КАЗАНСКИЙ (ПРИВОЛЖСКИЙ) ФЕДЕРАЛЬНЫЙ УНИВЕРСИТЕТ
ИНСТИТУТ МЕЖДУНАРОДНЫХ ОТНОШЕНИЙ,
ИСТОРИИ И ВОСТОКОВЕДЕНИЯ
Кафедра английского языка в сфере высоких технологий

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ENGLISH FOR PHYSICISTS

Учебное пособие

Казань-2016

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English for Physicists: Учебное пособие / М.Н. Сайфуллина, Н.М. Хабирова. – Казань: Казанский университет, 2016. – 109 с.

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Данное пособие предназначено для студентов первых и вторых курсов направления «Физика» Казанского Федерального Университета для занятия на уроках английского языка. Учебное пособие состоит из четырех разделов. Каждый подраздел учебного пособия включает в себя небольшой познавательный текст на английском языке, лексику по специальности, задания на закрепление лексических и грамматических навыков и развитие навыков говорения. В учебном пособии моделируются ситуации на английском языке, которые в будущем помогут студентам общаться на английском языке на профессиональные темы.

Принято на заседании кафедры английского языка

в сфере высоких технологий

Протокол № 8 от 21.03.2016

Предисловие

Настоящее пособие предназначено для занятий со студентами первых и вторых курсов физического факультета Казанского (Приволжского) федерального университета, по специальности «Физика – 03.03.02». Пособие разработано с учетом требований государственного стандарта высшего профессионального образования и предназначено для студентов, продолжающих изучение английского языка на базе программы средней школы.

Целью настоящего пособия является углубление и расширение словарного запаса, приобретение учащимися навыков правильного понимания и перевода оригинального текста (научной неадаптированной литературы) по специальности.

Учебное пособие состоит из четырех основных разделов (разделенных на несколько подразделов), а также приложений, включающих в себя набор фраз и устойчивых выражений, применяемых при реферировании научных статей, источниковедческой базы.

В учебное пособие включены оригинальные тексты, опубликованные в зарубежных научных изданиях, сокращенные по мере необходимости. При отборе статей учитывалась их познавательная ценность. Тексты снабжены упражнениями по изучению и закреплению лексики.

Все уроки по структуре идентичны, даны ясные формулировки заданий, что позволяет достичь искомой цели.

CONTENTS

UNIT 1. GENERAL PHYSICS

Text 1. Forces and motion

«Measure what is measurable
and make measurable what is not so»
Galileo

PRE-READING

Before reading the passage, answer all the following questions and discuss them with your partner. Then read the passage and find the facts supporting your ideas.

1. What do you know about motion?
2. Is the motion of a ghost an example of motion?
3. Can something stop moving? How would you show it?
4. Does a body moving forever in a straight line show that nature or space is infinite?
5. Can the universe move?

Active vocabulary

Word	Pronunciation	Translation
attract, v.	/əˈtrækt/	привлекать, притягивать, syn. pull
average, adj.	/ˈævərɪdʒ/	средний, syn. medium
blade, n.	/bleɪd/	лезвие, клинок
brake, n.	/breɪk/	тормоз
bump, v.	/bʌmp/	столкнуться, врезаться, syn. collide
dashboard, n.	/ˈdæʃbɔːd/	приборная доска, приборный щиток, щиток управления
direction, n.	/dɪˈrekʃən/	направление
drop, v.	/drɒp/	ронять
float, v.	/fləʊt/	держаться на поверхности воды, плавать
force, n.	/fɔːs/	сила, мощь
friction, n.	/ˈfrɪkʃən/	трение
govern, v.	/ˈɡʌvən/	управлять, править,

		регулировать, syn. rule
gravity, n.	/ˈɡrævəti/	сила тяжести, тяготение, syn. gravitation, pull
inertia, n.	/ɪˈnɜːʃə/	инерция
invisible, adj.	/ɪnˈvɪzəbl/	невидимый, незаметный
iron, n/adj.	/aɪən/	железо, железный
law, n.	/lɔː/	закон
lump, n.	/lʌmp/	бугор, выступ
marble, n/adj.	/ˈmɑːbl/	мрамор, мраморный
mass, n.	/mæs/	масса
molecule, n.	/ˈmɒlɪkjuːl/	молекула
motion, n.	/ˈməʊʃən/	движение, ход, syn. movement
naked, adj.	/ˈneɪkɪd/	обнаженный, голый, syn. bare
obstacle, n.	/ˈɒbstəkl/	препятствие, преграда, syn. hindrance, obstruction
orbit, n.	/ˈɔːbɪt/	орбита
paw, n.	/pɔː/	лапа
pole, n.	/pəʊl/	полюс
pull, v.	/pʊl/	притягивать(ся)
push, v.	/pʊʃ/	отталкивать(ся)
resistance, n.	/rɪˈzɪstəns/	сопротивление
rink, n.	/rɪŋk/	каток
roll, v.	/rəʊl/	катить(ся), откатывать(ся), скатывать(ся)
rub, v.	/rʌb/	тереть, втирать, натирать
rug, n.	/rʌg/	коврик, ковер
seatbelt, n.	/siːt belt/	ремень безопасности
shaggy, adj.	/ˈʃæg.i/	шероховатый
slide, v.	/slaɪd/	скользить, двигаться плавно
smooth, adj.	/smuːð/	гладкий, ровный, syn. even
speed, n.	/spiːd/	скорость (скалярная)
spin, v.	/spɪn/	крутить(ся), вертеть(ся)

surface, n.	/ˈsɜːfɪs/	поверхность
terminal, adj.	/ˈtɜːmɪnəl/	конечный
tide, n.	/taɪd/	морской прилив и отлив
universe, n.	/ˈjuːnɪvɜːs/	вселенная
velocity, n.	/vɪˈlɒsəti/	скорость (векторная)
weight, n.	/weɪt/	вес
windshield, n.	/ˈwɪndʃɪːld/	ветровое стекло, переднее стекло

READING

Read and translate the text using a dictionary if necessary:

Motion is the most fundamental observation in nature. Everyday motion is predictable and deterministic. Predictability is reflected in six aspects of motion: continuity, conservation, reversibility, mirror-invariance, relativity and minimization. Some of these aspects are valid for all motion, and some are valid only for everyday motion.

The world and the Universe are action-packed. People and animals are always on the move. The planets are constantly circling the Sun. Are there any rules to all this activity? Our world and the whole Universe are governed by the laws of nature. Scientists who try to understand and learn about these laws are called physicists. Here are some questions that physicists across history have wondered about: When you drop a ball, why does it fall on the ground? Why does not it float up? If you spin a top, why does not it spin forever? Why does it eventually stop? Maybe you have wondered about these things, too.

To answer those questions, physicists needed to discover the laws of motion. What is motion? Motion is movement in any direction. You can move up, down, forwards, backwards, and sideways. You can move in circles. You can wiggle, wave, twist, turn, roll, flip, sway, bend, pivot, shake, and spin.

A force is a push or a pull. Here is a simple example: A cat hits a ball with its paw and makes the ball roll across the floor. The cat uses force to make the ball move. When you kick a ball or pull open a door, you are also using force. The more force you use, the faster the object will move.

Speed measures how far an object moves in a certain amount of time. However, things do not always move at the same speed. Forces can cause moving objects to speed up or slow down. «Average speed» equals «distance divided by time».

So why do things in motion slow down and a stop after a while? The answer is «friction». Friction is another kind of force. Friction is two things rubbing or sliding against each other. Skis on snow. A car on a road. A ball rolling across a carpet. Friction is a force that slows down moving objects. If you roll a ball across a shaggy rug, you can see that there are lumps and bumps in the rug that make the ball slow down. The rubbing, or friction, between the ball and the rug is what makes the ball stop rolling. But what would happen if you rolled the ball across a very smooth surface and there was no wall or obstacle in the way? Would the ball keep rolling forever? Unfortunately, no. There is no such thing as a «frictionless surface». There is friction between all objects and materials when they are touching.

To the naked eye, an object or surface may look perfectly smooth. If you looked at it under a microscope, you could see the tiny lumps and bumps that create friction when any two objects slide against each other. There is even friction when an object moves through the air. The less friction there is, the longer objects in motion can keep moving. For example, if you pushed off and tried to slide across the sidewalk in sneakers, you would not get very far. There is too much friction between the rubber soles of your sneakers and the rough concrete sidewalk. However, if you wore ice skates and used the same amount of force to push off and slide across an ice rink, you would glide for a long way. There is not much friction between the thin metal blade of an ice skate and the slick ice of the rink.

Some forces are invisible and can make objects move without touching them. You have probably played around with magnets before and know that magnets have an invisible pull—a force that can attract iron and steel objects. A magnet has a «north pole» and a «south pole». If you take two magnets, the north pole of one magnet and the south pole of the other will pull toward each other. If you try to join the north poles of the two magnets, however, the magnets will push each other away. The same is true if you try to put the two south poles together—the magnets will repel each other.

Magnets may seem mysterious because they can pull on other objects and make them move without touching them. It would be wise to mention that there is another invisible force that you interact with every second of every day and you probably take it for granted. That force is gravity. Gravity is the invisible force that holds us to the surface of the Earth.

Earth's gravity pulls objects toward the center of the Earth. So when you drop a book, it falls to the ground instead of floating away. When you jump up, gravity pulls you back down.

Every object actually has gravity, whether it is the Earth, the Sun, a person, or just a marble. The more «mass» an object has, the stronger its force of gravity. Mass just means how much «stuff» is in an object. Some materials are packed with more stuff than others. For example, steel has more stuff in it than Styrofoam. If two balls are the same size, and one is made of foam and one is made of steel, the steel ball will have greater mass.

The Earth and moon both have gravity that is strong enough to pull them toward each other. Although the moon's gravity is not as strong as Earth's, it pulls on the water in our oceans and creates the tides. So, if the Earth and moon are pulled toward each other, why don't they crash into each other? The moon is held in orbit by the force of Earth's gravity. The speed of the moon's orbit is what prevents the moon from falling down to Earth. If the moon went slower, it would fall to Earth. If it went faster, it would escape the Earth's gravity and fly off into space.

Isaac Newton was a famous scientist who was interested in all sorts of things, from gravity and the orbits of planets to the rules about how objects move. One of his most important discoveries is called Newton's First Law of Motion. Using experiment and observation, Newton showed that objects have a tendency to keep doing what they are doing. Objects that are still, stay still. Objects that are moving, keep moving. A still object stays still and a moving object keeps moving in the same straight line, unless a force pushes or pulls it. Whether they are moving of not moving, objects resist changing their «state of motion». This is called inertia.

Inertia is the reason seatbelts are important. If you are in a fast-moving car and the driver slams on the brakes, the car will stop, but you will keep moving forward. The seatbelt stops you, so you do not hit the dashboard or windshield.

Mass vs. weight. The mass of an object stays the same no matter where you are in the Universe. That is because the amount of stuff in the object does not change. Weight is actually the pull of gravity on an object. You feel your weight because the ground is pushing against the pull of gravity. So the weight of an object can change depending on where it is in the Universe. An object that weighs 60 pounds on Earth would weigh only about 10 pounds on the moon because the force of gravity on the moon is only one-sixth as strong as it is on Earth. Although your mass would stay the same, you would feel much lighter on the moon or you would if you did not have to wear that heavy spacesuit.

Air resistance is a kind of friction. Molecules in the air push up against falling bodies while gravity down. The force of air resistance pulls them opposes the force of gravity. The friction created by air resistance is not strong enough to stop falling objects, but it can stop them from speeding up. Thanks to air resistance, falling objects reach a top speed, also called «terminal velocity», that is based on their size and mass.

The concepts of force, motion, gravity, mass, and inertia and more govern the world and our Universe. They are complex ideas but once you understand them, you will see everything a little more clearly.

(Adopted from www.kidsdiscover.com)

A. Checking your understanding

I. Read the passage carefully and find answers to the following questions.

1. What questions have the physicists wondered about?
2. What is motion?
3. What is force?
4. What is average speed?
5. What can make objects move without touching them?
6. What governs the Universe?

II. There are several definitions in the text. What are they? Complete the sentences.

1. … is a push or a pull.
2. … is a force that slows down moving objects.
3. … is the invisible force that holds us to the surface of the Earth.
4. … is the reason seatbelts are important.
5. … is a kind of friction.

III. Are these statements true or false?

1) People and animals are always on the move.
2) Scientists who try to understand and learn about these laws of nature are called economists.

3) Things always move at the same speed.
4) The less friction there is, the shorter objects in motion can keep moving.
5) A magnet has a «north pole» and a «west pole».
6) Thanks to air resistance, falling objects reach a top speed.

B. Work with language

I. Translate the following nouns and give the corresponding verbs.

Division, collection, emission, civilization, exaggeration, communication
explanation, utilization, evolution, relation, computation, direction, oscillation.

II. Think of nouns corresponding to the following adjectives and translate them into Russian.

Original, directional, universal, regional, centrifugal, conversational, gravitational, accidental, natural

III. Put all possible questions to the following sentences.

1. The planets are constantly circling the Sun.
2. Forces can cause moving objects to speed up or slow down.
3. The Earth and the Moon both have gravity.
4. Molecules in the air push up against falling bodies.
5. Isaac Newton was a famous scientist.

IV. Put the words into the right order. Check your answers with the text.

1. is| movement |in |direction| motion| any.
2. the| moon's| is not | strong| as Earth's| gravity| as.
3. causes |force |to make | move | cat| the ball| the.
4. a| still | stays | object | still.
5. in| the | push up | against| bodies | Molecules |air | falling.

V. Ask questions to the following statements. Start your questions with the words:

I wonder…; Could you clarify…; Could you tell me…; I'd like to know…; Have you any idea…; I'm interested to know…, etc.

1. People and animals are always on the move. (Why?)
2. The planets are constantly circling the Sun. (Why?)
3. There are some rules to all this activity. (What?)
4. Our world and the whole Universe are governed by the laws of nature. (What laws?)

VI. Translate the text and retell it in English:

Newton, one of the greatest scientists of all times was born in 1642 in the little village in Lincolnshire, England. His father was a farmer and died before Newton was born. His mother was a clever woman whom he always loved.

After the school, Newton studied mathematics at Cambridge University and received his degree in 1665. Then the university was closed because of the danger of plague and Newton went home for eighteen months. It was most important period in his life when he made his three great discoveries — the discoveries of the differential calculuses, of the nature of white light, and of the law of gravitation.

These discoveries are still important for the modern science. Newton had always been interested in the problems of light. Many people saw colors of a rainbow but only Newton showed, by his experiments, that white light consists of these colors.

It is interesting how he discovered the law gravitation. Once, as he sat at the garden, his attention was drawn by the fall of an apple. Many people saw such an usual thing before. But it was Newton who asked himself a question: "Why does that apple fall perpendicularly to the ground? Why doesn't it go sidewards or upwards?" The answer to this question was the theory of gravitation, discovered by Newton.

Newton died at the age of 84, and was buried in Westminster Abbey, where his monument stands today.

(Adopted from www.linguistic.ru)

VII. Render this text into English:

Никто не сможет выполнить просьбу!

Почему никто не может выполнить следующие две просьбы?

"Дайте мне точку опоры, и я переверну Землю!" - с великой и веселой нескромностью пригрозил когда-то Архимед, зная, что точки опоры ему никто не даст.

"Дайте мне координаты и скорости всех тел, и я рассчитаю будущее Вселенной!" - примерно так двумя тысячелетиями позже пообещал Лаплас, зная, что никто не сможет выполнить его просьбы, хотя бы из-за беспредельности мира.

В этих двух предложениях - история развития классической механики: от теории рычага до системы мироздания.

(Adopted from www.linguistic.ru)

C. Activities

I *What do you know about Newton's First Law of Motion. Find more information and make a report (or a presentation).*

I *Point to Ponder: What is your opinion about Albert Einstein's quote?*

"Concern for man himself and his fate must always form the chief interest of all technical endeavors, concern for the greatest unsolved problems of the organization of labor and the distribution of goods - in order that the creations of our minds shall be a blessing and not a curse to mankind. Never forget this in the midst of your diagrams and equations."

Albert Einstein

Text 2. Forces and matter. The standard model of particle

«Every particle of matter is attracted by or gravitates to every other particle of matter with a force inversely proportional to the squares of their distances» Isaac Newton

PRE-READING

Before reading the text try to discuss the following questions:

1. What do you know about the Large Hadron Collider?
2. Do science and technology do more good than harm? Leaving out military applications, do you think that scientific discoveries can have very dangerous effects?

Active vocabulary

Word	Pronunciation	Translation
accelerator, n.	/əkˈseləreɪtər/	акселератор
annihilation, n.	/əˌnaɪɪˈleɪʃən/	уничтожение, syn. destruction, ravage
attempt, n.	/əˈtempt/	попытка, syn. effort, try
boson, n.	/ˈbəʊsən/	бозон
charge, n.	/tʃɑːdʒ/	заряд, нагрузка, загрузка
charge parity violation	/tʃɑːdʒ ˈpærəti ˌvaɪəˈleɪʃən/	нарушение CP-инвариантности (комбинированной четности, CP-симметрии)
coalesce, v.	/kəʊəˈles/	коалесцировать
consequence, n.	/ˈkɒnsɪkwəns/	последствие, результат, syn. outcome, result
dimension, n.	/ˌdaɪˈmenʃən/	измерение, размерность
explosion, n.	/ɪkˈspləʊʒən/	взрыв, syn. burst
goal, n.	/gəʊl/	цель, syn. aim, purpose
hadron, n.	/ˈhædrɒn/	адрон
helium, n.	/ˈhiːliəm/	гелий
hydrogen, n.	/ˈhaɪdrədʒən/	водород
hypothesis, n.	/haɪˈpɒθəsiːz/	гипотеза
interact, v.	/ˌɪntərˈækt/	взаимодействовать

lepton, n.	/ˈleptɑn/	лептон
merge, v.	/mɜːdʒ/	сливать(ся), соединять(ся)
mutual, adj.	/ˈmjuːtʃuəl/	общий, взаимный, syn. commutual
nucleus, n.	/ˈnjuːkliəs/	ядро
particle, n.	/ˈpɑːtɪkl/	частица
plasma, n.	/ˈplæzmə/	плазма
quark, n.	/kwɑːrk/	кварк
renormalization, n.	/ˌrɪnɔrmələˈzeɪʃən/	перенормировка
residue, n.	/ˈrezɪdjuː/	остаток, осадок
string theory	/strɪŋ ˈθɪəri/	теория струн
substance, n.	/ˈsʌbstəns/	вещество, субстанция, syn. matter, stuff
validate, v.	/ˈvælɪdeɪt/	утверждать, подтверждать, syn. affirm, confirm
vacuum, n.	/ˈvækjuːm/	вакуум

READING

Read and translate the text using a dictionary if necessary:

Standard Model of particle physics, which was formulated in the 1970s, describes the universe in terms of Matter (fermions) and Force (bosons). The Standard Model consists of 17 particles. Twelve of the 17 fundamental matter-particles are fermions: 6 quarks and 6 leptons. The remaining five particles are bosons, four of which are physical manifestations of the forces through which particles interact. At high energies, the weak nuclear force merges with electromagnetic force.

The Higgs boson is associated with the Higgs field which gives mass to electrons, elementary quarks, Z and W bosons, and the Higgs boson itself. It would be wise to mention that the strong nuclear force associated with the gluon particle gives mass to atomic nuclei, by binding together the three quarks inside protons and neutrons, and all attempts to include gravitons or gravity into the Standard Model have failed. Gluons interact only with quarks and themselves, but all the other bosons interact with both leptons and quarks. Quarks carry both electrical and color charge, but leptons have no color charge, and only non-neutrino leptons have electrical charge. Neutrinos carry neither electrical nor color charge.

According to Big Bang theory, the existing universe emerged from an explosion in a vacuum that occurred 13.7 billion years ago. The four forces were unified until 10−43 seconds after the Big Bang, after which first gravity and then strong nuclear force separated from the other two forces.

At 10−12 seconds after the Big Bang electromagnetism separated from the weak nuclear force, and the universe was filled with a hot quark-gluon plasma that included leptons and antiparticles. At 10−6 seconds hadrons began to form. Most hadrons and antihadrons were eliminated by annihilation, leaving a small residue of hadrons by one second post-Big Bang. Between one and three seconds after Big Bang the universe was dominated by leptons/antileptons until annihilation of these particles left only a small residue of leptons.

The universe was dominated by photons created by all of the matter/antimatter annihilations, and the predominance of matter over antimatter had been established. Between 3 and 20 minutes after the Big Bang protons and neutrons began to combine to form atomic nuclei. A plasma of electrons and nuclei (ionized hydrogen and helium) existed for 300,000 years until the temperature dropped to 5,000ºC when hydrogen and helium atoms formed.

If matter and antimatter were perfectly symmetrical, the cooling of the universe would have resulted in particle/antiparticle annihilation that would have left the universe filled only with photons. However, for every billion mutual annihilations a particle of matter remained comprising the existing matter of the universe. The predominance matter over antimatter is a consequence of charge-parity violation (CP violation). About 99% of the photons in the universe (the cosmic microwave background) are the result of Big Bang annihilations. Photons from stars are a trivial contribution, by comparison.

The standard model used by cosmologists predicts that the universe is composed of 5% ordinary matter, 27% cold dark matter, and 68% dark energy. Dark matter reputedly caused hydrogen to coalesce into stars, and is a binding force in galaxies. Dark energy is accelerating the expansion of the universe. The cosmologists' standard model also predicts that within the first 10−32 of a second after the Big Bang, the universe doubled in size 60 times in a growth spurt known as inflation.

Dark matter does not interact with the electromagnetic force, thus making it transparent and hard to detect, despite the fact that dark matter must permeate the galaxy. Unlike visible matter, dark matter is nonbaryonic

- its composition is outside of the (unextended) Standard Model. Neutrinos may be a low-mass example of dark matter. Invisible Weakly Interacting Massive Particles (WIMPs having thousands of times the mass of a proton) have been hypothesized as being the substance of dark matter. It is believed that the effect of Earth moving through a dark matter «wind» results in a 10% greater dark matter flux when it is summer in the Northern Hemisphere than when it is winter. Some physicists believe that dark matter does not exist, but that theories of gravitation need to be revised (as is proposed by modified Newtonian dynamics).

The most prosaic goal of the Large Hadron Collider (LHC, the enormous particle accelerator that first began operation in September 2008 at CERN, Europe's particle physics laboratory near Geneva, Switzerland) was to find the Higgs boson. The Higgs boson adheres to the W and Z bosons to give them mass, but does not adhere to photons (leaving photons massless). The more particles interact with the Higgs field, the more massive they become. The bosons that mediate electromagnetism (photons) and the strong force (gluons) are massless, but the bosons that mediate the weak force (Z and W bosons) have a mass about a hundred times greater than the mass of a proton. The Higgs field, not the Higgs boson, gives energy to particles. Because of Einstein's E = mc2, giving energy is equivalent to giving mass. Heavier particles interact with the Higgs field more than lighter particles, the heavy top quark more than any other particle. A Higgs field would fill the vacuum of space with Higgs bosons, just as the electromagnetic field fills the vacuum of space with photons.

Two detectors were created to search for the Higgs boson: (1) CMS (Compact Muon Solenoid) and (2) ATLAS (A Toroidal LHS ApparatuS). Neither detector could detect a Higgs boson directly, but the Higgs boson rapidly decays into photons, Z or W bosons, or fermions, which CMS and ATLAS can detect. Detection is most accurate for decay into two photons, but that mode of decay only happens 0.2-0.3% of the time. The probability of a Higgs boson being produced from a single high-energy proton collision is about one in ten trillion (1 X 1013) because the interaction between quarks and gluons with the strong nuclear force are far more powerful than their interaction with the Higgs field. A Higgs boson could be formed from gluons from the colliding protons fusing together, or by quarks from the protons emitting Z or W bosons that fuse. Following the discovery of the Higgs boson, the LHC can focus on learning more about that boson's properties - and possibly explain why the Higgs boson is required to give particles a mass.

The LHC could validate or invalidate models of supersymmetry which double the number of particles in the standard model by pairing every boson with a fermion superparticle - and pairing every fermion with a boson superparticle (somewhat analogous to antimatter). However, most particle physicists are hoping to make discoveries with the LHC that gets beyond the Standard Model, including an understanding of dark matter. The Standard Model treats fundamental particles as point-like entities having no dimensions, adjusted for by a kludge called renormalization. String theory removes the need for renormalization and provides mathematically satisfying explanations for many other problems. But string theory has still not fulfilled its promise of unifying gravity and quantum mechanics. Nor has it produced testable hypotheses, because strings could only be measured at energies well beyond the capacities of existing particle accelerators. Some physicists worry that aesthetic elegance is displacing evidence as the basis of physical theory.

(Adopted from www.benbest.com)

A. Checking your understanding

I. Answer the following questions:

1. When were Standard Models of particle physics formulated?
2. How many particles does the Standard Model consist of?
3. What can you tell about the Big Bang theory?
4. What does the Standard Model used by cosmologists predict?
5. When and where did the particle accelerator first begin operation?
6. What was the goal of the large Hadron Collider?
7. In what way does the Standard Model treat fundamental particles?

II. Show your good knowledge of the text. Match the parts to make a sentence.

1. Standard Model of particle physics ...
2. The Standard Model consists …
3. About 99% of the photons in the universe…
4. The more particles interact with the Higgs field…

5. The Higgs field, not the Higgs boson…
6. Two detectors were created…
   a) are the result of Big Bang annihilation.
   b) describes the universe in terms of Matter.
   c) of 17 particles.
   d) to search for the Higgs boson.
   e) gives energy to particles.
   f) the more massive they become.

B. Working with language

I. Form adverbs from the following adjectives and translate them into Russian.

pure, comparative, rapid, equal, ordinary, certain, accidental, radioactive, previous, rare, heavy, reasonable, separate, haughty, profitable, peevish, cold, sufficient, effective

II. Look through the passage carefully and find English equivalents for the following Russian phrases.

Оставшиеся пять частиц, электромагнитная сила, ассоциироваться с, было бы правильным отметить, в отличие от, некоторые физики предполагают, необходимо пересмотреть.

*III. Match each word in **A** with its synonym in **B**.*

A.1 sudden and surprising; 2. to perceive; 3. rapid; 4. abrupt; 5. to presume; 6. to prevail;7. drastic; 8. immense;

B. a) very powerful; b) unlimited, immeasurable; c); quick; d) improbable, impossible to believe; e) to understand (see or notice); f) incredible ; g) to be most common or general; h) to suppose to be true without proof

IV. Fill in the blanks with information taken from the text.

1. At high energies, the weak nuclear force merges with … .
2. Neutrinos carry neither electrical nor… .
3. The four forces were unified until 10−43 seconds … .

4. The predominance matter over antimatter is a consequence of… .
5. Some physicists believe that dark matter does not exist, ...
6. However, most particle physicists are hoping … .

V. Write three questions beginning with: What will you do if…, What will happen if… .
Ask other students your questions. Useful expressions: I think, I'm sure, certainly, probably, doubtless, maybe.

VI. Render the text into English:

Прозвище лаборатории

Резерфорд, будучи студентом Кентерберийского университета, стал одним из инициаторов создания научного студенческого общества. Под студенческую лабораторию выделили холодный сарай с цементным полом. Лабораторию из-за этого величали "пещерой". Прочитав статью Герца об электромагнитных колебаниях, Резерфорд решил сконструировать в "пещере" беспроволочный телеграф. Это было первое открытие двадцатичетырехлетнего Резерфорда. Эту работу использовали в своих открытиях в области радио Александр Попов и Гульермо Маркони. Она произвела большое впечатление в университете, и Резерфорду даже "простили" его ошибки - фантазии на счет строения атома. А дело обстояло так.

Учась на втором курсе, он избрал для доклада на заседании общества тему "Эволюция материи". В нем он заявил, что все атомы построены из одних и тех же составных частей. По тем временам это было просто невежеством: царившая в физике атомистическая теория англичанина Джона Дальтона непоколебимо утверждала неделимость атома! На следующем заседании общества Эрнесту Резерфорду пришлось принести извинения своим товарищам за то, что он под видом научного доклада рассказывал явную белиберду!

(Adopted from www.teachmen.ru)

C. Activities

I. Think and say a few words about:

1. The Big Bang and subatomic world;
2. Distinct particle types known in nature
3. Protons and neutrons, their present and future.

II. *Prepare a short report about the most important discoveries in the field of physics and their role in the science development*.

Text 3. Work, energy and power

«Instrumental or mechanical science is the noblest and, above all others, the most useful»
Leonardo da Vinci

PRE-READING

Answer the following questions:

1) What do you know about energy?
2) Tell everything you know about the forms of energy.

Active vocabulary

Word	Pronunciation	Translation
application, n.	/ˌæplɪˈkeɪʃən/	применение
bond, n.	/bɒnd/	узы, связь, syn. link
calculate, v.	/ˈkælkjəleɪt/	вычислять, исчислять, высчитывать, syn. compute, figure out
define, v.	/dɪˈfaɪn/	определять, устанавливать, syn. determine, identify
energy, n.	/ˈenədʒi/	энергия
equal, adj.	/ˈiːkwəl/	равный
fission, n.	/ˈfɪʃən/	деление, расщепление
fusion, n.	/ˈfjuːʒən/	сплав, слияние
heat, n.	/hiːt/	жара, тепло
height, n.	/haɪt/	высота
kinetic, adj.	/kɪˈnet.ɪk/	кинетическая
lift, v.	/lɪft/	поднимать, syn. elevate, raise
measure, v.	/ˈmeʒər/	измерять
potential, adj.	/pəˈtenʃəl/	потенциальная
power, n.	/paʊər/	мощность
shelf, n.	/ʃelf/	полка
solar, adj.	/ˈsəʊlər/	солнечный
still, adj.	/stɪl/	неподвижный, спокойный, syn. fixed, motionless, rigid
stored, adj.	/stɔːd/	накопленный, запасенный

split, v.	/splɪt/	раскалывать(ся), разделять(ся), делить(ся), syn. dispart, divide
transfer, v.	/trænsˈfɜːr/	передавать, перемещать, переносить
wave, n.	/weɪv/	волна
work, v.	/wɜːk/	работа

READING

Read and translate the text using a dictionary if necessary:

Work can be defined as transfer of energy. In physics we say that work is done on an object when you transfer energy to that object. If one object gives energy to a second object, then the first object does work on the second object. Work is the application of a force over a distance (W= Fxd). Lifting a weight from the ground and putting it on a shelf is a good example of work. The force is equal to the weight of the object, and the distance is equal to the height of the shelf. Work-Energy principle states that the change in the kinetic energy of an object is equal to the net work done on the object.

Energy (E) can be defined as the capacity for doing work. The simplest case of mechanical work is when an object is standing still and we force it to move. The energy of a moving object is called kinetic energy. For an object of mass m, moving with velocity of magnitude v, this energy can be calculated from the following formula E= 1/2 mv^2.

There are two types of energy. The first is Kinetic Energy or Energy of Motion, the second is Potential Energy or Stored Energy. The forms of energy are:

Solar Radiation: infrared heat, radio waves, gamma rays, microwaves, ultraviolet light

Atomic/Nuclear Energy - energy released in nuclear reactions. When a neutron splits an atom's nucleus into smaller pieces it is called fission. When two nuclei are joined together under millions of degrees of heat it is called fusion.

Electrical Energy is the generation or use of electric power over a period of time expressed in kilowatt-hours (kWh), megawatt-hours (NM) or gigawatt-hours (GWh).

Chemical energy is a form of potential energy related to the breaking and forming of chemical bonds. It is stored in food, fuels and batteries, and is released as other forms of energy during chemical reactions.

Mechanical Energy - energy of the moving parts of a machine. Also refers to movements in humans.

Heat Energy is a form of energy that is transferred by a difference in temperature.

Special attention should be paid at the definition of the word «power». Power is the work done in a unit of time. In other words, power is a measure of how quickly work can be done. The unit of power is the Watt = 1 Joule/ 1 second. One common unit of energy is the kilowatt-hour (kWh). If we are using one kW of power, a kWh of energy will last one hour.

To calculate Work, we use the equation W=Fd, where F - force, d - distance. Because energy is the capacity to do work, we measure energy and work in the same units (N*m or joules). Power (P) is the rate of energy generation (or absorption) over time: P = E/t, where E - energy, t - time. Power's SI unit of measurement is the Watt, representing the generation or absorption of energy at the rate of 1 Joule/sec. Power's unit of measurement in the English system is the horsepower, which is equivalent to 735.7 Watts. *(Adopted from www.physics.com)*

A. Checking your understanding

I. *Review questions*:

1. What is the main idea of the text?
2. How can work be defined?
3. How do we define Work in physics?
4. What is energy?
5. What is kinetic energy?
6. What types of energy do you know?

II. *There are several definitions in the text. What are they? Complete the sentences*.

1) …is transfer of energy.
2) …is the capacity for doing work.
3) …is energy released in nuclear reactions.
4) … is the generation or use of electric power over a period of time expressed in kilowatt-hours (kWh), megawatt-hours (NM) or gigawatt-hours (GWh).

5) … a form of potential energy related to the breaking and forming of chemical bonds. It is stored in food, fuels and batteries, and is released as other forms of energy during chemical reactions.
6) … a form of energy that is transferred by a difference in temperature.
7) … energy of the moving parts of a machine. Also refers to movements in humans.
8) …is when two nuclei are joined together under millions of degrees of heat.

III. Are these sentences true or false?

1) The force is equal to the weight of the object.
2) Energy (E) can't be defined as the capacity for doing work.
3) The simplest case of mechanical work is when an object is standing still and we force it to move.
4) The energy of a moving object isn't called kinetic energy.
5) There are four types of energy.
6) The first is Kinetic Energy or Energy of Motion, the second is Potential Energy or Stored Energy.
7) To calculate Work, we can't use the equation W=Fd, where F - force, d - distance.

B. Work with language

I. *Form nouns from the following verbs and translate them into Russian*. To improve, to excite, to appoint, to develop, to move, to establish, to agree, to adjust.

II. *Think of the verbs corresponding to the following adjectives and translate them into Russian*.

Explosive, representative, expressive, offensive, protective, creative, refractive, indicative, attractive

III. Put all possible questions to the following sentences.

1. The force is equal to the weight of the object.
2. There are two types of energy.

3. We use the equation to calculate Work.
4. We measure energy and work in the same units.
5. Mechanical Energy refers to movements in humans.

IV. Put the words into the right order. Check your answers with the text.

1) application /of a force/ work/ a distance / is/ the/ over
2) lifting / from/ the / is /a /example of / work/ a / weight /ground/ good.

3) force / equal / the / weight/ the /object/ the/ is/ to/ of.
4) energy / a/ moving / called /kinetic / the/ energy/ of/ object/ is.
5) power / work/ in / a/ of/ time / is / the/ done/ unit.
6) in /other/ power / is/ a / measure /of / quickly /work / be /done/ words/ how/ can.
7) unit / power/ Watt = 1 Joule/ 1 second/ the / of / is / the.

V. Read and translate the word combinations:

Produced obtained transformed supplied available
Captured trapped
Degraded **ENERGY** transferred
Utilized provided
Derived from taken in released stored fixed passed along

C. Activities

Give your own examples of using different forms of energy in our life.

Text 4. Energy transfers and energy transformations

«Energy cannot be created or destroyed, it can only be changed from one form to another»
Albert Einstein

PRE-READING

Give answers to the following questions:

1. What do you know about photosynthesis?
2. Why is this process so important for the nature?

Active vocabulary

Word	Pronunciation	Translation
adenine, n.	/ˈædənin/	аденин
adenosine diphosphate/ ADP	/əˈdɛnəʊsɪnˈdɪfɒsfeɪt/	аденозина дифосфат/ АДФ
adenosine triphosphate/ ATP	/əˈdɛnəʊsɪnˈtrɪfɒsfeɪt/	аденозина трифосфат/ АТФ
bioenergetics, n.	/baɪəʊˌenədʒetɪks/	биоэнергетика
bioluminescence, n.	/ˌbaɪəʊˌluːmɪˈnɛsəns/	биолюминесценция
carbohydrate, n.	/ˌkɑːbəʊˈhaɪdreɪt/	углевод
chemical, adj.	/ˈkemɪkəl/	химический
conduction, n.	/kənˈdʌkʃən/	проводимость
conversion, n.	/kənˈvɜːʒən/	переход, превращение
disorder, n.	/dɪˈsɔːdər/	расстройство, беспорядок, syn. disarray
entropy, n.	/ˈentrəpi/	энтропия
enzyme, n.	/ˈenzaɪm/	энзим, фермент
glucose, n.	/ˈgluːkəʊs/	глюкоза
invariable, adj.	/ɪnˈveəriəbl̩ /	неизменный, постоянный, syn. changeless, permanent, unvaried
linkage, n.	/ˈlɪŋkɪdʒ/	соединение, сцепление, связь
metabolic, adj.	/metəˈbɑlɪk/	метаболический, относящийся к процессу обмена веществ
nitrogen, n.	/ˈnaɪtrədʒən/	азот

nucleoside, n.	/ˈnjuːkliəsaɪd/	нуклеозид
photosynthesis, n.	/ˌfəʊtəʊˈsɪnθəsɪs/	фотосинтез
randomness, n.	/ˈrændəmnəs/	беспорядочность, хаотичность, случайный характер
release, v.	/rɪˈliːs/	освобождать, высвобождать, выпускать, syn. give out, free
respiratory, adj.	/ˈrespərətɔːri/	дыхательный, респираторный
restore, v.	/rɪˈstɔːr/	возвращать, восстанавливать, syn. rebuild, rebuild, rehab
substrate, n.	/ˈsʌbstreɪt/	подложка, основа
spontaneously, adv.	/spɒnˈteɪniəslɪ/	непроизвольно, спонтанно
thermodynamics, n.	/ˌθɜːməʊdaɪˈnæmɪks/	термодинамика
transfer, n.	/trænsˈfɜːr/	перенос, передача
transformation, n.	/trænsˈfɔːməɪʃən/	изменение, преобразование, превращение
unidirectional, adj.	/ˈjuːnidaɪˈrekʃənəl/	однонаправленный
utilize, v.	/ˈjuːtɪlaɪz/	использовать, утилизировать
vital, adj.	/ˈvaɪtəl/	жизненно важный, насущный

READING

Read and translate the text using a dictionary if necessary:

Energy is the capacity to do work. All living organisms require energy for carrying on their vital metabolic activities. The primary source of energy for living system is solar radiation. The radiant energy of sunlight cannot be utilised directly by all living organisms. This ability rests only with the green plants. All the other organisms have to meet their energy requirement only through the green plants. They represent the entry point for the flow of energy in the living system, which is always unidirectional.

Energy that flows in the living system is called bio-energy and the study of changes in energy as it flows through a living system, is called bioenergetics. It would be wise to mention that all energy conversions in the living system are governed by certain invariable principles called laws of thermodynamics, as in any physical system.

There are two types of energy changes in the living system, namely energy transformation and energy transfer. The examples of energy transformation are following:

Photosynthesis - in which green plants transform radiant solar energy into chemical energy that gets stored as potential energy in carbohydrates.

Bioluminescence -in which chemical energy is transformed into light energy

Conduction of nerve impulses - in which chemical energy is transformed into electrical energy

Muscular activity - in which chemical energy is transformed into mechanical energy

A classic example of energy transfer in the living system is respiration. Here, the chemical (potential) energy stored in respiratory substrates like glucose, is transferred to ADP and is stored in ATP. The ATP molecules transfer energy to other biological molecules.

ATP (adenosine triphosphate) is an energy rich compound having three phosphate group attached to a nucleoside of adenine (a nitrogen base), called adenosine (adenine + pentose sugar). Of the three phosphate groups, the terminal one has a weak linkage. This phosphate group can break spontaneously whenever ATP forms a complex with an enzyme. The breaking up of this bond releases chemical energy causing an immediate shift in the bond energy giving rise to adenosine diphosphate (ADP). ATP is therefore commonly described as energy currency of the cell.

In the given article special attention should be paid at entropy (the usual symbol is S). Entropy is a measure of the degree of disorder or randomness of a system. It corresponds to the amount of energy that is not available for work in a system. Loss of energy in the form of heat results in an increase in the entropy of a system.

In the biological system, an increasing degree of entropy results in the death of a cell or an organism, unless energy is restored. Living organisms restore their lost energy either directly from sunlight (as in green plants) or from their food molecules (as in other organisms).

(Adopted from www.tutorvista.com)

A. Checking your understanding

I. Answer to the following questions:

1. What do all living organisms require?
2. What is primary source of energy for living system?
3. What is bio-energy?
4. How many types of energy changes in living organisms are there?
5. What are examples of energy transformation?

II. There are several definitions in the text. What are they? Complete the sentences.

1) … is the capacity to do work.
2) … is energy that flows in the living system.
3) … - in which green plants transform radiant solar energy into chemical energy that gets stored as potential energy in carbohydrates.
4) … - in which chemical energy is transformed into light energy.
5) … - in which chemical energy is transformed into electrical energy.
6) … - in which chemical energy is transformed into mechanical energy.
7) … is a classic example of energy transfer in the living system.
8) … is the study of changes in energy as it flows through a living system.

III. Are these sentences true or false?

1. The primary source of energy for living system is solar radiation.
2. The radiant energy of sunlight can be utilized directly by all living organisms.
3. All energy conversions in the living system are governed by certain invariable principles called laws of thermodynamics.
4. The ATP molecules don’t transfer energy to other biological molecules.
5. Living organisms restore their lost energy either directly from sunlight (as in green plants) or from their food molecules (as in other organisms).

B. Work with language

I. Think of verbs corresponding to the following nouns and translate them into Russian.

Reference, resistance, correspondence, existence, coalescence, conductance, difference

II. Put all possible questions to the following sentences.

1. All living organisms require energy for carrying on their vital metabolic activities.
2. The primary source of energy for living system is solar radiation.
3. The ATP molecules transfer energy to other biological molecules.
4. The breaking up of this bond releases chemical energy.
5. They represent the entry point for the flow of energy in the living system.

III. Put the words into the right order. Check your answers with the text.

1) types/ energy / changes / the / system / there / of /are / two / in / living.
2) example / of / transfer / in / the / system / respiration /a / classic / energy / living /is.
3) is/ measure /the / degree / of / disorder / entropy / a / of .
4) corresponds / the / energy / to / of / amount/ it .

IV. Guess the words:

1) htosnyohstsiep…..
2) cmlinoicbuenees…
3) tserpainori…
4) lagiooblic…
5) smecolleu...

C. Activities

I. Prepare a short report about important processes in nature (energy transformation and energy transfer) and their role.

II. Discuss the following questions in a group:

1. What do you know about the theory of cells?
2. Is the theory of cells important nowadays and why? Thermal physics
3. What do you know about scientists who worked in the field of thermal physics investigation?

III. Prepare a short report about the most important discoveries in biology and their role in the science's development.

UNIT 2. THERMAL PHYSICS

Text 1. The kinetic model of matter

«We are just light. Light condensed becomes matter»
Dr. Pillai

PRE-READING

Give answers to the following questions:

1. What do you know about the kinetic molecular theory of matter?
2. Tell about an application of this theory.

Active vocabulary

Word	Pronunciation	Translation
close, adj.	/kləʊz/	близкий, плотный, тесный
clump, n.	/klʌmp/	пучок, syn. cluster
condensation, n.	/ˌkɒndenˈseɪʃən/	конденсация
diffusion, n.	/dɪˈfjuːʒən/	рассеивание, диффузия
evaporation, n.	/ɪˌvæpəˈreɪʃən/	испарение
freezing, n.	/ˈfriːzɪŋ/	замерзание, замораживание
interaction, n.	/ˌɪntərˈækʃən/	взаимодействие
intermolecular, adj.	/ˌɪntɚməˈlekjəlɚ/	межмолекулярный
lattice, n.	/ˈlætɪs/	решетка
liquid, n/adj.	/ˈlɪkwɪd/	жидкость, жидкий
macroscopic, adj.	/ˌmækrəˈskɑpɪk/	макроскопический
melting, n.	/meltɪŋ/	плавление, расплавление, таяние
microscopic, adj.	/ˌmaɪkrəˈskɒpɪk/	микроскопический
overcome, v.	/ˌəʊvəˈkʌm/	преодолевать, syn. overpass
phase, n.	/feɪz/	фаза, этап
pressure, n.	/ˈpreʃər/	давление
property, n.	/ˈprɒpəti/	свойство, syn. attribute, feature
sample, n.	/ˈsɑːmpl/	образец, syn. example, pattern
solid, n/adj.	/ˈsɒlɪd/	твердое тело, твердый

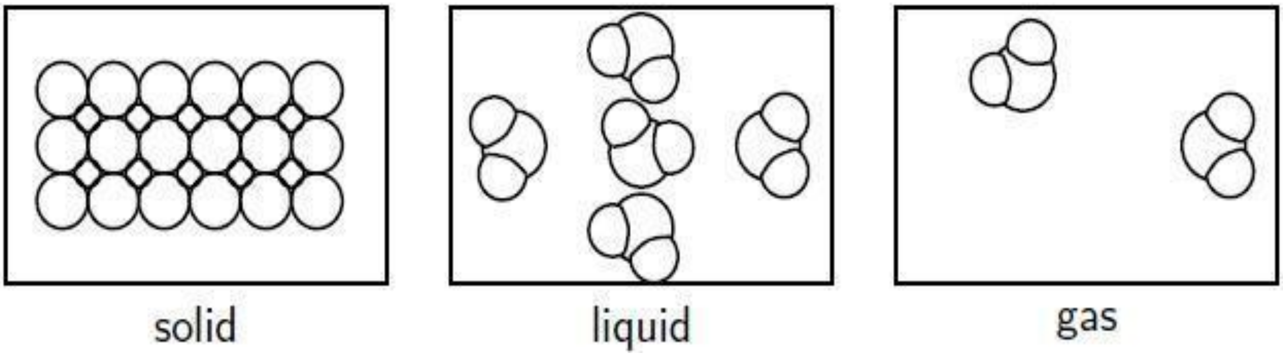
sublimation, n.	/ˌsʌblɪˈmeɪʃən/	испарение твердых тел, сублимация
temperature, n.	/ˈtemprətʃər/	температура
vapor, n.	/ˈveɪpər/	пар
volume, n.	/ˈvɒljuːm/	объем
weak, adj.	/wiːk/	слабый, неустойчивый

READING

Read and translate the text using a dictionary if necessary:

The kinetic molecular theory of matter offers a description of the microscopic properties of atoms (or molecules) and their interactions, leading to observable macroscopic properties (such as pressure, volume, temperature). An application of the theory is that it helps to explain why matter exists in different phases (solid, liquid, and gas) and how matter can change from one phase to the next.

The three phases of matter:



Notice that the spacing between atoms or molecules increases as we move from a description of the solid phase to the gaseous one. The kinetic molecular theory of matter states that:

Matter is made up of particles that are constantly moving.

All particles have energy, but the energy varies depending on the temperature the sample of matter is in. This in turn determines whether the substance exists in the solid, liquid, or gaseous state. Molecules in the solid phase have the least amount of energy, while gas particles have the greatest amount of energy.

The temperature of a substance is a measure of the average kinetic energy of the particles.

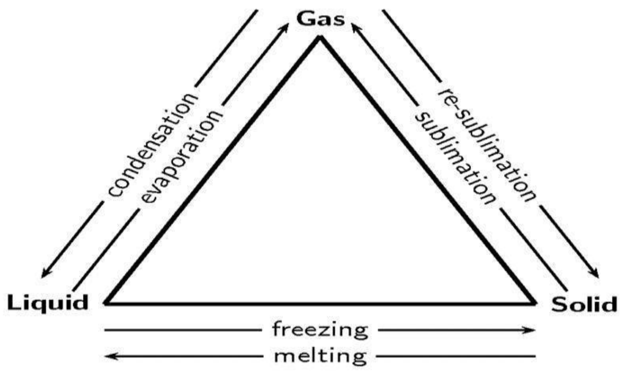
A change in phase may occur when the energy of the particles is changed.

There are spaces between particles of matter. The average amount of empty space between molecules gets progressively larger as a sample of matter moves from the solid to the liquid and gas phases.

There are attractive forces between atoms/molecules, and these become stronger as the particles move closer together. These attractive forces are called intermolecular forces.

Let's take water as an example. We find that in its solid phase (ice), the water molecules have very little energy and cannot move away from each other. The molecules are held closely together in a regular pattern called a lattice. If the ice is heated, the energy of the molecules increases. This means that some of the water molecules are able to overcome the intermolecular forces that are holding them close together, and the molecules move further apart, forming liquid water. This is why liquid water is able to flow: the molecules have greater freedom to move than they had in the solid lattice.

If the molecules are heated further, the liquid water will become water vapor, which is a gas. Gas particles have more energy and are on average at distances from each other which are much larger than the size of the atoms/molecules themselves. The attractive forces between the particles are very weak given the large distances between them. The illustration below shows a change in phase.



The kinetic theory of matter is also illustrated by the process of diffusion. Diffusion is the movement of particles from a high concentration to a low concentration. It can be seen as a spreading-out of particles resulting in their even distribution. Placing a drop of food coloring in water provides a visual representation of this process – the color slowly spreads out through the water. If matter were not made of particles, then we would

simply see a clump of color, since there would be no smaller units that could move about and mix in with the water.
(Adopted from www.boundless.com)

A. Checking your understanding

I. Review questions:

1) What are three phases of matter?
2) How can matter change from one phase to the other?
3) What is there between particles of matter?
4) When does the spacing between atoms or molecules increase?
5) What is matter made up of?
6) What do all particles have?
7) Why is liquid water able to flow?
8) When may a change in phase occur?
9) The kinetic theory of matter is also illustrated by the process of diffusion. Prove it.

II. Complete the sentences.

1. Intermolecular forces are …
2. Diffusion is …
3. The kinetic molecular theory of matter states that…
4. If the ice is heated …
5. The liquid water will become water vapor, if …
6. The liquid water is able to flow, because …
7. If matter were not made of particles, …
8. The temperature of a substance is…

III. Are these sentences true or false?

1. The kinetic molecular theory of matter states that matter is made up of particles that are constantly moving.
2. All particles have energy, but the energy varies depending on the temperature the sample of matter is in.

3. Molecules in the solid phase have the greatest amount of energy, while gas particles have the least amount of energy.
4. The average amount of empty space between molecules gets progressively smaller as a sample of matter moves from the solid to the liquid and gas phases.
5. If the molecules are heated further, the liquid water will become in its solid phase (ice).
6. Diffusion is the movement of particles from a high concentration to a low concentration

B. Work with language

*I. Match each word in **A** with its synonym in **B**.*

A. at random, to lack, to clarify, similarity, evidently, to conceive the idea, emergence, to presume, to verify, to conjecture

B. to confirm, to suppose, to guess, not to have, obviously, without reason or aim, to make clear, to form in the mind, likeness, appearance

II. Put all possible questions to the following sentences.

1) The kinetic molecular theory of matter states that all particles have energy.
2) Molecules in the solid phase have the least amount of energy.
3) There are spaces between particles of matter.
4) The kinetic theory of matter is also illustrated by the process of diffusion.
5) There are attractive forces between atoms.
6) The energy of the molecules increases, if the ice is heated.
7) The color slowly spreads out through the water.

III. Put the words into the right order. Check your answers with the text.

1. The |kinetic | offers |a description| of the microscopic| theory |of matter |properties |and molecular| their| interactions |of atoms (or molecules).
2. energy |in the solid | have| amount| of | Molecules |phase |the least.

3. attractive |There | forces |are| atoms| between.
4. water | Let's| as | example| take |an.
5. If | the | is |the |energy | the| molecules| increases| ice |heated | of.
6. forces| intermolecular |attractive |called |These| are| forces.
7. concentration| is |the | of | from| a |high |Diffusion| to| a| concentration| movement| particles| low.

IV. *Guess the words***:**

1. caromlule
2. icosopicmrc
3. fisonfidu
4. nicekti
5. rocsfe

V. Render the text into English:

В новогодний подарок - снежинки!

Великий немецкий ученый астроном и математик Иоганн Кеплер в 1611 году опубликовал небольшую книжку, которая называлась "Новогодний подарок, или о шестиугольных снежинках" (см. Кеплер И. О шестиугольных снежинках. - М.: Наука, 1982. - 192 с.). В ней он в шутливой форме описывал свои размышления по дороге к королевскому советнику фон Вакенфельсу. Он намеревался преподнести новогодний подарок своему покровителю, но ничего интересного не мог придумать. И тут он обратил внимание на падающие снежинки. "Этот подарок ниспослан с неба и несет в себе подобие звезд!" - воскликнул он.

Далее он обратил внимание на то, что снежинки содержат всегда шесть лучей, а не семь или пять. Размышляя об этом, Кеплер пришел к выводу, что причина шестиугольности снега, а также пчелиных сот и ячеек граната обусловлена одним: плотной упаковкой каких-то шаровых элементов, их составляющих. Это первая интуитивная догадка о геометрически правильном внутреннем строении кристаллов.

(Adopted from www.nkj.ru)

C. Activities

What do you know about scientists who worked in the field of thermal physics investigation? Find information and present it to your group.

Text 2. Thermal properties of matter

«All the properties of matter are so connected that we can scarcely imagine one thoroughly explained, without our seeing its relation to all the others; without, in fact, having the explanation of all» [PLA, vol. 1, «Constitution of Matter»]

PRE-READING

Give answers to the following questions:

1. Can you discuss the thermal properties of matter?
2. What is the difference in meanings between the terms of heat and temperature?

Active vocabulary

Word	Pronunciation	Translation
asymmetric, adj.	/ˌeɪsɪˈmetrɪk/	асимметричный
beaker, n.	/ˈbiːkər/	мензурка, лабораторный стакан
behavior, n.	/bɪˈheɪvjər/	поведение
blanket, n.	/ˈblæŋkɪt/	покров, слой, syn. coating, cover
calibrate, v.	/ˈkælɪbreɪt/	проверять, выверять; калибровать, градуировать
coefficient, n.	/ˌkəʊɪˈfɪʃənt/	коэффициент
contract, v.	/ˈkɒntrækt/	сжимать(ся),сокращать(ся), суживать(ся), syn. shrink, tighten
convenience, n.	/kənˈviːniəns/	удобство, syn. comfort
curve, n.	/kɜːv/	изгиб, кривая
expand, v.	/ɪkˈspænd/	расширять(ся),распространять(ся), syn. enlarge, vast, widen
equilibrium, n.	/ˌiːkwɪˈlɪbriəm/	равновесие
extremity, n.	/ɪkˈstreməti/	конечности
flame, n.	/fleɪm/	пламя, огонь, syn. blaze, fire
flow, n.	/fləʊ/	течение, поток
general, adj.	/ˈdʒenərəl/	общий, основной, syn. basic, fundamental
length, n.	/leŋθ/	длина

mark, v/n.	/mɑːk/	отмечать, обозначать, маркировать отметка, обозначение, маркировка
oscillate, v.	/ˈɒsɪleɪt/	двигаться взад и вперед, колебаться, осциллировать
peculiar, adj.	/pɪˈkjuːliər/	особенный, своеобразный, syn. especial, unusual
place, v.	/pleɪs/	ставить, помещать, размещать, syn. put
popsicle, n.	/ˈpɒpsɪkḷ /	мороженое на палочке
scale, n.	/skeɪl/	размер, масштаб, шкала
shape, n.	/ʃeɪp/	форма, очертание
shift, n.	/ʃɪft/	сдвиг, изменение
thermal, adj.	/ˈθɜːməl/	теплый, термальный; тепловой
thermometer, n.	/θəˈmɒmɪtər/	термометр
wax, n.	/wæks/	воск

READING

Read and translate the text using a dictionary if necessary:

To discuss the thermal properties of matter, we need to define some general thermal concepts, such as: the difference between heat and temperature, thermal equilibrium, the zeroth law of thermodynamics, and the absolute temperature scale.

In everyday language we use the terms «heat» and «temperature» loosely as if they had the same meaning. In physics they have different meanings. Consider the following example.

Take a beaker half filled with water and place some ice in it. Put a thermometer in the water and wait till the temperature of the water becomes stable so that the temperature of the water and the ice are the same. Now place the beaker over a Bunsen burner and start heating it. You will notice that the temperature of the water stays the same as long as there is ice left. We all agree that the flame is heating the water but the thermometer says that the temperature does not change. Once all the ice melts, the temperature of the water starts to rise. From this we can see that we need to closely examine our ideas about the meanings of heat and temperature and distinguish them. Temperature is related to the average kinetic energy of the particles (atoms or molecules). Heat is the amount of energy transferred to a system of particles. In the above examples, we were transferred heat to the system, which in turn melted the ice but the temperature did not change.

Thermal equilibrium

Thermal equilibrium is simply another way of saying that two or more objects are at the same temperature. For instance, your best friend and you have never met, not even shaken hands. Yet if you are in good health you can bet that your body temperatures are at 37 ºC. You are both in thermal equilibrium. Ignoring the fact that our extremities (e.g hands, feet and nose) may be colder than the rest of our body. This is sometimes called the zeroth law of thermodynamics. The reason for this is that physicists first found the first and second laws, then realised that there is a more fundamental law so they decided to give it the number zero. More formally the law can be quoted as follows:

«Zeroth law of thermodynamics: If object A and object B are in thermal equilibrium with object C, then they are in thermal equilibrium with each other».

Absolute Temperature scale

There is a physical lower temperature limit of matter. Nothing can be cooled below -273.15 ºC. For convenience, scientists have devised the absolute temperature scale which starts with -273.15 ºC and called it Kelvin (not degrees Kelvin). So the relationship between Celsius and Kelvin is:

TK=TC+273.15, where TK is the temperature in Kelvin, and TC is the temperature in Celsius.

Examples: Ice freezes at 0 ºC or TK= 0 +273.15= 273.15 Kelvin. Normal room temperature is at 20 ºC or TK = 20 + 273.15 = 293.15 Kelvin.

How to make a thermometer

To measure temperature we have to measure another macroscopic quantity that is directly influenced by temperature. There are many ways to do this. Thermometers use physical properties ranging from electrical resistance to radioactivity. But the oldest of all is the mercury thermometer. All materials change their physical dimensions when heated or cooled. The change in length is a direct measure of temperature.

To make a thermometer, we fill a thin glass tube with mercury (some use alcohol). Place the tube in ice that's been sitting in the room for a while and starting to melt. We then note the position of the mercury column on the glass tube. We can call this level whatever we like, but we choose to call it 0 ºC. We then place the tube in boiling water and watch the mercury column expand to another length. We then call this level 100 ºC for convenience. We can then divide the length between the two positions into 100 equal segments and call each one 1 ºC. Note that there is nothing special about this way of putting marks on a thermometer. It is simply for human convenience. We could have equally chosen a material other than water to calibrate our thermometer. We could have chosen wax. That it, we could have chosen 0 ºC to be the temperature when wax just starts to melt, and 100 ºC when it boils. There is also no need to call one 0 and one 100 such as the Fahrenheit scale which we will not be using here.

Thermal Expansion

When a material is heated or cooled, it changes its dimensions. Generally, it expands when heated and contracts when cooled although there can be exceptions to this rule.

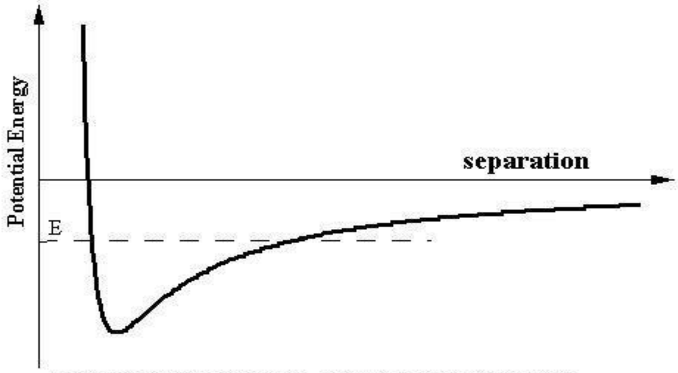
Examples: If water is gradually cooled, it shrinks in size as expected. But at 3.98 ºC it begins to expand again until it turns to ice at 0 ºC. This expansion is peculiar to water and is associated with the unusual shape of the water molecule. This behavior explains why lakes freeze from the top downwards in winter. The colder water is at the top of the lake because it expands and becomes less dense. When this water freezes it insulates the water below it from the outside cold air like a blanket. It is because of this property many fish can survive the winter rather than becoming part of a giant Popsicle.

When you first turn on a hot water tap, the water rushes out but is still cold. When it starts to become hot, the flow of water starts to become less and in some cases it stops. This can be explained as follows: the hot water heats the metal valve inside the tap which expands to block off any more flow of water. The change in length of a solid is related to the original length and the change in temperature.

$\Delta L = L_0 \alpha \Delta T$, where ΔL is the change in length, L_0 is the original length before the change, ΔT is the change in temperature, and α is the linear thermal coefficient of expansion, which is different for different materials.

Thermal Expansion at the atomic level

At the atomic level, thermal expansion means there is an increase in the average spacing between atoms. As a particular atom oscillates about its equilibrium position, it experiences an asymmetric potential energy as shown in figure 2. If it moves towards another atom it experiences a very steep rise in the potential energy. Whereas if it moves away from the other atom, it experiences a relatively slow increase in the potential energy and so travels much further. The asymmetry in the potential energy curve leads to a shift in the average position of the atom.



Potential energy between two atoms in a solid. For a given energy, E, the average separation increases due to the asymmetry of the curve.

(Adopted from www.physics.usyd.edu.au)

A. Checking your understanding

I. Give answers to the following questions:

1) What is the text concerned with?
2) Can you define the general thermal concepts?
3) Do we use the terms «heat» and «temperature» in the same meaning in everyday language and in Physics?
4) What is equilibrium? Give your examples of its understanding.
5) How do you understand the term "thermal equilibrium"?
6) Is there a physical lower temperature limit of matter?
7) What kind of a thermometer is the oldest of all?
8) Do you know how to make a thermometer?
9) When does a material change its dimensions?
10) What does thermal expansion mean at the atomic level?

II. Are these sentences true or false?

1. Once all the ice melts, the temperature of the water starts to rise.
2. Temperature isn't related to the average kinetic energy of the particles (atoms or molecules).
3. Heat is the amount of energy transferred to a system of particles.
4. Nothing can be cooled below - 300 ºC.
5. There is only one way to measure temperature.
6. To make a thermometer, we fill a thin glass tube with water (some use mercury, alcohol).
7. When a material is heated or cooled, it doesn't change its dimensions.

B. Work with language

I. Put all possible questions to the following sentences.

1) In everyday language we use the terms «heat» and «temperature».
2) In physics they have different meanings.
3) Temperature is related to the average kinetic energy of the particles.
4) Heat is the amount of energy transferred to a system of particles.
5) We can call this level 0 ºC.
6) To make a thermometer, we fill a thin glass tube with mercury.
7) We put a thermometer in the water.

II. Put the words into the right order. Check your answers with the text.

1) the |is | energy |a system| of | amount |of |particles |transferred |to| Heat
2) physics |In | have| different| meanings |they.
3) It |simply | for |is| convenience| human.
4) lower | matter| There is | a| physical |of |temperature| limit
5) If | cooled |in |shrinks| as| gradually |size |it |water |expected |is.
6) mercury| a |To |we |thin| with| tube| make| fill |a | glass |thermometer
7) asymmetry| The |average | of | leads to| a |the |atom |shift| in| position| the| in| potential| the| energy| curve.

III. Guess the words:

1) alsce
2) ecloemul
3) mqbiilireuu

4) nyexetirt
5) Cuessil

IV. Translate the following phrases into Russian and learn them:

Up to now, over many years, most recently, shortly after, every now and then, most of the time, throughout the 20^{th} century, within the next few years, for a while, well before, from this time on, every now and then.

C. Activities

I. Prepare a presentation on simple physical experiments which you can conduct at home (so there is the stuff you need on your hands).

II. Be ready to present and discuss the experiment conducted at home with your partner.

Text 3. Thermal (heat) energy transfers

Heat, like gravity, penetrates every substance of the universe; its rays occupy all parts of space. The object of our work is to set forth the mathematical laws which this element obeys. The theory of heat will hereafter form one of the most important branches of general physics. Baron Jean-Baptiste-Joseph Fourier

PRE-READING

Give answers to the following questions:

1. "Prometheus stole fire and brought it to people". Why was it so important?
2. What human activities depend on energy?

Active vocabulary

Word	Pronunciation	Translation
absorb, v.	/əbˈzɔːb/	впитывать, поглощать, syn. take in
collision, n.	/kəˈlɪʒən/	столкновение
container, n.	/kənˈteɪnər/	емкость, сосуд, тара
convection, n.	/kənˈvekʃən/	конвекция
cool, v.	/kuːl/	охлаждать, syn. chill
distant, adj.	/ˈdɪstənt/	далекий, дальний, syn. far, remote
electricity, n.	/ɪˌlekˈtrɪsəti/	электричество
electric heater	/ɪˈlektrɪkˈhiːtər/	электрический нагревательный прибор, электронагреватель
increase, v.	/ɪnˈkriːs/	увеличивать(ся), повышать(ся)
metal, n.	/ˈmetəl/	металл
neighbor, n/adj.	/ˈneɪbər/	сосед, соседний, ближний
radiation, n.	/ˌreɪdiˈeɪʃən/	радиация, излучение
ultimately, adv.	/ˈʌltɪmətli/	в конце концов, в конечном итоге, syn. finally
wood, n.	/wʊd/	дерево, древесина

READING

Read and translate the text using a dictionary if necessary:

Heat transfer is the transfer of thermal energy from a higher temperature object or system to another system, raising its temperature. This process changes the thermal energy of both systems involved until thermal equilibrium is reached. Thermal energy can be transferred from one end of a material to the other or from one material to another through conduction. It is also transferred indirectly by convection and radiation.

Conduction

Thermal energy can be transferred from one substance to another when they are in direct contact. The moving molecules of one material can increase the energy of the molecules of the other. Heat can also travel along a material as one molecule transfers energy to a neighboring one. Conduction is mainly seen with solid objects, but it can happen when any materials come into contact. When you put your hand in a container of warm water, you hand it heated by conduction from the water.

Some materials are better conductors of heat than others. For example, metals are good conductors of heat, while a material like wood is not. Metal heated on one end will soon be hot on the other end too, while that is not true with a piece of wood. Good conductors of electricity are often good conductors of heat. Since the atoms are closer together, solids conduct heat better than liquids or gazes. This means that two solid materials in contact would transfer heat from one to the other better than a solid in contact with a gas or a gas with a liquid.

Convection

When a gas or a liquid is heated, hot areas of the material flow and mix with the cool areas. Forced air heating and air conditioning are examples of heating (or cooling) by convection. This is an effective way of bringing a hot (or cold) fluid to a different area. Convection transfers heat over a distance faster than conduction. But ultimately conduction must transfer the heat from the gas to the other object, though molecular contact.

Radiation

A third method to transfer heat is by radiation. A warm or hot object gives off infrared electromagnetic radiation, which can be absorbed in another object at some separation, heating it up. However, the heat transfer only works in one direction. You cannot cool an object by radiation, as you can with conduction or convection. Electric heaters use radiation to heat an area. If a fan is added, the device uses both radiation and convection to heat the area. Transfer of heat by radiation travels at the speed of light and goes great distances, even in a vacuum. We are heated from the Sun through radiation transfer of heat.

To summarize, thermal (heat) energy can be transferred from one substance to another or one end of a material to the other through conduction. Also it can be transferred indirectly by convection and radiation. Atoms or molecules transfer kinetic energy to their neighbors through collisions. When objects are in contact this transfers heat by conduction. Liquids and gases can move high or low energy molecules to another region through convection. Atoms can radiate energy that can energize a distant atom, resulting in heat transfer by radiation.

(Adopted from www.school-for-champions.com)

A. Checking your understanding

I. Answer the following questions:

1) What problem is the passage deal with?
2) What is the main idea of the text?
3) Does the title of the passage adequately express the main idea?
4) Have you ever watched films about radioactive disasters? Which one(s)?

II. Review questions:

1) Why would two solid materials in contact transfer heat better than a solid in contact with a gas or a gas with a liquid?
2) What happens when a gas or liquid is heated?
3) What is the third method to transfer heat?
4) Can you cool an object by radiation? Why (not)?
5) How do atoms or molecules transfer kinetic energy to their neighbors?

III. <u>Look through the passage and fill in the blanks with the proper words.</u>

1. We are heated from the Sun through_______transfer of heat.
2. However, the heat transfer only works in one_________.
3. Good conductors of_______are often good conductors of heat.
4. Heat transfer is the transfer of thermal energy from a higher ______ object or system to another system, raising its temperature.
5. When objects are in contact this transfers_______by conduction.

B. Work with language

I. <u>Put all possible questions to the following sentences.</u>

1) Conduction is mainly seen with solid objects, but it can happen when any materials come into contact.
2) When you put your hand in a container of warm water, you hand it heated by conduction from the water.
3) Atoms can radiate energy that can energize a distant atom, resulting in heat transfer by radiation.
4) Thermal energy can be transferred from one substance to another when they are in direct contact.
5) The moving molecules of one material can increase the energy of the molecules of the other.

II. <u>Guess the words:</u>

1) uidliq
2) toseparnia
3) rdioaaitn
4) crtaineno
5) yegner

III. <u>Match these words with their opposites:</u>

A. local, temporary, general, concentrated, synthesized, outdated, deep, pure, natural, simple, fast, exact, small
B. slow, complicated, global, up-to-date, vast, shallow, permanent, man-made, diluted, decomposed, approximate, specific, contaminated.

IV. Render the text into English:

Генерал от физики

Итальянский физик Алессандро Вольта, вызванный в Париж по велению консула Франции Наполеона, докладывал о своих исследованиях перед членами французской Академии. Существует картина, изображающая доклад Вольта перед Наполеоном.

Интерес Наполеона к его исследованиям не был эпизодическим. Он осыпал его наградами, титулами графа, сенатора королевства Ломбардского, часто вспоминал физика. Если Вольта отсутствовал на каком - нибудь из приемов, Бонапарт немедленно спрашивал, не болен ли ученый. Когда в 1804 г. Вольта решил было оставить преподавание в университете, Наполеон, узнав об этом, решительно воспротивился: "Я не могу согласиться на отставку Вольта; если его тяготят обязанности профессора, можно сократить их; если хочет, пусть читает одну лекцию в год. Университет Навийский будет поражен смертельно, когда из списка его членов исключится имя Вольта. Притом, добрый генерал должен умереть на поле чести". Генерал от физики внял просьбе императора и остался на кафедре.

Наполеону докладывали о некоторых странностях Вольта. В Париже немало удивлялись, видя, как он ежедневно заходил к булочнику, покупал большой хлеб и медленно сжевывал его прямо на улице, погруженный в раздумья, и, не обращая никакого внимания на прохожих.

(Adopted from современная физика.рф)

C. Activities

Think and talk about:

1) Heat and energy. What interrelation is there between them?
2) Great discoveries in the field came from experimental practice and not vice versa. Why? Give examples.
3) Do you know Galileo to have constructed the first air-expansion thermometer? Find information about it.

UNIT 3. PHYSICS OF WAVES, ELECTRICITY AND MAGNETISM

Text 1. Sound and light

Boss: I just heard that light travels faster than sound. I`m wondering if I should shout when I speak, so that my lips appear to sync-up with my words.
Dilbert (thought): I little knowledge can be a ridiculous thing.
Scott Adams

PRE-READING

Before reading the passage, read its headline and say what you know about it. Discuss it with your partner. Then read the passage and find the facts supporting your knowledge.

Active vocabulary

Word	Pronunciation	Translation
advanced, adj.	/ədˈvɑːnst/	прогрессивный, продвинутый, syn. developed, progressive
comprehend, v.	/ˌkɒmprɪˈhend/	понимать, syn. understand
detectable, adj.	/dɪˈtektəbl̩ /	обнаружимый, детектируемый
dim, adj.	/dɪm/	тусклый, неяркий, syn. dull, wan
frequency, n.	/ˈfriːkwənsi/	частота
insect, n.	/ˈɪnsekt/	насекомое
light, n.	/laɪt/	свет
mammal, n.	/ˈmæməl/	млекопитающее
perceive, v.	/pəˈsiːv/	воспринимать, различать
pitch, n.	/pɪtʃ/	высота (тона, звука)
realm, n.	/relm/	область, сфера, syn. area, field
reptile, n.	/ˈreptaɪl/	пресмыкающееся
significant, adj.	/sɪɡˈnɪfɪkənt/	важный, значительный, syn. important, sufficient
sound, n.	/saʊnd/	звук
tone, n.	/təʊn/	звук, тон

vibration, n.	/vaɪˈbreɪʃən/	вибрация
visible, adj.	/ˈvɪzəbl/	видимый, зримый, syn. visual

READING

Read and translate the text using a dictionary if necessary:

Physics is a specific area of study in the field of science that focuses on the makeup and properties of both energy and matter, as well as how the two interact together. The most basic and significant matters in physics are the study of light and sound. A lot of more advanced principles and studies in the realm of physics lead back to general knowledge about the way both of these function. One of the most important facts to understand about both light and sound is that both are forms of energy that move in waves. While they are both forms of energy that travel in the form of waves, there are vital differences between sound waves and light waves.

Sound and light travel at significantly different speeds. Light waves move at speeds that are nearly one million times faster than sound waves are capable of traveling. Light waves are capable of moving through empty space at speeds of around 186,000 miles (or 299,792,458 meters) per second. This is faster than most humans can even begin to comprehend. This is also the reason behind the expression, «faster than the speed of light». In the field of physics, the term «light» is usually used to refer to electromagnetic radiation.

However, there are various other types of light. Other forms of light include infrared light, ultraviolet light and light that is visible to humans, known as visible light. Each type of light has different wave length frequencies, some being high and some being low. The frequency of the light determines if it is detectable by the human eye, although humans are capable of seeing different types of wave lengths than other species. Insects such as bees and spiders, for instance, are capable of viewing ultraviolet light, while reptiles like snakes can view some infrared lights. Some mammals, like monkeys, are capable of seeing the same light as humans. Others, like dogs, see similar light but view fewer colors that are a lot dimmer than humans perceive them to be. Dogs often perceive light and colors as a dull yellow, blue or gray. The main key to understanding light is in realizing that light is all around, in many forms, although humans are simply unable to view most types with their eyes alone.

Sound waves are much different than light waves in the manner in which they travel. Sound waves move much slower than light waves at speeds of about 1,125 feet (about 340 meters) per second. Sound waves are also different in the sense that they travel through any type of substance, whether solid, liquid or gas, whereas light travels best through empty space. When sound waves hit materials, they cause vibrations. These vibrations are either high frequency or low frequency. Low frequency sound waves produce low tones while high frequency waves create high-pitched tones.

When the frequency of the sound waves changes, it creates a change of pitch in the sound that is heard by the human ear. As with light waves, the level of sound wave frequencies that can be perceived is dependent upon the capability of the species body. Humans are actually not among the greatest hearing species in the world. Human ears are only capable of hearing frequencies of about 20 kilohertz (a form of measuring frequencies), while the species that is known to have the highest capability of hearing, the Greater Wax Moth, can hear frequencies of around 300 kHz. As with light waves, it is also important to remember that sound waves are everywhere, despite the fact that human ears are incapable of hearing many sounds.

Understanding the speed of light and sound, the way they travel and how they both operate is vital knowledge to have when it comes to pursuing more complex subjects in physics such as radiation and atoms.

(Adopted from www.boogeylights.com)

A. Checking your understanding

I. Give answers to the following questions:

1) What are basic and significant matters in physics to study?
2) What are the vital differences between sound waves and light waves?
3) Are there some other types of light? Can you name them?
4) What is peculiar about different animals` ability to view some types of light? Give examples.
5) What happens when sound waves hit materials?

II. *<u>There are several definitions in the text. What are they? Complete the sentences with appropriate words (in some sentences you need more than 1 word).</u>*

1) … - a specific area of study in the field of science that focuses on the makeup and properties of both energy and matter, as well as how the two interact together.
2) … … - both forms of energy that travel in the form of waves.
3) … … - are only capable of hearing frequencies of about 20 kilohertz.
4) ... determines if it is detectable by the human eye, although humans are capable of seeing different types of wave lengths than other species.

III. *<u>Are these sentences true or false?</u>*

1) When the frequency of the sound waves changes, it creates a change of pitch in the sound that is not heard by the human ear.
2) Each type of light has different wave length frequencies.
3) Humans are among the greatest hearing species in the world.
4) Both light and sound are forms of energy that move in waves.
5) The level of sound wave frequencies that can be perceived is dependent upon the capability of the species body.

B. Work with language

*<u>I. Match each word in **A** with its synonym in **B**.</u>*

A. to reverse, to conform, multitude, to occur, to come into being , relic, evidence, moment

B. something surviving from the past, proof, to happen, a great number, to turn in an opposite direction, instant, to correspond, to originate.

<u>II. Give English equivalents:</u>

a. частота световой волны
b. вызывать вибрации
c. инфракрасное излучение
d. жизненно необходимые знания
e. формы энергии
f. ультрафиолетовое излучение
g. зависеть от агрегатного состояния вещества
h. опознаваемый человеческими глазами
i. виды животных
j. пустое пространство

III. Guess the words:

1) dpees
2) nisstec
3) locro
4) iglth
5) cbusentsa

IV. Translate this text into Russian (in writing) and suggest your own title for the text.

At the end of the nineteenth century, the teenager Albert Einstein read a book series by Aaron Bernstein discussing the speed of light. The book asked what would happen if an observer moved at the same speed as light. Einstein thought much about the issue, and in particular, asked himself what kind of electromagnetic field he would observe in that case. Einstein later explained that this experiment convinced him already at that young age that nothing could travel at the speed of light, since the field observed would have a property not found in nature. Can you find out which one he meant?

Riding on a light beam situation would have strange consequences:

You would have no mirror image, like a vampire.

Light would not be oscillating, but would be a static field.

Nothing would move, like in the tale of sleeping beauty.

But also at speeds near the velocity of light observations would be interesting. You would:

see a lot of light coming towards you and almost no light from the sides or from behind; the sky would be blue/white in the front and red/black behind;

observe that everything around happens very very slowly;

experience the smallest dust particle as a deadly bullet.

Can you think of more strange consequences? It is rather reassuring that our planet moves rather slowly through its environment, when compared to the speed of light.

(Adopted from www.universe-physics.blogspot.com)

V. Render the text from Russian into English:

Странности Ампера

Ампер был чрезвычайно рассеян, предпочитал одиночество, имел неприятную для других привычку простодушно говорить все, что знал. Он был близоруким с детства.

Однажды, уходя из гостей, он перепутал шляпы и надел вместо своей круглой треугольную, принадлежавшую какому-то важному духовному лицу. Естественно, на другой день он с извинениями отнес ее владельцу. Но все посчитали это не рассеянностью, а обдуманным поступком, имевшим целью завести полезное знакомство.

Ампер не знал того, что он близорук. Ему казалось в порядке вещей, что предметы уже на небольшом удалении теряют четкие очертания, становятся размытыми. Однажды он ехал в карете с человеком, который тоже был близорук, но носил очки. Вероятно, видя, как щурится молодой человек, он предложил ему надеть свои очки. И то, что увидел сквозь них Ампер - четкий красочный мир, - так потрясло его, что он расплакался.

Близорукостью Ампера безжалостно пользовались школьники, которых он учил. Их забавляло, что учитель писал не кистью руки, как все, а делал это всей рукой и смешно изгибался при этом. Видя, что их преподаватель пишет покрупнее, чтобы было видно всем, дети стали прикидываться близорукими и просить, чтобы он писал еще крупнее. Ничего не подозревавший Ампер дошел до того, что на большой доске писал всего одно слово.

Будучи на лекции, Ампер мог спутать тряпку, которой стирают мел, с носовым платком. Ампер был чрезвычайно легковерен, и его часто разыгрывали, рассказывая совершенно невероятные истории. Он верил им - но не по глупости, а, как тонко заметил один из его друзей, потому что легковерие его было плодом воображения и гениальности. В любой несуразности, в кажущейся бессмысленности он машинально находил какой-то порядок, какую-то только ему ведомую гармонию.

Разумеется, это казалось забавным людям посредственным и завистливым, но именно поэтому не им, а Амперу удалось увидеть новые законы там, где их не видел никто.

(Adopted from www.interesnyjfakt.ru)

VI. Translate the following text from English into Russian:

Thomas Edison was born in 1847. He first went to school at the age of eight and a half. But after only three months his teacher called him «stupid» and he came home crying. From that time his mother taught him at home and he read science books by himself. He got a job sending telegraph messages. Then he started inventing things.

At the age of 12 he had a job selling newspapers. He made money in a clever but simple way. He checked the news stories first. When the news was interesting he took a lot of papers; when it was boring he took only few.

In 1877 he made a «phonograph» — the first ever sound recorder. The following year he invented the light bulb. In 1882 New York was the first city in the world with electric lights. In 1889 he made a «kinetoscope». He also made films for his new machine. In 1903 he made the world's longest film (It was ten minutes long!). After more than one thousand inventions, Edison died at the age of eighty-four. In his honor they switched off the lights all over America.

(Adopted from www.alleng.ru)

C. Activities

I. Make up a presentation for 5 min on biography/amazing facts about prominent scientists (Albert Einstein, Isaac Newton, Pierre and Marie Curie, etc.).

II. Be prepared to present an oral report.

Text 2. Properties of waves

«Life is a wave, which in no two consecutive moments of its existence is composed of the same particles» John Tyndall

PRE-READING

Ask and discuss the following questions in pairs/groups

1. What makes a wave a wave?
2. What characteristics, properties, or behaviors are shared by the phenomena that we typically characterize as being a wave?
3. How can waves be described in a manner that allows us to understand their basic nature and qualities?

Active vocabulary

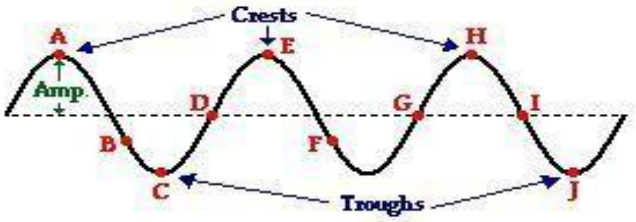
Word	Pronunciation	Translation
alternate, v.	/ˈɔːltəneɪt/	чередоваться
amplitude, n.	/ˈæmplɪtjuːd/	амплитуда
coil, n.	/kɔɪl/	виток; катушка
crest, n.	/krest/	гребень (волны)
compression, n.	/kəmˈpreʃən/	сжатие
dashed line	/dæʃtlaɪn/	пунктирная линия
density, n.	/ˈdensɪti/	плотность, удельная масса
displace, v.	/dɪˈspleɪs/	вытеснять, заменять, syn. dislodge
disturbance, n.	/dɪˈstɜːbəns/	нарушение покоя, волнения
exhibit, v.	/ɪɡˈzɪbɪt/	выставлять, показывать, syn. show, present
horizontal, adj.	/ˌhɒrɪˈzɒntəl/	горизонтальный
perpendicular, adj.	/ˌpɜːpənˈdɪkjʊlər/	перпендикулярный
rarefaction, n.	/reərˈfækʃən/	разрежение
rest position	/rest pəˈzɪʃən/	положение покоя
rope, n.	/rəʊp/	веревка, канат
spatial repetition	/ˈspeɪʃəl ˌrepɪˈtɪʃən/	пространственное повторение
transverse, adj.	/trænzˈvɜːs/	поперечная
trough, n.	/trɒf/	подошва (волны)

wavelength, n.	/ˈweɪvleŋθ/	длина волны

READING

Read and translate the text using a dictionary if necessary:

A transverse wave is a wave in which the particles of the medium are displaced in a direction perpendicular to the direction of energy transport. A transverse wave can be created in a rope if the rope is stretched out horizontally and the end is vibrated back-and-forth in a vertical direction. If a snapshot of such a transverse wave could be taken so as to freeze the shape of the rope in time, then it would look like the following diagram.

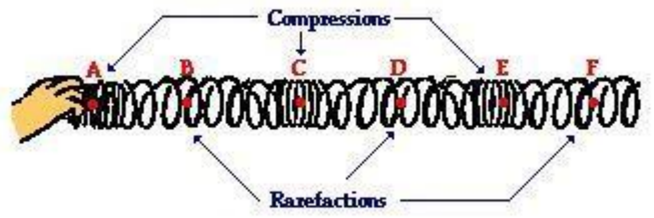


The dashed line drawn through the center of the diagram represents the equilibrium or rest position of the string. This is the position that the string would assume if there were no disturbance moving through it. Once a disturbance is introduced into the string, the particles of the string begin to vibrate upwards and downwards. At any given moment in time, a particle on the medium could be above or below the rest position. Points A, E and H on the diagram represent the crests of this wave. The crest of a wave is the point on the medium that exhibits the maximum amount of positive or upward displacement from the rest position. Points C and J on the diagram represent the troughs of this wave. The trough of a wave is the point on the medium that exhibits the maximum amount of negative or downward displacement from the rest position.

The wave shown above can be described by a variety of properties. One such property is amplitude. The amplitude of a wave refers to the maximum amount of displacement of a particle on the medium from its rest position. In a sense, the amplitude is the distance from rest to crest. Similarly, the amplitude can be measured from the rest position to the trough position. In the diagram above, the amplitude could be measured as the distance of a line segment that is perpendicular to the rest position and extends vertically upward from the rest position to point A.

The wavelength is another property of a wave that is portrayed in the diagram above. The wavelength of a wave is simply the length of one complete wave cycle. If you were to trace your finger across the wave in the diagram above, you would notice that your finger repeats its path. A wave is a repeating pattern. It repeats itself in a periodic and regular fashion over both time and space. The length of one such spatial repetition (known as a wave cycle) is the wavelength. The wavelength can be measured as the distance from crest to crest or from trough to trough. In fact, the wavelength of a wave can be measured as the distance from a point on a wave to the corresponding point on the next cycle of the wave. In the diagram above, the wavelength is the horizontal distance from A to E, or the horizontal distance from B to F, or the horizontal distance from D to G, or the horizontal distance from E to H. Any one of these distance measurements would suffice in determining the wavelength of this wave.

A longitudinal wave is a wave in which the particles of the medium are displaced in a direction parallel to the direction of energy transport. A longitudinal wave can be created in a slinky if the slinky is stretched out horizontally and the end coil is vibrated back-and-forth in a horizontal direction. If a snapshot of such a longitudinal wave could be taken so as to freeze the shape of the slinky in time, then it would look like the following diagram.



Because the coils of the slinky are vibrating longitudinally, there are regions where they become pressed together and other regions where they are spread apart. A region where the coils are pressed together in a small amount of space is known as a compression. A compression is a point on a medium through which a longitudinal wave is traveling that has the maximum density. A region where the coils are spread apart, thus maximizing the distance between coils, is known as a rarefaction. A rarefaction is a point on a medium through which a longitudinal wave is traveling that has the minimum density. Points A, C and E on the diagram above represent compressions and points B, D, and F represent rarefactions. While a transverse wave has an alternating pattern of crests and troughs, a longitudinal wave has an alternating pattern of compressions and rarefactions.

As discussed above, the wavelength of a wave is the length of one complete cycle of a wave. For a transverse wave, the wavelength is determined by measuring from crest to crest. A longitudinal wave does not have crest; so how can its wavelength be determined? The wavelength can always be determined by measuring the distance between any two corresponding points on adjacent waves. In the case of a longitudinal wave, a wavelength measurement is made by measuring the distance from a compression to the next compression or from a rarefaction to the next rarefaction. On the diagram above, the distance from point A to point C or from point B to point D would be representative of the wavelength.

(Adopted from www.physicsclassroom.com)

A. Checking your understanding

I. Give answers to the following questions:

1. What is a wavelength?
2. How can the wavelength be determined?
3. What types of waves are you familiar with?
4. Can you give their definitions and note the main features?
5. What is peculiar about the regions of a coil?

II. There are several definitions in the text. What are they? Complete the sentences with the appropriate word(s).

1. A______________is a wave in which the particles of the medium are displaced in a direction perpendicular to the direction of energy transport.
2. The length of one such spatial repetition (known as a wave cycle) is the________.
3. A________is a point on a medium through which a longitudinal wave is traveling that has the maximum density.
4. A_______________is a wave in which the particles of the medium are displaced in a direction parallel to the direction of energy transport.
5. A_________is a point on a medium through which a longitudinal wave is traveling that has the minimum density.

III. <u>Are these sentences true or false?</u>

1. The wavelength can always be determined by measuring the distance between any two corresponding points on adjacent waves.
2. A region where the coils are pressed together in a small amount of space is known as a compression.
3. A transverse wave can be created in a rope if the rope is stretched out vertically and the end is vibrated back-and-forth in a horizontal direction.
4. While a longitudinal wave has an alternating pattern of crests and troughs, a transverse wave has an alternating pattern of compressions and rarefactions.
5. A region where the coils are spread apart, thus maximizing the distance between coils, is known as a rarefaction.

B. Work with language

*<u>I.</u> <u>Match each word in **A** with its antonym in **B**.</u>*

A. conventional, relic, rigidity, to contract, to disagree, expansion, meaningful

B. uncommon, modern, flexibility, meaningless, contraction, to conform, to expand

<u>II.</u> <u>Give Russian equivalents to the following phrases:</u>

1. the cycle of the wave
2. the particles of the string
3. the maximum density
4. to be spread apart
5. to freeze the shape
6. the shape of the slinky
7. the diagram represent the troughs
8. begin to vibrate upwards and downwards
9. be described by a variety of properties
10. the rope is stretched out horizontally

III. Guess the words:

1) retsc
2) vewaletnhg
3) shosptna
4) icol
5) adigrma

IV. Read, translate and give the title to this article:

Light is, in general, a mixture of wavelengths. As a result, light wavelength or frequency are not sufficient to describe color. Color experts call hue that aspect of color that matches most closely the change with wavelength. But every color has two additional characteristics. For example, any given color can be bright or dark; brightness is a second, independent property of color. A third independent property of color is its saturation; it expresses how strongly a color differs from white. A strongly saturated color is the opposite of a pale or weakly saturated color.

Human color space is three-dimensional. Humans are trichromatic. Every color we see is described by three independent parameters, because the human eye has three types of cones, thus three types of color-sensitive cells. At least three parameters that can be varied. A modern artist, Tauba Auerbach, even produced a beautiful book version of the color space. The number three is also the reason that every display has at least three different types of pixels. These three parameters do not need to be hue, saturation and brightness value. They can also be taken to be the intensities of red, green and blue. Many other color properties can be used to describe color, such as lightness, chroma, purity, luma and others. Also descriptions with four and more parameters – which then are not independent from each other – are used, especially in the printing industry.

Many birds, reptiles, fish and various insects have four-dimensional color spaces that include the ultraviolet; butterflies and pigeons have five-dimensional color spaces, and other bird species have even higher-dimensional color spaces. Mantis shrimps possibly have the most complex eyes in the animal kingdom, with up to twelve-dimensional color spaces. In contrast to humans and apes, most mammals have only two-dimensional color spaces. Also color-blind persons can have lower-dimensional color spaces. In other terms, the number of dimensions of the perceived color space is not a property of light, nor a property of nature, but a specific property of our human eyes.

Colors in nature and colors perceived by humans differ. There is no color space in nature. Colors in nature and colors in human perception differ in an additional way, discovered by linguists. In human language, colors have a natural order. All people of the world, whether they come from the sea, the desert or the mountains, order colors in the following sequence: 1. black and white, 2. red, 3. green and yellow, 4. blue, 5. brown, 6. mauve, pink, orange, grey and sometimes a twelfth term that differs from language to language. (Colors that refer to objects, such as aubergine or sepia, or colors that are not generally applicable, such as blond, are excluded in this discussion.) The precise discovery is the following: if a particular language has a word for any of these colors, then it also has a word for all the preceding ones. The result also implies that people use these basic color classes even if their language does not have a word for each of them. These strong statements have been confirmed for over 100 languages.

(Adopted from www.motionmountain.net)

V. Render this text from Russian into English:

Физика слишком трудна для физиков

Когда М. Борн и В. Гейзенберг строили матричную квантовую механику, у них возникли затруднения, и они обратились к математику Д. Гильберту. Вот что он сказал. Когда ему приходилось иметь дело с матрицами, они получались у него в качестве побочного продукта собственных значений некой краевой задачи для дифференциального уравнения.

Д. Гильберт и посоветовал поискать уравнение, которое, возможно, стоит за этими матрицами. Не исключено, напутствовал он молодых физиков, вам откроется нечто интересное. Но они не вняли совету, сочтя это бестолковой идеей, порешив, что великий математик чего-то не понимает. А через несколько месяцев Э. Шредингер вывел знаменитое волновое уравнение, явившееся другим вариантом квантовых описаний.

Теперь пришло время посмеяться Д. Гильберту, который заметил, что если бы его послушали, то уравнение открыли бы, по крайней мере, на полгода раньше. "Видно, - заключил он, - физика слишком

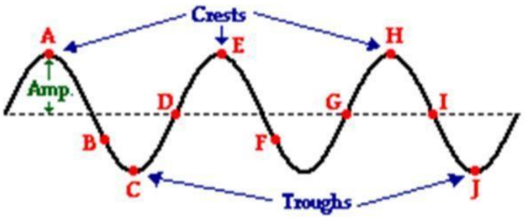
сложна для физиков". И добавил: "Физика достаточно серьезная наука, чтобы оставлять ее физикам".
(Adopted from www.nplit.ru)

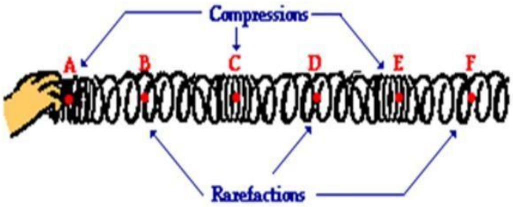
C. Activities

I. Look at the diagrams below.

II. Make a short plan noting the main points you are going to explain to your partner. There are some useful phrases: according to…, it would be wise/necessary to mention…, for instance, as for…, to make sure…, another point is that… ,in addition…, etc.

III. Present your explanation of the diagrams orally using only a plan.





Text 3. Electromagnetic forces and fields

«Is it a fact — or have I dreamt it — that, by means of electricity, the world of matter has become a great nerve, vibrating thousands of miles in a breathless point of time?»
Nathaniel Hawthorne

PRE-READING

In a small group discuss these problems and make notes of your main points. Then share opinions.

1) Any wall plug is a dipole driven by an alternating electric field. Why does not a wall plug, delivering 230 V or 100 V at 50 Hz or 60 Hz, radiate electromagnetic fields?
2) Why does a voltage transformer contain a ferromagnetic core?
3) Are there electromagnetic motors in biological systems?

Active vocabulary

Word	Pronunciation	Translation
acceleration, n.	/əkˌseləˈreɪʃən/	ускорение
ammeter, n.	/ˈæmiːtər/	амперметр
axis, n.	/ˈæksɪs/	ось
current, n.	/ˈkʌrənt/	ток
centripetal force	/ˌsentrɪˈpiːtəl fɔːs /	центростремительная сила
device, n.	/dɪˈvaɪs/	устройство, приспособление, syn. gadget
galvanometer, n.	/ˌɡælvəˈnɑmɪt̬ ər/	гальванометр
generator, n.	/ˈdʒenəreɪtər/	генератор
grasp, v.	/ɡrɑːsp/	схватывать, сжимать, syn. grab, clutch, seize
magnetite, n.	/ˈmæɡnɪtait/	магнетит, магнитный железняк
motor, n.	/ˈməʊtər/	двигатель, мотор
plane, n.	/pleɪn/	плоскость
radius, n.	/ˈreɪdiəs/	радиус
resistor, n.	/rɪˈzɪstər/	резистор, катушка сопротивления
sensitive, adj.	/ˈsensɪtɪv/	чувствительный

solenoid, n.	/ˈsəʊlənɔɪd/	соленоид
spectrometer, n.	/spekˈtrɒmɪtər/	спектрометр
thumb, n.	/θʌm/	большой палец
toroid, n.	/tərɔɪd/	тороид
torque	/tɔːrk/	вращающий момент
voltmeter, n.	/ˈvəʊltˌmiːtər/	вольтметр

READING

Read and translate the text using a dictionary if necessary:

The magnetic field of naturally occurring magnetite is too weak to be used in devices such as modern motors and generators; these magnetic fields must come from electric currents. Magnetic fields affect moving charges, and moving charges produce magnetic fields; therefore, the concepts of magnetism and electricity are closely linked to each other.

Magnetic fields and lines of force

A bar magnet attracts iron objects to its ends, called poles. One end is the north pole, and the other is the south pole. If the bar is suspended so that it is free to move, the magnet will align itself so that its north pole points to the geographic north of the earth. The suspended bar magnet acts like a compass in the earth's magnetic field. If two bar magnets are brought close together, the like poles will repel each other, and the unlike poles attract each other. This magnetic attraction or repulsion can be explained as the effect of one magnet on the other, or it can be said that one magnet sets up a magnetic field in the region around it that affects the other magnet. The magnetic field at any point is a vector. The direction of the magnetic field (B) at a specified point is the direction that the north end of a compass needle points at that position. Magnetic field lines, analogous to electric field lines, describe the force on magnetic particles placed within the field. Iron filings will align to indicate the patterns of magnetic field lines.

Force on a moving charge

If a charge moves through a magnetic field at an angle, it will experience a force. The equation is given by $F = q\, v \times B$ or $F = qvB \sin\theta$, where q is the charge, B is the magnetic field, v is the velocity, and θ is the angle between the directions of the magnetic field and the velocity; thus, using the definition of the cross product, the definition for the magnetic field is $B = \frac{F}{qv \sin\theta}$.

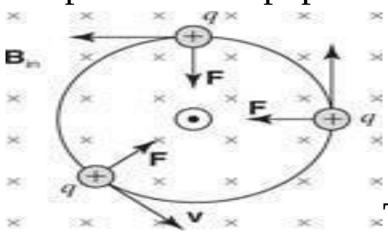
Magnetic field is expressed in SI units as a tesla (T), which is also called a weber per square meter:

$$T = \frac{Wb}{m^2} = \frac{N}{Cm/s} = \frac{N}{Am}$$

The direction of F is found from the right-hand rule, shown in Figure 1. Using the right-hand rule you can find the direction of magnetic force on a moving charge.

To find the direction of the force on the charge, with a flat hand point your thumb in the direction of the velocity of the positive charge and your fingers in the direction of the magnetic field. The direction of the force is out of the palm of your hand. (If the moving charge is negative, point your thumb opposite to its direction of motion.) Mathematically, this force is the cross product of the velocity vector and the magnetic field vector.

If the velocity of the charged particle is perpendicular to the uniform magnetic field, the force will always be directed toward the center of a circle of radius r, as shown in Figure 2. The x symbolizes a magnetic field into the plane of the paper - the tail of the arrow. (A dot symbolizes a vector out of the plane of the paper - the tip of the arrow.)



The magnetic force provides centripetal acceleration:

$F = qvB = \frac{mv^2}{r}$, or $r = \frac{mv}{qB}$ The radius of the path is proportional to the mass of the charge. This equation underlies the operation of a mass spectrometer, which can separate equally ionized atoms of slightly different masses. The singly ionized atoms are given equal velocities, and because their charges are the same and they travel through the same B, they will travel in slightly different paths and can then be separated.

Force on a current-carrying conductor

Charges confined to wires can also experience a force in a magnetic field. A current (I) in a magnetic field (B) experiences a force (F) given by the equation F = I l × B or F = IlB sin θ, where l is the length of the wire, represented by a vector pointing in the direction of the current. The direction of the force may be found by a right-hand rule similar to the one shown in Figure above. In this case, point your thumb in the direction of the current - the direction of motion of positive charges. The current will experience no force if it is parallel to the magnetic field.

Torque on a current loop

A loop of current in a magnetic field can experience a torque if it is free to turn. Figure (a) depicts a square loop of wire in a magnetic field directed to the right. Imagine in Figure (b) that the axis of the wire is turned to an angle (θ) with the magnetic field and that the view is looking down on the top of the loop. The x in a circle depicts the current traveling into the page away from the viewer, and the dot in a circle depicts the current out of the page toward the viewer.

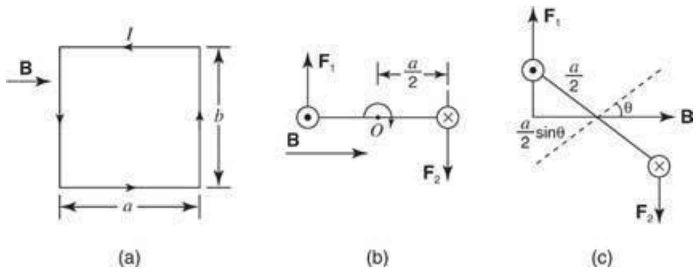


Figure 3

(a) Square current loop in a magnetic field B. (b) View from the top of the current loop. (c) If the loop is tilted with respect to B, a torque results.

The right-hand rule gives the direction of the forces. If the loop is pivoted, these forces produce a torque, turning the loop. The magnitude of this torque is t = NI A × B, where N is the number of turns of the loop, B is the magnetic field, I is the current, and A is the area of the loop, represented by a vector perpendicular to the loop.

Galvanometers, ammeters, and voltmeters

The torque on a current loop in a magnetic field provides the basic principle of the galvanometer, a sensitive current-measuring device. A needle is affixed to a current coil - a set of loops. The torque gives a certain deflection of the needle, which is dependent upon the current, and the needle moves over a scale to allow a reading in amperes.

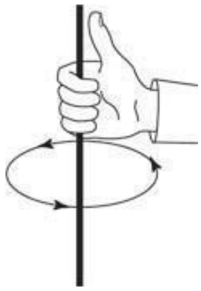
An ammeter is a current-measuring instrument constructed from a galvanometer movement in parallel with a resistor. Ammeters are manufactured to measure different ranges of current. A voltmeter is constructed from a galvanometer movement in series with a resistor. The voltmeter samples a small portion of the current, and the scale provides a reading of potential difference – volts between two points in the circuit.

Magnetic field of a long, straight wire

A current-carrying wire generates a magnetic field of magnitude B in circles around the wire. The equation for the magnetic field at a distance r from the wire is

$B = \frac{\mu_o I}{2\pi r}$, where I is the current in the wire and μ (the Greek letter mu) is the proportionality constant. The constant, called the permeability constant, has the value $\mu_o = 4\pi \times 10^{-7}\, T\, \frac{m}{A}$.

The direction of the field is given by a second right-hand rule, shown in Figure 4. Using the second right-hand rule you can determine the direction of the magnetic field resulting from a current.



Grasp the wire so that your thumb points in the direction of the current. Your fingers will curl around the wire in the direction of the magnetic field.

Ampere's law

Ampere's law allows the calculation of magnetic fields. Consider the circular path around the current. The path is divided into small elements of length (Δ l). Note the component of B that is parallel to l and take the product of the two to be B ǁ l. Ampere's law states that the sum of these products over the closed path equals the product of the current and μ ,

$\sum B_{\parallel} \Delta l = \mu_o I$.

Magnetic fields of the loop, solenoid, and toroid

A current generates a magnetic field, and the field differs as the current is shaped into (a) a loop, (b) a solenoid (a long coil of wire), or (c) a toroid (a donut-shaped coil of wire). The equations for the magnitudes of these fields follow. The direction of the field in each case can be found by the second right-hand rule. Figure 5 illustrates the fields for these three different configurations.

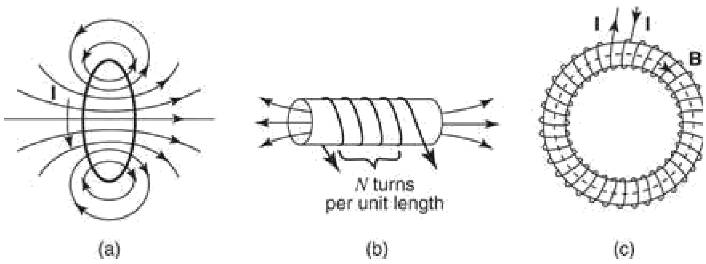


Figure 5
Magnetic field resulting from (a) a current loop, (b) a solenoid, and (c) a toroid.

a) The field at the center of a single loop is given by $B = \mu_0 \frac{I}{2r}$, where r is the radius of the loop.
b) The field due to a solenoid is given by B = μ_0 NI, where N is the number of turns per unit length.
c) The field due to a toroid is given by $B = \mu_0 \frac{NI}{2\pi R}$, where R is the radius to the center of the toroid.

(Adopted from www.cliffsnotes.com)

A. Checking your understanding

I. Give answers to the following questions:

1. Why are magnetism and electricity closely linked to each other?
2. What are the ammeter, voltmeter and galvanometer?
3. Which types of magnets are you familiar with? What are their peculiarities?
4. When do we use the right-hand rule? What does it state?
5. Which law allows the calculation of magnetic fields?

II. There are several definitions in the text. What are they? Complete the sentences with the appropriate word(s).

1. A bar magnet attracts iron objects to its ends, called_______.
2. One end is the____________, and the other is the____________.
3. Magnetic field is expressed in SI units as a______(T).
4. An_______is a current-measuring instrument constructed from a galvanometer movement in parallel with a resistor.
5. The magnetic field at any point is a_______.

III. <u>Are these sentences true or false?</u>

1. If two bar magnets are brought close together, the like poles will attract each other, and the unlike poles repel each other.
2. A current generates a magnetic field, and the field differs as the current is shaped into a loop, solenoid, toroid.
3. Magnetic field lines, not analogous to electric field lines, describe the force on magnetic particles placed within the field.
4. A loop of current in a magnetic field can experience a torque if it is free to turn.
5. The direction of the force may be found by the left-hand rule.

IV. <u>Think and answer.</u>

In summary, the electromagnetic field carries energy, linear momentum and angular momentum. It is thus appropriate to say that the electromagnetic field moves. The motion of the electromagnetic field can be visualized as the motion of its electric and its magnetic field lines. The motion of the electromagnetic field is described by a least action principle. The motion conserves energy and momentum. The motion is continuous, relative, reversible and mirror-invariant. We are directly led to ask: what is the nature of light then?

V. <u>Render the text into English.</u>

Ура эксперименту янки!

В одной английской лаборатории ученые попытались поставить опыт: вызвать электрическую искру из термопары. Один конец термопары был вставлен в кусок льда, другой лежал на раскаленной докрасна печке.

Чарльз Уитсон соединил два куска проволоки, замкнув цепь.

Искры не получилось. Майкл Фарадей заявил, что Уитсон делает это не так, как нужно, и сам проделал опыт в ином варианте. Но искры все же не было.

Тогда третий ученый, американец Джозеф Генри, приехавший в Англию, стал наматывать на палец проволоку плотной спиралью. Через несколько минут он объявил, что с удовольствием покажет как вызвать искр. Затем он просто присоединил эту маленькую спираль, надетую им на небольшой железный стержень, к одному из проводов термопары. На этот раз искра была отчетливо видна.

Фарадей восхищенно зааплодировал и воскликнул:

- Ура эксперименту янки! Но что же вы такое сделали?

И Джозефу Генри пришлось объяснять самоиндукцию ученому, который был известен на весь мир как человек, открывший индукцию.

(Adopted from www.humo.ru)

B. Work with language

I. Find the synonyms in the text to the following words.

a. gadget
b. generate
c. components
d. contemporary
e. be built
f. core
g. pull (n)
h. determine
i. sphere

II. Match 1-10 to a-j.

1. magnetic	a) pole
2. current	b) vector
3. electric	c) wire
4. bar	d) loop
5. velocity	e) law
6. current-carrying	f) instrument
7. current-measuring	g) magnet
8. Ampere`s	h)field
9. north	i) current
10. permeability	j) constant

III. <u>Guess the words:</u>

1. <u>mgtena</u>
2. <u>tnoieatqu</u>
3. <u>gecahr</u>
4. iedlf
5. sremeau

C. Activities

<u>Look through the text and resume it in writing (no more than 250-300 words in total).</u>

Text 4. Electromagnetic induction and Faraday`s laws

«It is right that we should stand by and act on our principles; but not right to hold them in obstinate blindness, or retain them when proved to be erroneous»
Michael Faraday

PRE-READING

Before we study the motion of an electromagnetic field in detail, let's have some fun with electricity. In a small group discuss these problems and make notes of your main points. Then compare your notes.

1) How can you distinguish a magnet from a non-magnetized metal bar of the same size and material using no external means?
   2. In 1722, George Graham discovered, by watching a compass needle, that the magnetic field of the Earth shows daily variations. Can you imagine why these variations occur?
2) If even knocking on a wooden door is an electric effect, we should be able to detect fields when doing so. Can you devise an experiment to check this?
3) Birds come to no harm when they sit on unprotected electricity lines. Nevertheless, one almost never observes any birds on tall, high voltage lines of 100 kV or more which transport power across longer distances. Why?
   5. A PC or a telephone can communicate without wires, by using radio waves. Why are not these and other electrical appliances able to obtain their power via radio waves, thus eliminating power cables? Do you know the reasons?

Active vocabulary

Word	Pronunciation	Translation
circuit, n.	/ˈsɜːkɪt/	цепь, контур
copper wire	/ˈkɒpər waɪər/	медная проволока, провод
deflect, v.	/dɪˈflekt/	изменять направление, отклоняться от курса
electrolysis, n.	/ɪˌlekˈtrɒləsɪs/	электролиз
electromotive force/emf	/ɪˌlektrəˈməʊtɪv fɔːs/	электродвижущая сила

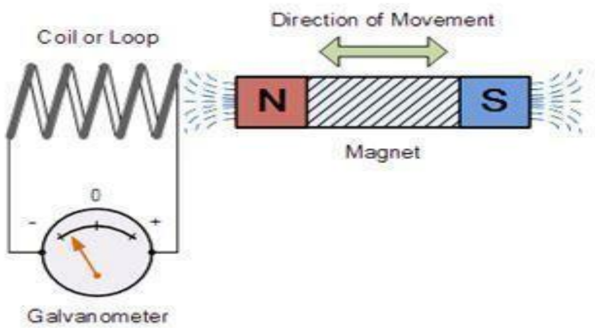
equation, n.	/ɪˈkweɪʒən/	уравнение
flux linkage	/flʌksˈlɪŋkɪdʒ/	потокосцепление
hence, adv.	/hens/	следовательно, syn. therefore, thus
induce, v.	/ɪnˈdjuːs/	индуцировать, наводить
induced current	/ɪnˈdjuːst ˈkʌrənt/	индуцированный ток
induction cooker	/ɪnˈdʌkʃən ˈkʊkər/	индукционная плита
needle, n.	/ˈniːdl/	стрелка, syn. Index
rotate, v.	/rəʊˈteɪt/	вращать(ся)
voltage, n.	/ˈvəʊltɪdʒ/	электрическое напряжение

READING

Read and translate the text using a dictionary if necessary:

In 1831 Michael Faraday, an English physicist, gave one of the most basic laws of electromagnetism called Faraday's law of electromagnetic induction. This law explains the working principle of most of the electrical motors, generators, electrical transformers and inductors. This law shows the relationship between electric circuit and magnetic field. Faraday performs an experiment with a magnet and coil. During this experiment, he found how emf is induced in the coil when flux linked with it changes. He has also done experiments in electro-chemistry and electrolysis.

Relationship between induced emf and flux. Faraday`s experiment



In this experiment, Faraday takes a magnet and a coil and connects a galvanometer across the coil. At starting, the magnet is at rest, so there is no deflection in the galvanometer i.e. needle of galvanometer is at the center or zero position. When the magnet is moved towards the coil, the needle of galvanometer deflects in one direction. When the magnet is held stationary at that position, the needle of galvanometer returns back to zero position. Now when the magnet is moved away from the coil, there is some deflection in the needle but in opposite direction and again when the magnet becomes stationary, at that point with respect to coil, the needle of the galvanometer returns back to the zero position. Similarly, if magnet is held stationary and the coil is moved away and towards the magnet, the galvanometer shows deflection in similar manner. It is also seen that, the faster the change in the magnetic field, the greater will be the induced emf or voltage in the coil.

Position of magnet	Deflection in galvanometer
Magnet at rest	No deflection in galvanometer
Magnet moves towards the coil	Deflection in galvanometer in one direction
Magnet is held stationary at same position (near the coil)	No deflection in galvanometer
Magnet moves away from the coil	Deflection in galvanometer but in opposite direction
Magnet is held stationary at same position (away from the coil)	No deflection in galvanometer

From this experiment, Faraday concluded that whenever there is relative motion between conductor and a magnetic field, the flux linkage with a coil changes and this change in flux induces a voltage across a coil.

Michael Faraday formulated two laws on the basis of above experiments. These laws are called Faraday's laws of electromagnetic induction.

Faraday's First Law

Any change in the magnetic field of a coil of wire will cause an emf to be induced in the coil. This emf induced is called induced emf and if the conductor circuit is closed, the current will also circulate through the circuit and this current is called induced current.

Methods to change magnetic field:

1. By moving a magnet towards or away from the coil
2. By moving the coil into or out of the magnetic field.
3. By changing the area of a coil placed in the magnetic field
4. By rotating the coil relative to the magnet.

Faraday's Second Law

It states that the magnitude of emf induced in the coil is equal to the rate of change of flux that linkages with the coil. The flux linkage of the coil is the product of number of turns in the coil and flux associated with the coil.

Methods to increase emf induced in a coil:

1. By increasing the number of turns in the coil.
2. By increasing magnetic field strength.
3. By increasing the speed of the relative motion between the coil and the magnet.

Applications of Faraday Law

Faraday law is one of the most basic and important laws of electromagnetism. This law finds its application in most of the electrical machines, industries and medical field etc.

- Electrical Transformers

It is a static device which is used to either step up or step down voltage or current. It is used in generating station, transmission and distribution system. The transformer works on Faraday's law.

- Electrical Generators

The basic working principle of electrical generator is Faraday's law of mutual induction. Electric generator is used to convert mechanical energy into electrical energy.

- Induction Cookers

The Induction cooker, is a most fastest way of cooking. It also works on principle of mutual induction. When current flows through the coil of copper wire placed below a cooking container, it produces a changing magnetic field. This alternating or changing magnetic field induces an emf and hence the current in the conductive container, and we know that flow of current always produces heat in it.

- Electromagnetic Flow Meters

It is used to measure velocity of blood and certain fluids. When a magnetic field is applied to electrically insulated pipe in which conducting fluids are flowing, then according to Faraday's law, an electromotive force is induced in it. This induced emf is proportional to velocity of fluid flowing.

- Form the bases of Electromagnetic Theory

Faraday's idea of lines of force is used in well-known Maxwell's equations. According to Faraday's law, change in magnetic field gives rise to change in electric field and the converse of this is used in Maxwell's equations.

- Musical Instruments

It is also used in musical instruments like electric guitar, electric violin etc.
(Adopted from www.electrical4u.com)

A. Checking your understanding

I. Give answers to the following questions:

1. Who is Michael Faraday?
2. What is this scientist famous for?
3. How many Faraday`s laws are you familiar with?
4. Can you explain what exactly they state?
5. Where can Faraday's laws be applied?

II. Complete the sentences by your own words. Then check the answers finding information in the text.

1. In 1831 Michael Faraday, an English physicist, gave one of the most basic…
2. This law shows the relationship between…
3. In his experiment, Faraday takes a magnet and a coil and connects a...
4. Faraday`s law finds its application in most of the electrical…
5. According to Faraday's law, change in magnetic field gives rise to change in electric field and the converse of this is used in…

III. Are these sentences true or false?

1. Faraday law is one of the most basic and important laws of classical mechanics.
2. Faraday's idea of lines of force is used in well-known Maxwell's equations.
3. Faraday concluded that whenever there is relative motion between conductor and a magnetic field, the flux linkage with a coil changes and this change in flux induces a voltage across a coil.

4. According to the experiment, when the magnet is moved towards the coil, the needle of galvanometer returns back to zero position.
5. When the magnet is held stationary at that position, the needle of galvanometer deflects in one direction.

B. Work with language

I. <u>Put all possible questions to the following sentences.</u>

1. The basic working principle of electrical generator is Faraday's law of mutual induction.
2. When current flows through the coil of copper wire placed below a cooking container, it produces a changing magnetic field.
3. Electrical Transformer is a static device which is used to either step up or step down voltage or current.
4. Faraday's First Law states that any change in the magnetic field of a coil of wire will cause an emf to be induced in the coil.
5. Faraday's Second Law states that the magnitude of emf induced in the coil is equal to the rate of change of flux that linkages with the coil.

II. <u>Guess the words:</u>

1. <u>xufl</u>
2. <u>eythro</u>
3. <u>ciloevty</u>
4. <u>talovge</u>
5. <u>peexriemnt</u>

<u>III. Do you know that ...</u>

The names *electrode, electrolyte, ion, anode and cathode* were suggested by William Whewell (b. 1794 Lancaster, d. 1866 Cambridge) on demand of Michael Faraday; Faraday had no formal education and asked his friend Whewell to form two Greek words for him. For anode and cathode, Whewell took words that literally mean ‘upward street’ and ‘downward street’. Faraday then popularized these terms, like the other words mentioned above.

IV. Translate the text into Russian. Divide the text into logical parts. Write down key words to each passage.

The first appliances built to generate electric currents were large rubbing machines. Then, in 1799 Alessandro Volta (b. 1745 Como, d. 1827 Como) invented a new device to generate electricity and called it a pile; today its basic element is called a (voltaic) cell, a primary cell* or, less correctly, a battery. (Correctly speaking, a battery is a collection of cells, as the one found in a car.) Voltaic cells are based on chemical processes; they provide much more current and are smaller and easier to handle than electrostatic machines. The invention of the battery changed the investigation of electricity so profoundly that Volta became world famous. At last, a simple and reliable source of electricity was available for use in experiments; unlike rubbing machines, cells and piles are compact, work in all weather conditions and make no noise. An apple or a potato or a lemon with a piece of copper and one of zinc inserted is one of the simplest possible voltaic cells. It provides a voltage of about 1 V and can be used to run digital clocks or to produce clicks in headphones. Volta was also the discoverer of the charge 'law' $q = CU$ for capacitors (C being the capacity, and U the voltage) and the inventor of the high sensitivity capacitor electroscope. A modest man, nevertheless, the unit of electrical potential, or 'tension', as Volta used to call it, was deduced from his name. A 'battery' is a large number of voltaic cells; the term was taken from an earlier, almost purely military use. (Voltaic cells exist in all biological cells. For halobacteria, the internal voltaic cells are even essential to survival. Living in saltwater, internal voltaic cells help them to avoid death due to osmosis). A battery in a mobile phone is just an elaborated replacement for a number of apples or potatoes.

(Adopted from www.famousscientists.org)

V. Render the text into English:

О фамилии основателя Королевского института Великобритании

Королевский институт Великобритании был создан 7 марта 1799 года. Инициатором его создания был граф Румфорд, который еще до 23 лет до этого звался Бенджаменом Томсоном и имел американское подданство. Но в 1776г. он переехал в Англию, через три года был избран в члены Королевского общества, получил дворянский титул графа Священной Римской империи. А по существующей до сих пор в Англии традиции, человек, произведенный в графы или лорды, может выбрать себе новое имя. Нередко оно оказывается связанным каким-нибудь образом с тем географическим местом, где проживал или проживает избранник.

Лорд Кельвин, например, взял себе имя по названию речки Кельвин, протекающей около Глазго, где он, будучи Уильямом Томсоном, жил и работал. А Бенджамен Томсон выбрал себе имя в честь города Румфорда. Через 150 лет генерального секретаря Королевского института Великобритании Мартина спросили, что дал науке институт. Он ответил лаконично: "Институт - это то место, где жил и работал Фарадей".

(Adopted from www.humo.ru)

C. Activities

Read, discuss this text (in pairs) and try to explain this puzzle:

Mirrors exist in many forms. An important mirror for radio waves is the ionosphere; especially during the night, when certain absorbing layers disappear, the ionosphere allows receiving radio stations from far away. When the weather is favorable, it is possible to receive radio stations sending from the antipodes. Another radio mirror is the Moon; with modern receivers it is possible to receive radio signals and, since a few years, even television signals reflected by the Moon.

Why do metals provide good mirrors? Metals are strong absorbers of light. Any strong absorber has a metallic shine. This is true for metals, if they are thick enough, but also for dye or ink crystals. Any material that strongly absorbs a light wavelength also reflects it efficiently. The cause of the strong absorption of a metal are the electrons inside it; they can move almost freely and thus absorb most visible light frequencies; this leads to evanescent waves in the material and strong reflection.

Strong reflection appears as soon as the absorption length is as low as about one wavelength. This is the reason that, for example, strong coffee, strong tea and dense alkali vapor work as mirrors. (However, strong reflection is also possible without strong absorption, as the ubiquitous dielectric multilayers show.)

Here is a puzzle: *a concave mirror shows an inverted image; so does a plane mirror if it is partly folded along the horizontal. What happens if this mirror is rotated around the line of sight?*

(Adopted from www.motionmountain.net)

UNIT 4. ATOMIC PHYSICS

Text 1. The nuclear atom

«The unleashed power of the atom has changed everything save our modes of thinking, and we thus drift toward unparalleled catastrophes»
Albert Einsten

PRE-READING

Give answers to the following questions:

1. Do you know what an atom is?
2. What are electrons, protons and neutrons?
3. Is there one or several theories on atom`s structure? Have you heard anything about atomic structure models?

Active vocabulary

Word	Pronunciation	Translation
attraction, n.	/əˈtrækʃən/	притяжение, тяготение, syn. gravity, gravitation, pull
basic, adj.	/ˈbeɪsɪk/	основной, главный, начальный, syn. fundamental, foremost, primal
bound, v.	/baʊnd/	ограничивать, сдерживать, syn. limit, restrict, straiten
cathode, n.	/ˈkæθəʊd/	катод
charged, adj.	/tʃɑːdʒd/	заряженный, полный, наполненный
compound, n/adj.	/ˈkɒmpaʊnd/	соединение, состав; составной, сложный, syn. complex, constitutive, multiple.
core, n.	/kɔːr/	ядро, внутренность, центр, syn. centre
dense, adj.	/dens/	густой, плотный, непрозрачный, syn. stout, compact
disperse, v.	/dɪˈspɜːs/	рассеивать(ся), разбрасывать, syn. dissipate

emerge	/ɪˈmɜːdʒ/	появляться, возникать, syn. appear, turn up, occur
foil	/fɔɪl/	фольга, контраст, фон
indivisible, adj.	/ˌɪn.dɪˈvɪz.ɪ.bl̩ /	неделимый, неразложимый, простой, syn. infrangible
immersed, adj.	/ɪˈmɜːs/	погруженный в жидкость, поглощенный
nuclear, adj.	/ˈnjuːkliər/	ядерный
pursuit, n.	/pərˈsuːt/	преследование, погоня, стремление
raisin, n.	/ˈreɪzən/	изюминка, изюм
ratio, n.	/ˈreɪʃiəʊ/	отношение, коэффициент, пропорция, соотношение
ray, n.	/reɪ/	луч, излучение, проблеск
shell, n.	/ʃel/	скорлупа, оболочка
stuff, n.	/stʌf/	материал, вещество, вещь, ткань syn. matter, substance

READING

Read and translate the text using a dictionary if necessary:

The search for the atom began as a philosophical question. It was the natural philosophers of ancient Greece that began the search for the atom by asking such questions as: What is stuff composed of? What is the structure of material objects? Is there a basic unit from which all objects are made? As early as 400 B.C., some Greek philosophers proposed that matter is made of indivisible building blocks known as atoms (the word «atom» in Greek means indivisible). To these early Greeks, matter could not be continuously broken down and divided indefinitely. Rather, there was a basic unit or building block that was indivisible and foundational to its structure. This indivisible building block of which all matter was composed became known as the atom.

The early Greeks were simply philosophers. They did not perform experiments to test their theories. In fact, science as an experimental discipline did not emerge as a credible and popular practice until sometime during the 1600s. So, the search for the atom remained a philosophical inquiry for a couple of millennia. From the 1600s to the present century, the search for the atom became an experimental pursuit. Several scientists are notable, among them are Robert Boyle, John Dalton, J.J. Thomson, Ernest Rutherford, and Neils Bohr.

Boyle's studies (middle to late 1600s) of gaseous substances promoted the idea that there were different types of atoms known as elements. Dalton (early 1800s) conducted a variety of experiments to show that different elements can combine in fixed ratios of masses to form compounds. Dalton subsequently proposed one of the first theories of atomic behavior that was supported by actual experimental evidence.

English scientist J.J. Thomson's cathode ray experiments (end of the 19th century) led to the discovery of the negatively charged electron and the first ideas of the structure of these indivisible atoms. Thomson proposed the Plum Pudding Model, suggesting that an atom's structure resembles the favorite English dessert - plum pudding. The raisins dispersed amidst the plum pudding are analogous to negatively charged electrons immersed in a sea of positive charge.

Nearly a decade after Thomson, Ernest Rutherford's famous gold foil experiments led to the nuclear model of atomic structure. Rutherford's model suggested that the atom consisted of a densely packed core of positive charge known as the nucleus surrounded by negatively charged electrons. While the nucleus was unique to the Rutherford atom, even more surprising was the proposal that an atom consisted mostly of empty space. Most the mass was packed into the nucleus that was abnormally small compared to the actual size of the atom.

Neils Bohr improved upon Rutherford's nuclear model (1913) by explaining that the electrons were present in orbits outside the nucleus. The electrons were confined to specific orbits of fixed radius, each characterized by their own discrete levels of energy. While electrons could be forced from one orbit to another orbit, it could never occupy the space between orbits.

Bohr's view of quantized energy levels was the precursor to modern quantum mechanical views of the atoms. The mathematical nature of quantum mechanics prohibits a discussion of its details and restricts us to a brief conceptual description of its features. Quantum mechanics suggests that an atom is composed of a variety of subatomic particles. The three main subatomic particles are the proton, electron and neutron. The proton and neutron are the most massive of the three subatomic particles; they are located in the nucleus of the atom, forming the dense core of the atom.

The proton is charged positively. The neutron does not possess a charge and is said to be neutral. The protons and neutrons are bound tightly together within the nucleus of the atom. Outside the nucleus are concentric spherical regions of space known as electron shells. The shells are the home of the negatively charged electrons. Each shell is characterized by a distinct energy level. Outer shells have higher energy levels and are characterized as being lower in stability. Electrons in higher energy shells can move down to lower energy shells; this movement is accompanied by the release of energy. Similarly, electrons in lower energy shells can be induced to move to the higher energy outer shells by the addition of energy to the atom. If provided sufficient energy, an electron can be removed from an atom and be freed from its attraction to the nucleus.

(Adopted from www.physicsclassroom.com)

A. Checking your understanding

I. Answer the following questions:

1. Why did the search for the atom remain a philosophical inquiry for a couple of millennia?
2. What did scientists contribute to the study of the atom?
3. Who discovered the negatively charged electron?
4. What is Ernest Rutherford famous for?
5. Can you name three main subatomic particles?

II. Give Russian equivalents to the following phrases:

a) energy shells
b) fixed ratios of masses
c) an indivisible building block
d) be bound tightly together
e) a credible and popular practice

III. Are these sentences true or false?

1. The word «atom» in Greek means divisible.

2. According to Neils Bohr`s study, the electrons were confined to specific orbits of fixed radius, each characterized by their own discrete levels of energy.
3. The protons and neutrons can be found in a loose state within the nucleus of the atom.
4. Thomson proposed the Cheesecake Model, suggesting that an atom's structure resembles the favorite American dessert – a cheesecake.
5. Bohr's view of quantized energy levels was the precursor to modern quantum mechanical views of the atoms.

B. Work with language

*I. Match each word in **A** with its synonym in **B**.*

A. 1. discrepancy; 2, to blow up; 3. to abandon; 4. to point out; 5. to reconcile;
6. to resolve; 7. to stir; 8. essence; 9. scarcely; 10 to burst

B. a) to inflate; b) inconsistence (difference); c) to make agree; d) hardly; e) to decide firmly; f) to show direction; g) to give up wholly and finally;
h) the very being or power of a thing; i) to break into pieces; j) to be emotionally moved

II. Put the words into the right order. Check your answers with the text.

1. shells/ The/ negatively/ are/ the/ electrons/ of/ the/ charged/ home.
2. question/ began/ the/ as/ search/ The/ for/ a philosophical/ atom.
3. particles/ The / proton/ are/ three/ the/ the most/ subatomic/ and/ neutron/ of/ massive.
4. is said/ neutron/ The/ to be/ a/ possess/ does not/ and/ neutral/ charge.
5. the/ became/ the 1600s/ From / the / to/ pursuit/ an experimental/ the search/ for/ present/ atom/ century.

III. *Guess the words*:

1. israin
2. llhse
3. demlo
4. erpiholsoph

5. sunulceo

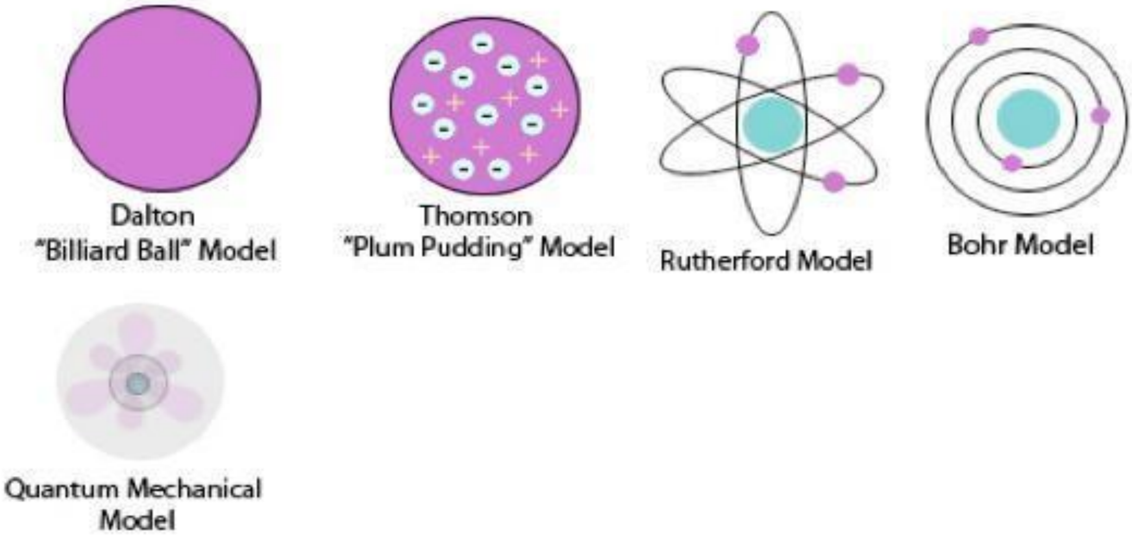
IV. Read the text, divide it to logical parts and translate into English.

Атомы - это крошечные частички, из которых состоит любое вещество. В точке в конце предложения может уместиться 2 млрд. атомов. Но поскольку электроны сильно удалены от ядра, атом - это в основном пустое пространство. Долгое время атом считался неделимой частицей. Однако в конце XIX в. была открыта одна из составных частей атома - электрон. В 1911 г. Э. Резерфорд доказал, что атом имеет плотное маленькое ядро. Позже физики открыли, что ядро состоит из частиц двух видов - протонов и нейтронов. У протонов положительный электрический заряд, нейтроны заряда не имеют. И протоны, и нейтроны состоят из разных сочетаний кварков. Вокруг ядра обращаются отрицательно заряженные электроны. Атом - электрически нейтральная система. Положительный заряд его ядра равен общему отрицательному заряду электронов. Внутри атома электроны вращаются вокруг плотного ядра из протонов и нейтронов. Число всех этих частиц разное у разных элементов. Атом, потерявший один и более электронов, называется положительным ионом, присоединивший электроны - отрицательным ионом. Атомы можно расщепить, но обычно они остаются целыми благодаря электрическому притяжению между положительными протонами и отрицательными электронами, а также благодаря ядерным силам, обеспечивающим целостность ядра. Каждый элемент состоит из атомов с определенным числом протонов в ядре. В атоме железа их 26, в атоме золота - 79. Число протонов в атоме называется атомным номером. Он соответствует порядковому номеру элемента в периодической таблице. Атомы с одинаковым числом протонов, но с разным числом нейтронов называются изотопами.

(Adopted from www.appdroider.ru)

C. Activities

Look at several models below. In pairs make notes and explain each model`s structure.



Text 2. Radioactivity

«The release of atomic energy has not created a new problem. It has merely made more urgent the necessity of solving an existing one»
Albert Einstein

PRE-READING

Give answers to the following questions:

1. How does radioactivity of an atom affect the human body/organism?
2. Do you know who regulates radioactive materials and radiation exposure?

Active vocabulary

Word	Pronunciation	Translation
acute, adj.	/əˈkjuːt/	острый, сильный, критический
artificial, adj.	/ˌɑːtɪˈfɪʃəl/	искусственный, неприродный, синтетический, syn. factitious
bone marrow	/bəʊnˈmærəʊ/	костный мозг
byproduct, n.	/ˈbɑɪˌprɑdəkt/	побочный продукт
cancer, n.	/ˈkænsər/	рак
carbon, n.	/ˈkɑːbən/	углерод
cell, n.	/sel/	клетка, ячейка
chain, n.	/tʃeɪn/	цепь, последовательность, связь, система, сеть
damage, v.	/ˈdæmɪdʒ/	повреждать, причинять ущерб, портить, syn. destroy, make harm, ruin
decay, n.	/dɪˈkeɪ/	(радиоактивный) распад
decrease, v.	/dɪˈkriːs/	уменьшать(ся),убавлять(ся), сокращать(ся), syn. diminish, lessen
dose, n.	/dəʊs/	доза, доля, порция
estimate, v.	/ˈestɪmət/	оценивать, syn. assess, evaluate
excited, adj.	/ɪkˈsaɪtɪd/	возбужденный
hemorrhaging, n.	/ˈhemərɪdʒɪŋ/	кровотечение, syn. bleeding

half-life, n.	/ˈhɑːf laɪf/	период полураспада
infrared, adj.	/ˌɪnfrəˈred/	инфракрасный
inhale, v.	/ɪnˈheɪl/	вдыхать, syn. inbreathe
ingest, v.	/ɪnˈdʒest/	проглатывать,глотать,syn. swallow
iodine, n.	/ˈaɪədiːn/	йод
ionize, v.	/ˈaɪənaɪz/	ионизировать
isotope, n.	/ˈaɪsətəʊp/	изотоп
likelihood, n.	/ˈlaɪklihʊd/	вероятность, syn. possibility, probability
lymph node	/lɪmf nəʊd/	лимфатический узел
nuclide, n.	/ˈnuklaɪd/	нуклид, ядро с определенным нуклонным составом
penetrate, v.	/ˈpenɪtreɪt/	проникать, проходить, syn. come through, permeate
poisoning, n.	/ˈpɔɪzənɪŋ/	отравление, интоксикация, syn. intoxication, toxication
potassium, n.	/pəˈtæsiəm/	калий
preponderance, n.	/prɪˈpɒndərəns/	перевес, преимущество
radioisotope, n.	/ˌreɪdioʊˈaɪsəˌtoʊp/	радиоактивный изотоп,радиоизотоп
random, adj.	/ˈrændəm/	случайный, произвольный
repel, v.	/rɪˈpel/	отталкивать, отбрасывать, отражать
stable, adj.	/ˈsteɪbl/	прочный, устойчивый, постоянный, syn. firm, rigid, steady
ultraviolet, adj.	/ˌʌltrəˈvaɪələt/	ультрафиолетовый
undergo, v.	/ˌʌndəˈɡəʊ/	испытывать, переносить, syn. overcome
via, prep.	/vaɪə/	через

READING

Read and translate the text using a dictionary if necessary:

Sometimes the nucleus of an atom is unstable. A change will occur in the nucleus to make it more stable. The change is called decay. When a nucleus decays it will emit some particles or waves. Emitting particles or waves from the nucleus is called radioactivity.

Radioactivity was discovered by A. H. Becquerel in 1896. Radioactive decay is a random process which gives out heat. The particles or waves that are emitted are called radiation. The radiation was classified by E. Rutherford as alpha, beta, and gamma rays (for the first three letters of the Greek alphabet) according to their ability to penetrate matter and ionize air.

Alpha decay

An alpha particle is identical to a helium nucleus, being made up of two protons and two neutrons bound together. It initially escapes from the nucleus of its parent atom, invariably one of the heaviest elements, by quantum mechanical processes and is repelled further from it by electromagnetism, as both the alpha particle and the nucleus are positively charged. The process changes the original atom from which the alpha particle is emitted into a different element. Its mass number decreases by four and its atomic number by two. For example, uranium-238 will decay to thorium-234. Sometimes one of these daughter nuclides will also be radioactive, usually decaying further by one of the other processes described below.

Beta decay

Beta decay itself comes in two kinds: $\beta+$ and $\beta-$. As for $\beta-$ emission, it occurs by the transformation of one of the nucleus's neutrons into a proton, an electron and an antineutrino. Byproducts of fission from nuclear reactors often undergo $\beta-$ decay as they are likely to have an excess of neutrons. $\beta+$ decays is a similar process, but involves a proton changing into a neutron, a positron and a neutrino.

Gamma decay

After a nucleus undergoes alpha or beta decay, it is often left in an excited state with excess energy. Just as an electron can move to a lower energy state by emitting a photon somewhere in the ultraviolet to infrared range, an atomic nucleus loses energy by emitting a gamma ray. Gamma radiation is the most penetrating of the three and will travel through several centimetres of lead. Beta particles will be absorbed by a few millimetres of aluminium, while alpha particles will be stopped in their tracks by a few centimetres of air, or a sheet of paper.

Half-lives and probability

Radioactive decay is determined by quantum mechanics – which is inherently probabilistic. So, it’s impossible to work out when any particular atom will decay, but we can make predictions based on the statistical behavior of large numbers of atoms. The half-life of a radioactive isotope is the time after which, on average, half of the original material will have decayed. After two half-lives, half of that will have decayed again and a quarter of the original material will remain, and so on.

Uranium and plutonium are only weakly radioactive but have very long half-lives – in the case of uranium-238, around four billion years, roughly the same as the current age of the Earth, or the estimated remaining lifetime of the Sun. The half of the uranium-238 around now will still be here when the Sun dies. Iodine-131 has a half-life of eight days, so, once fission has stopped, less than 1% of iodine-131 produced in a nuclear reactor will remain after about eight weeks. Other radioisotopes of iodine are even shorter-lived. Caesium-137, however, sticks around for longer. It has a half-life of around 30 years, and, because of this and because it decays via the more hazardous beta process, is thought to be the greatest health risk if leaked into the environment.

Although some radioactive materials are produced artificially, many occur naturally and result in there being a certain amount of radiation in our environment all the time – the «background radiation».

In the background

There is a natural level of radiation all around us, which comes from several sources. Some gamma radiation comes from space as cosmic rays. Other radiation comes from sources in the atmosphere, such as radon gas and some of its decay products.

There are also natural radioactive materials in the ground – and as well as the obvious elements such as uranium there are also radioactive isotopes of common substances such as potassium and carbon. To understand how much background radiation is around, it helps to distinguish between effects on normal matter and on the human body.

The amount of radiation absorbed by non-biological matter is measured in grays, a unit equivalent to a joule of energy per kilogram of mass. For biological tissue, a dose equivalent is measured in sieverts (Sv) depending on the type of radiation involved and how much damage that radiation does to the particular cells affected.

The average amount of radiation received from background sources in the UK is around 2–2.5 mSv per year. Because of the preponderance of granite, which contains higher than average levels of uranium, in areas such as Cornwall or Aberdeenshire it can be twice this level – not high enough to cause any concern, but high enough that nuclear facilities can’t be built there as the background level already exceeds the maximum allowed radiation limit. In some parts of the world, such as northern Iran, the background radiation is as high as 50 mSv per year.

There are a variety of other natural and routine artificial causes of low doses of radiation. A dental x-ray will give you a dose of under 1 mSv; a full-body CT scan, 10 mSv. As fewer cosmic rays are stopped by the atmosphere the higher you go, the crew of a passenger jet flying between the US and Japan once a week for a year would receive an additional a dose of around 9 mSv. Under normal conditions, the dose limit for workers in the nuclear industry is 50 mSv per year.

The effects on human health

There are two main health effects caused by radiation, which act over the short- and long-term and also at shorter and greater distances. Radiation causes health problems by killing cells in the body, and the amount and type of damage done depends on the dose of radiation received and the time over which the dose is spread out.

The dose limits for emergency workers in the event of a nuclear accident are 100 mSv if protecting property or 250 mSv in a life-saving operation. Between that upper limit and 1 Sv received within a single day, exposure is likely to cause some symptoms of radiation poisoning, such as nausea and damage to organs including bone marrow and the lymph nodes. Up to 3 Sv these same effects are more serious with a likelihood of acquiring infections due to a reduced number of white blood cells in the body – with treatment, survival is probable but not guaranteed.

Larger doses will, in addition to those symptoms above, cause hemorrhaging, sterility and skin to peel off; an untreated dose of more than 3.5 Sv will be fatal, and death is expected even with treatment for doses of more than 6 Sv. The radiation level decreases with the square of the distance from its source, so someone twice as far away from an external source will receive a quarter of the radiation.

Receiving a high dose in a shorter time usually causes more acute damage, as greater doses kill more cells, while the body can have had time to repair some damage with more time having elapsed between doses. However, radioactive material that is spread to a wider area can cause longer-term health effects via prolonged exposure, particularly if they enter the food chain or are inhaled or ingested directly. Taking radioactive materials into the body also presents the greatest danger from atoms that undergo alpha-decay, as alpha particles are not very penetrative and are easily absorbed by a few centimeters of air.

Radioactive isotopes of iodine, which undergo beta-decay, can build up in the thyroid gland and can cause thyroid cancer. Attempts to prevent this involve distributing pills that include nonradioactive iodine-127 and which flood the thyroid, preventing uptake of radioactive iodine. For one-off doses, such as those from medical scans, the risk of later developing cancer is estimated at around 1 in 20 000 per mSv received. Absorbing an accumulated dose of 1 Sv over a longer period of time is estimated to eventually cause cancer in 5% of people. However, there is disagreement over whether very small doses comparable to the level of background radiation actually contribute to health effects.

(Adopted from www.iop.org)

A. Checking your understanding

I. Give answers to the following questions:

1. What causes a decay starting?
2. How many types of decay are known in physics?
3. Is there a link between a dose of radioactivity and human's health?
4. Can natural radioactive sources be found around us?
5. Where exactly can they be found? What is their amount?

II. There are several definitions in the text. What are they? Complete the sentences.

1. Sometimes the nucleus of an atom is not stable. The change is called a ______.
2. Emitting particles or waves from the nucleus is called________.
3. The_________of a radioactive isotope is the time after which, on average, half of the original material will have decayed.
4. ________ ________is a random process which gives out heat.
5. The particles or waves that are emitted are called________.

III. Are these sentences true or false?

1. There are not natural radioactive materials in the ground at all.
2. Uranium and plutonium are strongly radioactive but have very short half-lives.
3. The radiation was classified by E. Rutherford as alpha, beta, and gamma rays (for the first three letters of the Greek alphabet) according to their ability to penetrate matter and ionize air.
4. Radiation causes health problems by killing cells in the body, and the amount and type of damage done depends on the dose of radiation received and the time over which the dose is spread out.
5. Gamma radiation is the least penetrating of the three and will not travel through several centimeters of lead.

B. Work with language

I. Give Russian equivalents to the following phrases:

a) nuclear chain reaction
b) single fission process
c) vertical cloud chamber
d) cosmic ray particle
e) wide energy spread
f) total energy liberation
g) thick material layer
h) critical size level
i) nuclear power production
j) ordinary steam turbine
k) original fission neutrons

II. <u>Put the words into the right order. Check your answers with the text.</u>

1. rays/ gamma/ comes from/ as/ Some/ cosmic/ radiation/ space.
2. with/ a nucleus/ beta/ an excited/ energy/ After/ or/ excess/ alpha/ undergoes/ left in/ it is/ decay/ state/ often.
3. was/ in / A. H. Becquerel/ Radioactivity/ by/ 1896/ discovered.
4. emit/ a/ nucleus/ will/ or/ waves/ When/ it/ particles/ some/ decays.
5. gives out/ decay/ a/ process/ heat/ Radioactivity/ random/ which/ is.

III. <u>Guess the words:</u>

1) seod
2) barobs
3) tafal
4) cyade
5) lentmee

IV. <u>Skim the passage as fast as possible and find answers to the following questions.</u>

1) What is the main problem in maintaining a steady chain reaction?
2) What are "control rods" used for?
3) What is the design of a "swimming pool" reactor?
4) What purposes are nuclear power reactors used for?

Nuclear reactors

A sample of fissionable material smaller than the "critical size" is unable to carry on a nuclear chain reaction. If the size of the sample is exactly critical, the number of neutrons produced in each generation is the same as that produced in the previous one, resulting in steady nuclear energy liberation. The original Fermi-pile and its later modifications maintain nuclear reactions at the critical size level. *It must be mentioned in this connection that the conditions of "criticality" are extremely unstable: a small deviation (отклонение) in one direction will result in the rapid extinction (уменьшение количества нейтронов) of fission neutrons and the cut-off of the nuclear chain reaction, whereas a deviation in another direction will lead to a rapid multiplication of the fission neutrons and the melting (плавление) of the entire structure.*

Thus, the important problem in maintaining a steady chain reaction is that of regulating the rate of neutron production and of keeping the chain reaction from "dying out" or "running away". *This is achieved by using "control rods" made from neutron-absorbing materials (such as boron) which arc automatically pushed in or pulled out from narrow channels drilled through the reacting fissionable material as soon as the rate of neutron production drops below or exceeds the desired level.*

We have already mentioned that Fermi-piles were unsuitable for purposes of nuclear power production because of the high dilution of uranium by carbon; they should be considered rather as "alchemical plants" in which plutonium is produced. For the purpose of nuclear power production, we use the controlled nuclear chain reactions in pure fissionable materials, such as U235 or Pu234, which can be run at quite high temperatures.

In the so-called "swimming pool" reactor (реактор бассейнового типа) in which several cylindrical containers filled with pure fissionable material arc placed at the bottom of a large water tank, the water circulating through the tank carries away the heat produced in the fission process and also protects the observer from the deadly nuclear radiation. The color of the water turns blue as a result of the so-called Cherenkoffs radiation produced in water by high-energy electron.

(Adopted from www.studfiles.ru)

C. Activities

I. Read the text one more time and give an adequate translation of the sentences marked with an asterisk.

II. Summarize the passage and present your report in oral.

APPENDIX I

Phrases for summary and rendering

1. The text/ article under consideration is about…

2. The text/ article deals with ...

3. At the beginning the author describes /depicts/ touches upon/ explains/ introduces/ mentions/ characterizes/ points out/ generalizes/ reveals/ exposes/ reveals, highlights, etc.

4. The text/ article begins (opens) with a (the) description of introduction of/ the

mention of/ the analysis of a summary of/ the characterization of/ (author's) opinion of, etc.

5. Then/ after that/ further/ further on/ next the author passes on to/ goes on from ...to/ goes on to say that/ gives a detailed analysis/ description of, etc.

6. In conclusion the author depicts, claims, reports, etc.

7. The author concludes with a/ the description of/ his recollections of/ the generalization of/ the characterization of/ (his) opinion of …, etc.

8. To finish with, the author …

APPENDIX II

Linking words

Beginning

First(ly)

First of all

For a start

In the first place

Initially

To begin/start with

Let us begin/start by

First and foremost

First and most importantly

Going further

Second(ly)/third(ly)

In the second place

Subsequently

Simultaneously

And then

Next

Formerly/previously

Adding information

And

In addition

As well as

Also

Too

Furthermore

Moreover

Besides

Above all

Along with

Additionally

Besides

Further

Not only . . . but also . . .

Not to mention

One could also say

What is more

Sequencing ideas

The former, … the latter

Firstly, secondly, finally

The first point is

The following

Giving a reason

Due to / due to the fact that

Owing to / owing to the fact

that Because

Because of

Since

As

Well, you see

The (main/basic) reason is that

Let me explain. You see

But the point is

Giving a result

Therefore

So

Consequently

This means that

As a result

Comparison/Contrast

Although / even

though Nevertheless

In theory… in

practice…

Both… and …

Analogously

Equally

Likewise

Just like

Similarly

Correspondingly

In the same way

In the same manner

By the same token

Alternatively

But/ However

Conversely/ On the contrary

Despite / despite the fact that

In spite of / in spite of the fact that

Differing from/ In contrast\Instead

In comparison

In reality

On the one hand/ On the other hand

Notwithstanding/ Nonetheless/ Nevertheless

Still/ Yet

Unlike

Whereas/ While

Emphasis

Indeed/truly In

fact/actually

Notably

Particularly/specifically Especially/mainly

Admittedly

Of course /certainly/surely

No doubt

Obviously

Needless to say

As a matter of fact

For this reason

Clarification

In other words

That is

Namely

That is to say

To put in another way,

One example of this is

For example/for instance

Such as

Frequently

As an illustration

To demonstrate

To illustrate

Transitions

Accordingly

As a consequence

For this/that reason

Hence

In that case

On account of this

Therefore

Thus

Summarizing

In short

In brief

In summary

To summarize

To conclude

In conclusion

Eventually

In the end (I’d like to say that)

Weighing up all pros and cons

To crown it all

Concluding

Summing up/to sum up

To conclude/in summary

Finally

In short/in brief

On the whole

Ultimately

Last/lastly

Last of all

Last but not the least

Personal or other people's opinion

In my opinion/In my view/To my mind

To my way of thinking

Personally I believe that/ I think that…

It strikes me that

I feel very strongly that

I'm inclined to believe that

It seems to me that

As far as I am concerned

As far as I know

It's popularly believed that

People often claim that

It is often alleged that

Some people argue that

A lot of people think/believe that

As I see it

From my point of view

If I'm not mistaken

To my way of thinking

I'll say straightforwardly

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