Capacitance 5. Resistor 6. Farads 7. Insulator 8. Electron 9. Conductor 10. Charge	a. Capacitance unit b. material that does not conduct electricity c. Capacitors, which combined parallelly d. Jar with inner and outer lining of tin, which allows you to accumulate charge e. Material with low resistance, which easily passes current f. Smallest indivisible particle with negative charge g. Property of matter that is a measure of its excess or deficit of electrons h. element, which accumulates a charge i. ability to store electric charge j. element with high resistance

Definition game № 7

Match the following terms with definitions and translate them into Russian

Terms	Definitions
1. gravitational potential energy. 2. potential difference. 3. electric circuit. 4. valence. 5. semiconductor. 6. crystal lattice. 7. thermos.	a. Difference in electric charge between two objects; a charge will tend to move from the area of higher potential to the area of lower potential. b. Energy associated with position in a gravitational field, or the amount of work an object can perform by returning to its original position.

8. metal. 9. gravity. 10. vector.	c. the ability of atoms of chemical elements to form a certain number of chemical bonds with atoms of other elements. d. Complete path of an electric current, including a source of potential difference and usually including various components (e.g., resistors, diodes). e directed segment, that is the segment that has shown the beginning (also called point of application) and an end. f. the material, which occupies an intermediate position between conductors and insulators. g the force that attracts objects towards one another. h. auxiliary geometric image introduced for the analysis of the structure of the crystal. i. a vacuum flask or bottle which can keep liquids at a desired temperature. j chemical elements or alloys, and the mines where their ores come from.

Definition game № 8

Match the following terms with definitions and translate them into Russian

Terms	Definitions
1. Electric current 2. Resistance 3. Voltage 4. Charge 5. Force	a. a physical quantity that is a measure of the impact on this body by other bodies. b. a physical quantity characterizing the properties of the conductor to prevent the passage of electric current and is equal to the ratio of the voltage at the ends of the conductor to the current flowing through it c. is a flow of electric charge d. a physical quantity whose value is equal to the effective electric field (including third-party fields) performed by a single trial transfer of electric charge from point A to B e. a scalar is a physical quantity that determines the bodies ability to be a source of electromagnetic fields and to take part in the electromagnetic interaction.

Definition game № 9

Match the following terms with definitions and translate them into Russian

Terms	Definition
1.electroscope 2. breakdown 3. farad 4. oscilloscope 5 capacitor	A) The phenomenon of a sharp increase in current in a solid, liquid or gaseous dielectric (or semiconductor), which occurs when the voltage is applied above the critical. B) Units of capacitor capacity C) Device for indicating the presence of electric charge. D) A two-terminal network with a constant or variable capacitance value and low conductivity; device for the accumulation of charge and energy of the electric field. E) The device intended for research (observation, recording, measurement) of the amplitude and time parameters of an electrical signal applied to its input, either directly on the screen, or recorded on a photographic tape.

№ 10

Match the following terms with definitions and translate them into Russian

Terms	Definitions
1. semiconductor 2. free electron 3. photoconductivity 4. electric force 5. crystal lattice	a. these are the most distant electrons from the nucleus, which are able to leave their place and freely wander between atoms. The remote electrons are especially weakly held by the metal nuclei. b. auxiliary geometric image introduced for the analysis of the structure of the crystal. c. this property of semiconductors to increase the electrical conductivity under the influence of electromagnetic radiation. d. this is the force with which the electric field acts on the electric charge brought into it. e. the material, which occupies an intermediate position between conductors and insulators.

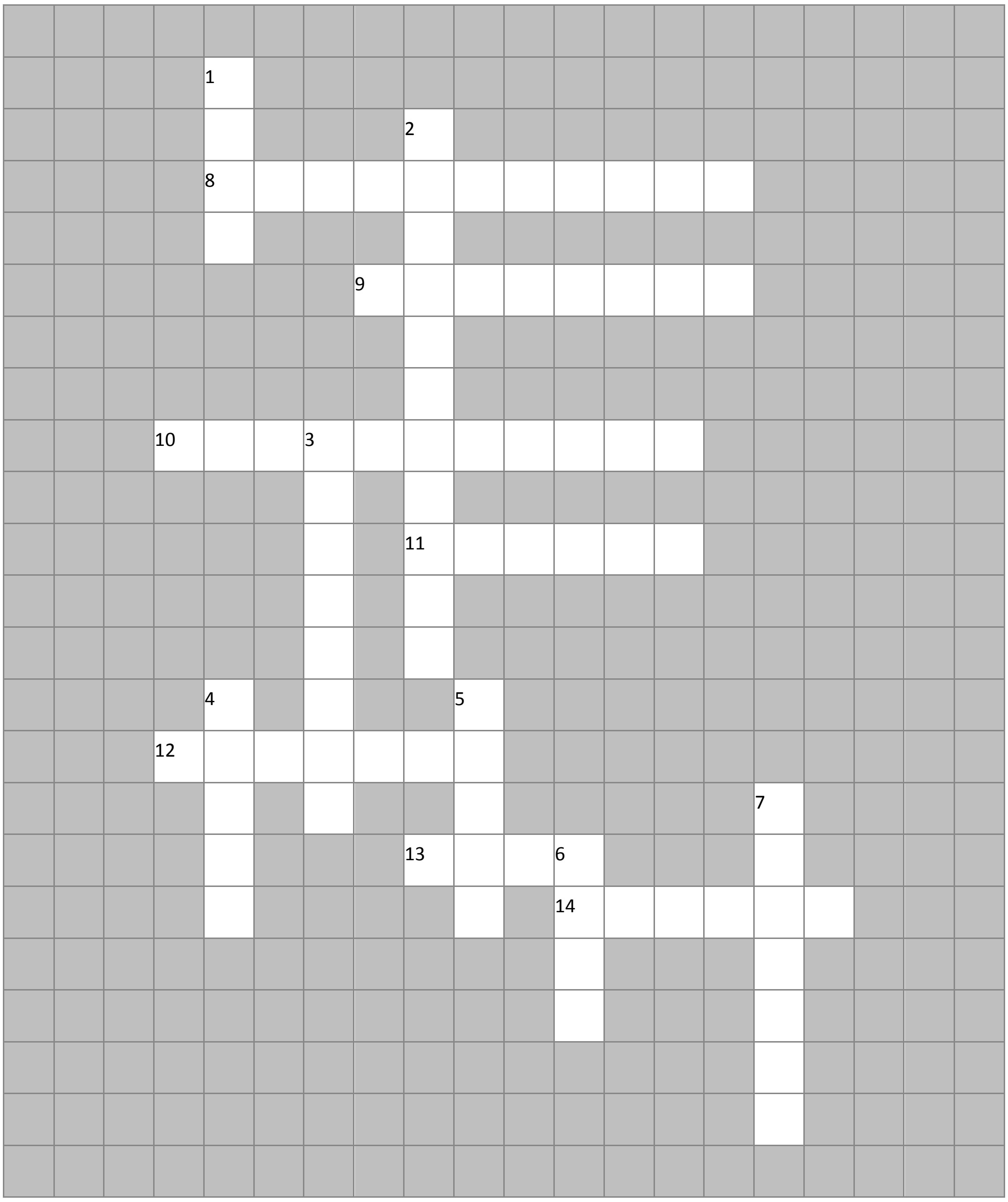
№ 11

Match the following terms with definitions and translate them into Russian

Terms	Definitions

1. superconductivity 2. semiconductor 3. supercapacitor 4. resistor 5. acceptors	a. The materials the electrical conductivity of which is less than that of metals and more than that of dielectrics b. is a passive two-terminal electrical component that implements electrical resistance as a circuit element. c. in solid state physics an impurity in the crystal lattice, which gives the crystal a p-type conductivity type, in which the charge carriers are holes. d. a phenomenon of exactly zero electrical resistance and expulsion of magnetic flux fields occurring in certain materials. e. also called supercap is a high-capacity capacitor with capacitance values much higher than other capacitors. They typically store 10 to 100 times more energy per unit volume.

CROSSWORDS
Crossword № 1

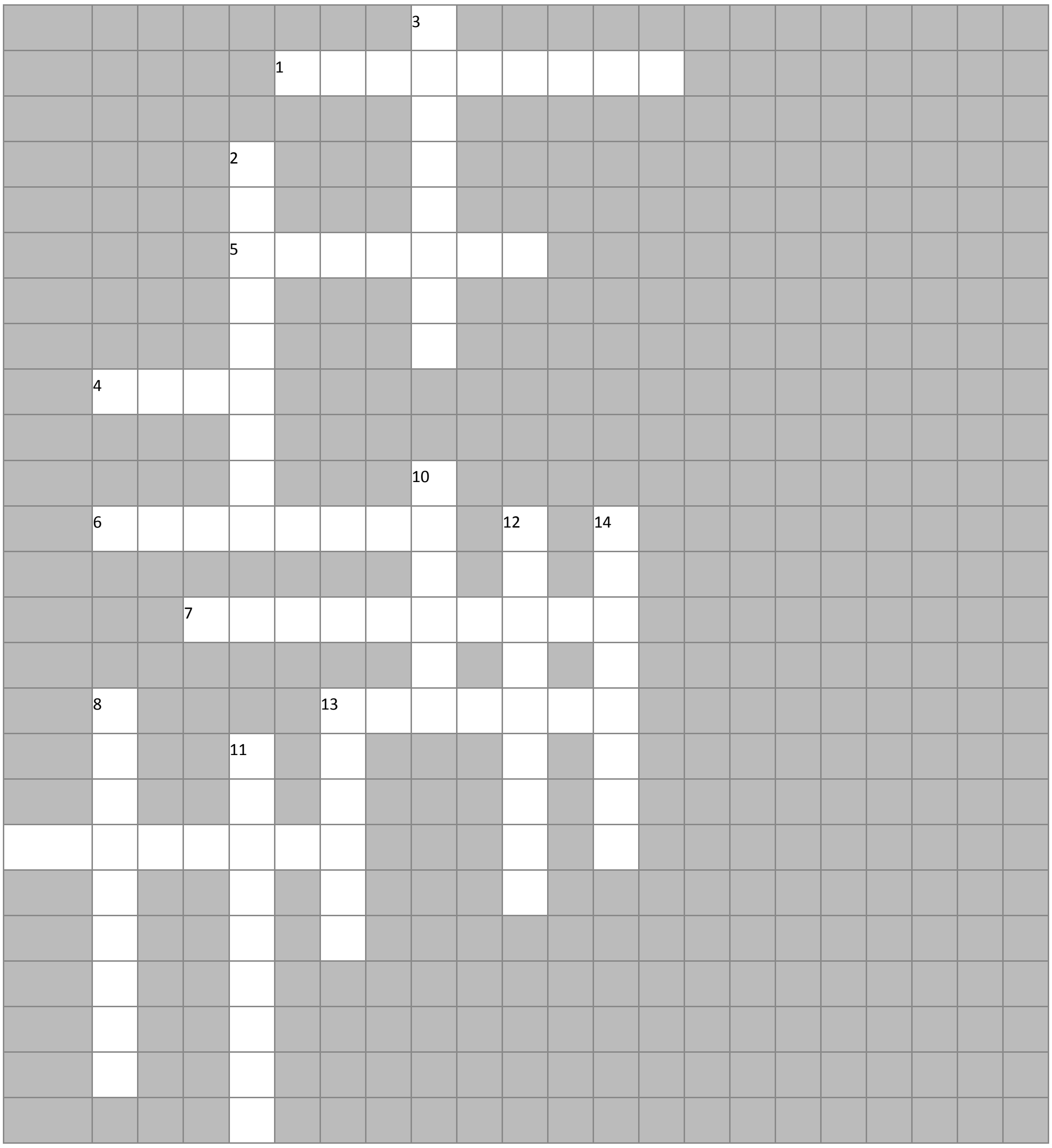


Vertically:
8. Unit of capacity
9. Unit of measurement of mass in SI
10. is a natural phenomenon by which objects with mass attract one another
11. Unit of force
12. electric potential difference
13. the smallest constituent unit of ordinary matter
14 is the base unit of electric current in the International System of Units

Horizontally:
1. physical quantity expressing the perception of hot and cold
2. Unit of force
3. One of the main characteristics of the movement

4. is the derived unit of frequency
5. is both a property of a physical body and a measure of its resistance to acceleration
6. is a derived unit of energy
7. there are parallel and serial …

Crossword № 2

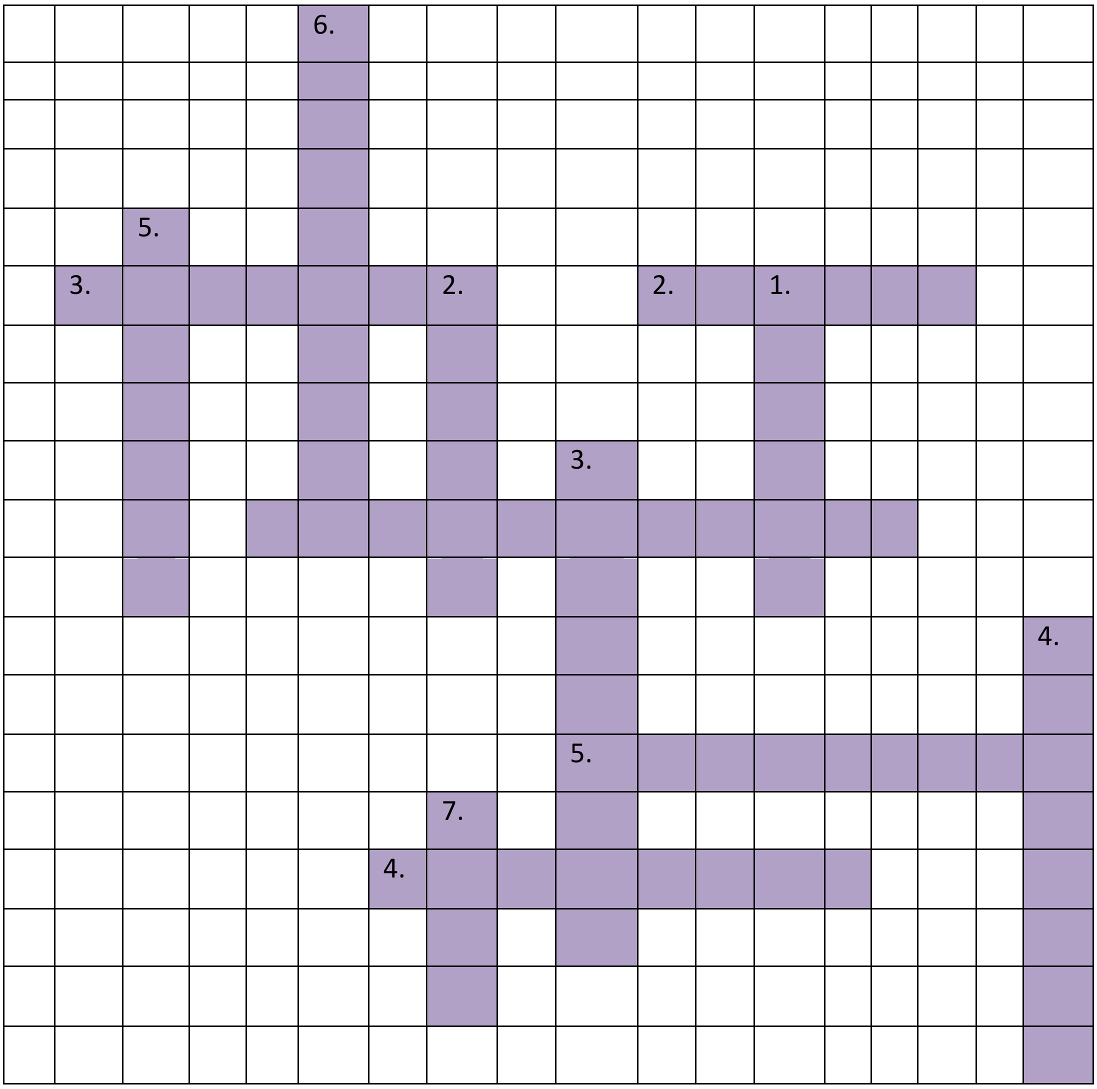


Vertically:

2. m the large size or importance of something
3. speed measured in particular direction
8. study of matter, energy, and the laws governing their interactions

10. directed segment, that is the segment that has shown the beginning (also called point of application) and an end
11. an object that provides electricity for things such as radios, toys, or cars
12. Material that allows electric charge to pass freely, with little resistance
13. Property of matter that is a measure of its excess or deficit of electrons
14. Smallest indivisible particle with negative charge

Crossword № 3



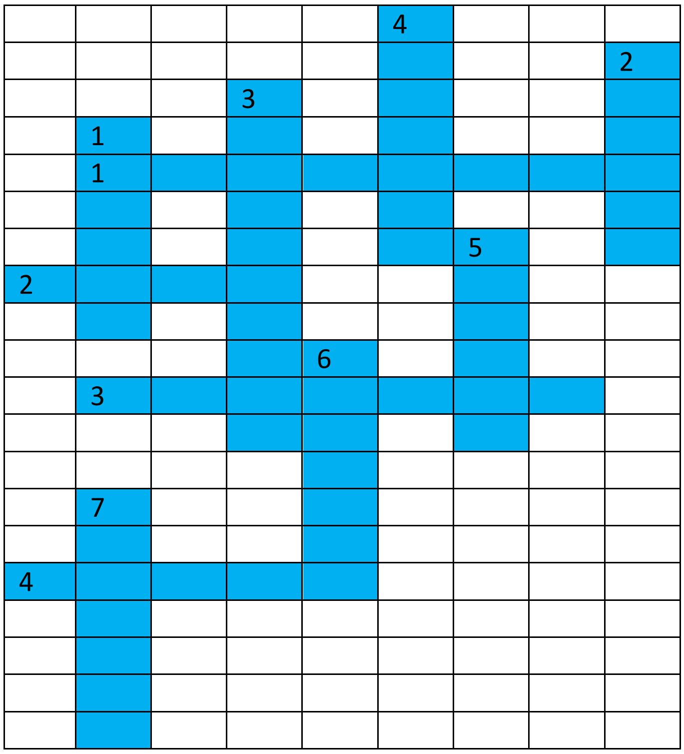
Vertically:
1. The physical property of matter that causes it to experience a force when placed in an electromagnetic field
2. The simplest figure to apply Ostrogradsky-Gauss theorem.
3. A process that occurs without transfer of heat or matter between a thermodynamic system and its surroundings.
4. Ratio of force applied over an area

5. Flow of electric charge
6. Bi-dimensional cristalline layer of carbon
7. The derived unit of electric potential

Horizontally:

1. A scientist well known for his cat paradox.
2. Space that is empty of matter.
3. The small, dense region that consists of protons and neutrons
4. The antimatter counterpart of the electron.
5. Measure of change of the variable over a single period.

Crossword № 4



Horizontally:

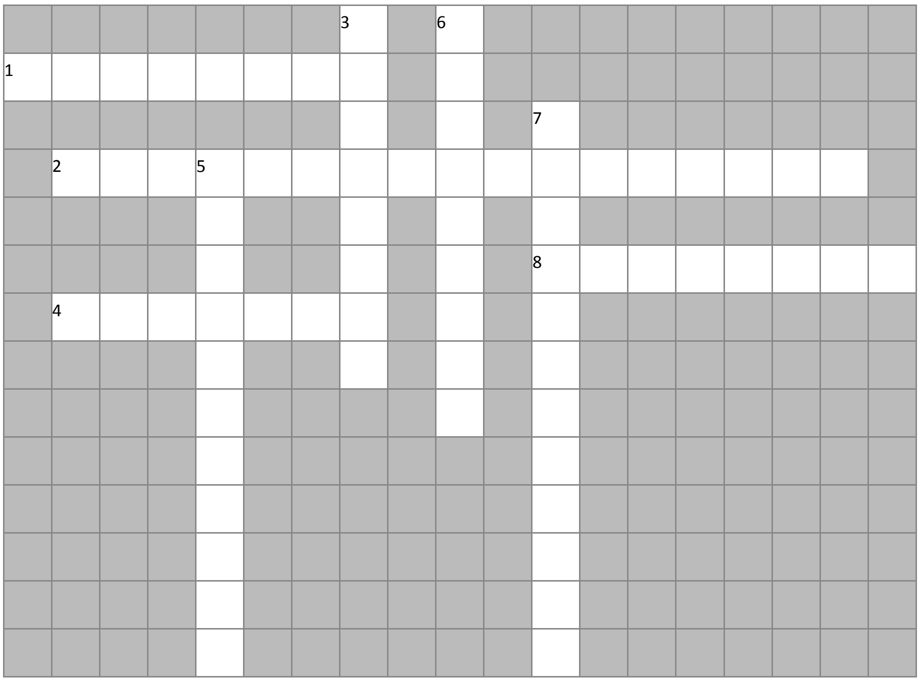
1. Who developed the theory of relativity?
2. Who developed the model of the atom, in which proposed that energy levels of electrons are discrete?
3. Who discovered the phenomena of electromagnetic induction?
4. Who developed the first law of thermodynamics?

Vertically:

1. Who laid the foundations of classical mechanics?
2. The founder of quantum theory.
3. The father of nuclear physics.
4. He is best known for his work in low-temperature physics.
5. Who made fundamental contributions to many areas of theoretical physics?
6. He restated and developed the nebular hypothesis of the origin of the Solar System.

7. Who discovered the electron?

Crossword № 5



Horizontally:

1)
Is all of space and
time. 2)
A phenomenon of
exactly zero
resistance. 4)
Electric ….
contains a
resistor, battery,
capacitor etc. 8)
A scientist who
invented the
theory of
relativity.

Vertically:

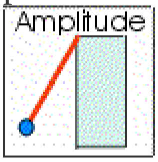
3) Characteristic of position change in time.
5) A field of physics connected with presence and motion of electric charge.
6) The material that can carry current through it.
7) A rate of change of velocity.

Glossary of Physics Terms

Absolute humidity (or Saturation value) The maximum amount of water vapor, which could be present in 1 m^3 of the air at any given temperature, is called absolute humidity.
Absolute magnitude A classification scheme, which compensates for the distance, differences to stars. It calculates the brightness that stars would appear to have if they were all at a defined, standard distance of 10 parsec
Absolute scale Temperature scale set so that zero is at the theoretical lowest temperature possible. This would occur when all random motion of molecules has ceased
Absolute zero The theoretical lowest temperature possible, which occurs when all random motion of molecules has ceased
Acceleration due to gravity The acceleration produced in a body due to the earth's attraction is called acceleration due to gravity. It is denoted by the letter g. Its SI unit is m/s^2. On the surface of the earth, its average value is $9.8 m/s^2$. The value of g on the surface of the earth increases in going towards the poles from the equator. The acceleration due to gravity of the earth decreases with altitude and with depth inside the earth. The value of g at the center of the earth is zero.
Acceleration The rate of change of velocity of a moving object is called its acceleration. The SI units of acceleration are m / s^2. By definition, this change in velocity can result from a change in speed, a change in direction, or a combination of changes in speed and direction
Adiabatic cooling The decrease in temperature of an expanding gas that involves no additional heat flowing out of the gas. It is the cooling from the energy lost by expansion
Adiabatic heating The increase in temperature of compressed gas that involves no additional heat flowing into the gas. It is heating from the energy gained by compression
Air mass A large, more or less uniform body of air with nearly the same temperature and moisture conditions throughout
Allotropic forms Elements that can have several different structures with different physical properties-for example, graphite and diamond are two allotropic forms of carbon
Alpha particle The nucleus of a helium atom (two protons and two neutrons) emitted as radiation from a decaying heavy nucleus; also known as an alpha ray
Alternating current An electric current that first moves one direction, then the opposite direction with a regular frequency
Amp Unit of electric current. It is equivalent to coulomb/sec.
Ampere Full name of the unit Amp

Amplitude (of waves) The maximum displacement of particles of the medium from their mean positions during the propagation of a wave is called the amplitude of the wave.

Amplitude (of an oscillation) The maximum displacement of a body from its mean position during an oscillatory motion is called the amplitude of oscillation.



Angle of incidence Angle of an incident (arriving) ray or particle to a surface; measured from a line perpendicular to the surface (the normal)

Angle of reflection Angle of a reflected ray or particle from a surface; measured from a line perpendicular to the surface (the normal)

Angular Acceleration The rate of change of angular velocity of a body moving along a circular path is called its angular acceleration. Angular acceleration is denoted by a.

Angular Displacement The angle described at the center of the circle by a moving body along a circular path is called angular displacement. It is measured in radians.

Angular Momentum Quantum Number From quantum mechanics model of the atom, one of four descriptions of the energy state of an electron wave. The quantum number describes the energy sublevels of electrons within the main energy levels of an atom

Angular Velocity The rate of change of angular displacement is called angular velocity.

Astronomical unit The radius of the earth's orbit is defined as one astronomical unit (A.U.)

Atom The smallest unit of an element that can exist alone or in combination with other elements

Atomic mass unit Relative mass unit (u) of an isotope based on the standard of the carbon-12 isotope, which is defined as a mass of exactly 12.00 u; one atomic mass unit (I u) is 1/12 the mass of a carbon-12 atom

Atomic number The number of protons in the nucleus of an atom

Atomic Weight Weighted average of the masses of stable isotopes of an element as they occur in nature, based on the abundance of each isotope of the element and the atomic mass of the isotope compared to carbon-12

Avogadro's Number The number of carbon-12 atoms in exactly 12.00 g of C that is 6.02 x 10^23 atoms or other chemical units. It is the number of chemical units in one mole of a substance

Axis The imaginary line about which a planet or other object rotates

Background Radiation Ionizing radiation (alpha, beta, gamma, etc.) from natural sources

Balanced Forces When a number of forces act on a body, and the resultant force is zero, then the forces are said to be resultant forces.

Balmer series A set of four line spectra, narrow lines of color emitted by hydrogen atom electrons as they drop from excited states to the ground state

Barometer An instrument that measures atmospheric pressure, used in weather forecasting and in determining elevation above sea level

Beat Rhythmic increases and decreases of volume from constructive and destructive interference between two sound waves of slightly different frequencies

Beta particle High-energy electron emitted as ionizing radiation from a decaying nucleus; also known as a beta ray

Big bang theory Current model of galactic evolution in which the universe was created from an intense and brilliant explosion from a primeval fireball

Binding energy The energy required to break a nucleus into its constituent protons and neutrons; also the energy equivalent released when a nucleus is formed

Black hole The theoretical remaining core of a supernova that is so dense that even light cannot escape

Blackbody radiation Electromagnetic radiation emitted by an ideal material (the blackbody) that perfectly absorbs and perfectly emits radiation

Bohr model Model of the structure of the atom that attempted to correct the deficiencies of the solar system model and account for the Balmer series

Boiling point The temperature at which a phase change of liquid to gas takes place through boiling. It is the same temperature as the condensation point

Boundary The division between two regions of differing physical properties

British thermal unit The amount of energy or heat needed to increase the temperature of one pound of water one degree Fahrenheit (abbreviated Btu)

Cathode rays Negatively charged particles (electrons) that are emitted from a negative terminal in an evacuated glass tube

Celsius scale of temperature In the celsius scale of temperature, the ice-point is taken as taken as the lower fixed point (0 deg C) and the steam-point is taken as the upper fixed point (100 deg C). The interval between the ice point and steam point is divided into 100 equal divisions. Thus, the unit division on this scale is 1degC. This scale was earlier called the centigrade scale. 1 deg C = 9/5 deg F.

Centigrade Alternate name for the Celsius scale

Centrifugal force An apparent outward force on an object following a circular path that. This force is a consequence of the third law of motion

Centripetal force The force required to pull an object out of its natural straight-line path and into a circular path; centripetal means

Chain reaction A self-sustaining reaction where some of the products are able to produce more reactions of the same kind; in a nuclear chain reaction neutrons are the products that produce more nuclear reactions in a self-sustaining series

Circular Motion The motion of a body along a circular path is called circular motion.

Coefficient of cubical expansion The increase in volume of a substance per unit original volume per degree rise in temperature is called its coefficient of cubical xpansion. The SI unit of coefficient of cubical expansion is K-1.

Coefficient of linear expansion The increase in length per unit original length per degree rise in temperature is called the coefficient of linear expansion. The SI unit of the coefficient of linear expansion is K-1.

Compression A part of a longitudinal wave in which the density of the particles of the medium is higher than the normal density is called a compression.
Compressive stress A force that tends to compress the surface as the earth's plates move into each other
Condensation (sound) A compression of gas molecules; a pulse of increased density and pressure that moves through the air at the speed of sound
Condensation (water vapor) Where more vapor or gas molecules are returning to the liquid state than are evaporating
Condensation nuclei Tiny particles such as tiny dust, smoke, soot, and salt crystals that are suspended in the air on which water condenses condensation point the temperature at which a gas or vapor changes back to a liquid
Condensation point the temperature at which a gas or vapor changes back to a liquid
Conduction The transfer of heat from a region of higher temperature to a region of lower temperature by increased kinetic energy moving from molecule to molecule
Constructive interference The condition in which two waves arriving at the same place, at the same time and in phase, add amplitudes to create a new wave
Control rods Rods inserted between fuel rods in a nuclear reactor to absorb neutrons and thus control the rate of the nuclear chain reaction
Convection Transfer of heat from a region of higher temperature to a region of lower temperature by the displacement of high-energy molecules-for example, the displacement of warmer, less dense air (higher kinetic energy) by cooler, denser air (lower kinetic energy)
Conventional current Opposite to electron current-that is, considers an electric current to consist of a drift of positive charges that flow from the positive terminal to the negative terminal of a battery
Coulomb Unit used to measure quantity of electric charge; equivalent to the charge resulting from the transfer of 6.24 billion particles such as the electron
Coulomb's law Relationship between charge, distance, and magnitude of the electrical force between two bodies
Covalent bond A chemical bond formed by the sharing of a pair of electrons
Covalent compound Chemical compound held together by a covalent bond or bonds
Crest The point of maximum positive displacement on a transverse wave is called a crest.
Critical angle Limit to the angle of incidence when all light rays are reflected internally
Critical mass Mass of fissionable material needed to sustain a chain reaction
Curvilinear Motion The motion of a body along a curved path is called curvilinear motion.
Cycle A complete vibration
De-acceleration See retardation
Decibel scale A nonlinear scale of loudness based on the ratio of the intensity level of a sound to the intensity at the threshold of hearing

Destructive interference The condition in which two waves arriving at the same point at the same time out of phase add amplitudes to create zero total disturbance. (also see constructive interference
Dew point temperature The temperature at which condensation begins
Dew Condensation of water vapor into droplets of liquid on surfaces
Diffraction The bending of light around the edge of an opaque object
Diffuse reflection Light rays reflected in many random directions, as opposed to the parallel rays reflected from a perfectly smooth surface such as a mirror
Direct current An electrical current that always moves in one direction
Direct proportion When two variables increase or decrease together in the same ratio (at the same rate)
Dispersion The effect of spreading colors of light into a spectrum with a material that has an index of refraction that varies with wavelength
Displacement The change in the position of an object in a particular direction is called displacement. Displacement may also be defined as the shortest distance between the initial and final position of a moving body. It is a vector quantity.
Distance The actual length of the path traveled by a body irrespective of the direction is called the distance traveled. It is a scalar quantity.
Doppler effect An apparent shift in the frequency of sound or light due to relative motion between the source of the sound or light and the observer
Echo A reflected sound that can be distinguished from the original sound, which usually arrives 0.1 sec or more after the original sound
Elastic strain An adjustment to stress in which materials recover their original shape after a stress is released
Electric circuit Consists of a voltage source that maintains an electrical potential, a continuous conducting path for a current to follow, and a device where work is done by the electrical potential; a switch in the circuit is used to complete or interrupt the conducting path
Electric current The flow of electric charge electric field force field produced by an electrical charge
Electric field lines A map of an electric field representing the direction of the force that a test charge would experience; the direction of an electric field shown by lines of force
Electric generator A mechanical device that uses wire loops rotating in a magnetic field to produce electromagnetic induction in order to generate electricity
Electric potential energy Potential energy due to the position of a charge near other charges
Electrical conductors Materials that have electrons that are free to move throughout the material; for example, metals
Electrical energy A form of energy from electromagnetic interactions; one of five forms of energy-mechanical, chemical, radiant, electrical, and nuclear
Electrical force A fundamental force that results from the interaction of electrical charge and is billions and billions of times stronger than the gravitational force; sometimes called the

Electrical insulators Electrical nonconductors, or materials that obstruct the flow of electric current

Electrical nonconductors Materials that have electrons that are not moved easily within the material-for example, rubber; electrical nonconductors are also called electrical insulators

Electrical resistance The property of opposing or reducing electric current

Electrolyte Water solution of ionic substances that conducts an electric current

Electromagnet A magnet formed by a solenoid that can be turned on and off by turning the current on and off

Electromagnetic force One of four fundamental forces; the force of attraction or repulsion between two charged particles

Electromagnetic induction Process in which current is induced by moving a loop of wire in a magnetic field or by changing the magnetic field

Electromagnetic waves The waves which are due to oscillating electrical and magnetic fields and do not need any material medium for their propagation are called electromagnetic waves. These waves can, however, travel through material medium also. Light waves, radio waves are examples of electromagnetic waves. All electromagnetic waves travel in vacuum with a speed of 3×10 8 m/s.

Electron configuration The arrangement of electrons in orbits and sub-orbits about the nucleus of an atom

Electron current Opposite to conventional current; that is, considers electric current to consist of a drift of negative charges that flows from the negative terminal to the positive terminal of a battery

Electron pair A pair of electrons with different spin quantum numbers that may occupy an orbital

Electron volt The energy gained by an electron moving across a potential difference of one volt; equivalent to 1.60 x 10^-19 Joules

Electron Subatomic particle that has the smallest negative charge possible and usually found in an orbital of an atom, but gained or lost when atoms become ions

Electronegativity The comparative ability of atoms of an element to attract bonding electrons

Electrostatic charge An accumulated electric charge on an object from a surplus or deficiency of electrons; also called

Element A pure chemical substance that cannot be broken down into anything simpler by chemical or physical means; there are over 100 known elements, the fundamental materials of which all matter is made

Energy The capacity of a body to do work is called its energy. Energy is a scalar quantity. The SI unit of energy is Joule.

Escape Velocity The minimum velocity with which an object must be thrown upwards so as to overcome the gravitational pull and escape into space, is called escape velocity (V esc). The escape velocity depends upon the mass and radius of the planet/star. It does not depend upon the mass of the body thrown up. The escape velocity of earth is given by.

Evaporation Process of more molecules leaving a liquid for the gaseous state than returning from the gas to the liquid. It can occur at any given temperature from the surface of a liquid. Evaporation takes place only from the surface of the liquid. Evaporation causes cooling. Evaporation is faster if the surface of the liquid is large, the temperature is higher and the surrounding atmosphere does not contain a large amount of vapor of the liquid.

Fahrenheit scale of temperature On the Fahrenheit scale, the ice point, the ice point (lower fixed point) is taken as 32? F and the steam point (upper fixed point) is taken as 212 deg F. The interval between these two points is divided into 180 equal divisions. Thus, unit division on the Fahrenheit scale is 1deg F. The temperatures on the Celsius scale and the Fahrenheit scale are related by the relationship, C/100 = (F - 32) / 180. The temperature of a normal healthy person is 37 deg C or 98.6 deg F.

First law of motion Every object remains at rest or in a state of uniform straight-line motion unless acted on by an unbalanced force

Fluids Matter that has the ability to flow or be poured; the individual molecules of a fluid are able to move, rolling over or by one another

Force Force is a push or pull which tends to change the state of rest or of uniform motion , the direction of motion, or the shape and size of a body. Force is a vector quantity. The SI unit of force is Newton, denoted by N. One N is the force which when acts on a body of mass 1 kg produces an acceleration of 1 m/s^2.

Force of gravitation The force with which two objects attract each other by virtue of their masses is called the force of gravitation. The force of attraction acts even if the two objects are not connected to each other. It is an action-at-a-distance force.

Fracture strain An adjustment to stress in which materials crack or break as a result of the stress

Free fall The motion of a body towards the earth when no other force except the force of gravity acts on it is called free fall. All freely falling bodies are weightless.

Freezing point The temperature at which a phase change of liquid to solid takes place; the same temperature as the melting point for a given substance

Frequency (of waves) The number of waves produced per second is called its frequency.

Frequency (of oscillations) The number of oscillations made by an oscillating body per second is called the frequency.

Friction The force that resists the motion of one surface relative to another with which it is in contact. The cause of friction is that surfaces, however smooth they may look to the eye, on the microscopic scale have many humps and crests. Thus the actual area of contact is very small indeed, and the consequent very high pressure leads to local pressure welding of the surface. In motion the welds are broken and remade continually.

Fuel rod Long zirconium alloy tubes containing fissionable material for use in a nuclear reactor

Fundamental charge Smallest common charge known; the magnitude of the charge of an electron and a proton, which is 1.60 x 10^-19 coulomb

Fundamental frequency The lowest frequency (longest wavelength) that can set up standing waves in an air column or on a string

Fundamental properties A property that cannot be defined in simpler terms other than to describe how it is measured; the fundamental properties are length, mass, time, and charge

g Symbol representing the acceleration of an object in free fall due to the force of gravity; its magnitude is 9.80 m/sec^2 (32.0 ft/sec^2)

Gamma ray Very short wavelength electromagnetic radiation emitted by decaying nuclei

Gases A phase of matter composed of molecules that are relatively far apart moving freely in a constant, random motion and have weak cohesive forces acting between them, resulting in the characteristic indefinite shape and indefinite volume of a gas

Gram-atomic weight The mass in grams of one mole of an element that is numerically equal to its atomic weight

Gram-formula weight The mass in grams of one mole of a compound that is numerically equal to its formula weight

Gram-molecular weight The gram-formula weight of a molecular compound

Gravitational constant G The constant G which appears in the equation for Newton's law of gravitation is called the universal constant of gravitation or the gravitational constant. Numerically it is equal to the force of gravitation, which acts between two bodies of mass 1kg each separated by a distance of 1m. The value of G is 6.67×10-11 Nm^2/kg^2.

Gravitational potential energy = mgh

Greenhouse effect The process of increasing the temperature of the lower parts of the atmosphere through redirecting energy back toward the surface; the absorption and reemission of infrared radiation by carbon dioxide, water vapor, and a few other gases in the atmosphere

Ground state Energy state of an atom with electrons at the lowest energy state possible for that atom

Half-life The time required for one-half of the unstable nuclei in a radioactive substance to decay into a new element

Heat Heat is a form of energy, which makes a body hot or cold. Heat is measured by the temperature-effect it produces in any material body. The SI unit of heat is Joule(J).

Heisenberg uncertainty principle You cannot measure both the exact momentum and the exact position of a subatomic particle at the same time-when the more exact of the two is known, the less certain you are of the value of the other

Hertz Unit of frequency; equivalent to one cycle per second

Horsepower Measurement of power defined as a power rating of 550 ft-lb/sec

Hypothesis A tentative explanation of a phenomenon that is compatible with the data and provides a framework for understanding and describing that phenomenon

Impulse The impulse acting on a body is equal to the product of the force acting on the body and the time for which it acts. If the force is variable, the impulse is the integral of Fdt from t0 to t1. The impulse of a force acting for a given time interval is equal to change in momentum produced over that interval. J=m(v-u), assuming that the mass m remains constant while the velocity changes from v to u. The SI units of impulse are kg m/s.

Impulsive force The force which acts on a body for a very short time but produces a large change in the momentum of the body is called an impulsive force.

Incandescent Matter emitting visible light as a result of high temperature for example, a light bulb, a flame from any burning source, and the sun are all incandescent sources because of high temperature

Incident ray Line representing the direction of motion of incoming light approaching a boundary

Index of refraction The ratio of the speed of light in a vacuum to the speed of light in a material

Inertia The property of matter that causes it to resist any change in its state of rest or of uniform motion. There are three kinds of inertia- inertia of rest, inertia of motion and inertia of direction. The mass of a body is a measure of its inertia.

Infrasonic Sound waves having too low a frequency to be heard by the human ear; sound having a frequency of less than 20 Hz

Insulators Materials that are poor conductors of heat-for example, heat flows slowly through materials with air pockets because the molecules making up air are far apart; also, materials that are poor conductors of electricity, for example, glass or wood

Intensity A measure of the energy carried by a wave

Interference Phenomenon of light where the relative phase difference between two light waves produces light or dark spots, a result of light's wavelike nature

Intermolecular forces Forces of interaction between molecules

Internal energy Sum of all the potential energy and all the kinetic energy of all the molecules of an object

Inverse proportion The relationship in which the value of one variable increases while the value of the second variable decreases at the same rate (in the same ratio)

Ionization Process of forming ions from molecules

Ionized An atom or a particle that has a net charge because it has gained or lost electrons

Isostasy A balance or equilibrium between adjacent blocks of crust

Isotope Atoms of an element with identical chemical properties but with different masses; isotopes are atoms of the same element with different numbers of neutrons

Joule Metric unit used to measure work and energy; can also be used to measure heat; equivalent to newton-meter

Kelvin scale of temperature On this scale, the ice-point (the lower fixed point) is taken as 273.15K and the (the upper fixed point) is taken as 373.15K. The interval between these two points is divided into 100 equal parts. Each division is equal to 1K.

Kepler's first law Relationship in planetary motion that each planet moves in an elliptical orbit, with the sun located at one focus

Kepler's laws of planetary motion The three laws describing the motion of the planets

Kepler's second law Relationship in planetary motion that an imaginary line between the sun and a planet moves over equal areas of the ellipse during equal time intervals

Kepler's third law Relationship in planetary motion that the square of the period of an orbit is directly proportional to the cube of the radius of the major axis of the orbit

Kilocalorie The amount of energy required to increase the temperature of one kilogram of water one degree Celsius: equivalent to 1,000 calories

Kilogram The fundamental unit of mass in the metric system of measurement

Kinetic Energy Energy possessed by a body by the virtue of its motion is called kinetic energy. Kinetic energy = 1/2 m v^2

Latent heat of evaporization The heat absorbed when one gram of a substance changes from the liquid phase to the gaseous phase, or the heat released when one gram of gas changes from the gaseous phase to the liquid phase

Latent heat of fusion The quantity of heat required to convert one unit mass of a substance from solid to the liquid state at its melting point (without any change in its temperature) is called its latent heat of fusion (L). The SI unit of latent heat of fusion is J kg-1.

Latent heat Refers to the heat hidden in phase changes

Law of Conservation of Energy The change of one form of energy into another is called transformation of energy. For example, when a body falls its potential energy is converted to kinetic energy.

Law of conservation of mass Same as law of conservation of matter; mass, including single atoms, is neither created nor destroyed in a chemical reaction

Law of conservation of matter Matter is neither created nor destroyed in a chemical reaction

Law of conservation of momentum The total momentum of a group of interacting objects remains constant in the absence of external forces

Light-year The distance that light travels through empty space in one year, approximately 9.5 x 10^11 km

Line spectrum Narrow lines of color in an otherwise dark spectrum; these lines can be used as

Lines of force Lines drawn to make an electric field strength map, with each line originating on a positive charge and ending on a negative charge; each line represents a path on which a charge would experience a constant force and lines closer together mean a stronger electric field

Liquids A phase of matter composed of molecules that have interactions stronger than those found in a gas but not strong enough to keep the molecules near the equilibrium positions of a solid, resulting in the characteristic definite volume but indefinite shape of a liquid

Liter A metric system unit of volume, usually used for liquids

Longitudinal waves The wave in which the particles of the medium oscillate along the direction along the direction of propagation of wave is called the longitudinal wave. Sound waves are longitudinal waves.

Loudness A subjective interpretation of a sound that is related to the energy of the vibrating source, related to the condition of the transmitting medium, and related to the distance involved
Luminosity The total amount of energy radiated into space each second from the surface of a star
Luminous An object or objects that produce visible light; for example, the sun, stars, light bulbs, and burning materials are all luminous
Magnetic domain Tiny physical regions in permanent magnets, approximately 0.01 to 1 mm, that have magnetically aligned atoms, giving the domain an overall polarity
Magnetic field Model used to describe how magnetic forces on moving charges act at a distance
Magnetic poles The ends, or sides, of a magnet about which the force of magnetic attraction seems to be concentrated
Magnetic quantum number From quantum mechanics model of the atom, one of four descriptions of the energy state of an electron wave; this quantum number describes the energy of an electron orbital as the orbital is oriented in space by an external magnetic field, a kind of energy sub-sublevel
Magnetic reversal The flipping of polarity of the earth's magnetic field as the north magnetic pole and the south magnetic pole exchange positions
Magnitude The size of a measurement of a vector; scalar quantities that consist of a number and unit only, no direction, for example
Mass defect The difference between the sum of the masses of the individual nucleons forming a nucleus and the actual mass of that nucleus
Mass number The sum of the number of protons and neutrons in a nucleus defines the mass number of an atom; used to identify isotopes; for example, Uranium 238
Mass The quantity of matter contained in a body is called its mass. The SI unit of mass is kg. The mass of a body remains the same everywhere. It is a measure of inertia, which means a resistance to a change of motion
Matter Anything that occupies space and has mass
Mechanical energy The form of energy associated with machines, objects in motion, and objects having potential energy that results from gravity
Mechanical wave The waves, which need a material medium for their propagation, are called mechanical waves. Mechanical waves are also called elastic waves. Sound waves, water waves are examples of mechanical waves.
Melting point The temperature at which a phase change of solid to liquid takes place; the same temperature as the freezing point for a given substance
Metal Matter having the physical properties of conductivity, malleability, ductility, and luster
Meter The fundamental metric unit of length
Millibar A measure of atmospheric pressure equivalent to 1.000 dynes per cm ^2
Miscible fluids Fluids that can mix in any proportion
Mixture Matter made of unlike parts that have a variable composition and can be separated into their component parts by physical means

Model A mental or physical representation of something that cannot be observed directly that is usually used as an aid to understanding

Mole An amount of a substance that contains Avogadro's number of atoms, ions, molecules, or any other chemical unit; a mole is thus 6.02 x 10^23 atoms, ions, or other chemical units

Momentum Momentum is considered to be a measure of the quantity of motion in a body. The momentum of a body is defined as the product of its mass and velocity. Its SI units are kg m /s.

Natural frequency The frequency of vibration of an elastic object that depends on the size, composition, and shape of the object

Negative electric charge One of the two types of electric charge; repels other negative charges and attracts positive charges

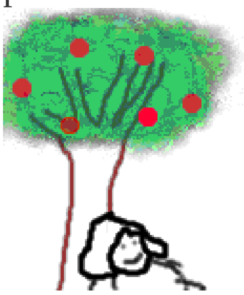
Negative ion Atom or particle that has a surplus, or imbalance, of electrons and, thus, a negative charge

Net force The resulting force after all vector forces have been added; if a net force is zero, all the forces have canceled each other and there is not an unbalanced force

Newton A unit of force defined as kg.m/sec^2; that is, a 1 Newton force is needed to accelerate a 1 kg mass 1 m/sec^2

Newton's first law of motion A body continues in a state of rest or of uniform motion in a straight line unless it is acted upon by an external (unbalanced) force.

Newton's law of gravitation The gravitational force of attraction acting between any two particles is directly proportional to the product of their masses, and inversely proportional to the square of the distance between them. The force of attraction acts along the line joining the two particles. Real bodies having spherical symmetry act as point masses with their mass assumed to be concentrated at their center of mass.



Newton's second law of motion The rate of change of momentum is equal to the force applied OR the force acting on a body is directly proportional to the product of its mass and acceleration produced by the force in the body.

Newton's third law of motion To every action there is an equal and opposite reaction. The action and reaction act on two different bodies simultaneously.

Noise Sounds made up of groups of waves of random frequency and intensity

Non Uniform Acceleration When the velocity of a body increases by unequal amounts in equal intervals of time, it is said to have non-uniform acceleration.

Non Uniform Speed When a body travels unequal distances in equal intervals of time then it is said to have non-uniform speed.

Non Uniform Velocity When a body covers unequal distances in equal intervals of time in a particular direction, or when it covers equal distances in equal intervals but changes it's direction it is said to have non uniform velocity.

Normal A line perpendicular to the surface of a boundary
Nuclear energy The form of energy from reactions involving the nucleus, the innermost part of an atom
Nuclear fission Nuclear reaction of splitting a massive nucleus into more stable, less massive nuclei with an accompanying release of energy
Nuclear force One of four fundamental forces, a strong force of attraction that operates over very short distances between subatomic particles; this force overcomes the electric repulsion of protons in a nucleus and binds the nucleus together
Nuclear fusion Nuclear reaction of low mass nuclei fusing together to form more stable and more massive nuclei with an accompanying release of energy
Nuclear reactor Steel vessel in which a controlled chain reaction of fissionable materials releases energy
Nucleons Name used to refer to both the protons and neutrons in the nucleus of an atom
Nucleus Tiny, relatively massive and positively charged center of an atom containing protons and neutrons; the small, dense center of an atom numerical constant a constant without units; a number
Ohm Unit of resistance; equivalent to volts/amps
Ohm's law The electric potential difference is directly proportional to the product of the current times the resistance
Orbital The region of space around the nucleus of an atom where an electron is likely to be found
Origin The only point on a graph where both the x and y variables have a value of zero at the same time
Oscillatory motion The to and fro motion of a body about its mean position is called oscillatory motion. Oscillatory motion is also called vibratory motion. Oscillatory motion is periodic in nature.
Pauli exclusion principle No two electrons in an atom can have the same four quantum numbers; thus, a maximum of two electrons can occupy a given orbital
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Period (wave): The time required for one complete cycle of a wave
Periodic wave A wave in which the particles of the medium oscillate continuously about their mean positions regularly at fixed intervals of time is called a periodic wave.
Permeability The ability to transmit fluids through openings, small passageways, or gaps

Phase change The action of a substance changing from one state of matter to another; a phase change always absorbs or releases internal potential energy that is not associated with a temperature change

Phase The particles in a wave, which are in the same state of vibration, i.e. the same position and the same direction of motion are said to be in the same phase.

Phases of matter The different physical forms that matter can take as a result of different molecular arrangements, resulting in characteristics of the common phases of a solid, liquid, or gas

Photoelectric effect The movement of electrons in some materials as a result of energy acquired from absorbed light

Photons A quanta of energy in light wave; the particle associated with light

Physical change A change of the state of a substance but not the identity of the substance pitch the frequency of a sound wave

Planck's constant Proportionality constant in the relationship between the energy of vibrating molecules and their frequency of vibration; a value of 6.63 x 10^-34 joule-sec

Plasma A phase of matter; a very hot gas consisting of electrons and atoms that have been stripped of their electrons because of high kinetic energies

Plastic strain An adjustment to stress in which materials become molded or bent out of shape under stress and do not return to their original shape after the stress is released

Polaroid A film that transmits only polarized light

Positive electric charge One of the two types of electric charge; repels other positive charges and attracts negative charges

Positive ion Atom or particle that has a net positive charge due to an electron or electrons being torn away

Potential Energy Energy possessed by a body by the virtue of its position or configuration is called potential energy. There are two types of potential energies, gravitational and elastic. The potential energy of a body by virtue of its height from the ground is called its gravitational potential energy. The potential energy of a body by virtue of its configuration (shape) is called its elastic potential energy.

Power The rate of doing work is called power. Power is a scalar quantity. The SI unit of power is Watt (1 W = 1 J/sec)

Pressure Defined as force per unit area; for example, pounds per square inch (lb/in^2)

Primary coil Part of a transformer; a coil of wire that is connected to a source of alternating current

Principle of calorimetry If no heat is lost to the surroundings and there is no change of state also, then,

Principle quantum number From quantum mechanics model of the atom, one of four descriptions of the energy state of an electron wave; this quantum number describes the main energy level of an electron in terms of its most probable distance from the nucleus

Projectile An object thrown into space either horizontally or at an acute angle and under the action of gravity is called a projectile. The path followed by a projectile is called its trajectory. The horizontal distance traveled by a projectile is called its range. The time taken by a projectile from the moment it is thrown until it touches the ground is called its time of flight.

Proof A measure of ethanol concentration of an alcoholic beverage; proof is double the concentration by volume; for example, 50 percent by volume is 100 proof.

Properties Qualities or attributes that, taken together, are usually unique to an object; for example, color, texture, and size

Proportionality constant A constant applied to a proportionality statement that transforms the statement into an equation

Pulse A wave of short duration confined to a small portion of the medium at any given time is called a pulse. A pulse is also called a wave pulse.

Quanta Fixed amounts; usually referring to fixed amounts of energy absorbed or emitted by matter

Quantum mechanics Model of the atom based on the wave nature of subatomic particles, the mechanics of electron waves; also called wave mechanics

Quantum numbers Numbers that describe energy states of an electron; in the Bohr model of the atom, the orbit quantum numbers could be any whole number 1, 2, 3, and so on out from the nucleus; in the quantum mechanics model of the atom, four quantum numbers are used to describe the energy state of an electron wave

Rad A measure of radiation received by a material (radiation absorbed dose)

Radiant energy The form of energy that can travel through space; for example, visible light and other parts of the electromagnetic spectrum

Radiation The transfer of heat from a region of higher temperature to a region of lower temperature by greater emission of radiant energy from the region of higher temperature

Radioactive decay constant A specific constant for a particular isotope that is the ratio of the rate of nuclear disintegration per unit of time to the total number of radioactive nuclei

Radioactive decay series Series of decay reactions that begins with one radioactive nucleus that decays to a second nucleus that decays to a third nucleus and so on until a stable nucleus is reached

Radioactive decay The natural spontaneous disintegration or decomposition of a nucleus

Radioactivity Spontaneous emission of particles or energy from an atomic nucleus as it disintegrates

Rarefaction A part of a longitudinal wave in which the density of the particles of the medium is less than the normal density is called a rarefaction.

Real image An image generated by a lens or mirror that can be projected onto a screen

Rectilinear Motion The motion of a body in a straight line is called rectilinear motion.

Reflected ray A line representing direction of motion of light reflected from a boundary

Reflection The change when light, sound, or other waves bounce backwards off a boundary

Refraction A change in the direction of travel of light, sound, or other waves crossing a boundary

Relative humidity = (m/ms) x 100 where m is the actual mass of water vapor present in certain volume of the air and ms is the mass of water vapor required to saturate the same volume of the air at the same temperature.

Relative humidity The percentage of the amount of water vapor actually present in a certain volume of the air to the amount of water vapor needed to saturate it is called the relative humidity of the air.

Resonance When the frequency of an external force matches the natural frequency and standing waves are set up

Restoring force The force which tends to bring an oscillating body towards its mean position whenever it is displaced from the mean position is called the restoring force.

Resultant Force A single force, which acts on a body to produce the same effect in it as, done by all other forces collectively, is called the resultant force.

Retardation Negative acceleration is called retardation. In retardation the velocity of a body decreases with time.

Reverberation Apparent increase in volume caused by reflections, usually arriving within 0.1 second after the original sound

Saturated air Air in which equilibrium exists between evaporation and condensation; the relative humidity is 100 percent

Saturated solution The apparent limit to dissolving a given solid in a specified amount of water at a given temperature; a state of equilibrium that exists between dissolving solute and solute coming out of solution

Scalar Quantity A physical quantity, which is described completely by its magnitude, is called a scalar quantity.

Scientific law A relationship between quantities, usually described by an equation in the physical sciences; is more important and describes a wider range of phenomena than a scientific principle

Scientific principle A relationship between quantities concerned with a specific, or narrow range of observations and behavior

Second law of motion The acceleration of an object is directly proportional to the net force acting on that object and inversely proportional to the mass of the object

Second The standard unit of time in both the metric and English systems of measurement

Secondary coil Part of a transformer, a coil of wire in which the voltage of the original alternating current in the primary coil is stepped up or down by way of electromagnetic induction

Second's Pendulum A simple pendulum whose time period on the surface of earth is 2 seconds is called the second's pendulum.

Semiconductors Elements that have properties between those of a metal and those of a nonmetal sometimes conducting an electric current and sometimes acting like an electrical insulator depending on the conditions and their purity; also called metalloids

Shear stress Produced when two plates slide past one another or by one plate sliding past another plate that is not moving

Simple harmonic motion The vibratory motion that occurs when there is a restoring force opposite to and proportional to a displacement

Simple Pendulum A heavy point mass (actually a small metallic ball), suspended by a light inextensible string from a frictionless rigid support is called a simple pendulum. A simple pendulum is a simple machine based on the effect of gravity.

Solenoid A cylindrical coil of wire that becomes electromagnetic when a current runs through it

Solids A phase of matter with molecules that remain close to fixed equilibrium positions due to strong interactions between the molecules, resulting in the characteristic definite shape and definite volume of a solid

Sonic boom Sound waves that pile up into a shock wave when a source is traveling at or faster than the speed of sound

Specific heat Each substance has its own specific heat, which is defined as the amount of energy (or heat) needed to increase the temperature of one gram of a substance one degree Celsius

Speed The distance traveled by a body in one unit of time is called its speed. If a body covers distance s in time t then it's speed is given by s / t. It is a scalar quantity and it's SI unit's are m / s.

Spin quantum number From quantum mechanics model of the atom, one of four descriptions of the energy state of an electron wave; this quantum number describes the spin orientation of an electron relative to an external magnetic field

Standing waves Condition where two waves of equal frequency traveling in opposite directions meet and form stationary regions of maximum displacement due to constructive interference and stationary regions of zero displacement due to destructive interference

State of Motion When a body changes it's position with respect to a fixed point in it's surroundings then it is said to be in a state of motion. The states of rest and motion are relative to the frame of reference.

State of Rest When a body does not change its position with respect to a fixed point in it's surrounding, then it is said to be in a state of rest. The states of rest and motion are relative to the frame of reference.

Steam-point It is the temperature of steam over pure boiling water under 1 atm pressure. The steam point is taken as the upper fixed point (100 deg C or 212 deg F) for temperature scales.

Superconductors Some materials in which, under certain conditions, the electrical resistance approaches zero

Super-cooled Water in the liquid phase when the temperature is below the freezing point

Supersaturated Containing more than the normal saturation amount of a solute at a given temperature

Temperature It is a numerical measure of hotness or coldness of a body. According to the molecular model, it is a measure of the average kinetic energy of the molecules of the body. Heat flows from a body at higher temperature to a body at lower temperature.

Tensional stress The opposite of compressional stress; occurs when one part of a plate moves away from another part that does not move

Thermal Capacity The quantity of heat required to raise the temperature of the whole body by one degree (1K or 1deg C) is called its thermal capacity.

Thermal Equilibrium When the two bodies in contact are at the same temperature and there is no flow of heat between them, these are said to be in thermal equilibrium. The common temperature of the bodies in thermal equilibrium is called the equilibrium temperature.

Thermal Expansion The increase in the size of an object on heating is called thermal expansion.

Thermometer It is a device used for numerical measurement of temperature. The commonly used thermometer is mercury thermometer.

Third law of motion Whenever two objects interact, the force exerted on one object is equal in size and opposite in direction to the force exerted on the other object; forces always occur in matched pairs that are equal and opposite

Time Period (of a wave) The time taken by a wave to travel through a distance equal to its wavelength is called its time period. It is denoted by T. Time period of a wave=1/frequency of the wave.

Time Period (of an oscillation) The time taken to complete one oscillation is called the time period of an oscillation. The time period of a pendulum does not depend upon the mass of the bob and amplitude of oscillation. The time period of a pendulum is directly proportional to the square root of the length and inversely proportional to the square root of the acceleration due to gravity.

Total internal reflection Condition where all light is reflected back from a boundary between materials; occurs when light arrives at a boundary at the critical angle or beyond

Transverse waves A wave in which the particles of the medium oscillate in a direction perpendicular of the direction of propagation of wave is called the transverse wave. Water waves, light waves and radio waves are examples of transverse waves.

Trough The point of maximum negative displacement on a transverse wave is called a trough.

Ultrasonic Sound waves too high in frequency to be heard by the human ear; frequencies above 20,000Hz

Unbalanced forces When a number of forces act on a body and the resultant force is not zero, then the forces are said to be unbalanced.

Uniform Acceleration When the velocity of a body increases by equal amounts in equal intervals of time it is said to have uniform acceleration.

Uniform Circular Motion The motion of an object in a circular path with uniform speed is called uniform circular motion. Uniform circular motion is accelerated motion.
Uniform Speed When a body travels equal distances in equal intervals of time then it is said to have uniform speed.
Uniform Velocity When a body travels along a straight line in particular direction and covers equal distances in equal intervals of time it is said to have uniform velocity.
Universal law of gravitation Every object in the universe is attracted to every other object with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between the centers of the two masses
Unpolarized light Light consisting of transverse waves vibrating in all conceivable random directions
Van der Wall's force General term for weak attractive intermolecular forces
Vapor The gaseous state of a substance that is normally in the liquid state
Vector Quantity A quantity, which needs both magnitude and direction to describe it, is called a vector quantity. Such a physical quantity should also follow the vector law of addition.
Velocity Distance traveled by a body in a particular direction per unit time is called its velocity. It can also be defined as the displacement of the body per unit time. It is a vector quantity. The SI units of velocity are m / s.
Vibration A back and forth motion that repeats itself
Virtual image An image where light rays appear to originate from a mirror or lens; this image cannot be projected on a screen
Volt Unit of potential difference equivalent to joules/coulomb
Voltage drop The electric potential difference across a resistor or other part of a circuit that consumes power
Watt Metric unit for power; equivalent to joule/sec
Wave mechanics Alternate name for quantum mechanics derived from the wavelike properties of subatomic particles
Wave motion The movement of a disturbance produced in one part of a medium to another involving the transfer of energy but not the transfer of matter is called wave motion.
Wave period The time required for two successive crests or other successive parts of the wave to pass a given point
Wave velocity The distance traveled by a wave in one second is called the wave velocity. The wave velocity of a wave depends upon the nature of the medium through which it passes.
Wave (mechanical) A periodic disturbance produced in a material medium due to the vibratory motion of the particles of the medium is called a wave.
Wave A disturbance or oscillation that moves through a medium
Wavelength The distance between the two nearest points on a wave, which are in the same phase, is called the wavelength of the wave. The distance between two adjacent crests or two adjacent troughs is called its wavelength.

Weight The force with which a body is attracted towards the center of the earth is called its weight. The SI unit of weight is N. The gravitational units of weight are kg-wt and g-wt. The weight of a body of mass m is given by mg. Its value will depend upon the value of g at that place. The weight of a body is measured with a spring balance.

Weightlessness The state when the apparent weight of a body becomes zero is called the state of weightlessness. All objects while falling freely under the action of gravity appear weightless.

Work = Force x Displacement in the direction of the force

Work Work is done when a force acting on a body displaces it. Work is a scalar quantity. The SI unit for work is Joule.

http://www.tutor4physics.com/glossary.htm

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