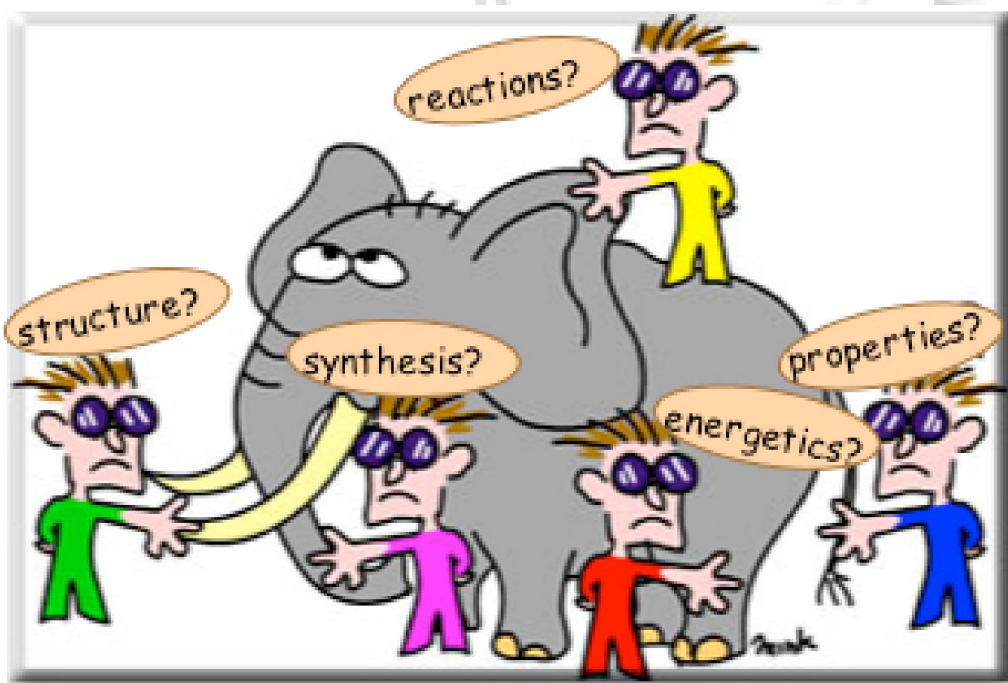


# *Chemistry* *in questions and tests*

Учебное пособие



Иваново  
2011

Министерство образования и науки Российской Федерации  
Ивановский государственный химико-технологический университет

М. Н. Милеева

## **CHEMISTRY IN QUESTIONS AND TESTS**

Учебное пособие

*Допущено УМО по классическому университетскому образованию  
в качестве учебного пособия для студентов высших учебных заведений,  
обучающихся по направлению ВПО 020100-бакалавр химии*

Иваново 2011

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Пособие систематизирует материалы по толкованию химии как науки и учебной дисциплины, определяет базовые химические понятия, приводит данные по именованию химических элементов и их соединений. В пособии рассматриваются основные состояния вещества, периодическая система, а также физические и химические свойства веществ. Материал представлен в виде многочисленных схем и таблиц, а также разнообразных вопросников и тестов. Имеется целый ряд заданий, нацеленных на формирование логического мышления студентов. Приводятся промежуточные и итоговые контрольные задания и тесты, подобрана серия предложений для перевода на русский и английский языки, а также имеется подборка текстов для самостоятельного перевода на английский язык.

Предназначено для самостоятельной работы студентов-бакалавров (направление 020100 «Химия»), но также может применяться на практических занятиях.

Пособие используется в качестве дополнительного материала к учебнику английского языка для студентов-химиков, рекомендованного Советом по химии УМО университетов РФ (М. М. Кутепова. «*Мир химии*». М., 2001).

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университет, 2011

**Dedicated to my dear  
intellectually gifted students  
whose bright and original thoughts  
I derived my inspiration from**



## Предисловие

Пособие предназначено для аудиторной и самостоятельной работы студентов первого (базового) уровня обучения (бакалавриат) вузов и факультетов университетов химического профиля, а также слушателей факультативных курсов по английскому языку для специальных целей (ESP). Пособие рассчитано на 40-50 академических часов аудиторного времени (преимущественно разделы *Introductory* и *Unit 1*) и 120-150 академических часов самостоятельной работы (*Units 2-7*).

В соответствии с требованиями федерального государственного образовательного стандарта высшего профессионального образования по направлению подготовки 020100 «Химия» пособие целенаправленно формирует профессиональные компетенции анализа и систематизации информации, извлеченной из предъявляемых оригинальных текстов по специальности, в графическом виде; совершенствует навыки аналитического и критического мышления; упрочивает междисциплинарные связи, а также способствует развитию всесторонне развитой и гармоничной языковой личности.

Представленные в пособии материалы тщательно отбирались и неоднократно успешно апробировались. Они содержат богатую и разнообразную дополнительную информацию к учебнику «Мир химии» М. М. Кутеповой.

В пособии систематизируются базовые понятия основного курса английского языка для специальных целей и компилируются многочисленные эвристические находки. Приоритет при отборе получали задания и вопросы, характерные для педагогических технологий деятельностного и компетентностного подхода к обучению. Авторский курс английского языка для специальных целей, читаемый на факультете фундаментальной и прикладной химии, базируется на технологии развития критического мышления через чтение и письмо, а также эмоционально-смысловом методе обучения иностранному языку отечественного лингвиста И. Ю. Шехтера.

В связи с вышеизложенным приводимые в пособии задания построены по принципу мозговых штурмов, составления кластеров и концептуальных таблиц на основе ключевых слов и понятий, нахождения аналогий между частями информации и причинно-следственных отношений, выявления проблемы в тексте информации и определения ее значимости для структурирования и решения проблемы.

## Методические рекомендации

В целях стимулирования и совершенствования ассоциативного мышления студентов целесообразно предварить чтение **Вводной главы** вопросами 1-3, 5 из первого раздела (**Unit 1**). После обсуждения в студенческой аудитории различных аспектов темы «*Химия в нашей жизни*» для увеличения словарного запаса по данной теме, а также аналитического и критического осмысления информации предлагается познакомиться с вводным разделом. Следует упомянуть, что дополнительные вопросы к нему (14-35) сформулированы в следующем разделе (**Unit 1**). В качестве самостоятельного задания может быть логическое обоснование приводимых в этом же разделе таблиц (1-2) или схематичное построение собственных. Приводимые в первом разделе цитаты (4, 6-13, 22) преследуют несколько целей. С одной стороны, они привлекают внимание студентов к именам выдающихся ученых с мировым именем, внесших наиболее существенный вклад в химическую науку, пробуждают познавательную активность и интерес к получению новой информации в связи с изучаемой темой, а с другой – ненавязчиво вовлекают в обсуждение, инициируя тем самым мыслительную деятельность слушателей.

Кроме этого, первый раздел (**Unit 1**) также посвящен толкованию химии как науки вообще и учебной дисциплины, в частности. Только после перевода специально отобранных изречений о химии именитых ученых, рассмотрения трактовки понятия «*химия*» в различных англоязычных словарях, выполнения упражнений на закрепление основных лексических единиц (46-49, 51, 61, 64, 65) оправдано обращение к расшифровке схем (50, 52, 59, 66, 67, 70-74) и наглядному выстраиванию своих аргументированных терминологических цепочек.

Особенностям именования и происхождению знакомых названий химических элементов и их соединений, принципам построения периодической системы, состояниям вещества, их физическим и химическим свойствам, описанию отдельных химических элементов и веществ посвящен второй раздел (**Unit 2**).

Следующий раздел (**Unit 3**) описывает свойства и особенности воды, самого распространенного вещества в природе, простейшего устойчивого в обычных условиях химического соединения водорода с кислородом.

Необходимый материал по названию и функциям химического лабораторного оборудования, нормам и правилам поведения в лаборатории объединен в четвертом разделе (**Unit 4**).

Для закрепления и рубежного контроля рассмотренного материала каждый раздел (**Units 1-3**) завершается промежуточными тестами.

Специально разработанные итоговые тесты и контрольные задания как для первой ступени обучения (1-2 курсы), так и для второй (3-4 курсы) обобщены в отдельном разделе (*Unit 5*). Кроме этого, предлагается итоговый тест по именованию химических элементов и соединений, а также подборка предложений для перевода как на русский, так и на английский язык.

Тексты (*Unit 6*) для перевода на английский язык имеет смысл предлагать студентам либо в целях повышения их рейтинга, либо в качестве предэкзаменационной самостоятельной письменной работы.

Завершающий раздел (*Unit 7*) объединяет самые разные задания для студентов с продвинутым уровнем владения английским языком. Кроссворды, обобщенные в этом разделе, можно также с легкостью использовать в качестве промежуточного контроля по изучаемым темам.

В целях облегчения работы преподавателей и их обращения к тем или иным разделам ниже приводится таблица соответствий вопросов и заданий пособия урокам учебника «*Мир химии*» М. М. Кутеповой.

Раздел пособия	Задания разделов	Разделы учебника « <i>Мир химии</i> »
Introductory notes		
Unit 1. Chemistry through schemes and definitions	1-13, 28, 37-38, 39, 41, 68, 70-5	Unit 1. Overview of chemistry
	40, 42-48, 50-51, 67	Unit 4. Matter in the universe
	53-58, 64-66	Unit 3. Periodic table and periodic law
	59-62	Unit 5. Why is water so important?
	69, 76	Unit 2. History of chemistry
Unit 2. Do you know chemical elements?	Аудиторно или самостоятельно	Unit 3. Periodic table and periodic law
Unit 3. What do you know about water?	Самостоятельно	Unit 5. Why is water so important?
Unit 4. Chemical laboratory and equipment	Самостоятельно	Unit 4. Matter in the universe

Unit 6. Rendering into English	Тексты для самостоятельного перевода	Units 1-5
	Сколько кислоты в капле дождя?	Unit 9. Man and his environment
	Необычные свойства полимеров	Unit 8. The age of polymers
	Молекулярная гастрономия	Unit 10. Science and its future
Unit 7. For you, Brainiacs!		Unit 3. Periodic table and periodic law
	6, 13	Unit 8. The age of polymers
	20, 43	Unit 5. Why is water so important?

Любому опытному преподавателю ESP, обучающему студентов-бакалавров по указанной специальности, не составит труда использовать данное пособие по собственному выбору.

От всей души надеюсь, что настоящее учебное пособие окажется интересным и надежным подспорьем в работе.

Выражаю глубокую искреннюю благодарность всем своим студентам, неординарное мышление которых, живой положительный отклик на внедрение в процесс обучения креативных находок, нестандартная логика рассуждений, плодотворные синергетические усилия в огромной степени содействовали появлению данного пособия.



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***ДАРЮ ИМ ИХ ХИМИЮ. РАД!*** [15]

**Do not learn English blindly but use as much English as possible!**

*Introductory notes*

*We have discovered the secret of life!*  
Francis Crick (1916 — 2004)

Have you ever thought that it is quite easy to draw a parallel between our society and the study of chemistry? It is intriguing enough to find analogues with chemistry within the community. We are all individuals but have some common features and interests. Our actions and behaviour could easily be associated with those of chemical elements. We act and communicate according to special rules and laws. We feel sometimes how eagerly we can talk and make friends with one person and how difficult it is with the other one. Chemical elements also react with each other, one of them rather easily, the second 'reluctantly'. There can be no reactions between the third ones. Every chemical element has its own place in the periodic system of elements, which may be called its 'home'. They are united into groups according to their specific properties. They are surrounded by a lot of 'neighbours' in the periodic table. Every place there has its own identifications. Does not it resemble our living conditions?

Let us plunge into wonderful and thrilling world of chemistry. We come across chemistry nearly everywhere, often without recognizing it. Every morning going to the bathroom we take a toothpaste containing fluorine. Combing our hair we use either a plastic or wooden comb. Choosing fashionable ready-made clothes we never think of involved chemical technologies. Eating or drinking every day does not make us mediate upon chemical alimentary processes progressing in our organism. Getting our teeth into favourable and fleshy fruit we take pleasure in it without enumerating all its necessary vitamins and important chemical processes occurring in our organism. Adding a slice of lemon into a cup of our morning tea we just enjoy the taste of tea instead of analyzing the reaction between these substances. Observing oneself in the mirror in the search of new wrinkles we regret about the time passed rather than of multiple natural changes.

It is absolutely wonderful how firm the alliance of chemistry with our life is. Have you ever thought what our frame of mind and activity depend on? Would it be a surprise for you to learn that the answer is found on the molecular level? It is an open secret that we live due to our own natural biological rhythms. Biological clock of the organism helps people to adjust to proper time both psychologically and physiologically. However, our mood and as a consequence of it our ability to work is dependable upon chemical substances dopamine and serotonin produced by the brain. Swiss scientists [12] discovered that systems of the organism regulating diurnal rhythm influence hormones production

responsible for the mood. Subject to the time of day special enzyme either reduces or raises their level in the organism, the enzyme production itself being regulated by 'time' genes. The role of the latter is to control the organism adaptation according to its biological clock. The investigation on mice has clearly proved that the absence of 'time' genes leads to decreased production of cheerfulness hormones. So do remember that our being in good spirits is uppermost a chemical process rather than impact of environment!

As chemistry is a natural science it exists everywhere in our life. Let us think about our surroundings from chemical point of view. As our task is to find parallels between human life and the science of chemistry we should compare both spheres. The central figure in the life is a **person**, that of chemistry being a chemical element. What is our body? There are several ways to speak of it. As the word '*body*' itself has different meanings, it is possible to interpret it from unlike points of view. You can use it for designating large amount, group of people or clothing. One can begin with enumerating the parts of the human body, describe a shape of the body, speak of the functions of it, mention major inner organs and their role, give examples of the body movements, and finally explain how to look after one's body.

Chemically, the human body consists mainly of water and organic compounds such as lipids, proteins, carbohydrates, and nucleic acids. The human body is about 60 percent water by weight. All extracellular fluids of the body, for example, the blood plasma, the lymph, and the interstitial fluid as well as the cells themselves contain water. It has a very important function without which the chemistry of life could not take place. Water is a universal solvent. Lipids (chiefly fats, phospholipids, and steroids) are major structural components of the human body. Fats provide the body with necessary energy reserves, fat pads serving as insulation and shock absorbers. Phospholipids, the steroid compound cholesterol and proteins are major constituents of the membrane surrounding each cell. Our hair and nails are also composed of protein. Collagen is a fibrous, elastic material making up much of the body's skin, bones, tendons, and ligaments. Proteins perform numerous functional roles in the body. Particularly important are cellular proteins called enzymes, which catalyze the chemical reactions necessary for life. Carbohydrates represent fuel resources of the human body either as simple sugars circulating through the bloodstream or as glycogen, a storage compound found in the liver and the muscles. Nucleic acids make up the genetic materials of the body.

Along with water and organic compounds, the body's constituents include various inorganic minerals, chief among them being calcium, phosphorus, sodium, magnesium, and iron. Calcium and phosphorus in the form of calcium-phosphate crystals form majority of the body's bones. Calcium and sodium are also found as ions in the blood and interstitial fluid. Ions of phosphorus, potassium, and magnesium abundant within the intercellular fluid play vital

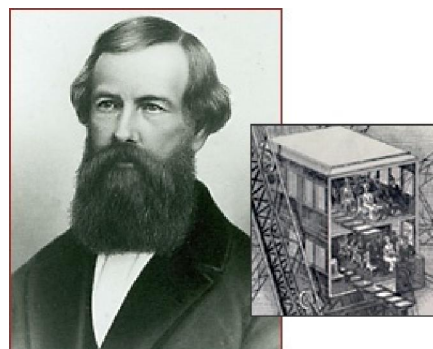
roles in the body's metabolic processes. Iron is present mainly as part of hemoglobin, the oxygen-carrying pigment of the red blood cells. Other mineral constituents of the body, found in minute but necessary concentrations, include cobalt, copper, iodine, manganese, and zinc [5].

Summarizing this brief chemical excursion on our body it is possible to say that every person is a small walking chemical plant! Main elements found in the periodical table are also present in our body. Processes of breathing and moving, nutrition and its changes into energy and materials for growth require chemical involvement. Thus, starting with the simplest description of a human being we feel no doubts about his links with chemistry on physiological level. In this case it's possible to say that nature itself is the great inventor and brilliant designer.

Let us continue our reasoning. Every chemical element has its proper place in the periodical system. Its precise spot may be compared with an element's own 'home'. The 'address' of an element is nothing more than its atomic weight depending on its chemical properties. Analogy is obvious. We all have **homes**. What chemical traits it is possible to find there?

In order to be safe and secure against unfriendly environment people build reliable houses. Bricks, steel and concrete structures, glass items, timber, electrical and communication systems, plumbing and vertical transportation are very familiar to us nowadays. Building construction has always been an ancient human activity. It started naturally for moderating the effects of climate. The first functional shelter was in the form of a tent made of animal skins, presumably supported by central wooden poles. Early building materials were perishable, such as leaves, branches, and animal hides. Later, more durable natural materials such as clay, stone, and timber and, finally, synthetic materials like brick, concrete, metals, and plastics were used. To supply their houses with fresh water as well as to remove wastewater from the buildings first pipes of lead were made. This system is called now plumbing, the word originating from the Latin *plumbum*, which means lead. By the way, isn't it the name of a chemical element?

People continue to increase human comfort (through inventing and designing!) by precise regulation of air temperature, light and sound levels, humidity, odours, air speed, and other factors. The Romans applied glass to buildings making the first clear window glass, produced by blowing glass cylinders that were then cut and laid flat. Egyptians had used it mostly for jewelry and small ornamental vessels. It was the Romans who devised many kinds of coloured glass for use in mosaics to decorate interior surfaces. The central open fire being the major source of heat was



transformed from the roman innovation of hypocaust to the masonry fireplace and chimney. Elisha Graves Otis's first safe steam-powered roped elevators were improved by the French engineer Léon Édoux to hydraulic ones for buildings of about 15 stories. The development of the electric motor by George Westinghouse made it possible to invent the high-speed electric-powered roped elevator (called "lightning" elevators in comparison to the slower hydraulics) and lead to the electric-powered moving staircase, or escalator.

The appearance of electric power in our houses we are obliged to several famous people. They are as follows: the British physicist Michael Faraday, the American inventor Thomas Alva Edison, the French engineer and chemist Georges Claude and some others. The American inventor and industrialist Willis Haviland Carrier developed his system of "man-made weather," finally applying it together with heating, cooling, and control devices as a complete system. He managed to solve the problem of humidity removal by condensing the water vapour on droplets of cold water sprayed into an airstream. Now the so-called variable air volume (VAV) system is widely used supplying conditioned air at a single temperature, the volume varying according to the heat loss or gain in the occupied spaces. Not in vain a famous Swiss-born French architect Le Corbusier stated that "*a house is a machine for living in*".

As soon as a man had learned to build his primitive shelters he started thinking about **clothing** and accessories for a human body. The most obvious function of dress is to provide warmth and protection. However, many scholars believe that the first crude garments and ornaments had religious or ritual origin. Another very important function of dress is to identify the wearer providing information about his sex, age and occupation as well as to make the wearer more attractive. At first skins of various animals either as raw hides or taw leather were utilized, loincloths being a first prehistoric garment. A loincloth may be made of wool, leather, or linen tightly belted at the waist. The belt had the aim to contrast the slender waist. The women were mostly wearing a bell-shaped skirt, often in a series of flounces, over a loincloth.

Tawing method yielded white, stiff leather that was dyed with various colours. Leather was also widely used for footwear, belts, and straps. Footwear for both sexes was made from fabric or soft leather in the form of sandals or boots. Sandals were the most common footwear in early civilizations, a few cultures having shoes. The mountain people living on the border of Iran had a type of soft shoes made of wraparound leather similar to moccasins, no difference being between the right and the left shoe. Outdoors both sexes also wore sandals or shoes. In winter calf-length boots were adopted, and short woolen, fur-lined cloaks were fastened by pins around the shoulders.

Decorative items such as necklaces and armlets of beads, amber, and ivory were used to adorn oneself. Diggings in various places demonstrate boxwood and bone combs, reindeer horn buttons and plaques. Instead of simple

woolen cloaks worn for warmth by both men and women oriental styles of Persia, India and China offered fitted sewn garments based upon coats, tunics and trousers. To the fine linens available in costume were added cotton from India and silk from China.

The technological advance contributed to the production of synthetic textile fibers. Permanent pleating, fast dyes, crease resistance, preshrinking, and other easy-care characteristics of synthetics have made it possible to manufacture clothing more quickly and less expensively. Although traditional natural fabrics remain popular, they have been almost completely replaced by synthetics in the manufacture of some garments. Similarly, the underwear industry was revolutionized when latex thread was employed, along with the zipper, to fabricate comfortable two-way stretch suspender belts.



It is an open secret that exclusively due to their keenness of observation on environment people have managed to invent a lot for themselves including buildings, cloths, footwear, etc. Cobweb, for instance, has interested people long since. Just recall a myth about poor but skilled weaver Arachna, who was turned into a spider for her daring to compete in her skills with the goddess Athena. Modern scientists also desire to create artificial web similar to that of spiders, as natural one is extremely strong and flexible thanks to silk of certain proteins.

Scientists from Jewish University in Jerusalem in close collaboration with experts from Munich and Oxford Universities used genetic engineering for web fibers making [22]. For this purpose they took horticultural spider genes. Artificial fibers obtained appeared six times stronger than nylon and steel fiber of the same diameter being one thousandth of millimeter. These wonderful fibers may be used for bulletproof vests manufacturing, surgical sutures production, micro conductors, optic fibers and fishing rods making without mentioning creative clothes designing.

German investigators developed a micromachine to generate artificial web thread [11]. It is artificial canal made of a piece of glass and microtubules imitating spider's processes similar to the spider's canal forming cobweb. However, man-made web granularity does not permit it to compete with the natural one.

Here are some interesting facts from the footwear history. Their modern view is presented below. Familiar things, aren't they? Do you know that the shoestring was invented in England as early as in 1790? Before shoestrings footwear was commonly fastened with buckles.





The first rubber soled shoes called plimsolls were developed and manufactured in the United States on January 24, 1899 by Irish-American Humphrey O'Sullivan. He patented the rubber heel which outlasted the leather one. Vulcanization process discovered and patented by Charles Goodyear uses heat to meld rubber to cloth or other rubber components for a sturdier, more permanent bond.

One more very important sphere of human activity with traits of chemistry is **healthcare**. First of all it should be noted that the extent of an individual's physical, emotional, mental, and social ability was absolutely necessary to cope with his environment. Religion and magic underlie the medicine of prehistoric people. The first magicians and sorcerers by the process of trial and error learned to distinguish which plants and herbs were edible and rather eatable, which of them were poisonous and which could be used for healing wounds. Only the initiated were involved in medicine. Therefore, administration of a vegetable drug or remedy by mouth and the treatment of wounds and broken bones were always accompanied by incantations, dancing, grimaces, and other tricks of the magicians. The use of charms and talismans, still prevalent in modern times, is of ancient origin.

Medieval physicians analyzed symptoms, examined excreta, and made their diagnoses. Then they might prescribe diet, rest, sleep, exercise, or baths; or they could administer emetics and purgatives or bleed the patient. Surgeons could treat fractures and dislocations, repair hernias, and perform amputations and a few other operations. Some of them prescribed opium, mandragora, or alcohol to deaden pain. Childbirth was left to midwives, who relied mostly on folklore and tradition.

This voluminous experience has lately been adopted and improved due to great achievements of the developed scientific approach. A lot of new materials have appeared and been currently invented. Infinite variety of plastics has been employed in medicine for almost everything from suture material to heart valves; for strengthening the repair of hernias; for replacement of the head of the femur; for replacement of the lens of the eye after extraction of the natural lens for cataract; for valves to drain fluid from the brain in patients with hydrocephalus; and for many other purposes. Inert metals, such as vitallium, have also found their proper place in surgery, largely in orthopedics for the repair of fractures and the replacement of joints.

Every individual nowadays can take a health examination which is likely to comprise a series of different tests either instrumental or physical and chemical. The latter include blood, urine and spinal-fluid analyses, providing physicians with necessary information.

In connection with the discussed issue it is sensible to quote a British doctor Robert Hutchison (1871 — 1960) generalizing the commonest opinion about the secret of problem-free existence in *Newcastle Medical Journal*. He

declared: “*The scientific truth may be put quite briefly: eat moderately, having an ordinary mixed diet, and don't worry*” [19].

Summarizing the medical issue let us address the well-known book of uncertain date and of composite authorship which is called “*Regimen Sanitatis Salernitanum*” (“*Salernitan Guide to Health*”) [23]. Written in verse, it has gone through numerous editions and has been translated into many languages. Among its oft-quoted couplets are the following lines that we are to follow in order to be healthy:

*Use three physicians still, first Doctor Quiet,  
Next Doctor Merryman and Doctor Diet.*

Most of the world’s primitive people had practiced **cleanliness** and **personal hygiene**. The main reason for that was often their religious believes, including, apparently, a wish to be pure in the eyes of their gods. Now it goes without saying that hygienic regulations should be strictly observed. However, a number of first steps in public health were made during the Middle Ages. The real reason behind such a decision was natural attempts to cope with unsanitary conditions of the cities and, by means of quarantine, to stop the spread of different infectious diseases. The next logic step was the establishment of hospitals and development of medical care and social assistance to people.

It is a well known fact that public health preventive measures are of more importance than curative medicine. It was not until XIX century when those measures were largely introduced. Strange enough but nearly all the cities of that time had poorer water and drainage systems than Rome had possessed 1,800 years previously! Contaminated and infected water supplies couldn’t but cause sudden and violent outbreaks of typhoid, cholera, and other waterborne infections. Later special laws were enforced concerning water-, food- and insect-borne infections nearly in every country. Due to strict correspondence to these laws many infectious diseases in some countries were eliminated.

The commonest procedure for keeping our body clean has always been that of bathing. In ancient Greece baths were used for religious purification, personal cleanliness, and even private or social relaxation. Public baths formed an important part of the Roman Empire culture. One of the most ancient and grandest example of these facilities are the Baths of Caracalla built in Rome for the pleasure of the leisure classes about AD 217. They contained space for 1600 bathers, covering 28 acres or 11 hectares. The huge, vaulted interior embraced baths, swimming pools,



lecture halls, lounges, and exercise conveniences. Once lined with marble, the ruins of the Baths of Caracalla now provide a majestic open-air setting for opera performances.

The bath as an institution has a long history. The early Christian church considered physical cleanliness less important than spiritual purity and did not encourage private bathing. Medieval builders paid more attention to fortifications and fireplaces than to water supply and drains. It is hardly believable but in chilly northern Europe bathing was regarded unhealthy! In northeastern Europe not penetrated by Roman influence the Finns and Russians developed a taste for steam baths of the ancient Scythian nomads on the Eurasian steppe. Finnish and Russian families built small wooden rooms or huts (Finnish sauna is famous all over the world!) with benches around the walls. Water thrown on heated rocks created dense clouds of steam, in which the bathers sweated. They were then soaped, rubbed, flogged with bunch of softened green birch twigs, and washed with tepid water. Finally they were splashed with cold water or plunged into snow or an icy stream.

Islamic societies also valued baths for religious, hygienic, and social purposes, developed sophisticated bathing facilities. Public baths served the same functions as Roman ones featuring a combination of steaming, cleaning, and massage. They consisted of a large, domed, steam-heated central room surrounded by smaller accommodations, the whole being decorated with marble or mosaics. One could spend the day at the baths, enjoying refreshments and meeting friends. Turkish baths, like Roman ones, in time degenerated into resorts of idleness and indulgence.



Modern baths have taken many forms. In some cases they have combined features from many types of older baths, including the Turkish bath and the Oriental tub bath, or *furo*. Below you can see a bath at Myoken Spa, Kagoshima, Kyūshū Island. Since 1900s public baths have frequently taken the place of domestic facilities.

Water treatments in general are called hydrotherapy originated probably in China, since cold baths were used for fevers there as early as 180 BC. Particular kinds of baths nowadays using special waters such as carbonated or chemically treated waters, medicated and mineral, at high or low temperatures have curative value. The body may be soaked not only in water but as well in some other aqueous matter such as mud, steam, or milk.

Personal hygiene is always associated with a lot of accessories we have in our bathrooms. Soap, bath salts, bath oil, and similar detergents are so common that they are not usually considered medicines. Bath salts and other bath preparations combine water-softening agents such as sodium carbonate or borax

with perfume, bath oils also being popular skin-softening and perfuming aids. Looking after our hair we habitually apply various shampoos, conditioners and hairsprays, for drying it we sometimes make use of hairdryers. Hair lotions and hair sprays are used to condition the hair, keep it in place, or make it glossy. Shampoos are based on soap or synthetic detergents.

Hairdressing, arranging or otherwise altering the hair for both enhanced beauty and practicality has been an important part of the costume of men and women since prehistoric times. At first the hair of both sexes was worn long and looped, later braided and dressed with jewels, pearls, and ribbons. Heavy wigs or a padding of false hair, worn also by both men and women, are known from an early period. The processes involved in hair may include its cutting, plucking, curling, braiding, bleaching, dyeing, powdering, oiling, or adding false hair or ornaments. You may do it yourself or address to a hairdresser. The variety of hairstyles now is enormous. What to do with your hair is your personal choice though Martin Luther once mentioned that hair is “the richest ornament of women”. However, tastes differ. Let us close this topic with a very intriguing quotation of an English pamphleteer William Prynne (1660 — 1669): “*A woman with cut hair is a filthy spectacle, and much like a monster...it being natural and comely to women to nourish their hair, which even God and nature have given them for a covering, a token of subjection, and a natural badge to distinguish them from men.*” [14]

Soap is the commonest cleaning agent made from animal and vegetable fats, oils, and greases. Ancient world didn't know such a cleaning agent. Nevertheless, Egyptians strictly followed hygienic rules washing themselves with pounded brick, sand, pumice and ashes. From chemical point of view soap is the sodium or potassium salt of a fatty acid, formed by the interaction of fats and oils with alkali. Oils and fats used in soap production are compounds of glycerin and a fatty acid, such as palmitic, or stearic acid. After treating these compounds with an aqueous solution of an alkali (sodium hydroxide) they decompose to form glycerin and the sodium salt of the fatty acid.

The most important function of the majority of soaps is to remove grease and other dirt. However, we never think what the mechanism of such an action is. For an average man it is of no interest that purification process depends upon special components called surface-active agents, or surfactants. It is molecular structure of surfactants that act as a link between water and the dirt particles, loosening the latter from the surface to be cleaned. As a chemist you should know that the ability of the molecule to perform this function is accounted for its hydrophilicity and hydrophobicity. The hydrophilic end of the molecule is attracted to water, the hydrophobic one being attracted to substances insoluble in water. Analyzing this chemical process further you can see that the structure of the hydrophilic end is similar to water-soluble salts, while the other part of the molecule frequently contains a hydrocarbon chain, its structure being similar to

the structure of grease, oil, and many fats. Exactly this peculiar structure permits soap to accomplish its cleaning function.

Using different types of soap you take them as means of hygiene without interpreting a soap powder as a hydrated mixture of soap and sodium carbonate or liquid soap as solution of soft potassium soap dissolved in water. Trying to make clothes white or lighter in colour you usually take bleach which is a chemical liquid. You should not remember that caustic soda, or sodium hydroxide, NaOH manufactured principally by electrolysis of a common salt



**P&G**

solution, chlorine and hydrogen being its important by-products, is used in the manufacture of soap. Instead, you can easily name a large American international company established in 1837 by James Gamble, a soap maker, and William Procter a candle maker in Cincinnati, Ohio. “*Procter & Gamble*” is now a world-known trade mark of *Ivory* soap, *Crest* toothpaste, *Tide* soap for clothes, *Mr. Clean* for bathroom and kitchen surfaces and *Oil of Olay* cream.

It is impossible to disregard another very catching sphere of human life concerning the art of beautifying the face and body that is also rather closely connected with the question under discussion. A British scholar, preacher and one of the most witty and prolific authors of the 17th century Thomas Fuller (1608 — 1661) once stated: “*There is a great difference between painting a face and not washing it*” [6]. The word ‘cosmetics’ itself originated from Greek and means ‘the art of decoration’, however, the first proofs of their application refer to glacial age. The man had hardly ever climbed off the tree and already took a lipstick and a pencil for eyes. It is far from being exaggeration, archeologists having found lipstick and sticks for eyelashes in the caves of glacial age.

Concepts about human beauty greatly varied together with the development of mankind. Nevertheless, cosmetics and make-up were used in ancient Egypt, Babylon, Assyria, Rome, and Judea. Archeologists have found tools for preparing cosmetic ointments and liquids, grindings and tinctures, being extensively employed by both sexes. The earliest historical record of cosmetics application is linked with Egypt referring to circa 2920-2770 BC. Tombs of that era have yielded scented unguent jars. Such incenses, as well as perfumed oils, were extensively used by both men and women to keep their skin supple and unwrinkled in the dry heat of Egypt. The women of Egypt were also the first to develop the art of decorating eyes. The chief focus of make-up concerned in applying dark green color (made of powdered malachite) to the under lid and in blackening the lashes and the upper lid with kohl, a preparation made of antimony, carbon, copper oxide or soot. The Egyptians applied rouge to cheeks, red ointment to lips, and henna to nails and feet, and ladies traced the

veins on their temples and breasts with blue paint, tipping their nipples with gold. Men also painted their eyelids with kohl. Kohl was similar to the eyeliner used by women today. Rich ancient women even had a special case for their fragrant accessories to be at hand. Here you can see a prototype of such a handbag.

Egyptians recognized not only cosmetic, but also medical behaviour of aromatic oils and paints for body and face. They knew that oils softened skin, and aromatic tinctures disinfected it. They were able to prepare bright luminous paints from sea shells and animal fats. Cosmetic means were freely sold at numerous small perfume shops. Palm oil was used for face and body skin, mint oil was offered for hands, mayoral ointment was prepared for hair. Instead of powder the mixture of chalk with white lead was used. Wine yeasts and ruddle served as blush. Eyelashes and eyebrows were penciled by slate pencils and soot.

Today a large variety of cosmetics is also available. Using them we never think whether it is connected with chemistry. We just know that cold cream is an emulsion of various oils and waxes and water. We employ it to cleanse and soften the skin. Widespread face and dusting powders based on talcum (powdered magnesium silicate) and zinc oxide are necessary for drying and adding a satiny texture to the skin. Nail polishes are lacquers or plastics available in many colors. Hair-coloring dyes, tints, and rinses available in a wide spectrum of shades and colors are also commonly used cosmetic products. Henna is a vegetable dye used for centuries to impart a red tint to the hair. Weak solutions of hydrogen peroxide are often employed as hair bleaches. Mascara, a compound of gum and black, green, or blue pigment is generally used for coloring the eyebrows and eyelashes. Sulfides of calcium and barium having the property of removing hair from the skin are active agents in cosmetic depilatories. Bronzes are creams imitating suntan colour to the skin. Whereas perfumes are not classified as cosmetics, deodorants are. They may contain a special astringent (which is again a chemical compound aluminum sulfate) to close sweat glands pores and an antibacterial ingredient, hexachlorophene, being banned from deodorants in 1972.

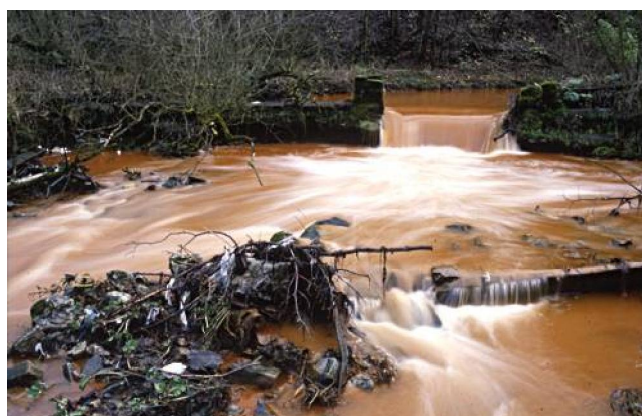
It would be unfair to state that cosmetics and perfumery are confined to use exclusively by women. There is a series of grooming aids especially for men. Among them one can find powders, colognes and lotions, particularly alcohol-based after-shave lotions; bay rum, a mixture of alcohol, oil of bay, and oil of orange, originally made with rum; hair tonics, often with an alcohol or quinine base; as well as deodorants.

One of the marketing means is advertising



posters promoting this or that popular item of cosmetics. In the poster designed by a French illustrator Jules Chéret you can see prominent illustrations and a minimum of text. His idealized female figure emphasizes beauty and vitality; it is the image role rather than the words to convey the message. An American businessman Charles Haskell Revson (1906 — 1975), who turned a \$300 investment into the largest retail cosmetics and fragrance manufacturing firm in the United States, once said: “*In the factory we make cosmetics. In the store we sell hope.*” [1]

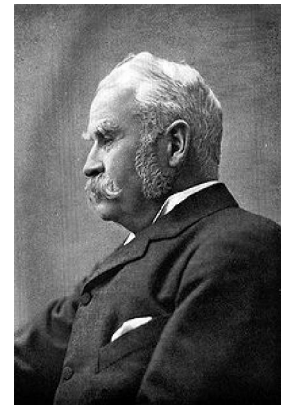
Let us go on dwelling upon different aspects of our life in connection with chemistry. If a person is healthy, has his own home, is warmly dressed and satiated it is quite natural for him to start thinking of personal surroundings. A man decided to better till the land he lived on and cultivate animals. He began to farm arable land for growing **crops** and keeping **domestic animals**. He cut and dried grass for feeding his cows, sheep and pigs, dried stems of wheat plants for his livestock to sleep on. His farming activity couldn't do without some chemical involvements. To make land more fertile and make plants grow more successfully he had to use both natural and artificial fertilizers; to supply his fields and pastures with water he had to take pipes made of steel; to build barns and sheds for animals he had to employ construction materials mentioned above. In order to keep his crops from birds, rodents and especially pests and insects he sprayed them with pesticides or insecticides. To free himself from plants growing where they are not wanted he made use of herbicides, i. e. chemicals poisonous to those plants and killing them. To facilitate crop plants harvesting defoliant are applied to them. This chemical dust or spray is to cause the leaves to drop off prematurely.



Working lands conventional farmers often use synthetic pesticides to kill weeds, disease-causing fungi, and harmful insects. They never speculate upon chemically processing petroleum, natural gas, ammonia, and a number of other raw materials to manufacture these pesticides. Nature friendly organic farmers also use pyrethrum, a substance extracted from chrysanthemums, a variety of soaps, and oil from the neem tree as well as the so-called Bordeaux mixture consisted of copper sulphate and calcium oxide to control disease-causing fungi. Chemical fertilizers and pesticides applied to crops often leach into the soil and are carried by rain to rivers, contributing to water pollution, one of the most critical environmental problems of the 20th century. Organic farmers minimize water pollution by using non-toxic fertilizers and pesticides.

All mentioned above topics concerned the problem of **technology**, in other words the development of necessary household items manufacturing. The Greek origin of the term ‘technology’ witnesses about rather high development level of that community. The first part of the Greek word *technē* means “art, craft”, the second one *logos* implying in Greece a discourse on the arts, both fine and applied. Utilitarian values of metals has a very long history extending over approximately 6,500 years as gold, silver and copper occurred in the native or metallic state. However, they were not fully satisfied all the purposes of living and required further development thanks to inquisitive human mind. This idea is realized in the lines of a British librettist and playwright W. S. Gilbert (1865 – 1936) who once noticed:

*When every blessed thing you hold  
Is made of silver, or of gold,  
You long for simple pewter.  
When you have nothing else to wear  
But cloth of gold and satins rare,  
For cloth of gold you cease to care —  
Up goes the price of shoddy. [8]*

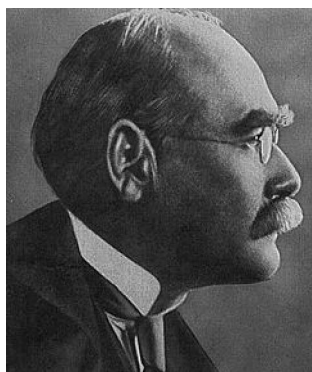


Manufacturing industry known since the New Stone Age, exploited techniques for grinding corn, baking clay, spinning and weaving textiles, and probably for dyeing, fermenting, and distilling. Some above mentioned processes were developed into specialized crafts by the time the first urban civilizations appeared. The early metalworkers acquired the techniques of extracting and working the softer metals like gold, silver, copper, and tin. They discovered that those metals could be fashioned into shapes by melting and casting in molds. Another step was the finding of metals recovering from metal-bearing minerals. It became possible due to observations of their colour, texture and weight, as well as difference in flame colour and smell when heated. By the way, all these properties are distinguished as physical ones.

Bronze, iron and brass were the earliest metallic materials for building successive civilizations and of which major implements for both war and peace were generally made, the establishment of a brass industry being one of the important metallurgical contributions of the Romans. The first important steel production was started in India using the same process already known to ancient Egyptians. However, the Chinese were the first to oxidize the carbon from cast iron in order to produce steel or wrought iron indirectly, rather than according to the direct method of starting from low-carbon iron. The most meaningful developments in metallurgy were centred on iron making, weapons, agricultural implements, domestic items, and even personal adornments made of iron being very widespread. Great Britain was famous for its fine-quality iron cutlery produced near Sheffield.



The role of iron for not only prehistoric time was echoed in the poem of an Indian-born British writer and poet Rudyard Kipling (1865 — 1936) “*Cold Iron*”:



*Gold is for the mistress, silver for the maid,  
Copper for the craftsman cunning at his trade.  
“Good!” said the Baron, sitting in his hall,  
“But Iron, Cold Iron, is master of them all.” [27]*

It is also true if we recall standard antique equipment of the Roman legionnaire who was armed with an iron helmet and breastplate, a short sword and an iron-tipped spear. Inventive Roman military technology contributed to further achievements in this sphere.

In ancient times some metal processing means were devised. Brass, an alloy of copper and zinc without tin, was obtained by the calamine method. To produce necessary reducing conditions zinc carbonate or zinc oxide were added to copper and then melted under a charcoal cover. A cupellation procedure was also known since great antiquity. It was employed in order to get rid of lead from the silver by melting the alloy in shallow porous clay or a bone-ash receptacle called a cupel, while a stream of air over the molten mass preferentially oxidized the lead. Then the oxide was partially removed by skimming the molten surface, the remainder being absorbed into the porous cupel. As a result silver metal and any gold were retained on the cupel. The process of the lead recovery from the skimming and discarded cupels was accomplished upon their heating with charcoal. The same cupellation method was exploited to refine the gold from such contaminates as copper, tin, and lead. Gold, silver and lead were used mostly for artistic and religious purposes, personal adornment, household utensils, and equipment for the chase. The casting process was also well established. Its main idea was to pour molten metal into any specially shaped mold to keep the shape of the mold while solidifying. The practice of ancient history proved melting of the base metal (iron, aluminum or copper) to be the basis for alloys obtaining. Only after it the alloying agents could be added.

And again it is quite possible to observe the close links between metallurgical processes developed in antiquity and the science of chemistry. Ancient peoples in various locations noticed that almost any metal is oxidized in air, gold being the only exception. Another special property of metal surface is its ability to serve as a catalyst during chemical reactions. First metalworkers knew rather well the necessary conditions for obtaining better results. They learned to use the amalgamating property of mercury, for instance, for metals recovery and refining. Methods of determining whether ores were worth mining and extracting, modes of evaluating the metal content in ores, procedures used

for crushing and concentrating, approaches to proper cooling and heating conditions, processes of calamine, metal casting and molding, melting and smelting, refining and cupellation had been mastered.

Thus, we have got added evidence that the science of chemistry breathes a new life into everything it touches upon. But not always the progress of it is beneficial for mankind. In this connection it is worth mentioning the use of some chemical compounds in warfare such as toxic agents, incendiary weapons, as well as the application of defoliants and herbicides for military purposes. That is why more than 140 states including major nations are parties to the Geneva Protocol of 1925 [29] prohibiting “*the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids, materials or devices*”.

Thereby it's quite naturally to come to a very important conclusion. Chemical science and technology are part and parcel of men's everyday existence. It's useless to say that chemistry contributes greatly into the quality of our life. Existed frontiers of our reality are being renewed every moment and much depends on this science. All around us that we use for various purposes, things we wear or live in, devices and gadgets known as home appliances, ‘toys’ both for children and adults are produced with the help of chemistry through controlled chemical reactions.

Our life is pierced through with various processes: those of plants and flowers growing, education and communication, iron items rusting and wood burning, thinking and digestion, observation and ageing, deductive or inductive reasoning, treating somebody or something, and so on and so forth... The most tangible human needs cover food and energy supply, different useful materials, health care, devices raising the life quality, economic vitality. All the above mentioned processes appeared to be very closely connected with chemistry as all living processes are chemical reactions. As precisely these chemical changes underlie all life processes understanding of chemical reactivity is inevitably linked to our ultimate understanding of life.

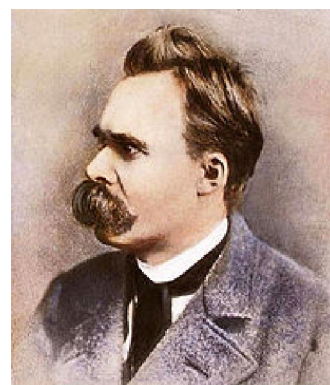
Chemists are proved to play an extremely important role in the life of a society as their main task is to provide people with all the necessary things. In other words, they are to design new chemical reactions and make them serve the smallest human needs. Only chemists manage to answer an enormous variety of social needs through deep analyzing and understanding of the factors governing chemical reactions. More than that, it is chemists who furnish their control. Due to its rapid responsiveness to human needs chemistry has easily and undoubtedly become a crucial factor in the nation's well-being.

Chemistry has always taken an active part in the eternal people's struggle for survival, comfort, prosperity and freedom from toil. Nothing concerns humans more than ways and methods of preserving the conquered achievements and perfecting them. Human craving for knowledge and improving of existed

surroundings caused flight of thoughts in different areas. Thus, chemistry could not help penetrating into the making of pottery and glass, weaving and leatherworking, manufacturing and military technologies, fine-metalworking and transport. Its brave and original penetration practically in every sphere agitated the intellects of the age making them think hard. They endlessly invented and persisted in getting into proper shape their innovations. Of course, not all of them were chemists as all sciences on a large scale are applied to human needs. However, it is chemistry that is central among the sciences.

Let us make some conclusions. Chemistry is a fascinating and important subject, and it is at the heart of life and everything around us. For this reason, it is often called '*the central science*'. The processes in our brains involve chemical reactions. Chemical reactions convert the food that we eat into molecules for building tissue and providing energy. The clothes we wear, houses we live in, and vehicles that transport us are made of natural and synthetic chemical materials. The earth under our feet is comprised of rocks, minerals, and soil – all of which can be appreciated on a chemical basis. Taxol, found in the Pacific Yew tree of the Northwest's ancient forests, is an example of a molecule that has helped the lives of many by its activity as an anticancer agent. The basis for the medicinal action of taxol also rests upon chemistry.

According to a quotation by a well-known German classical scholar, philosopher and critic of culture Friedrich Nietzsche (1844-1900) better living of humans is possible only through chemistry [20].



## UNIT 1. CHEMISTRY THROUGH SCHEMES AND DEFINITIONS

*Nothing can be more incorrect  
than the assumption ... that  
physics has one method, chemistry another,  
and biology a third.*  
Thomas Huxley (1825 – 1895)

1. What does chemistry mean for you? Give any of your associations with this word. Explain these associations.
2. What do you understand by chemistry?
3. Write an essay (100-150 words) on the topic “*Why I am fond of Chemistry*”.

4. Jacob Grimm (1785 – 1863), one of the well-known brothers Grimm, wrote that “*chemistry is gibberish of Latin and German; but in Liebig’s hands it becomes a powerful language*”.

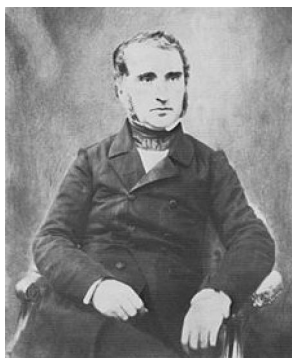
***Give your comments upon this statement.***

***Find the information on Liebig’s contributions into chemistry.***

***Why do you think chemistry is described as “a powerful language”?***

5. Write an essay on the topic “*What is chemistry English? Where is it used?*”

6. A German chemist and teacher Justus Liebig (1803 – 1873) described a science that promoted the birth of chemistry in such a way: “*In the progressive growth of astronomy, mechanical science was developed, and when this had been, to a certain degree, successfully cultivated, it gave birth to the science of chemistry*”.



***What did Liebig mention by “mechanical science”?***

***Do you know due to what science chemistry appeared?***

7. He also wrote in 1851: *Only about seventy years ago this science, like a grain of seed from a ripe fruit, separated from the other physical sciences. With Black, Cavendish and Priestley, its new era began. Medicine, pharmacy, and the useful arts, had prepared the soil upon which this seed was to germinate and to flourish.*

**Translate this statement.**

**About what science did Justus Liebig write? What do you understand by “useful arts”?**

**Find some information about the contributions of the people mentioned to this science.**

8. A self-taught German scientist and inventor Johann Philipp Reis (1834 – 1874) stated that “*chemistry is the dirty part of physics*”.

**Why do you think the definition “dirty” is used? How can you explain this fact?**

**Do you agree with such a definition? Give your arguments.**

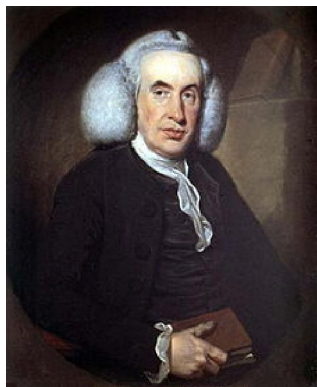


9. An outstanding French chemist Antoine-Laurent Lavoisier is considered to be the ‘father of modern chemistry’. He described chemistry in such a way: *Chemistry affords two general methods of determining the constituent principles of bodies... When, for instance, by combining water with alcohol, we form the species of liquor called, in commercial language, brandy or spirit of wine, we certainly have a right to conclude, that brandy, or spirit of wine, is composed of alcohol combined with water. We can produce the same result by the analytical method; and in general it ought to be considered as a principle in chemical science, never to rest satisfied without both these species of proofs. We have this advantage in the analysis of atmospheric air, being able both to decompound it, and to form it a new in the most satisfactory manner.*

**Translate the following quotation of Antoine Lavoisier.**

**What two general methods did Lavoisier bear in mind?**

10. A Scottish physician, chemist and agriculturalist (1710 – 1790) William Cullen gave such a description of chemistry: *Chemistry is an art that has furnished the world with a great number of useful facts, and has thereby contributed to the improvement of many arts; but these facts lie scattered in many different books, involved in obscure terms, mixed with many falsehoods, and joined to a great deal of false philosophy; so that it is not great wonder that chemistry has not been so much studied as might have been expected with regard to so useful a branch of knowledge, and that many professors are themselves but very superficially acquainted with it. But it was particularly to be expected, that, since it has been*



*taught in universities, the difficulties in this study should have been in some measure removed, that the art should have been put into form, and a system of it attempted — the scattered facts collected and arranged in a proper order. But this has not yet been done; chemistry has not yet been taught but upon a very narrow plan. The teachers of it have still confined themselves to the purposes of pharmacy and medicine, and that comprehends a small branch of chemistry; and even that, by being a single branch, could not by itself be tolerably explained.*

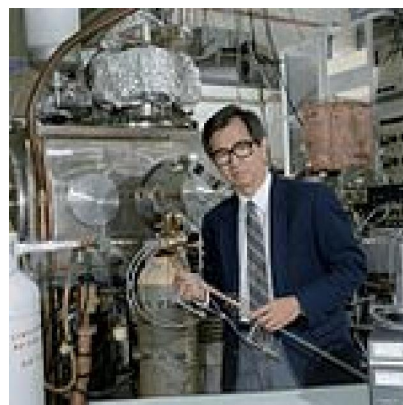
***Translate this passage.***

***Why do you think chemistry should be taught in universities?***

***What “useful facts” do you consider chemistry has finished the world with nowadays?***

***Render the passage in English.***

11. Another description of chemistry was given by the first Taiwanese Nobel Prize laureate Yuan T. Lee. He wrote: *Chemistry is the study of material transformations. Yet knowledge of the rate, or time dependence, of chemical change is of critical importance for the successful synthesis of new materials and for the utilization of the energy generated by a reaction. During the past century it has become clear that all macroscopic chemical processes consist of many elementary chemical reactions that are themselves simply a series of encounters between atomic or molecular species. In order to understand the time dependence of chemical reactions, chemical kineticists have traditionally focused on sorting out all of the elementary chemical reactions involved in a macroscopic chemical process and determining their respective rates.*



***Translate this passage.***

***What is meant by “material transformations”?***

***What do you think promotes “the successful synthesis of new materials”?***

12. In the vestibule of the Manchester Town Hall two life-sized marble statues are placed facing each other. So high the honour is done to the two greatest sons of Manchester.

The first person is known as the founder of modern chemistry, the atomic theory and the laws of chemical-combining proportions. He gave to the world the final proof that in every kind of chemical change no loss of matter occurs.

The second scientist is considered to be the founder of modern physics and the discoverer of the law of energy conservation. He proved that in all the varied modes of physical change, no loss of energy takes place.

***Do you know the names of these outstanding scientists?***

***Find some additional information on their contributions to chemistry.***

13. Do you agree with the statement of an English physical chemist Sir Cyril



Norman Hinshelwood (1897 – 1967) that “*chemistry is the most excellent child of intellect and art*”?

***Give your comments upon the statement. Why do you think this branch of science was given such a definition?***

***What is the role of intellect in science?***

***What is mentioned by “art”?***

14. Does chemistry play any role in the building industry? What do you think building and construction chemistry is? Describe their functions and purposes. What is the chemistry of construction materials?

15. Do you agree that chemistry is the building block of construction? How can you prove it?

16. Translate the terms using a dictionary. Distinguish materials applied in building chemistry and those used in construction chemistry:

- |                            |                            |
|----------------------------|----------------------------|
| • bedding mortars          | • calcium aluminate cement |
| • floor leveling compounds | • non-shrink grouts        |
| • rapid floor screeds      | • repair mortars           |
| • sealers                  | • self leveling toppings   |
| • tile adhesives           | • tile grouts              |
| • water-stop mortars       |                            |

17. Define properties and functions of the following terms using a dictionary: cement, ceramics, clay, diatomaceous earth, limestone, glass, gypsum, plaster of Paris, marble, mortar, rock, sandstone, silica, slag.

18. Find some information about cement, concrete and reinforced concrete with the help of a bilingual dictionary. Compare the properties of the materials.

19. The principal author of the Declaration of Independence and the third President of the United States Thomas Jefferson (1743 – 1826) in one of his letters said that he *wished to see chemistry applied to domestic objects*.

***What chemical processes are used in brewing and making cider?***

***What processes are necessary for the making of bread, butter, cheese, soap, to the incubation of eggs?***



20. Chemistry is also involved in textile industry. What chemical reactions are there the main processes?

21. Do you agree that the food industry is just a specialised form of chemistry? Give your arguments.

22. What is the main function of human clothing? Is it possible to match different items of clothing with the time they are used in? What century might these garments be worn in? In what way does chemistry contribute to clothing industry?



23. Give examples of natural and synthetic fibers. Speak on advantages of each.

24. The Romans were the first to use mortar. The ancient Sumerians (located in present-day Iraq and Iran) used bitumen (tar). What was it used for?

25. Why do you think the temples and buildings of the Incas have stood the test of time?

26. Name at least three materials in the construction of modern buildings.

27. Compare construction materials of ancient civilizations with those used in society today. Is it possible to find any intergenerational continuity here?



28. A Swedish scientist Svante Arrhenius (1859 – 1927) once wrote: *Chemistry works with an enormous number of substances, but cares only for some few of their properties; it is an extensive science. Physics, on the other hand, works with rather few substances, such as mercury, water, alcohol, glass, air, but analyses the experimental results very thoroughly; it is an intensive science. The child of these two sciences has inherited the extensive character from chemistry. Upon this depends its all-embracing feature, which has attracted so great admiration. But on the other hand, it has its profound quantitative character from the science of physics.*



**Translate the quotation.**

**Can you name “the child of these two sciences”, the founder of which Arrhenius is considered to be?**

29. Describe the human body from the chemical point of view using as many chemical terms as possible. Do you agree that it is a small walking chemical plant? Give your opinion.

30. What aspects make up personal hygiene?



31. Without what substance, according to the opinion of a German chemist Alwin Mittasch (1869 – 1953), “*chemistry would be a sword without a handle, a light without brilliance, a bell without sound*”?



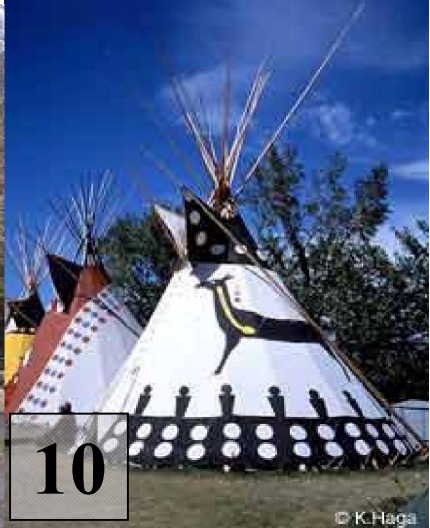
**Give the definition of this substance.**

**Do you agree with such an opinion?**

**Give your arguments.**

32. Name the kind of the houses you see below, define the nationality living in it and describe materials to be used in each dwelling house.





33. Summarize types of dwelling you know.

34. Polymeric products are used widely in the construction industry because they offer a range of desirable performance properties not available from traditional materials. Find information in what way polymeric products differ from natural ones.

35. Match each pair of shoes with either the season or occasion. What makes you think so? In what way are these items connected with chemistry?



36. Do you agree with the opinion of John Calvin Coolidge, the 30th President of the United States, who once stated: *Wherever we look, the work of the chemist has raised the level of our civilisation and has increased the productive capacity of the nation?*



*Give your comments on the quotation and illustrate it with as many examples as possible.*

*In what way chemistry contribute to productive capacity increasing?*

37. Give a detailed description of chemistry as a science.

38. An American actor Adam Sandler (1966 – ) once mentioned: *Chemistry can be a good and bad thing.*

*When do you think chemistry is “a good thing”?*

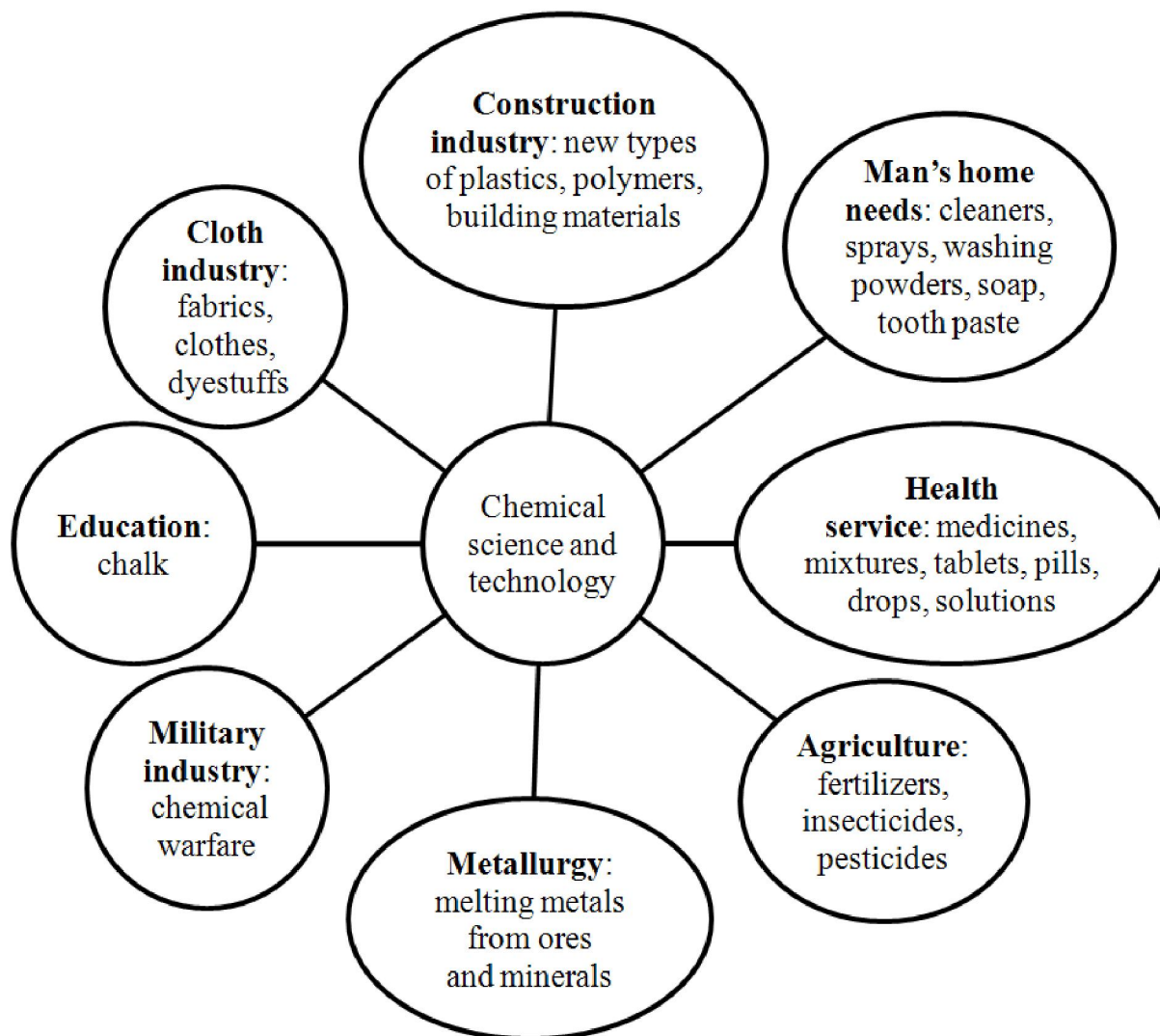
*What in your opinion makes chemistry “bad”?*

*Is chemistry ‘the dismal science’ or ‘the rocket science’ for you?*



39. Summarize the key role of chemistry in our life using the following chart. Do you agree chemistry is a universal science? Give your reasons.

**Chart 1. Chemistry in our life**



40. Complete the following definitions of several chemical terms. Use the words from the list below.

Composition, compound, decomposition, element, gas, liquid, molecule, plasma, product, property, reaction, states

When you talk about the ... of something, you are referring to the way in which its various parts are put together and arranged.

A chemical ... becomes evident during a chemical reaction; that is, any quality that can be established only by changing a substance's chemical identity. Simply speaking, chemical ... cannot be determined just by viewing or touching the substance; the substance's internal structure must be affected for its chemical ... to be investigated [28].

... of matter are the distinct forms that different phases of matter take on.

... is air-like substance which expands freely to fill any space available.

... is a substance that can flow and has no fixed shape.

... is a distinct phase of matter, separate from the traditional solids, liquids, and gases. It is a collection of charged particles that respond strongly and collectively to electromagnetic fields, taking the form of gas-like clouds or ion beams.

A chemical ... is a process that leads to the transformation of one set of chemical substances to another. Chemical ... can be either spontaneous, requiring no input of energy, or non-spontaneous, typically following the input of some type of energy, namely heat, light or electricity.

... is the process by which organic material is broken down into simpler forms of matter.

... is a substance on the right side of a chemical reaction.

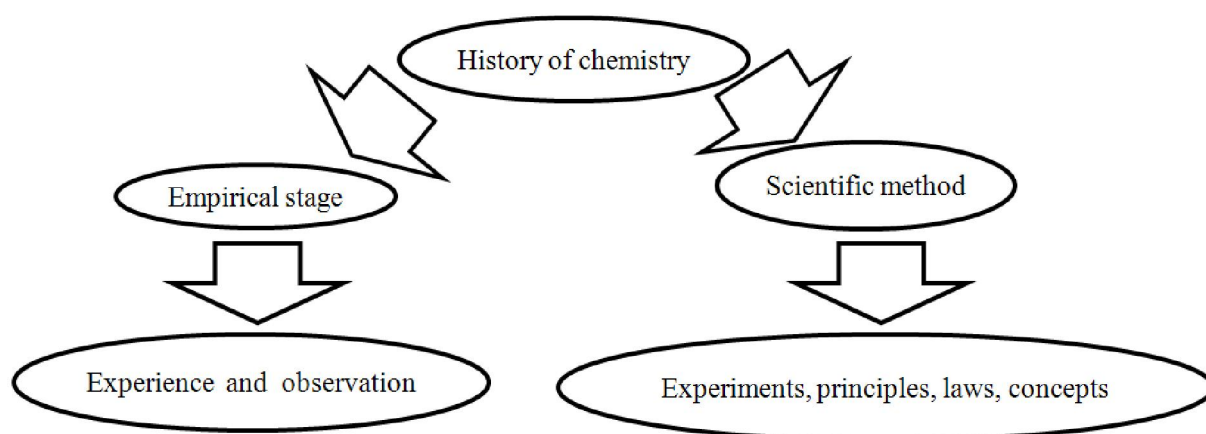
A combination of at least two atoms in a specific spatial arrangement held together by attractive forces called chemical bonds is known as ... .

A molecule may contain atoms of the same element or atoms of two or more elements joined in a fixed ratio. If the atoms belong to different elements, then the molecule is also known as a ... .

... is a substance that consists of only one type of atom.

41. Using Chart 2, describe the development of chemistry and explain the difference between the empirical stage and scientific method.

**Chart 2. Chemistry as a science**



42. **Complete the text with the appropriate chemical notions:**

... is anything that has mass and occupies space. Chemists study matter from one particular point of view: they explain the ... of matter in terms of the invisible building blocks of which it is made. ... are the indivisible, discrete particles of which all matter is composed. ... are collections of atoms which are held together by links called chemical (bonds) [3].

43. A German chemist Carl Wilhelm Wolfgang Ostwald (1883 – 1943) once stated: *What we call matter is only a complex of energies which we find together in the same place.*

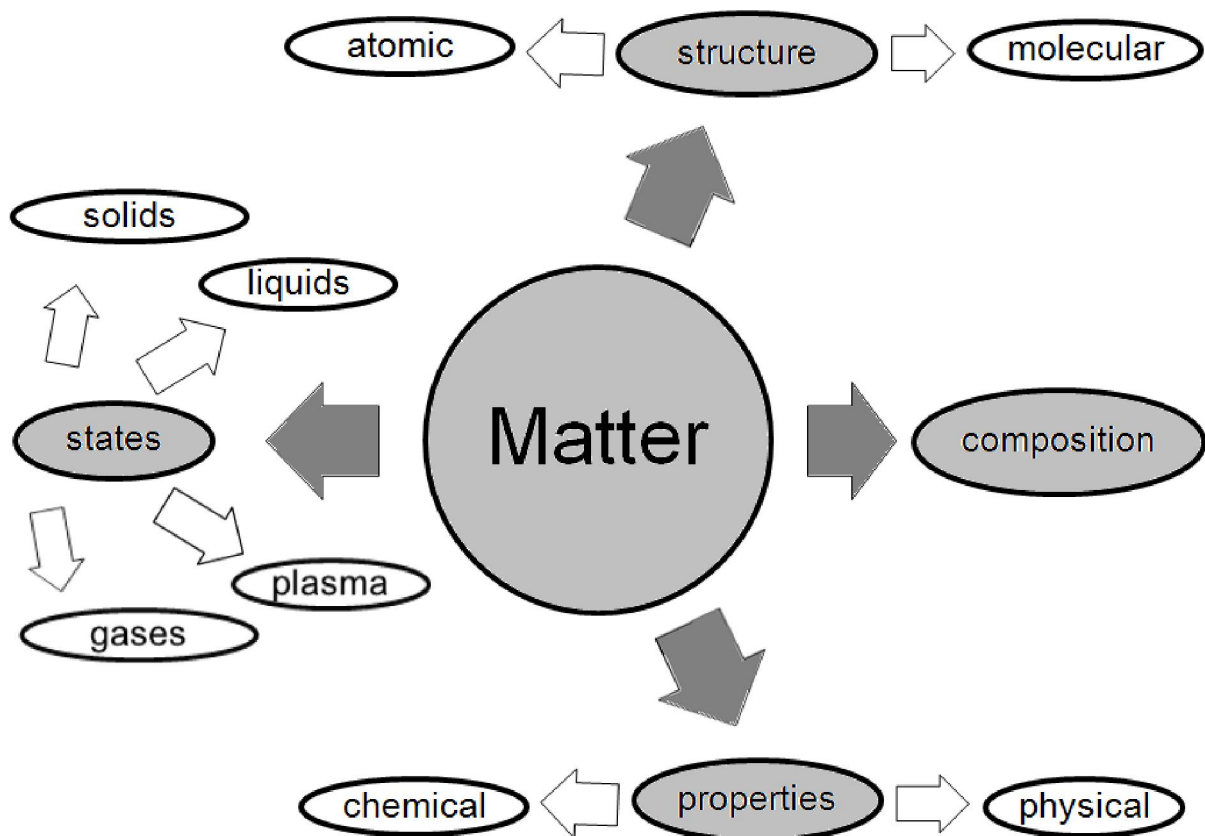
A German theoretical physicist Werner Karl Heisenberg (1901 – 1976) described matter in such a way: *The smallest particles of matter were said [by Plato] to be right-angled triangles which, after combining in pairs, ... joined together into the regular bodies of solid geometry; cubes, tetrahedrons, octahedrons and icosahedrons. These four bodies were said to be the building blocks of the four elements, earth, fire, air and water ... [The] whole thing seemed to be wild speculation. ... Even so, I was enthralled by the idea that the smallest particles of matter must reduce to some mathematical form ... The most important result of it all, perhaps, was the conviction that, in order to interpret the material world we need to know something about its smallest parts.*



**Translate this quotation.**

44. Give a modern description of matter using information about the development of its definition and Chart 3.

**Chart 3. Matter**



45. A well-known English chemist, meteorologist and physicist was the first



to have chosen the word “atom” to signify these ultimate particles. He wrote: *Matter, though divisible in an extreme degree, is nevertheless not infinitely divisible. That is, there must be some point beyond which we cannot go in the division of matter...*

***Do you know the name of this scientist?***

***Prepare a presentation on his contribution to chemistry.***

46. Elements are made up of atoms, the smallest particle that has any of the properties of the element.

***What English chemist, in 1803, proposed a modern theory of the atom based on the following assumptions?***

- Matter is made up of atoms that are indivisible and indestructible.
- All atoms of an element are identical.
- Atoms of different elements have different weights and different chemical properties.
- Atoms of different elements combine in simple whole numbers to form compounds.
- Atoms cannot be created or destroyed. When a compound decomposes, the atoms are recovered unchanged. [3]

Most of the materials that occur on Earth, such as wood, coal, minerals, or air, are mixtures of many different and distinct chemical substances. Each pure chemical substance (e.g., oxygen, iron, or water) has a characteristic set of properties that gives it its chemical identity.

47. ***Complete the following sentences with the terms ‘mixture’ and ‘substance’.***

A ... is 2 or more types of elements that have been chemically bound to form a new substance while a ... is 2 or more atoms of different types that are mixed together without being chemically bound.

48. ***Complete the following text with the words from this list:***

Atoms, compounds, covalent, electrons, ionic, molecules, negative

Elements combine to form chemical ... that are often divided into two categories. Metals often react with nonmetals to form ... compounds. These compounds are composed of positive and ... ions formed by adding or



subtracting ... from neutral ... and molecules. Nonmetals combine with each other to form ... compounds, which exist as neutral .... [3]

49. **Choose the correct characteristics of ionic or molecular compounds.**

Table salt (ionic compounds; molecular compound)

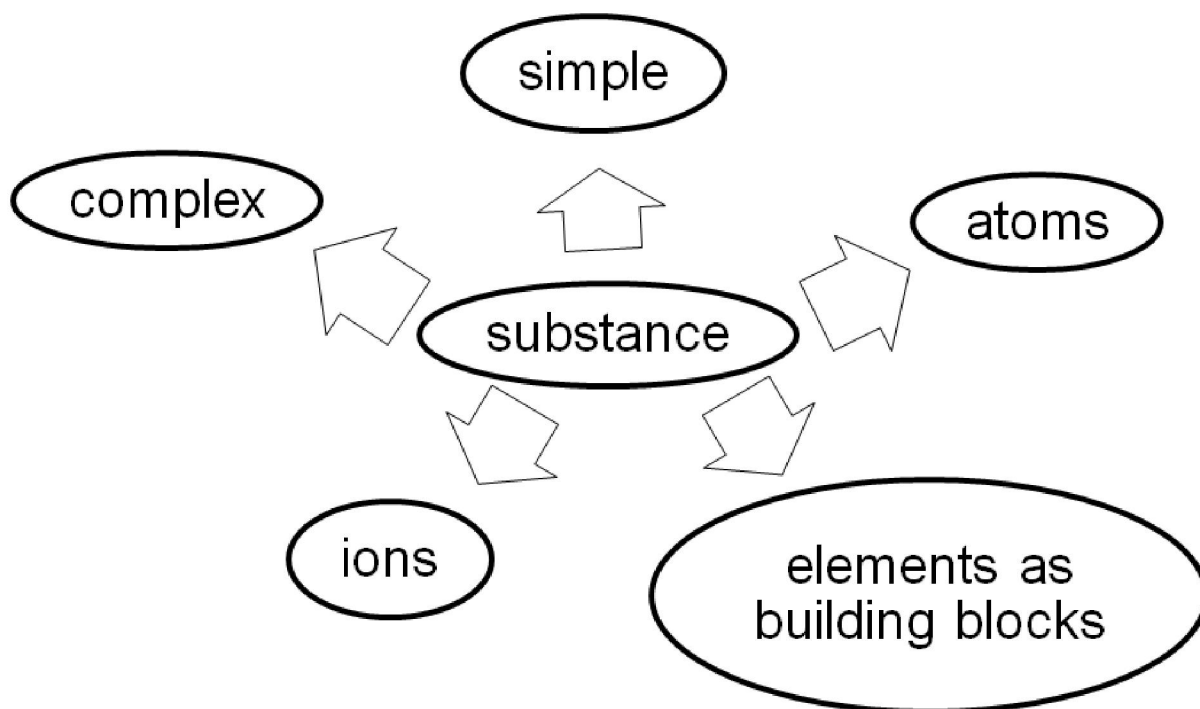
High melting and boiling points (ionic compounds; molecular compounds)

Strong force of attraction between particles (ionic compounds; molecular compounds)

Separate into charged particles in water to give a solution that conducts electricity (ionic compounds; molecular compounds)

50. What can you say about substance according to Chart 4?

**Chart 4. Substance**



51. **Define each state of matter**

This state of matter has no definite volume or shape; diffuses rapidly to fill the container; conforms to the shape of the container entirely; molecules vibrate and move freely at high speeds; molecules are well separated with no regular arrangement; compressible – a balloon can be squeezed to make it smaller.

This state of matter has definite volume but no definite shape; shape is confined to, but not determined by, the container it fills; molecules are close together but with no regular arrangement; molecules vibrate, move around and slide past one another; not easily compressed.

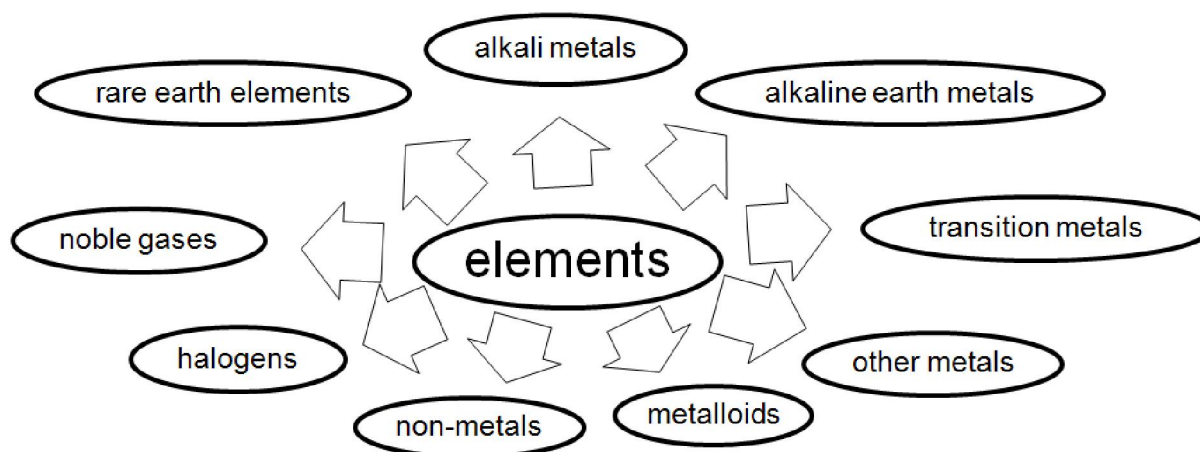
This state of matter has a definite volume and shape doesn't take the shape of its container; rigid because molecules are locked into place and packed closely together; molecules vibrate (but do not move) in fixed space relative to each other; not easily compressed.

The fourth state of matter; gas with free electrons and positive ions; unlike gases, it conducts electricity well; lightning, sun and stars, comet tails, neon signs; it is most matter in the universe.

52. **Translate the following quotation of Lavoisier who wrote:** *All that can be said upon the number and nature of elements is, in my opinion, confined to discussions entirely of a metaphysical nature. The subject only furnishes us with indefinite problems, which may be solved in a thousand different ways, not one of which, in all probability, is consistent with nature. I shall therefore only add upon this subject, that if, by the term elements, we mean to express those simple and indivisible atoms of which matter is composed, it is extremely probable we know nothing at all about them; but, if we apply the term elements, or principles of bodies, to express our idea of the last point which analysis is capable of reaching, we must admit, as elements, all the substances into which we are capable, by any means, to reduce bodies by decomposition.*

53. What is an element? Give your comments on the term 'element'.

#### Chart 5. Elements classification



54. What halogens do you know? Name them.

55. What alkali metals do you know? Name them.

56. What alkaline-earth metals do you know? Name them.

57. What rare-earth metals do you know? Name them.

58. What noble gases do you know? Name them.



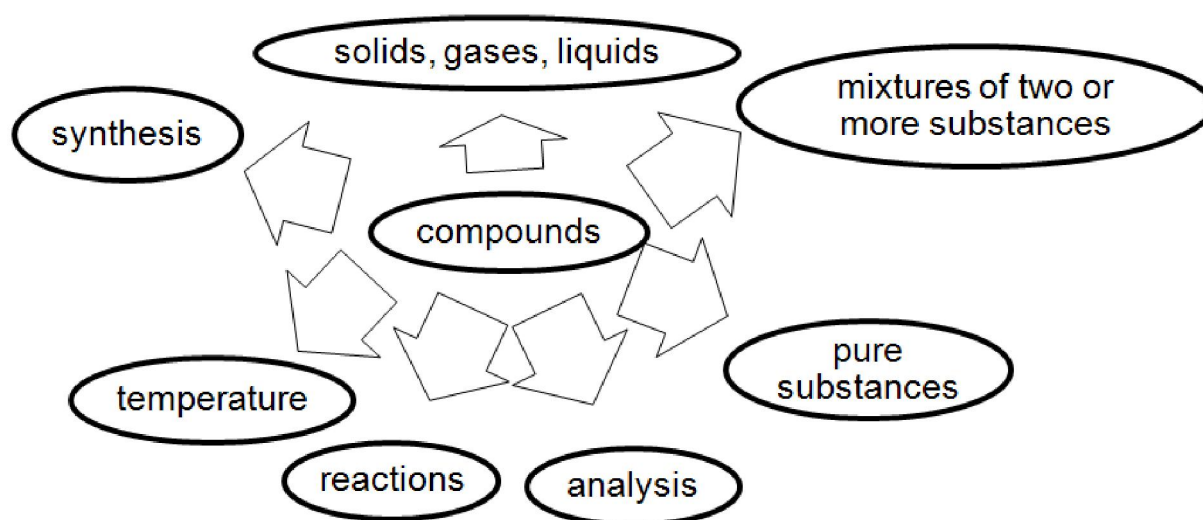
59. Carl Wilhelm Ostwald once mentioned: *The only difference between elements and compounds consists in the supposed impossibility of proving the so-called elements to be compounds.*

**Translate this statement.**

**Explain the difference between elements and compounds.**

**Summarize the information on compounds with the help of the following chart.**

**Chart 6. Compounds**



60. A German physicist Johannes Stark (1874 – 1957) wrote that “*the abundance of chemical compounds and their importance in daily life hindered the chemist from investigating the question, in what does the individuality of the atoms of different elements consist?*”.



**Translate the quotation.**

**Give examples of chemical compounds; explain their role in daily life.**

**Argument which “individuality” is more important: compounds’ or that of elements.**

61. **Speak on the differences between compounds and mixtures using the following words and word combinations:**

a fixed proportion by mass, are different from, chemical properties of a mixture, chemical reaction, constituents of a mixture, energy, mass of elements, composition, physical method, physical properties of a mixture, the law of constant composition, to separate, unique

62. ***Comment on the following statement:***  
*A mixture is a physical change while a compound is a chemical change.*  
***Give a detailed answer with several examples.***

63. What are characteristics of molecular compounds?

64. ***Differentiate ‘chemical’ and ‘physical’ changes inserting these words into the sentences.***

... change is a process in which one or more substances are changed into one or more different substances. ... changes occur when objects or substances undergo a change that does not alter their chemical nature. A ... change is any change not involving a modification in the substance’s chemical identity. Matter undergoes ... change when the composition of the substances modifies: one or more substances combine or break up to form new substances. A ... change involves a change in physical properties. ... properties can be observed without changing the composition of matter. Examples of ... properties include: texture, shape, size, colour, volume, mass, weight, and density. [5]

An example of a ... change occurs when making a baseball bat. A piece of wood is carefully crafted into a shape which will allow a batter to best apply force on the ball. Even though the wood has changed shape and therefore ... properties, the ... nature of the wood has not been altered. The bat and the original piece of wood are still the same ... substance. [10]

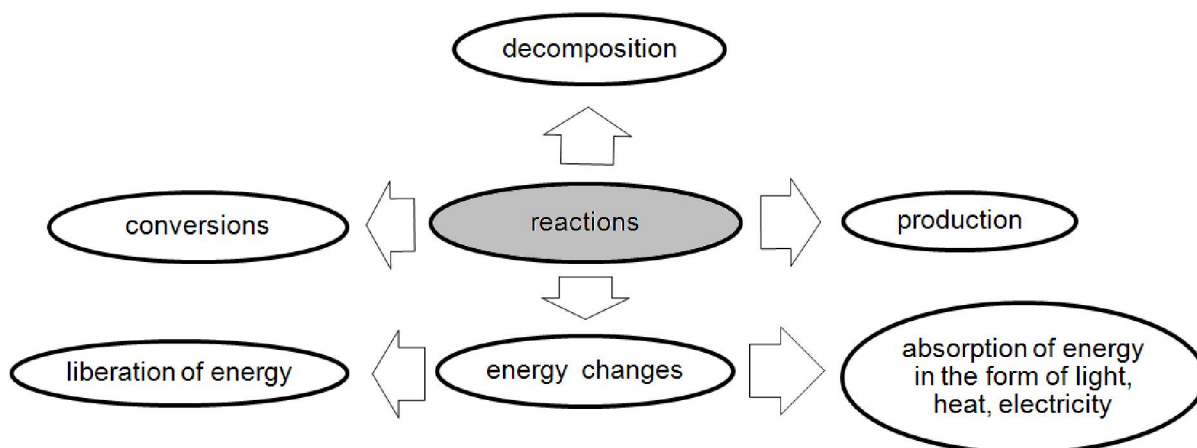
Changes are sometimes hard to categorize strictly as physical or as chemical. Dissolving salt in water involves the breaking of ... bonds, yet is often described as a ... change. Some teachers hold that a ... change is a rearrangement of atoms, but many ... changes also involve the rearrangement of atoms. Many ... changes are irreversible, and many ... changes are reversible, but reversibility is not a certain criterion for classification. Although ... changes are often recognized by an indication such as odor, color change, production of a precipitate, or production of a gas, every one of these indicators can result from ... change. [16]

65. ***Define whether a change is chemical or physical***

A rusting bicycle, burning leaves, burning toast, corroding metal, cream being whipped, fireworks exploding, freezing chocolate covered bananas, frying an egg, glass breaking, hair bleaching, hammering wood together to build a playhouse, making salt water to gargle a throat with, melting butter for popcorn, melting ice cream, mixing lemonade powder into water, mowing the lawn, pouring milk on the oatmeal, separating sand from gravel, spoiling food, squeezing oranges to make orange juice

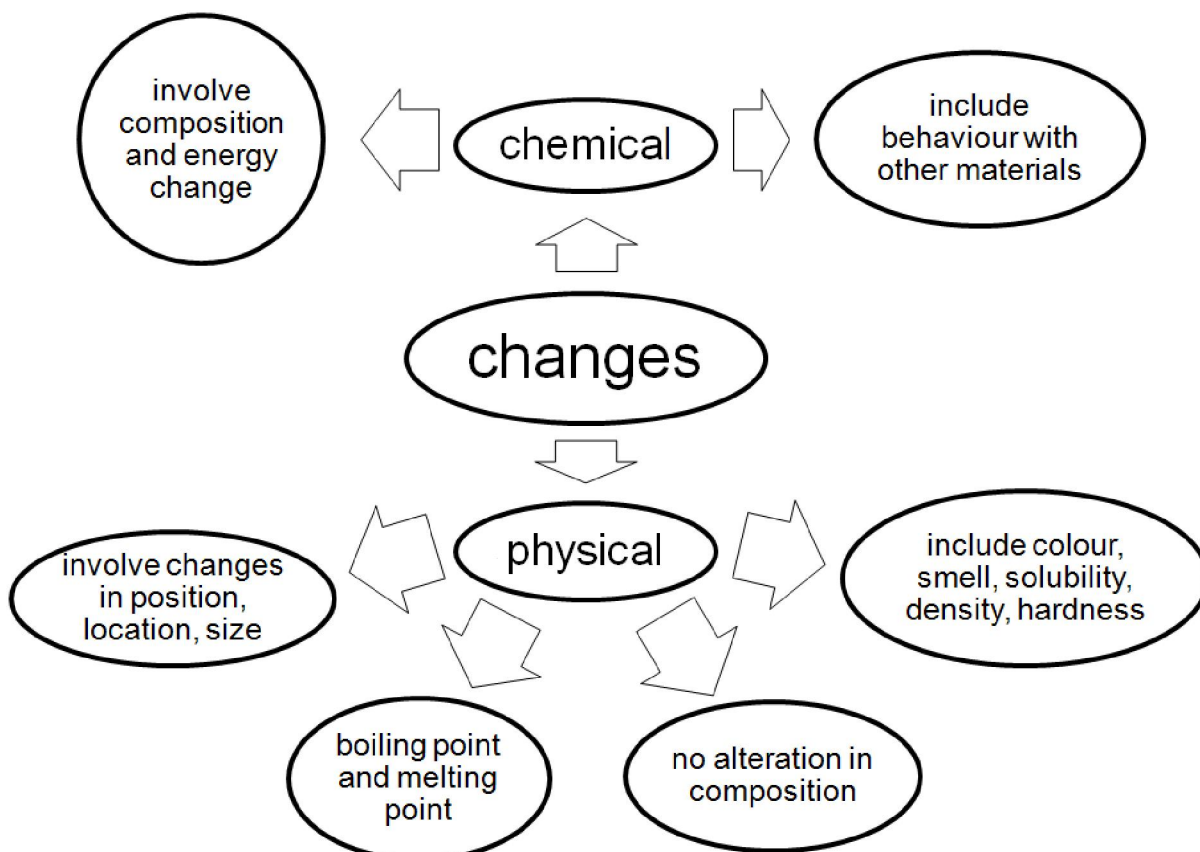
66. What are typical features of chemical reactions?

**Chart 7. Chemical reactions**



67. *Summarize everything you know about chemical and physical changes of matter.* Give a detailed answer with the help of the chart.

**Chart 8. Changes of matter**



68. *Divide the following branches of chemistry into three categories:*  
(1) the areas of specialization that emerged early in the history of chemistry; (2) interdisciplinary branches; (3) new specialties and branches.

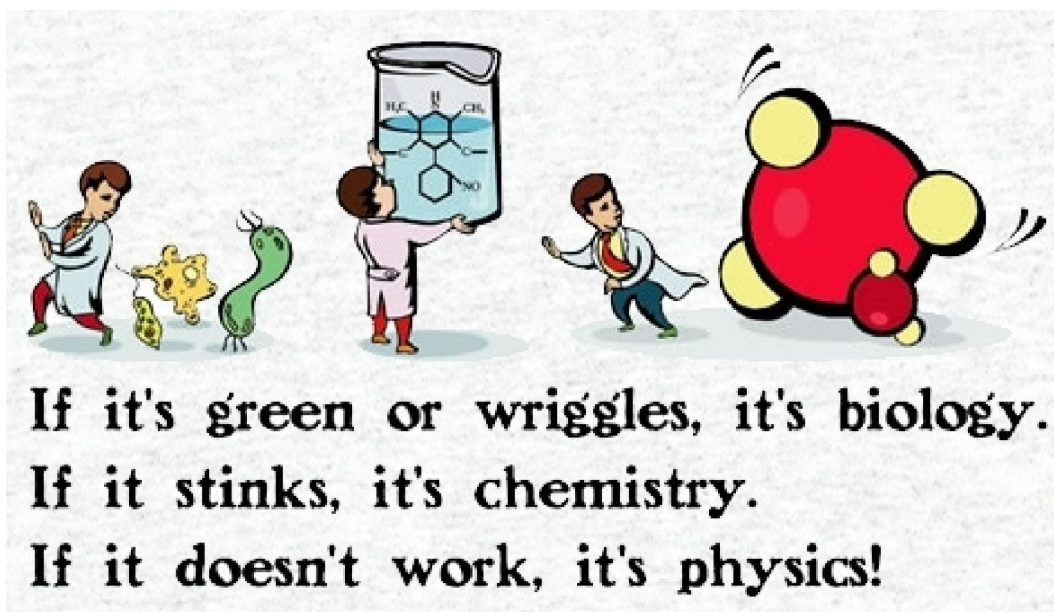
*Analytical chemistry*  
*Chemical physics*  
*Cosmochemistry*  
*Geochemistry*  
*Industrial chemistry*  
*Medicinal chemistry*  
*Pharmacology*  
*Theoretical chemistry*

*Biochemistry*  
*Chemistry of polymers*  
*Environmental chemistry*  
*Histochemistry*  
*Industrial chemistry*  
*Organic chemistry*  
*Physical chemistry*

*Chemical engineering*  
*Computer chemistry*  
*Forensic chemistry*  
*Iatrochemistry*  
*Inorganic chemistry*  
*Pesticide chemistry*  
*Soil chemistry*

69. One of the discoveries of early Islamic chemists was that this substance, which is a mixture of nitric and hydrochloric acids, could dissolve the noblest metal, gold, fueled the imagination of alchemists for the next millennium.

***Do you know the name of this substance?***

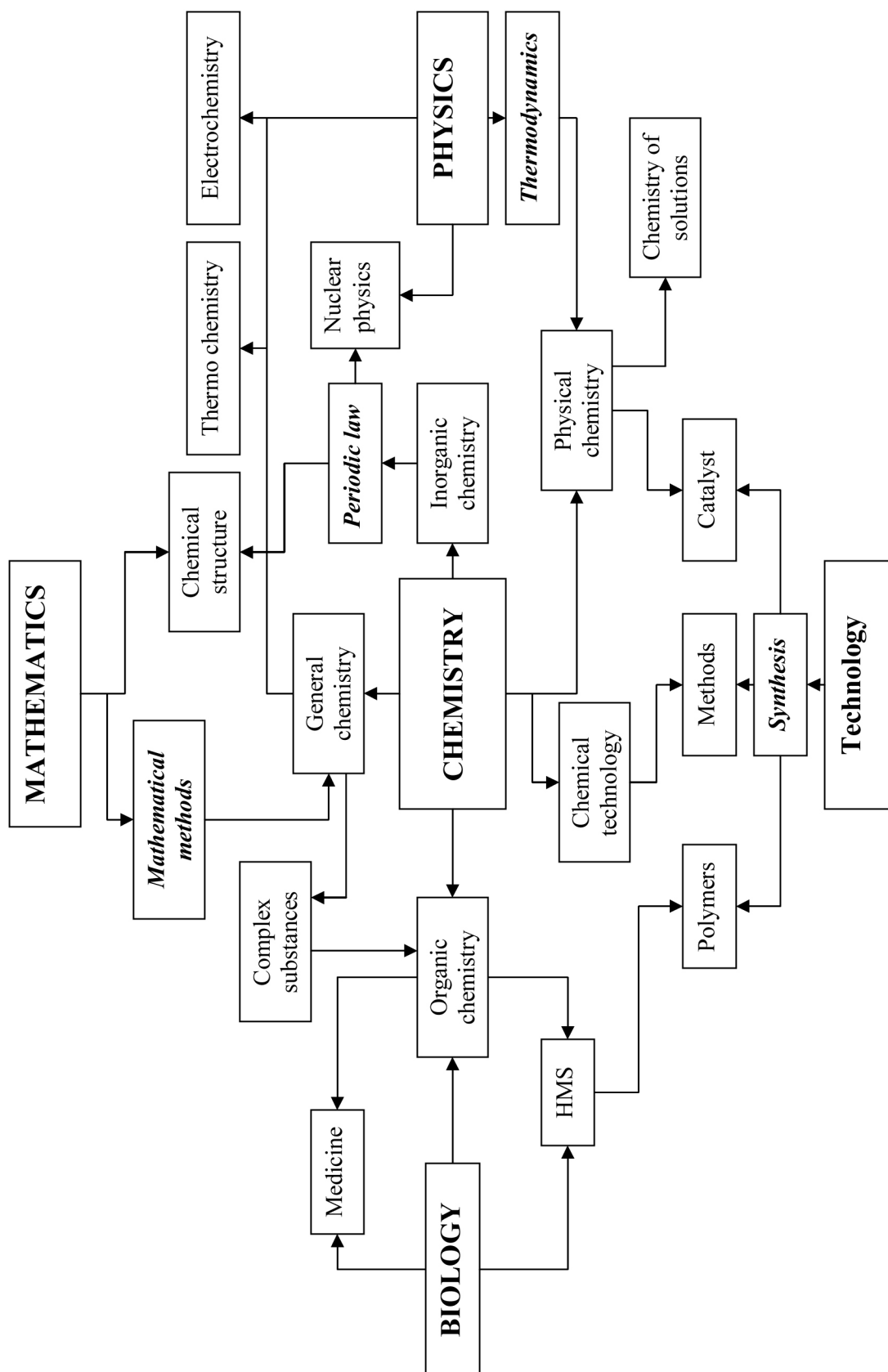


***Below there are several students' views of chemistry and its role in modern everyday life. You may either describe what you see or draw your personal chart.***

70. ***Describe the following chart.***

Why do you think these three sciences are located as the basis of two triangles? Do you agree that mathematics should be placed in the top of the triangle?

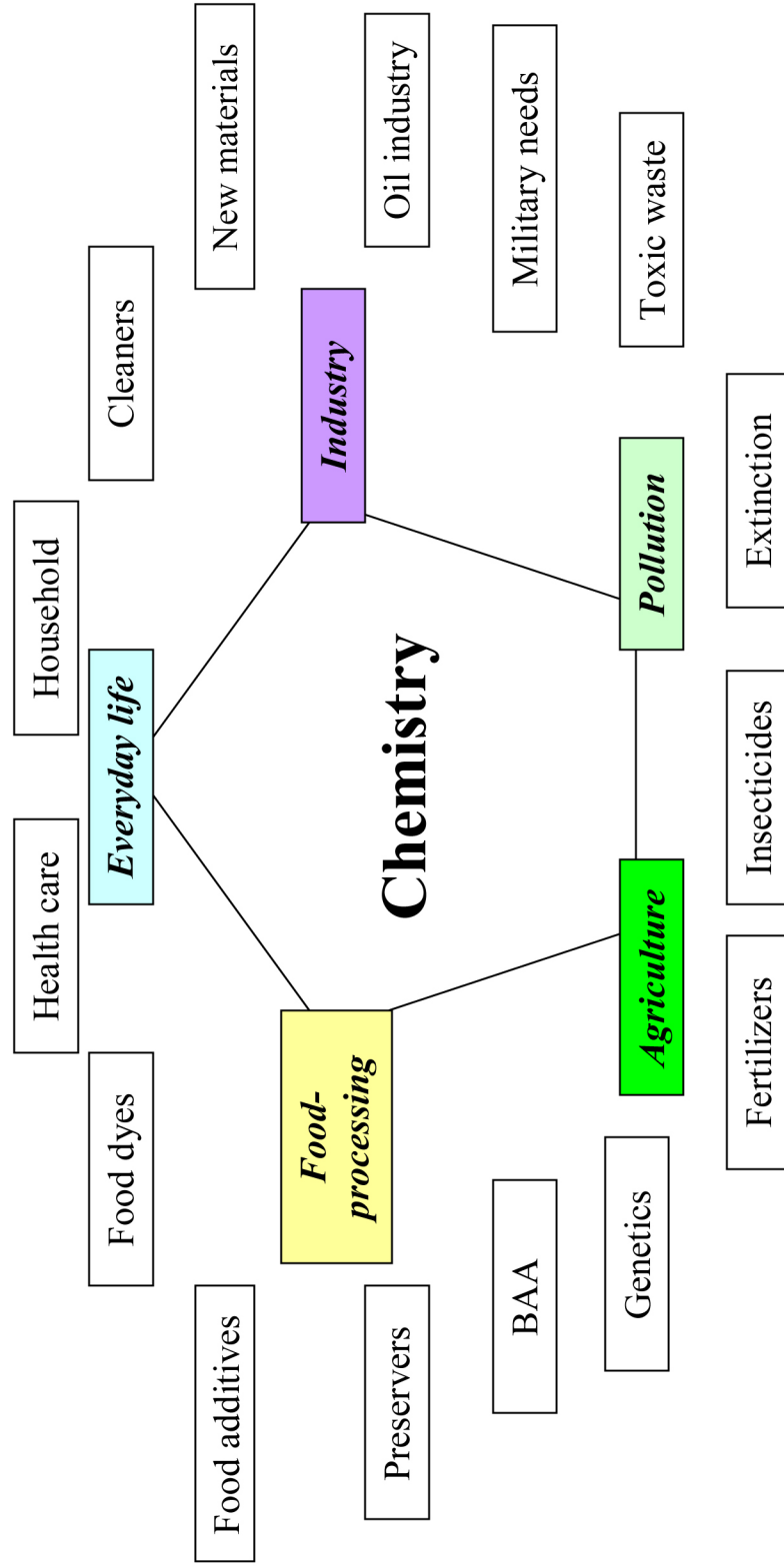
**Chart 9. Chemistry and technology**



71. **Describe the following Chemistry Pentagram.**

Do you agree with mentioning these five areas with which chemistry is mostly closely connected? Describe every aspect in detail.

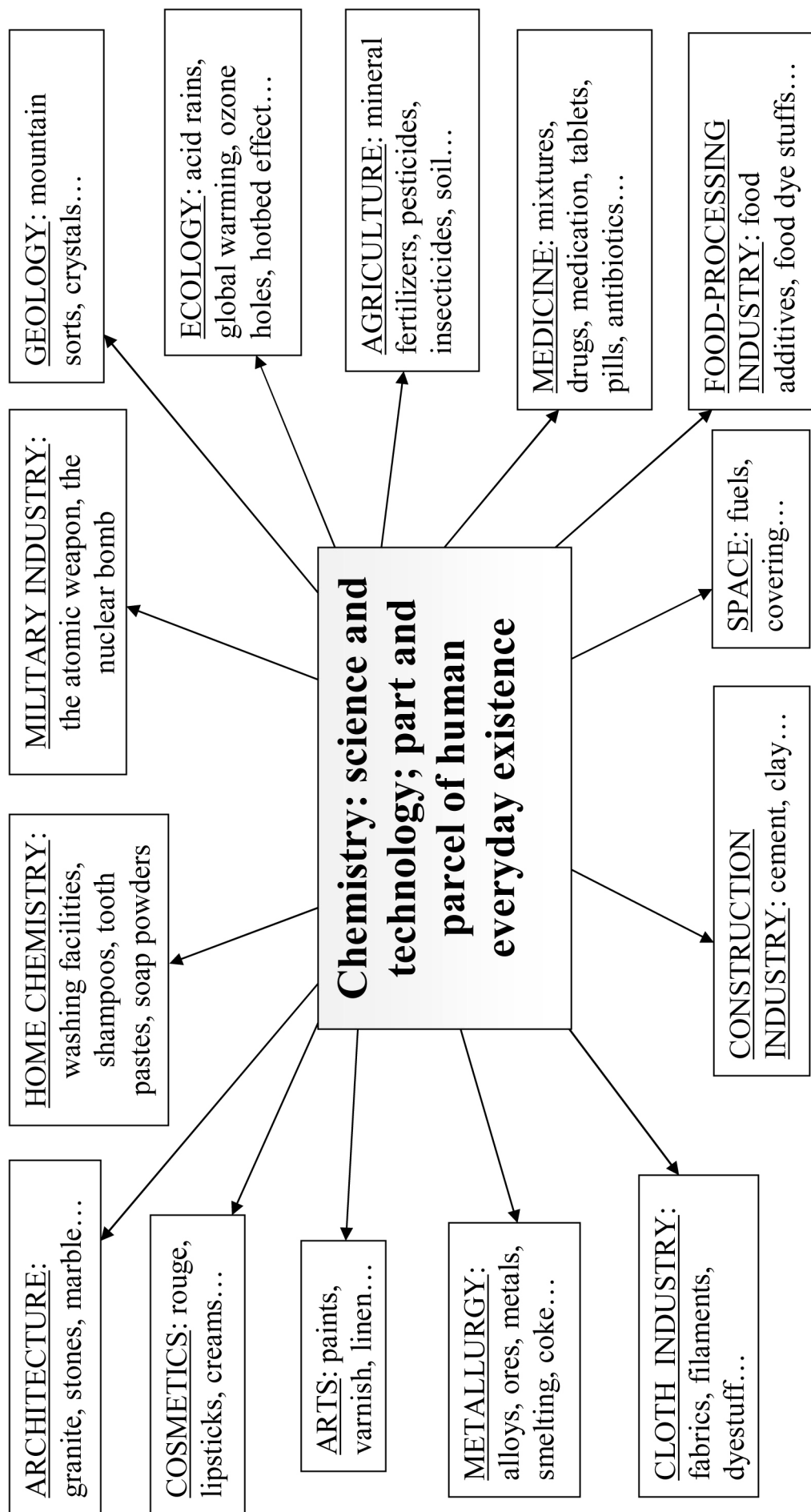
**Chart 10. Chemistry pentagram**



72. Describe the following chart giving details of every area where chemistry plays a central role.

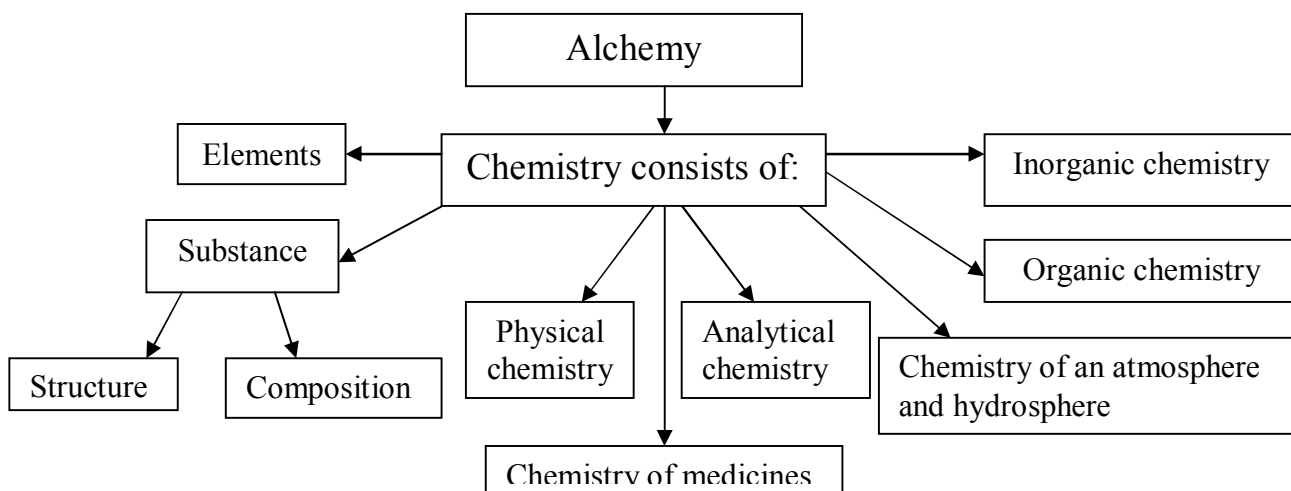


**Chart 11. Key position of chemistry**



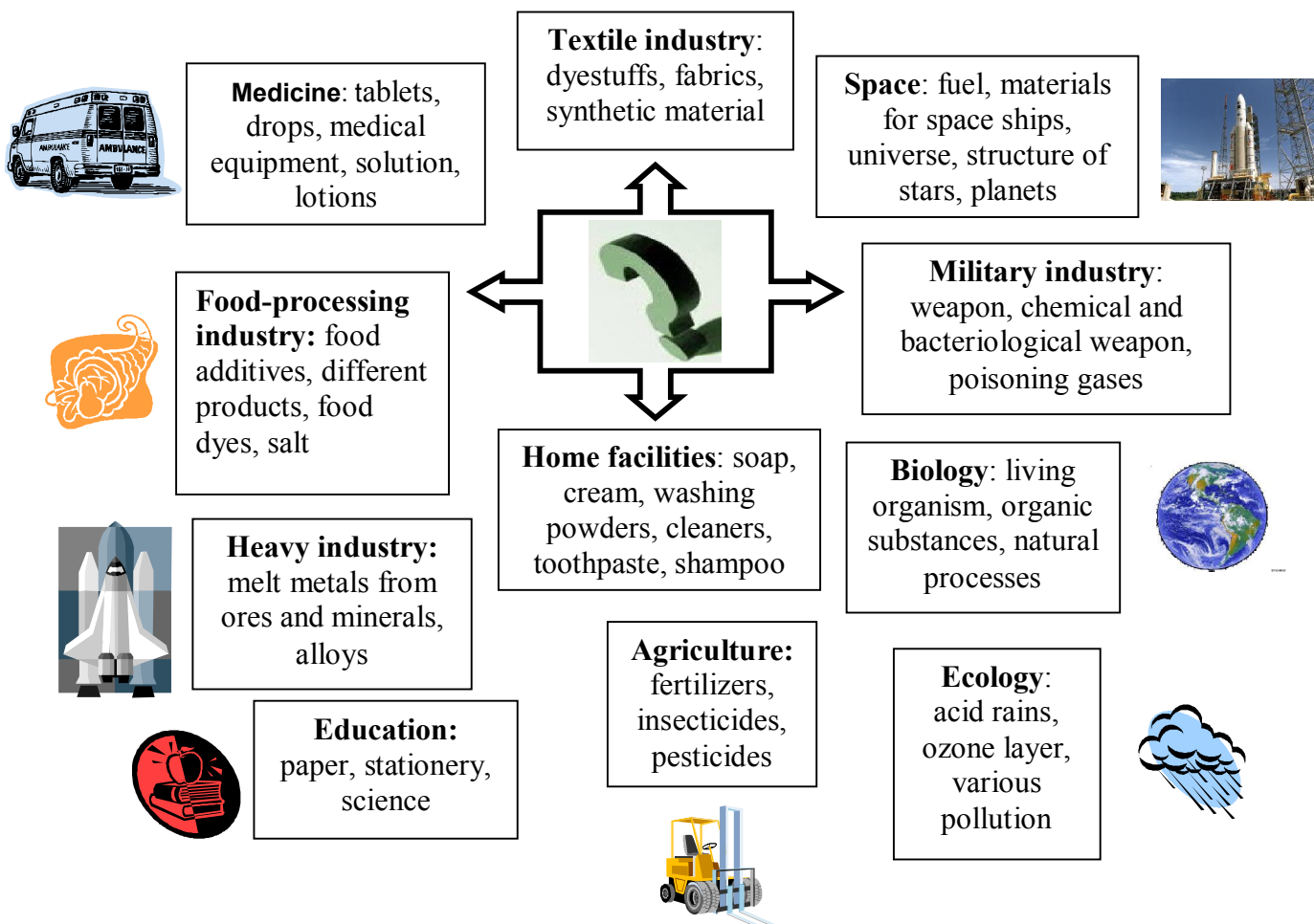
73. Speak on the history of chemistry and give the full definition of this discipline.

**Chart 12. Chemistry definition**



74. *In what way would you complete the central part of the chart? What would you place instead of a question mark?*

**Chart 13. Chemistry and society**



75. As chemistry is a natural science it exists everywhere in our life. Chemistry has always taken an active part in the eternal people's struggle for survival, comfort, prosperity and freedom from toil.

*Write a short essay to prove close connections of chemistry with the following industries and areas:*

*agriculture*

*arts and crafts*

*construction industry*

*ecology*

*food-processing industry*

*fuel industry*

*heavy industry*

*household needs*

*military industry*

*public health*

*space exploration*

*stationery*

*textile industry*

76. It is taught that Robert Boyle in the 17<sup>th</sup> century originated the science of chemistry. A variety of Muslim chemists, including Ar-Razi, Al-Jabir, Al-Biruni and Al-Kindi, performed scientific experiments in chemistry some 700 years prior to Boyle. An early experimental scientific method for chemistry began emerging among early Muslim chemists. Humboldt regards the Muslims as the founders of chemistry.

The first and most influential of them was the 9<sup>th</sup> century chemist, Jabir



ibn Hayyan better known under his European name Geber. He is considered the “father of chemistry” because of many inventions of his in this area [13]. He isolated many chemical substances, produced many medications and described many laboratory apparatus.

The only acid known to the ancients was vinegar. Using new equipment such as the alembic and processes such as pure distillation, Muslim chemists were the first to discover and isolate a variety of new acids.

*Can you guess the names of chemical substances isolated by Geber?*

You have to unscramble the anagrammed words composing new words using all the given letters in one name.

- **lory + chic + rho + D** (a mineral acid)
- **citrin** (a mineral acid)
- **fur + suc + IL** (a mineral acid)
- **scar + in + e** (a chemical element)

## Quiz 1

- ... is a subdiscipline within chemistry involving the scientific study of the structure, properties, composition, reactions, and preparation (by synthesis or by other means) of carbon-based compounds, hydrocarbons, and their derivatives.  
a) organic chemistry      b) general chemistry      c) inorganic chemistry
- The fundamental building block of matter is the ...  
a) molecule      b) ion      c) atom
- What is called the mass number?  
a) The sum of protons and neutrons in an atom.  
b) The number of neutrons in the nucleus of an atom.  
c) The number of protons in the nucleus of an atom.
- What is the formula of the marsh gas?  
a)  $\text{CO}_2$       b)  $\text{CH}_4$       c)  $\text{SO}_2$
- Barium sulfate, thorium oxalate and cadmium sulfide are all...  
a) crystals.      b) insoluble in water.      c) minerals.
- The simplest form of matter is...  
a) compounds.      b) mixtures.      c) elements.

## Quiz 2

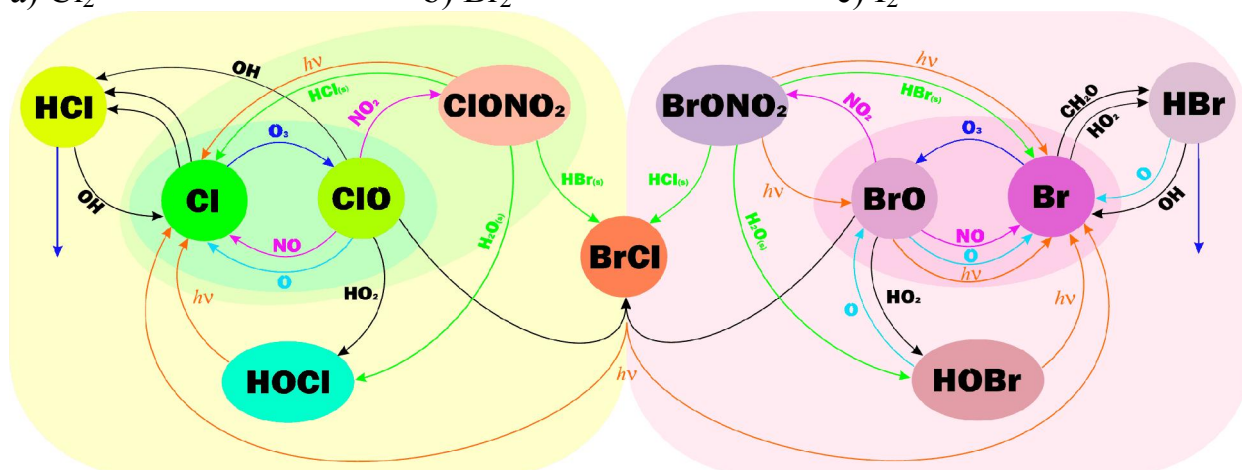
- The amount of energy that removes the most loosely bound electron from an isolated gaseous atom is known as...  
a) ionization potential      b) electrode potential      c) applied potential
- Which compound forms a greenish-blue solution when it is dissolved in water?  
a)  $\text{ZnCl}_2$       b)  $\text{NiCl}_2$       c)  $\text{FeCl}_3$
- What substance is called the 'king of the chemicals'?  
a)  $\text{H}_2\text{SO}_4$       b)  $\text{NaCl}$       c)  $\text{H}_2\text{O}$
- Which gas is the lightest one?  
a) He      b)  $\text{H}_2$       c)  $\text{O}_2$
- During any chemical reaction the number of ... must remain constant.  
a) reactants      b) products      c) each type of atom

6. The only halogen existing in liquid state under normal conditions is...

a)  $\text{Cl}_2$

b)  $\text{Br}_2$

c)  $\text{I}_2$



### Quiz 3

1. Air, water, table salt, petrol, sugar, aspirin are different kinds of matter as they...

a) can be weighed and seen.

b) occupy space and have mass.

c) have mass and weight.

2. When chlorine condenses to a liquid it keeps its yellow colour. Will it also keep the colour while freezing to a solid?

a) keeps

b) does not keep

c) keeps only in condensing

3. Being less reactive than chlorine but more reactive than iodine, this element reacts vigorously with metals, especially in the presence of water. It bonds easily with many elements and has a strong bleaching action. What is this element?

a) fluorine

b) oxygen

c) bromine

4. Mercury vapour and liquid mercury are ...

a) the same substance.

b) different substances.

c) are not substances.

5. If there is no change in substance or form, this characteristic is called ...

a) a chemical property.

b) a transitive property.

c) a physical property.

6. Which of these typical home processes describes a physical change?

a) baking potatoes

b) frying potatoes

c) cutting potatoes

## Quiz 4

1. This colorless gas has a sweetish odor and is prepared by heating ammonium nitrate. It is generally used as an anesthetic. What is its chemical formula?  
a)  $\text{CO}_2$                                       b)  $\text{N}_2\text{O}$                                       c)  $\text{NH}_3$
2. Which of the following examples is a chemical change?  
a) melting                                      b) compression of air                                      c) boiling of mercury
3. Which of the following examples is not a physical change?  
a) change in volume                                      b) bubbles formation                                      c) change in temperature
4. According to what law the masses of the products are equal to the mass of a compound when this compound decomposes?  
a) law of conservation of momentum  
b) law of conservation of mass  
c) law of conservation of energy
5. Which of the following properties is not a chemical one?  
a) color                                      b) flammability                                      c) reactivity
6. The existence of an element as more than one solid, liquid or gaseous substance or in more than one crystalline form is known as ...  
a) allotopia.                                      b) allotropy.                                      c) allotyping.

## Quiz 5

1. Beryllium, magnesium, calcium, strontium, barium and radium all have two outer electrons and are members of ... .  
a) Group 8A                                      b) Group 2A                                      c) Group 1A
2. What are correct chemical symbols for elements 'cobalt' and 'yttrium'.  
a) Ca and Ir                                      b) Cu and I                                      c) Co and Y
3. Mg and K are the symbols of what elements?  
a) manganese and calcium  
b) magnesium and potassium  
c) magnesium and calcium
4. The atoms of the elements in Group 4A are all known to have ... outer electrons.

- a) two                                      b) four                                      c) six

5. It is well-known that aluminium is relatively light and has the density of 2.7 g/mL. Do you think this metal will sink in water?

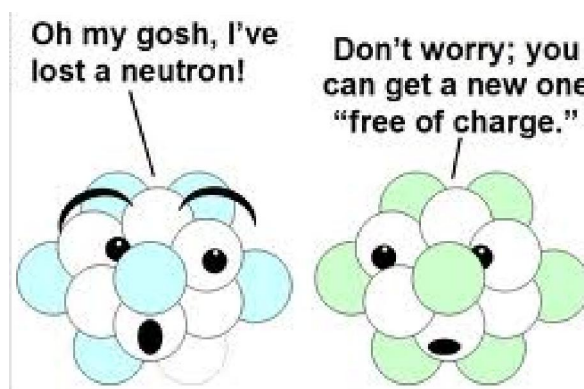
- a) Yes, it will.                              b) No, it won't.                              c) Nobody knows.

6. Which of the following descriptions of antimony is wrong?

- a) It is a moderately active element.  
b) It does not combine with oxygen in the air at room temperature.  
c) It is not a toxic chemical element.

7. Which chemical element has 6 protons and 8 neutrons?

- a) iron                                      b) hydrogen                                      c) carbon



## Quiz 6

1. The atom of this chemical element has 2 protons and 2 neutrons in its nucleus. What is its mass number? Name the element.

- a) 2                                      b) 4                                      c) 6

2. Under what common name is nitrous oxide (N<sub>2</sub>O) known?

- a) laughing gas                              b) marsh gas                              c) ammonia

3. What is the electron arrangement for sulfur?

- a) 2-8-5                                      b) 2-8-7                                      c) 2-8-6

4. A human body uses this element not only to keep teeth and bones strong, but also to enable muscles to contract. Besides, it is an important part of the blood clotting process. Its electron arrangement is 2-8-8-2. What element is it?

- a) phosphorus                              b) calcium                                      c) fluorine

5. An element with the electron arrangement of 2-8-1 would be ...

- a) an alkali metal.                      b) an alkaline earth metal.                      c) a metalloid.
6. How many electrons are there in the outer electron level of halogens?  
a) 3    b) 5    c) 7
7. In which of the following pairs both elements are noble gases?  
a) argon and helium                      b) fluorine and chlorine                      c) bromine and helium

### Quiz 7

1. Which statement does not describe gas particles?  
a) They are widely separated from one another.  
b) They are very strongly intermolecularly bonded.  
c) They are moving rapidly and randomly.
2. Nitrogen gas is kept in a two-liter flask under the pressure of 0.75 atm. How much is the pressure in millimeters of mercury?  
a) 570 mm Hg                                      b) 760 mm Hg                                      c) 800 mm Hg
3. The boiling point is the temperature at which the vapor pressure of the liquid is ... the applied pressure on the liquid.  
a) above    b) equal to    c) below
4. Which example does not correspond to Boyle's Law?  
a) Change of pressure in a syringe  
b) Increase in size of bubbles as they rise to the surface.  
c) Lungs expand as they fill with air.
5.  $150 \text{ cm}^3$  of gas is kept under the pressure 120 cm Hg. What will the pressure of the gas be after doubling its volume?  
a) 120 cm Hg                                      b) 150 cm Hg                                      c) 60 cm Hg
6. Which of the following gas properties are related to Gay-Lussac's Law?  
a) temperature and volume  
b) pressure and temperature  
c) pressure and volume
7. Deep sea creatures would die if they are brought to the surface of the sea. What gas law can be used for explanation of this phenomenon? [2]  
a) Avogadro's Law                                      b) Dalton's Law                                      c) Boyle's Law



## UNIT 2. DO YOU KNOW CHEMICAL ELEMENTS?

*For me too, the periodic table was a passion. ...  
As a boy, I stood in front of the display for hours,  
thinking how wonderful it was that each of those  
metal foils and jars of gas had its own distinct personality.*  
Freeman John Dyson (1923 – )



Have a look at the song “*The Elements*” written in 1959 by Tom Lehrer [5] that recites the names of all the chemical elements that were known at that time up to number 102, Nobelium.

*There’s antimony, arsenic, aluminum, selenium,  
And hydrogen and oxygen and nitrogen and rhenium,  
And nickel, neodymium, neptunium, germanium,  
And iron, americium, ruthenium, uranium,*

*Europium, zirconium, lutetium, vanadium,  
And lanthanum and osmium and astatine and radium,  
And gold, protactinium and indium and gallium,  
And iodine and thorium and thulium and thallium.*

*There’s yttrium, ytterbium, actinium, rubidium,  
And boron, gadolinium, niobium, iridium,  
And strontium and silicon and silver and samarium,  
And bismuth, bromine, lithium, beryllium and barium.*

*There’s holmium and helium and hafnium and erbium,  
And phosphorus and francium and fluorine and terbium,  
And manganese and mercury, molybdenum, magnesium,  
Dysprosium and scandium and cerium and caesium,*

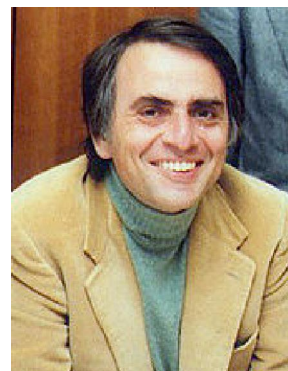
*And lead, praseodymium, and platinum, plutonium,  
Palladium, promethium, potassium, polonium,  
And tantalum, technetium, titanium, tellurium,  
And cadmium and calcium and chromium and curium.*

*There’s sulfur, californium and fermium, berkelium,  
And also mendelevium, einsteinium, nobelium,  
And argon, krypton, neon, radon, xenon, zinc and rhodium,  
And chlorine, carbon, cobalt, copper, tungsten, tin and sodium.*

*These are the only ones of which the news has come to Harvard,  
And there may be many others but they haven’t been discovered.*

Indeed, since that time, 11 more have been discovered, and 9 of those have been named. Those 9 are lawrencium, rutherfordium, dubnium, seaborgium, bohrium, hassium, meitnerium, darmstadtium, and roentgenium.

1. An American science communicator in natural sciences Carl Edward Sagan (1934 – 1996) wrote about the purpose of chemistry in such a way: *Chlorine is a deadly poison gas employed on European battlefields in World War I. Sodium is a corrosive metal which burns upon contact with water. Why each of these substances has the properties it does is a subject called chemistry.*



***Can you name the compound these substances form together?***

***What placid and nonpoisonous material do they make together?***

2. The Periodic Table is the ultimate guidebook for students of chemistry. According to what principle is it arranged?

3. Who proposed the present form of the Periodic Table?

4. Mendeleev saw that if the elements known in his time were arranged in order of increasing atomic mass, certain properties (like corrosive metals that react violently with water) recurred at regular intervals.

***Why did he observe in his table several holes?***

5. What discoveries made in the first half of the 20<sup>th</sup> century helped to understand why the elements would show this type of periodicity?

6. What is the main property, distinguishing metals from nonmetals?

7. What makes hydrogen the notable exception from the elements?

8. Why is the Periodic Table a terrific tool for a chemist?

9. How can you learn the charge of metal cation? That of the anions?

10. How were chemical elements named?

11. There are several chemical elements which names do not correspond to the symbols they have. That is explained by the fact that their chemical symbols are Latin by origin and the matching names are English.

***Find pairs for the given below names which meanings are identical.***

*Argentum, Aurum, Cuprum, Ferrum, Hydrargyrum, Kalium, Natrium, Plumbum, Stannum, Stibium, Wolfram*

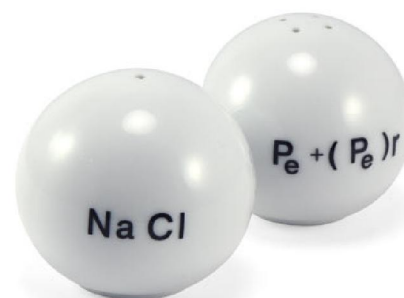
12. Using your everyday knowledge of materials, **classify** each of these as an element, a compound, or as a mixture. Give other examples of each material that you can come across in your household.

a. water	b. nickel	c. US nickel coin
d. diamond	e. sulfur dioxide	f. lemonade
g. copper	h. sea salt	i. iron
g. table sugar	k. steel	l. table salt
m. gold	n. orange juice	o. air
p. graphite	q. chromium	r. cooking oil

13. What metals and non-metals were known in antique practical chemistry?

14. Write the formulas for the compounds below.

1. aluminum phosphate	2. perchloric acid
3. ammonium sulfate	4. phosphoric acid
5. barium nitrate	6. potassium hydroxide
7. calcium phosphate	8. sodium chloride
9. calcium sulphate	10. sodium oxide
11. chloric acid	12. sodium sulfide
13. lead (IV) telluride	14. strontium fluoride
15. nitrous acid	16. sulfuric acid



15. **Translate the quotation of Dmitri Mendeleev:**

*Elements which are similar as regards their chemical properties have atomic weights which are either of nearly the same value (e. g. Pt, Ir, Os) or which increase regularly (e. g. K, Ru, Cs). If all the elements are arranged in the order of their atomic weights, a periodic repetition of properties is obtained. When the elements are arranged in vertical columns according to increasing atomic weight, so that the horizontal lines contain analogous elements again according to increasing atomic weight, an arrangement results from which several general conclusions may be drawn. We must expect the discovery of many as yet unknown elements-for example, elements analogous to aluminum and silicon- whose atomic weight would be between 65 and 75.*

**What law was described in this quotation?**

16. A Swiss psychiatrist Carl Jung (1875 – 1961) compared “the meeting of two personalities with the contact of two chemical substances”.

**Can you explain such a comparison from a chemical point of view?**

17. Name the compounds below



A	B
1. $(\text{NH}_4)_2\text{O}$	2. LiF
3. $\text{Ag}_2\text{SO}_4$	4. $\text{Mg}_3\text{N}_2$
5. AlCl	6. $\text{N}_2\text{F}_4$
7. $\text{NCl}_3$	8. $\text{N}_2\text{O}_4$
9. $\text{Ba}(\text{NO}_3)_2$	10. NaBr
11. $\text{Ca}_3\text{P}_2$	12. NaF
13. $\text{CaI}_2$	14. $\text{AlCl}_3$
15. $\text{CaSO}_4$	16. $\text{TiCl}_2\text{I}_2$
17. $\text{Cd}(\text{NO}_3)_2$	18. $\text{NH}_4\text{Cl}$
19. CO	20. $\text{P}_4\text{O}_{10}$
21. $\text{CO}_2$	22. $\text{Pb}(\text{OH})_2$
23. $\text{Cr}_2\text{O}_3$	24. $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
25. $\text{Fe}_2(\text{CO}_3)_3$	26. $\text{PBr}_5$
27. $\text{Fr}_2\text{SO}_4$	28. $\text{S}_2\text{F}_6$
29. $\text{H}_2\text{SO}_3$	30. $\text{SeBr}_4$
31. $\text{H}_3\text{PO}_3$	32. $\text{SiS}_2$
33. HClO	34. $\text{SO}_2$
35. $\text{HClO}_2$	36. $\text{PbC}_2\text{O}_4$
37. $\text{HNO}_3$	38. $\text{Zn}(\text{NO}_3)_2$
39. $\text{K}_2\text{S}$	40. $(\text{CH}_3)_2\text{CO}$

18. From the Arabic names of **al-natron** and **al-qaliy** the modern symbols for these chemical elements originated.

*Can you name these two elements?*

19. Julius Meyer (1830 – 1895), a German chemist, was contemporary and competitor of Dmitri Mendeleev to draw up the first periodic table of chemical



elements. Speculating in 1870 on the existence of subatomic particles, he wrote: *That the as yet undivided chemical elements are absolutely irreducible substances, is currently at least very unlikely. Rather it seems, that the atoms of elements are not the final, but only the immediate constituents of the molecules of both the elements and the compounds — the molecule as foremost division of matter, the atoms being considered as second order, in turn*

*consisting of matter particles of a third higher order.*

*Translate this passage.*

20. *What acid was first concentrated by Geber in the 8<sup>th</sup> century from vinegar through distillation?*

*What acid did Geber isolate from the sour component of lemons and other unripe fruits and which one was discovered from wine-making residues?*

21. Write the formulas for the compounds below:

aluminum carbonate	aluminum sulfide	ammonium cyanide
ammonium sulfate	beryllium nitrate	calcium bromide
calcium phosphate	chromium (VI) sulfate	cobalt (III) carbonate
cobalt (III) sulfide	copper (II) acetate	copper (II) bicarbonate
copper (II) nitrite	copper (II) oxide	gallium sulfate
iron (II) sulfite	iron (III) phosphide	lead (IV) nitride
lithium arsenide	lithium oxide	magnesium acetate
zinc nitride	manganese (IV) carbonate	platinum (IV) phosphate
nickel (II) hydroxide	nickel (II) selenide	nickel (III) cyanide
nickel (III) sulfite	nitric acid	phosphoric acid
manganese (VII) nitrate	potassium oxide	silver bromide
silver nitrate	silver sulfate	sodium hydroxide
sodium nitrate	sodium permanganate	sulfuric acid
tin (II) hydroxide	vanadium (IV) phosphate	vanadium (V) phosphate
manganese (III) fluoride	zinc phosphate	zirconium phosphate

22. Below come the descriptions of some chemical elements.

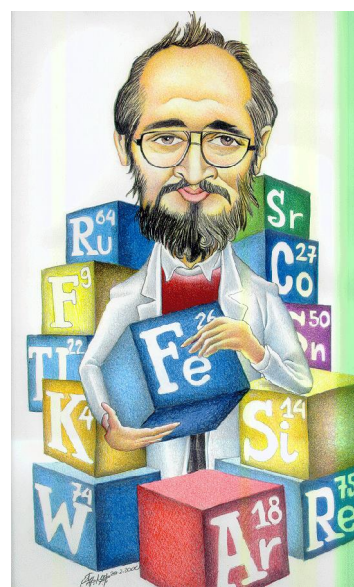
*Can you name them?*

A Roman statesman and scholar Plinius mentioned this element as it was widely used for dwelling purifying and was considered to throw away devildom. What was the name of the element?

A Russian chemist Volfkovitch in 1920 worked with this element and a legend of a “luminous monk” appeared after that. What element did he work with?

After the Bronze century came the century of this metal. Ancient people actively started to melt it and use for making implements as well as weapons.

An English chemist Thomas Nox died while



discovering this element, his brother George becoming an invalid. What element did he discover?

Ancient Greeks and Romans used this metal for gold cleaning, knew about its compounds virulence, especially its corrosive sublimate. For many centuries alchemists considered it the most component of all the metals and believed that if it were restored hardness it would become gold.

Element number 24 is an ingredient of different sorts of steel. What is the name of the element?

Every ancient people knew this metal. It was found as native metal. It was widely used for coining, making jewelry, cutlery, food ware, decorations for furniture and cloths. Ancient Greeks and Romans knew the properties of amalgam.

Give the name and symbol for each element in the A group with two outer electrons. To which A group do they belong?

He discovered plutonium, the ninth transuranium element that was given the name of the discoverer during his life. What is the name of the element?

How many chemical elements were known in 1869?

How many elements are called in the honour of the part of the world? What are they?

How many elements have symbols like accords? What are these elements?

How many elements have symbols that are written like English conjunctions? What are they?

How many elements have symbols that are written like English prepositions? What are they?

How many elements have symbols that are written like English pronouns? What are they?

How many elements have symbols that are written like English verbs? What are these elements?

It is a colorless, odorless, tasteless, non-toxic, inert, monatomic chemical element that heads the noble gas group in the periodic table.

It is a metallic chemical element with atomic number 30. In nonscientific context it is sometimes called 'spelter'. Its plating of steel is the major application for this element; other applications are in batteries and in alloys, for example brass. Its production includes roasting, leaching and at the end electrowinning. Commercially pure element is known as Special High Grade, often abbreviated SHG, and is 99.995% pure. It is an essential mineral, necessary for sustaining all life, but at higher concentrations poisoning can occur.

On the periodic table of elements, what are the only chemical symbols that are made with only two vowels?

The last of the predicted by Mendeleev chemical elements was named 'eco-caesium' in 1839. Today its number is 87. What is its name nowadays?

The name of this element is not connected with the Danish physicist's name. A French chemist and physicist Joseph-Louis Gay-Lussac discovered it much earlier. What is the name of the element?

The paradoxical properties of the element under number 81 were described by a French novelist and dramatist Alexandre Dumas. What is the name of the element?

The so-called *aqua regia* won't melt this element with a royal name but hydrofluoric acid will.

There are more than 20 kg of this element number 20 in the organism of a human being. What is the name of it?

This chemical element (from the Greek word meaning '*pale green*') is a halogen. As the anion, which is part of common salt and other compounds, it is abundant in nature and necessary to most forms of life, including humans. In its common elemental form under standard conditions, it is a pale green gas about 2.5 times as dense as air. It is a powerful oxidant and is used in bleaching and disinfectants. As a common disinfectant its compounds are used in swimming pools to keep them clean and sanitary.

This chemical element is a multivalent nonmetal of the nitrogen group. Due to its high reactivity it is never found as a free element in nature on Earth. It is a component of DNA and RNA, as well as ATP, and is an essential element

for all living cells. The most important commercial use of \_\_\_\_\_-based chemicals is the production of fertilizers.

This chemical element is a steely-gray, lustrous, hard metal that takes a high polish and has a high melting point. It is also odourless, tasteless, and malleable. It was named after the Greek word “χρῶμα” meaning colour because of the many colorful compounds made from it.

This chemical element is nonmetallic and tetravalent — making four electrons available to form covalent chemical bonds. There are three naturally occurring isotopes. It is one of the few elements known to man since antiquity. It is the fourth most abundant element in the universe by mass after hydrogen, helium, and oxygen. It is present in all known life forms, and in the human body, it is the second most abundant element by mass (about 18.5%) after oxygen. This abundance, together with the unique diversity of organic compounds and their unusual polymer-forming ability at the temperatures commonly encountered on Earth, make this element the chemical basis of all known life.

This element is also known since ancient times. Coins and medallions made of it were used in ancient Egypt; water pipes made of this metal were known in ancient Rome. Its melting evidently was the first known metallurgical processes.

This element is known since ancient times as it was the first metal applied already in prehistoric epoch. In ancient Egypt its alloy with silver was widely used. It also was used for coining and making beautiful jewelry. There is some mentioning of this metal in Homer’s books. Medieval alchemists up to the XV<sup>th</sup> century unsuccessfully tried to find a philosophical stone to transform all existed metals into this noble one.

This element was given the name of the whole continent in 1901. What is it?

This natural mineral has been used for a long time. However, an element number 5 was obtained only in the last century. Name this element.

This substance was widely used by professional poisoners. What is the name of this chemical element?

This very well-known metal existed both as a pure form and as an alloy with tin or stannum. Bronze century was a whole epoch in humanity evolution



characterized by bronze usage for making household ware, implements and payloads or weapons.

What are the lands in the honour of which two elements are called?

What element had been discovered fifteen years before the country it was called in the honour of became united?

What element had been discovered twenty years before the country in the honour of which it was called got its independence?

What element was called in the honour of Russia?

What is the atomic number of the chemical element named after D. I. Mendeleev?

What is the only country called in the honour of the chemical element?

What is the surname of the man in whose honour the mineral which 'gave' the name to samarium was called?

What is the town in the honour of which four elements are named? What are these elements? Where is the town situated?

Which element takes two cells in the periodic system?

Which element was called in the honour of European capital?

Which element was firstly discovered on the sun?

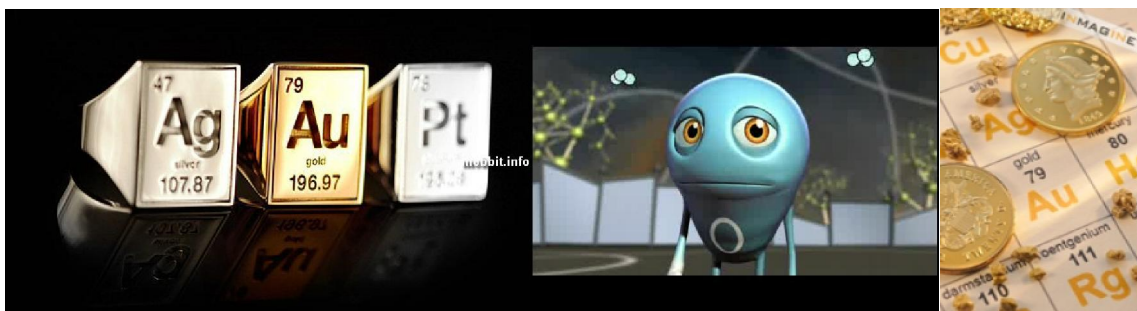
Which element was named in the honour of the town where the largest royal palace in Europe is situated?

Which two elements are called in the honour of Scandinavia?

Which two elements are named in the honour of France?

23. Name the following chemical element with such a description:

Name, symbol, number	_____, _____, ____
Element category	Alkali metals
Group, period, block	1, 2, s
Standard atomic weight	6,941(2)g mol <sup>-1</sup>



24. This is a list of chemical elements named after people. The symbol and atomic number are given in brackets.

Bohrium (Bh, 107)	Curium (Cm, 96)	Einsteinium (Es, 99)
Fermium (Fm, 100)	Gallium (Ga, 31)	hafnium (105)
Lawrencium (Lr, 103)	Meitnerium (Mt, 109)	Mendelevium (Md, 101)
Nobelium (No, 102)	Roentgenium (Rg, 111)	Rutherfordium (Rf, 104)
	Seaborgium (Sg, 106)	

***Do you know these people? Can you name them?***

***Find background information about every scientist after whom an element was named.***

25. Another group of elements got their names to commemorate the names of gods from Greek mythology.

Niobium (Nb, 41)	Promethium (Pm, 61)	Tantalum (Ta, 73)
Thorium (Th, 90)	Titanium (Ti, 22)	Vanadium (Va, 23)

***Do you know these Greek gods?***

26. Another list of chemical elements has the names of some places such as cities or countries.

Americium	Berkelium	Californium	Copper
Darmstadtium	Dubnium	Erbium	Europium
Francium	Gallium	Germanium	Hafnium
Hassium	Holmium	Lutetium	Magnesium
Polonium	Rhenium	Ruthenium	Scandium
Strontium	Terbium	Thulium	Ytterbium
Yttrium			

***Can you name these places?***

***Find information about discoveries of these elements.***

Many chemical elements are named after astronomical bodies which are named after Greek or Roman deities. However, *Gadolinium* (Gd, 64) is named

from the mineral gadolinite, which in turn is named after the Finnish chemist and geologist Johan Gadolin. *Samarium* (Sm, 62) is named from the mineral samarskite which in turn is named after Colonel Samarski, a Russian mine official.

27. And at last have a look at a list of chemical elements named after astronomical objects. Do you know them?

Cerium	Helium	Neptunium
Palladium	Plutonium	Selenium
Tellurium	Uranium	

*Name these planets.*

28. What do you think: are there any letters from the English alphabet which are absent in the Periodic Table?

29. Purified alcohol was first produced by Arnau de Villanova, a Spanish alchemist in 1300 A. D. Numerous Muslim chemists produced medicinal-grade alcohol as early as the 10<sup>th</sup> century. They used alcohol as a solvent and antiseptic.

*What process was used for alcohol production at that time?*

30. Do you agree that the periodic table is the elegance of scientific theory and has predictive power? *Can you prove it?*

31. Find the information about Nobel Prize winners who discovered chemical elements.

**CHEMICAL ELEMENTS DISCOVERED BY NOBEL PRIZE WINNERS\***  
Click on an element box for an article on a chemical element. For a biography, click on the name or photograph of a Nobel Prize winner.

**Sir William Ramsay**  
argon 1894 with Lord Rayleigh

**Lord Rayleigh**  
helium 1895  
neon, krypton, and xenon 1898 (with Morris W. Travers)

**Henri Moissan**  
fluorine 1886

**Georg Charles von Hevesy**  
hafnium 1923 (with Dirk Coster)

**Emilio Segrè**  
technetium 1937 (with Carlo Perrier)  
astatine 1940 (with Dale R. Corson and K.R. MacKenzie)

**Marie and Pierre Curie**  
polonium and radium 1898

**Edwin M. McMillan**  
neptunium 1940 (with Philip H. Abelson)

**Otto Hahn**  
protactinium 1917 (with Lise Meitner)

**Frederick Soddy**  
polonium and radium 1898

**Glenn T. Seaborg**  
plutonium 1940 (with coworkers)  
americium 1944 (with coworkers)  
curium 1944 (with coworkers)  
berkelium 1949 (with coworkers)  
californium 1950 (with coworkers)  
mendelevium 1955 (with Albert Ghiorso and other coworkers)  
nobelium 1958 (with Albert Ghiorso and other coworkers)

## Quiz 1

1. What English chemist in 1865 classified the 56 elements that had been discovered into eleven groups which were based on similar physical properties? The known elements were arranged in order of atomic weights and observed similarities between the first and ninth elements, the second and tenth elements, etc. This scientist proposed the 'Law of Octaves'. What was his name?

a) John Newlands



b) Robert Boyle



c) Henry Moseley



2. This German chemist was contemporary and competitor of Dmitri Mendeleev to draw up the first periodic table of chemical elements. He compiled a Periodic Table of 56 elements based on the periodicity of properties such as molar volume when arranged in order of atomic weight. What was his name?

a) Lothar Meyer



b) Justus Liebig



c) Jacob Berzelius

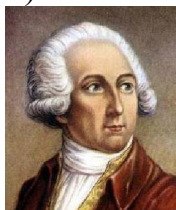


3. This French chemist wrote the first extensive list of 33 elements. He also distinguished between metals and non-metals. Who was this outstanding scientist?

a) Pierre Curie



b) Antoine Lavoisier



c) Michel Chevreul



4. What Swedish chemist developed a table of atomic weights and introduced letters to symbolize elements?

a) Jöns Jakob Berzelius



b) Svante Arrhenius



c) Carl Wilhelm Scheele



5. This German chemist developed ‘triads’, groups of 3 elements with similar properties such as, for instance, lithium, sodium and potassium. What is his name?

a) Johann Döbereiner



b) Lothar Meyer



c) Paul Ehrlich



6. What Scottish chemist discovered the noble gases received the Nobel Prize in Chemistry in 1904 “in recognition of his services in the discovery of the inert gaseous elements in air”?

a) William Ramsay



b) Daniel Rutherford



c) Thomas Graham



7. This outstanding English physicist determined the atomic number of each of the elements. He modified the Periodic Law to read that the properties of the elements vary periodically with their atomic numbers.

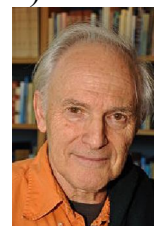
a) John Newlands



b) Henry Moseley



c) Harold Kroto



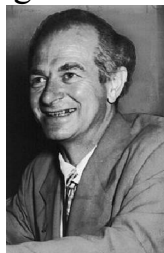
8. What American scientist won the 1951 Nobel Prize in chemistry for “discoveries in the chemistry of the transuranium elements” and developed the

actinide concept, which led to the current arrangement of the actinoid series in the periodic table of the elements?

a) Glenn Seaborg



b) Linus Pauling



c) Robert Mulliken



## Quiz 2

1. Which of the following elements is a halogen?

a) iodine

b) xenon

c) arsenic

2. The physical properties of sulfur are atomic number 16 and an atomic weight of 32.06. Its melting point is  $113^{\circ}\text{C}$ , a boiling point being  $444^{\circ}\text{C}$ . An experimental sulfur sample melts sharply at  $119^{\circ}\text{C}$  and boils at  $445^{\circ}\text{C}$ . Characterize this sample: what is it?

a) mixture with sulfur

b) pure sulfur

c) impure sulfur

3. Find the correct arrangement of the elements according to the smallest order of atomic radius:

a) Helium, neon, fluorine, oxygen, hydrogen

b) Hydrogen, oxygen, fluorine, neon, helium

c) Helium, hydrogen, fluorine, oxygen, neon

4. This element has the largest atomic radius of all the elements on the periodic table. What is it?

a) hydrogen

b) fluorine

c) francium

5. Being in the same group, Li, Na and K have the same nuclear charge. Which of these elements uses the smallest number of electron energy levels?

a) Li

b) Na

c) K

6. Moving left to right across a period atomic radius ...

a) increases.

b) decreases.

c) is the same.

7. Which halogen has the smallest atomic radius?

a) iodine

b) bromine

c) chlorine

8. How many protons, neutrons and electrons are there in U-238?  
a) 88 – 138 – 88                      b) 92 – 146 – 92                      c) 86 – 136 – 86

### Quiz 3

1. The term 'ionization energy' of an atom or molecule means the energy needed to remove electrons from an atom. What ionization energy do large atoms require?

- a) low ionization energy    b) high ionization energy    c) do not require energy

2. How does electron affinity change moving down a group?

- a) It increases.                      b) It decreases.                      c) No changes.

3. Which arrangement type corresponds to the relative size of Be, Mg and Ca atoms, respectively?



4. Group VIIA elements, the halogens, have ... electron affinities because the addition of an electron to an atom results in a completely filled shell.

- a) no                                      b) low                                      c) high

5. An electronegative element forms negative ions and has a tendency to ... electrons.

- a) gain                                      b) lose                                      c) replace

6. What element is the third most abundant element by mass in the Universe, behind hydrogen and helium, and the most abundant element by mass in the Earth's crust?

- a) oxygen                                      b) aluminium                                      c) nitrogen

7. Which chemical element does not react with hydrogen?

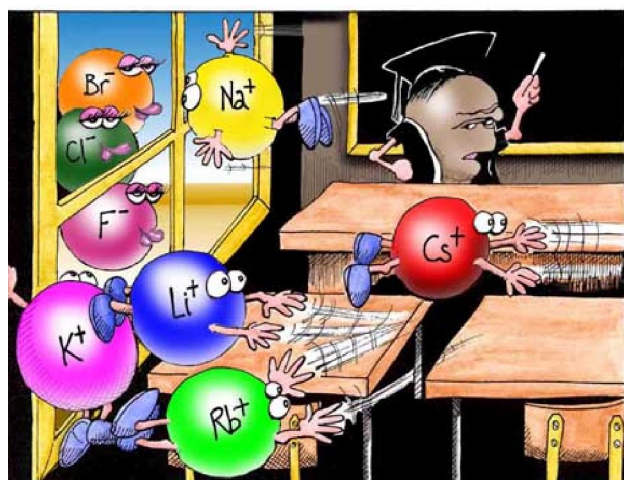
- a) chlorine                                      b) helium                                      c) iodine

### Quiz 4

1. If to compare the properties of a compound with those of the elements it is made up of, these properties are ...

- a) never changed.                      b) always different.                      c) always the same.

2. 'Al', 'Ag', 'Au', 'As', 'At', 'Ar' or 'Ac' all are chemical ...  
 a) symbols.                                      b) formulas.                                      c) elements.
3.  $\text{H}_3\text{PO}_4$  is the formula for ...  
 a) phosphorous acid                              b) phosphoric acid                              c) phosphoric iron
4. The numbers 2 and 3 in the formula  $\text{Mg}_3\text{N}_2$  are ...  
 a) subscripts.                                      b) superscripts.                                      c) underscripts.
5. All the alkaline earth metals have two electrons in their valence shell, so the energetically preferred state of achieving a filled electron shell is to lose two electrons to form ...  
 a) doubly charged negative ions.                                      b) doubly charged positive ions.                                      c) hydrogen bond.



6. The calcium ion bears a +2 charge, and the phosphate ion bears a -3 charge. To balance the charges for electrical neutrality, we need to have ...  
 a) two  $\text{Ca}^{2+}$  ions and two  $\text{PO}_4^{3-}$  ions.  
 b) two  $\text{Ca}^{2+}$  ions and three  $\text{PO}_4^{3-}$  ions.  
 c) three  $\text{Ca}^{2+}$  ions and two  $\text{PO}_4^{3-}$  ions.

7.  $\text{LiF}$  is a(n) ... compound.

- a) covalent compound                              b) ionic compound                              c) molecular compound

## Quiz 5

1. We are surrounded with matter that is physical substance which occupies space and possesses rest mass. Everything around us exists mostly as ...  
 a) pure substance.                                      b) elements.                                      c) compounds.
2. To know the elements that make up a compound and to learn the ratio of the atoms of those elements one should use chemical ...  
 a) symbol.                                      b) formula.                                      c) composition.
3. A strong force of attraction holding atoms together in a molecule or crystal, resulting from the sharing of electrons between atoms is known as ...  
 a) a covalent bond.                                      b) an ionic bond.                                      c) a magnetic bond.



4. A chemical formula gives the ratio of the different kinds of atoms present in the compound. This atoms ratio of the compound is shown by numbers called ...
- a) superscript.                      b) subscript.                      c) index.
5. What do you call a charged species composed of two or more atoms covalently bonded or a metal complex acting as a single unit?
- a) a polyatomic ion.                      b) a negative ion.                      c) a background ion.
6. If an atom gains two electrons it becomes ...
- a) a positively charged ion.    b) a negatively charged ion.    c) a non-charged ion.
7. What is the name of the compound made of lithium and bromine?
- a) lithium bromate                      b) bromic lithium                      c) lithium bromide
8. Sulphuric acid is an example of a compound with what type of bonds?
- a) ionic bonds                      b) covalent bonds                      c) a magnetic bond

### Quiz 6

1. Number and sign written by the symbol of an ion to indicate its charge is named ...
- a) index.                      b) indicator.                      c) superscript.
2. A strong force of attraction holding atoms together in a molecule or crystal is called ...
- a) chemical bond.    b) specific interaction.    c) Van der Waals interaction.
3. What is the name of the compound with the formula  $N_2O_4$ ?
- a) nitrogen oxide                      b) dinitrogen oxide                      c) dinitrogen tetraoxide
4. A negatively charged ion that would be attracted to the anode in electrolysis is called ...
- a) anion                      b) cation                      c) proton
5. What is the formula of tetraphosphorus decaoxide?
- a)  $P_4O_{10}$                       b)  $P_2O_5$                       c)  $H_3PO_4$
6. A molecule that does not have oppositely charged ends is known as ...
- a) diatomic molecule.    b) nonpolar molecule.    c) polar molecule

7. When  $\text{Na}^+$  reacts with  $\text{Cl}^-$  to form sodium chloride, the formed compound is ...
- a) neutral.                      b) negatively charged.                      c) positively charged.
8. An easy way to remember the charge of a metal cation (Na, Mg or Al, for example) is to note that ...
- a) it is the same as the group number.  
 b) it is the same as the period number.  
 c) it is its group number minus eight.

### Quiz 7

1.  $\text{HClO}_2$  is the formula of ...
- a) superoxide.                      b) acid.                      c) alkali.
2. The formula  $\text{Fe}_2\text{O}_3$  shows that in the compound there are ...
- a) two atoms of iron and three of oxygen.  
 b) three atoms of iron and two of oxygen.  
 c) two atoms of iron and two of oxygen.
3. The absence of a subscript in a chemical formula means that a unit of the compound contains ...
- a) no atoms of element.      b) two atoms of element.      c) one atom of element.
4. Classify the following compound:  $\text{SO}_2$  is ...
- a) ionic compound.                      b) molecular compound.      c) neither of them.
5. The amount of a catalyst present at the end of a reaction should be ... as at the beginning of the reaction.
- a) the same                      b) different                      c) decreased
6. What is the type of the following chemical reaction:  
 $\text{AgNO}_3 + \text{HCl} \Rightarrow \text{AgCl}_{(s)} \downarrow + \text{HNO}_3$ ?
- a) single displacement reaction  
 b) double displacement reaction  
 c) triple displacement reaction
7. Oxidation is a process in which a chemical substance changes and ... of electrons increases an atom's oxidation state.
- a) the loss                      b) the gain                      c) the exchange
8. What metal forms peroxide when heated in oxygen?

- a) beryllium                      b) strontium                      c) rubidium

### Quiz 8

1. What element in liquid form and in the presence of a magnetic field forms a magnet and has been shown to be able to form a bridge, between the two poles of a magnet, capable of supporting its own weight?

- a) hydrogen                      b) oxygen                      c) nitrogen

2. A chemical bond is a strong force of ... holding atoms together in a molecule.

- a) attraction                      b) repulsion                      c) gravitation

3. Lithium, sodium, potassium, rubidium and cesium behave as ...

- a) low reactive metals.      b) highly reactive metals.      c) non-reactive metals.

4. Most enzymes produced by living organisms acts as catalysts and are proteins with large complex molecules whose action depends on their particular molecular shape.

- a) true and true                      b) false and true                      c) false and false

5. Steam reforming, also known as fossil fuel reforming, is a current method for producing ... This is achieved in a processing device called a reformer which reacts steam at high temperature with the fossil fuel.

- a) hydrogen gas.                      b) natural gas.                      c) laughing gas

6. Starch, petrol, methane, hydrocarbons, carbon dioxide, and carbon tetrachloride are all ... molecules.

- a) dipole                      b) polar                      c) non-polar

7. Hydrogen was probably discovered many times. In 1671, for example, English chemist Robert Boyle (1627-91) described experiments in which he added ... to hydrochloric acid and sulfuric acid.

- a) iron                      b) copper                      c) hydrargyrum

### Quiz 9

1. How many elements were known at the end of XX<sup>th</sup> century?

- a) 112                      b) 110                      c) 118

2. How many elements on the periodic table occur naturally? Conventional wisdom says that the first ... elements, from element one, hydrogen, to element ..., uranium, are all naturally occurring, but in fact some of these elements are highly unstable and have only been observed when they have been created artificially..

- a) 112                                      b) 92                                      c) 90

3. The *Guinness Book of Records* recorded the rarest element on Earth, stating: "Only around 0.9 oz (25 g) of this element occurs naturally in the Earth's crust." [30]

- a) astatine                                      b) mercury                                      c) chlorine

4. Negatively charged anions in the human body include phosphate and chloride. Positively charged cations found there include calcium, sodium, and potassium. What is the second most abundant positively charged intracellular (inside the cells) ion in the body? It is also the fourth most abundant mineral in the body.

- a) selenium                                      b) magnesium                                      c) manganese

5. Roughly 96 percent of the mass of the human body is made up of just four elements: oxygen, carbon, hydrogen and nitrogen, with a lot of that in the form of ...

- a) electrolytes.                                      b) minerals.                                      c) water.

6. This element is synonymous with life. Its central role is due to the fact that it has four bonding sites that allow the building of long, complex chains of molecules. It is the basic building block of all organic compounds and molecules.

- a) oxygen                                      b) nitrogen                                      c) carbon

7. Water is the most abundant compound on Earth's surface, covering about 70%. What is water from chemical point of view?

- a) mixture                                      b) compound                                      c) complex

## Quiz 10

1. The generalization that the elements, when listed in order of their atomic numbers (originally, atomic weights), fall into recurring groups, so that elements with similar properties occur at regular intervals is known as ...

- a) the periodic component      b) the periodic law      c) the periodic table

2. The d-block is the portion of the periodic table that contains the element groups 3-12. The d-block elements are often also known as ...

- a) post-transition metals.
- b) transition metals.
- c) inner transition metals.

3. Metals include the areas shaded light blue in the periodic table and share many characteristics. Find the one which does not correspond to the proper description of metals.

- a) They are good conductors of heat and electricity.
- b) Most metals are malleable and ductile.
- c) They do not possess luster.

4. The alkali metals, the alkali earths, the halogens and the noble gases are arranged in the periodic table in ...

- a) groups.
- b) periods.
- c) blocks.

5. Horizontal series of rows in the periodic table are known as ...

- a) groups.
- b) blocks.
- c) periods.

6. The s-block of the periodic table of elements consists of the first two groups: the alkali metals and alkaline earth metals, plus hydrogen and ...

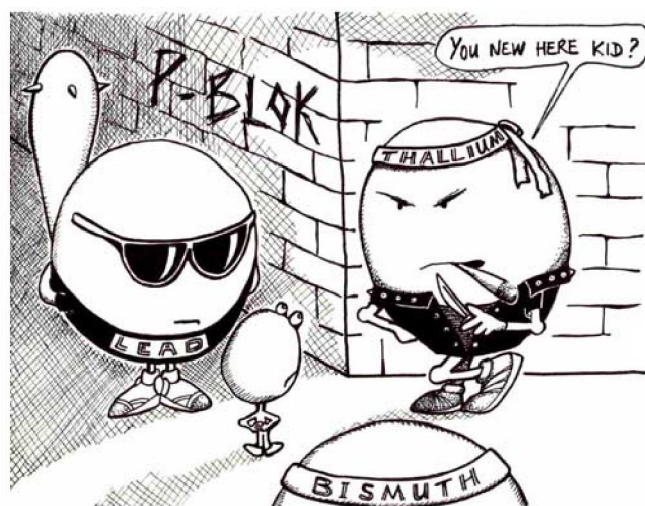
- a) lutetium.
- b) helium.
- c) lawrencium.

7. In what block of the periodic table is Boron group located?

- a) d-block
- b) -block
- c) p-block f

8. The conventional divisions of this block in the periodic table follow periods of similar atomic number rather than groups of similar electron configuration. Thus, it is divided horizontally into the lanthanoid series and the actinoid series. What is this block?

- a) p-block
- b) f-block
- c) s-block



### UNIT 3. WHAT DO YOU KNOW ABOUT WATER?

*Water is the driver of Nature.*  
Leonardo da Vinci (1452-1519)

Teacher: *What is the formula for water?*

Student: *H, I, J, K, L, M, N, O.*

Teacher: *That's not what I taught you.*

Student: *But you said the formula for water was H to O.*



1. Give your comments on the epigraph to the unit.  
***Do you think that this quotation is still actual? Give some arguments.***

2. What is water?

3. Antoine de Saint-Exupéry (1900 – 1944), an outstanding French writer, gave utterance to his admiration: *Water has no taste, no color, no odor; it cannot be defined, art relished while ever mysterious. Not necessary to life, but rather life itself. It fills us with a gratification that exceeds the delight of the senses.*



***Translate this quotation.***

***What in your opinion makes water “art relished” and “mysterious”?***

4. Do you agree that water is ‘*the do everything*’ molecule? Give your arguments.

5. David Lawrence (1885 – 1930) was an English novelist, poet, playwright, essayist, literary critic and painter. He wrote about water: *Water is H<sub>2</sub>O, hydrogen two parts, oxygen one, but there is also a third thing, that makes water ...*

***Can you name this third thing that makes water?***

***What do you think it might be?***



6. When do you think water is dangerous?

7. Do you agree with the statement of a French explorer Jacques Cousteau (1910 – 1997) who said: *Water and air, the two essential fluids on which all life depends, have become global garbage cans.*



8. ***Translate the text into Russian. Title it.***

H<sub>2</sub>O or HOH is the most abundant molecule on Earth's surface, constituting about 70% of the Earth's surface in liquid, solid, and gaseous states. It is in dynamic equilibrium between the liquid and gas states at standard temperature and pressure. At room temperature, it is a nearly colorless (with a hint of blue), tasteless, and odorless liquid. Many substances dissolve in water and it is commonly referred to as the universal solvent. Because of this, water in nature and in use is rarely pure, and may have some properties different from those in the laboratory. However, there are many compounds that are essentially, if not completely, insoluble in water. Water is the only common substance found naturally in all three common states of matter. Water is essential for all life on the Earth. Water also usually makes up 55% to 78% of the human body.

9. ***Complete the text about forms of water, guess and insert the missed words.***

Water can take many forms. The solid state of water is known as ...; the gaseous state is known as ... (or...), and the common ... phase is generally taken as simply water. Above a certain critical ... and ... (647 K and 22.064 MPa), water ... assume a supercritical condition, in which liquid-like clusters float within a vapor-like phase.

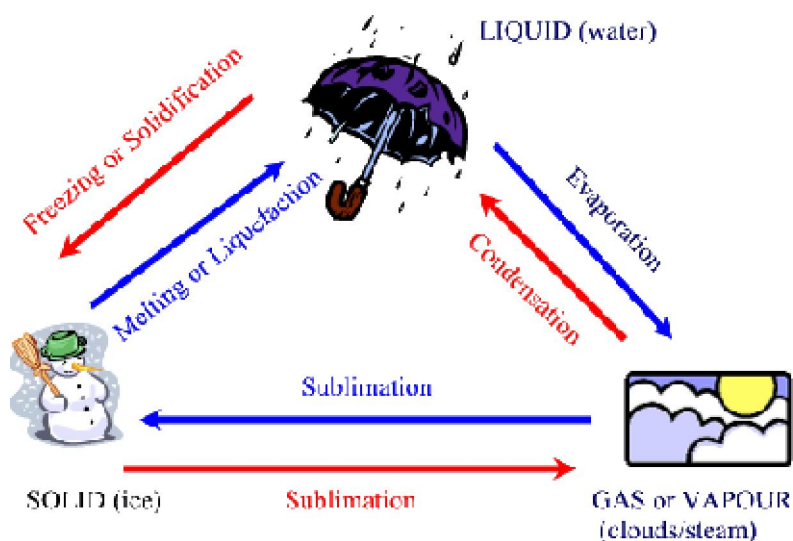
In natural water, almost all of the ... atoms are of the isotope protium, <sup>1</sup>H. ... water is water in which the hydrogen is replaced by its heavier isotope, deuterium, <sup>2</sup>H. It is chemically almost ... to normal water. Heavy water is used in the ... industry to slow down neutrons. By contrast in situations where heavy water may be used, water in which the ... is protium may sometimes be called light water. This is where the term light water reactor (nuclear reactor using light water) comes from.

10. ***Translate the following passage.***

The water cycle, also known as the hydrologic cycle or H<sub>2</sub>O cycle, describes the continuous movement of water on, above and below the surface of the Earth. Water can change states among liquid, vapor, and solid at various places in the water cycle. Although the balance of water on Earth remains fairly constant over time, individual water molecules can come and go, in and out of the atmosphere. The water moves from one reservoir to another, such as from river to ocean, or from the ocean to the atmosphere, by the physical processes of evaporation, condensation, precipitation, infiltration, runoff, and subsurface

flow. In so doing, the water goes through different phases: liquid, solid, and gas. [5]

11. *What are properties of water in all three states?*



12. Water is a liquid and not a gas at room temperature (about 25°C) and normal atmospheric pressure.

*What are almost all other compounds with similar molar masses under the same conditions?*

13. Most liquids contract when they solidify.

*What does water do when it freezes?*

14. *Give your comments on the words of a Scottish poet Charles Mackay (1814 – 1889): Water is the mother of the vine, the nurse and fountain of fecundity, the adorning and refresher of the world.*



*Give some arguments to prove Mackay's opinion.*

15. What solid can float?

16. Why water is called the universal solvent?

17. Why is the water property of having a high surface tension beneficial for plants?

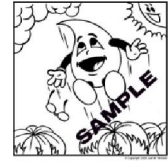
18. *Choose the correct article or preposition*

Capillary action refers (-; to; at) (-; the; a) process of water moving up (a; -; the) narrow tube against (-; the; a) force of gravity. It occurs because water adheres (-; to; at) the sides of the tube, and then surface tension tends (at;



**on; to)** straighten the surface making it rise, and more water is pulled up through cohesion. The process is repeated as **(the; a; -)** water flows up **(the; a; -)** tube until there is enough water that gravity counteracts **(-; a; the)** adhesive force.

19. Are clouds in the sky and the 'cloud' exhaled on a cold day the same forms of water? Define these forms.



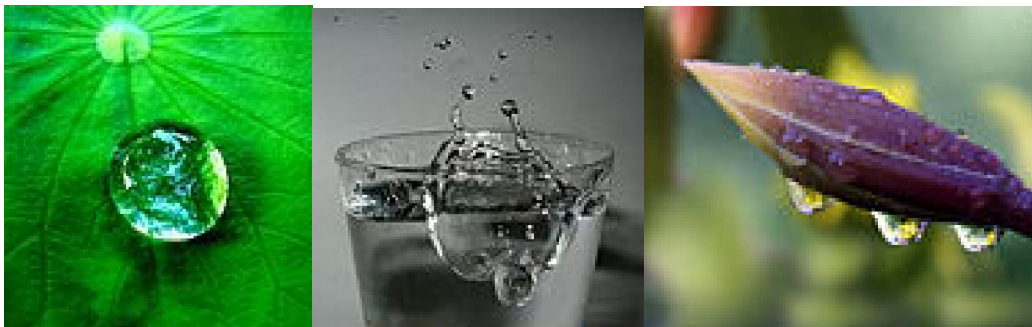
20. What water property helps different elements and minerals move over the surface of the earth?

21. Agree or disagree with the statement: *Rainwater is the purest form of water.* Give arguments.

22. What is the pH value of neutral (distilled) water? Compare it with that of sea water.

23. Water in the Great Salt Lake is assumed to have about a 20 % salt concentration. If a glass were full of water from the Great Salt Lake, would there be one inch of salt left when the water evaporated? [2]

24. What do you think the form of a rain drop is?



25. ***Distinguish between the definitions of physical and chemical water properties***

- Alkalinity. This is the capacity of water to neutralize an acid or a base, so that the pH of the water will not change.
- Conductivity. This means the amount of electricity that water can conduct. It is expressed in a chemical magnitude.
- Density. The density of water means the weight of a certain amount of water. It is usually expressed in kilograms per cubic metre.
- Light absorption. This is the amount of light a certain amount of water can absorb over time.
- The pH. The pH has its own scale, running up from 1 to 14. The pH shows whether a substance is acid (pH 1-6), neutral (pH 7) or basic (pH 8-14).

The number of hydrogen atoms in the substance determines the pH. The more hydrogen atoms a substance contains, the lower the pH will be. A substance that contains many hydrogen atoms is acid. We can measure the pH by dipping a special colouring paper in the substance, the colours shows which pH the substance has.

- Thermal properties. This refers to what happens to water when it is heated; at which temperature it becomes gaseous and that sort of thing.
- Viscosity. This means the syrupiness of water and it determines the mobility of water. When the temperature rises, the viscosity degrades; this means that water will be more mobile at higher temperatures.

26. Denver is the capital and the most populous city of the U.S. state of Colorado. Denver is nicknamed the “Mile-High City” because its official elevation is exactly one mile (1.6 km) above sea level.

Siesta beach in Florida is considered the best American beach this year.

*Compare these two places of interest and decide where water will boil easily.*

27. *How is this phenomenon called? In what way is it connected with water?*



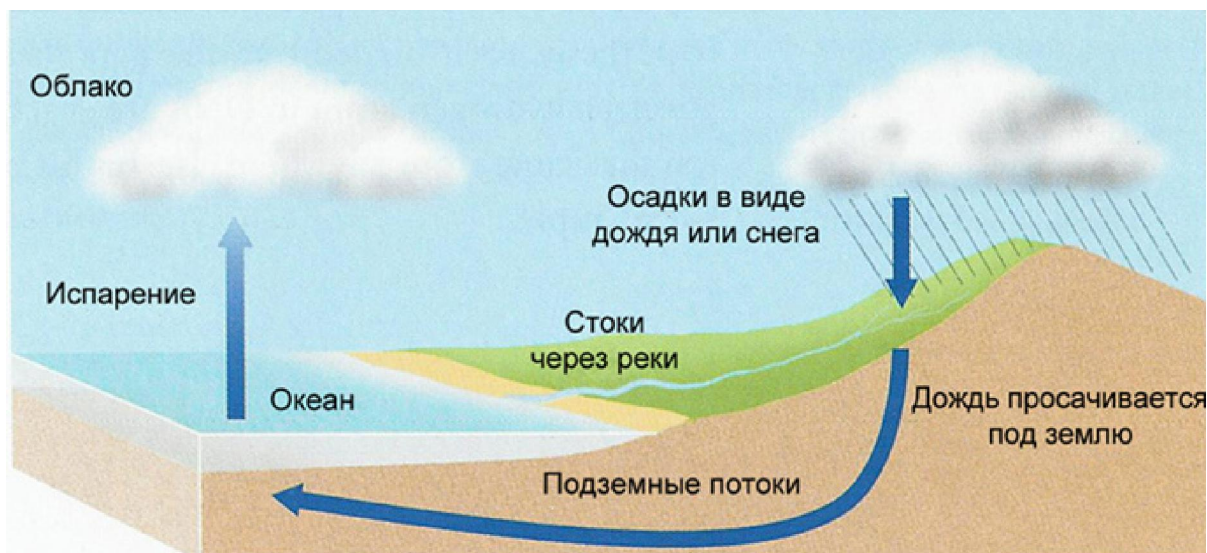
28. Most sulfates are soluble.  
*Which ionic compounds are exceptions of this rule?*

29. **Translate the text into English**

Источником движения воды на Земле является энергия Солнца. Солнечные лучи попадают на поверхность Земли, передают свою энергию воде и нагревают ее, превращая в пар. В среднем каждый час с одного квадратного метра водной поверхности испаряется один килограмм воды! Теоретически за 1000 лет почти вся вода Мирового океана может побывать в виде пара.

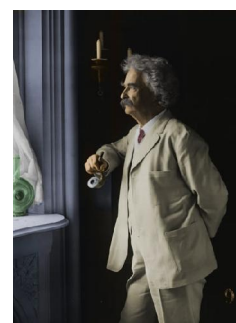
Огромные объемы атмосферной воды переносятся на значительные расстояния и попадают на Землю в виде атмосферных осадков. Атмосферные осадки попадают в реки, которые несут свои воды в Мировой океан. Так осуществляется круговорот воды в природе. Различают малый и большой круговорот. Малый круговорот связан с выпадением атмосферной воды в виде осадков в Мировой океан, большой круговорот – с выпадением в виде осадков на суше.

30. **Describe the water cycle using the scheme below**



31. What is the importance of water for agriculture, power generation and public health?

32. An American writer and humorist Mark Twain (1835 – 1910) in his work of science fiction “Three Thousand Years among the Microbes” wrote: *...the two individuals combined, constitute a third individual – and yet each continues to be an individual....here was mute Nature explaining the sublime mystery of the Trinity so luminously that even the commonest understanding could comprehend it, whereas many a trained master of words had labored to do it with speech and failed.*



**The combination of what “individuals” are described here?**

***Why do you think water is named “the sublime of the Trinity”?***

33. Aristotle described the experiment of his in such a way: *Salt water when it turns into vapour becomes sweet, and the vapour does not form salt water when it condenses again. This I know by experiment. The same thing is true in every case of the kind: wine and all fluids that evaporate and condense back into a liquid state become water. They all are water modified by a certain admixture, the nature of which determines their flavour.*

***What experiment was performed by Aristotle?***

34. You are given a mixture of sand, salt and water. How would you separate the three compounds?

35. A Hungarian Biochemist Albert Szent-Györgyi (1893 – 1986) said that “*water is life’s mater and matrix, mother and medium. There is no life without water*”.

***Do you agree with such an opinion?***

***Support your answer with arguments.***



36. Most chlorides are soluble.

***Chlorides of what metals are exceptions?***

37. ***Which of these compounds are soluble?***

- a) ammonium nitrate,  $\text{NH}_4\text{NO}_3$  (*used in fertilizers*)
- b) sodium sulfate,  $\text{Na}_2\text{SO}_4$  (*used as an additive in detergents*)
- c) mercury sulfide,  $\text{HgS}$  (*the mineral cinnabar*)
- d) aluminum hydroxide,  $\text{Al}(\text{OH})_3$  (*used in some antacid tablets*)

38. This useful concentration unit is based on the chemical mole and is defined as the number of moles of solute present in one liter of solution.

***What is a useful concentration unit in chemistry?***

39. Are all sodium, potassium, and ammonium compounds soluble or insoluble?



40. What property of water in your opinion made an American comedian William Fields (1880 – 1946) claim that he “*never drank water*”?

41. What do you think damage effects of dihydrogen monoxide are?

## Quiz 1

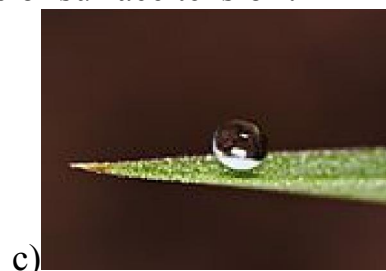
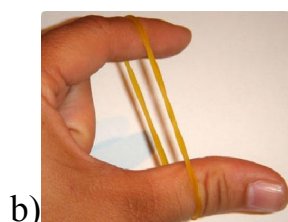
1. Scientists separate components of solutions by ...

- a) distillation and crystallization methods.
- b) solvent extraction and chromatography.
- c) both a) and b)

2. What electronegative atom is not a hydrogen bond acceptor, regardless of whether it is bonded to a hydrogen atom or not?

- a) fluorine
- b) nitrogen
- c) chlorine

3. Which of the following photos is not an example of surface tension?



4. How does hydrogen bonding affect living organisms? Which of the following statements is wrong?

- a) It allows lakes and oceans to have a moderating effect on the temperature.
- b) It helps plants obtain the water they need to live.
- c) It causes the growth of magnetic bacteria in ponds and lakes.

5. Vinegar is basically a solution of acetic acid in water. What is solute of vinegar in this case?

- a) acetic acid
- b) water
- c) alcohol

6. The nylon rod carries a positive charge. Which end of the water molecule is attracted to the rod?

- a) the positive end
- b) the negative end
- c) none of them

7. If the solvent is a gas, only gases are dissolved under any given set of conditions. Air is an example of a gaseous solution. What chemical element serves the solvent for air in this case?

- a) oxygen
- b) nitrogen
- c) argon

8. Nucleotides make up the basic units of DNA and RNA molecules. A nucleotide is an organic molecule made up of a nucleotide base, a five-carbon sugar (ribose or deoxyribose) and at least one ...

- a) amine group
- b) -OH group
- c) phosphate group

9. Which feature of polymer chains does not influence the properties of the polymer formed?  
a) length of the chain      b) additives      c) flexibility

## Quiz 2

1. Carbohydrates include sugars, starches, cellulose and many other compounds found in living organisms. Carbohydrates consisting of two to ten simple sugars are called ...  
a) monosaccharides      b) polysaccharides      c) oligosaccharides
2. What is the oxidation state of C in  $\text{CO}_3^{2-}$ ?  
a) +4      b) +3      c) +2
3. Classify potassium hydroxide. It is ...  
a) non-electrolyte      b) weak electrolyte      c) strong electrolyte
4. Why is platinum used in preference to other metals in half-cells where the reaction itself does not involve a metal element? [31]  
a) It is cheap material.  
b) It is malleable and ductile.  
c) It is generally nonreactive.
5. Which arrangement of acids corresponds to the order of decreasing base strength?  
a) perchloric acid, sulfurous acid, boric acid  
b) sulfurous acid, boric acid, perchloric acid  
c) boric acid, perchloric acid, sulfurous acid
6. In what region of the electromagnetic spectrum one can identify the vibrations of individual bonds?  
a) infrared      b) visible      c) ultraviolet
7. What pollutant gas is not present in the gaseous mixtures produced through the combustion of petrol in the engine of the car?  
a) carbon monoxide      b) carbon dioxide      c) hydrocarbons
8. The octet rule works particularly well for elements in the ... period of the periodic table.  
a) first      b) second      c) seventh

### Quiz 3

- Which element contains one proton more than uranium?  
a) plutonium                      b) neptunium                      c) americium
- Electrolytes are substances which, when dissolved in water, break up into cations (plus-charged ions) and anions (minus-charged ions). Strong electrolytes fall into three categories. Which of the mentioned below categories is not suitable for strong electrolytes?  
a) strong acids                      b) strong bases                      c) insoluble salts
- The measurement of dipole moment helps in distinguishing between polar and non-polar molecules. Non-polar molecules have zero dipole moment while polar molecules have some value of dipole moment. Which of the following compounds has a dipole moment?  
a)  $\text{BF}_3$                       b)  $\text{HF}$                       c)  $\text{CH}_4$
- Which of the following compounds are insoluble in water?  
a)  $\text{CH}_3\text{COOH}$                       b)  $\text{CCl}_4$                       c)  $\text{CH}_3\text{OCH}_3$
- The concentration of argon in air is approximately 9000 ppm [2]. What is this value as a percent?  
a) 0,9%                      b) 0,09%                      c) 0,009%
- Which definition does not correspond to chemical equilibrium?  
a) A state of dynamic balance in which the rates of forward and reverse reactions are equal.  
b) Le Chatelier-Brown's principle cannot be used to predict the effect of a change in conditions on a chemical equilibrium.  
c) The concentrations of the reacting substances do not change with time.
- The strength of dispersion forces depends on the ... of molecules.  
a) number                      b) charge                      c) shape
- If an acid is added to water, the hydronium ion concentration ...  
a) increases.                      b) decreases.                      c) does not change.

### Quiz 4

- A strong electrolyte is an electrolyte that completely dissociates in solution. The solution will contain ... of the electrolyte. Strong electrolytes are good conductors of electricity.

- a) only ions and no molecules  
 b) only molecules and no ions  
 c) both ion and molecules
2. A needle is floating on water. If you add washing-up liquid to the water will it ... the hydrogen bonding at the surface?  
 a) reduce                                      b) enhance                                      c) keep
3. Which of the following processes is an endothermic one?  
 a) crystallization  
 b) making magnesium oxide from magnesium and air  
 c) making copper oxide from copper carbonate
4. Which arrangement of the following compounds is in order of increasingly exothermic lattice enthalpy?  
 a)  $\text{Li}_2\text{O}$ ,  $\text{LiF}$ ,  $\text{MgO}$                       b)  $\text{LiF}$ ,  $\text{Li}_2\text{O}$ ,  $\text{MgO}$                       c)  $\text{MgO}$ ,  $\text{LiF}$ ,  $\text{Li}_2\text{O}$
5. What is the oxidation state of Al in  $\text{Al}_2\text{Cl}_6$ ?  
 a) +4    b) +3    c) +2
6. Which definition of base is an odd one?  
 a) It tastes bitter, feels soapy or greasy.  
 b) It produces an excess of hydrogen ions in aqueous solution.  
 c) It accepts protons during a chemical reaction.
7. Hydrochloric acid is ... dissociated into ions.  
 a) fully    b) partially    c) never
8. How many protons does an atom of  ${}^{239}_{94}\text{Pu}$  contain?  
 a) 94 protons                                      b) 86 protons                                      c) 88 protons

### Quiz 5

1. What is the symbol showing the atomic number and the mass number for the radioactive gas found in some homes that has 86 protons and 136 neutrons?  
 a)  ${}^{226}_{88}\text{Ra}$                                       b)  ${}^{238}_{92}\text{U}$                                       c)  ${}^{222}_{86}\text{Rn}$
2. An increase in temperature for an exothermic reaction ... the value of the equilibrium constant.  
 a) decreases                                      b) increases                                      c) does not change



3. If a base is added to water, water molecules will ... a proton to the base, that is, they behave as a Brønsted acid.

- a) donate                                      b) accept                                      c) transfer

4. During World War II US pilots carried LiH tablets to save their lives in the event of a crash in the ocean. What gas did they use to fill their life belts and lifeboats? [2]

- a) hydrogen                                      b) oxygen                                      c) helium

5. Water is involved in all aqueous acid-base equilibria because it can act as either a weak acid or a weak base. If an acid is added to water, water molecules can ... protons donated by the acid, that is, they behave as a Brønsted base.

- a) accept                                      b) donate                                      c) transfer

6. What is the volume of air that an adult person exhales in an 8-hour day, if each breath has a volume of about 1 L and the person exhales 15 times a minute? [31]

- a) 7000 L                                      b) 7100 L                                      c) 7200 L

7. These gases are found in the troposphere: Rn, CO<sub>2</sub>, CO, O<sub>2</sub>, Ar, N<sub>2</sub>. Which is the correct order of their abundance in the troposphere?

- a) O<sub>2</sub>, Ar, N<sub>2</sub>, Rn, CO<sub>2</sub>, CO  
b) N<sub>2</sub>, O<sub>2</sub>, Ar, CO<sub>2</sub>, CO, Rn  
c) CO<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, Ar, Rn, CO

8. For which gases is it convenient to express their concentrations in parts per million (ppm)?

- a) CO<sub>2</sub>, CO                                      b) N<sub>2</sub>, O<sub>2</sub>, Ar                                      c) O<sub>2</sub>, CO<sub>2</sub>

## Quiz 6

1. The carbon atom can readily form single, double and triple bonds. Which bond is present in methane?

- a) single                                      b) double                                      c) triple

2. The term 'silent killer' is used when your senses cannot detect a colourless and odourless gas. What is the formula of this gas?

- a) O<sub>3</sub>                                      b) SO<sub>2</sub>                                      c) CO

3. In urban areas, the concentration of formaldehyde in outdoor air is typically about 0,01 ppm. In contrast, the level of formaldehyde in indoors can

average 0,1 ppm, the level at which most people will smell its pungent odour [2]. What factors cannot lead to formaldehyde accumulation indoors?

- a) cigarette smoke                      b) domestic appliances                      c) synthetic materials

4. The odour of ozone can be detected in concentrations as low as 10 ppb (parts per billion). Is it possible to detect its odour in the troposphere with 0,118-ppm ozone concentration?

- a) Yes, as the concentration will be well above the detection limit.  
b) No, as the concentration will be much lower the detection limit.  
c) Yes, as ozone obtains very pungent odour in the troposphere.

5. Which of the following pairs are not allotropes?

- a) diamond and graphite  
b) water and hydrogen peroxide  
c) white and red phosphorus

6. Which order of these types of radiation demonstrates increasing energy per photon?

- a) gamma rays, infrared radiation, visible light  
b) infrared radiation, visible light, gamma rays  
c) visible light, gamma rays, infrared radiation

7. Ethanol,  $C_2H_5OH$ , can be isolated from sugars and starches in crops such as corn or sugar cane. The ethanol is used as a gasoline additive and when burned, it combines with  $O_2$  to form  $H_2O$  and  $CO_2$ . How many moles of  $CO_2$  are produced from each mole of  $C_2H_5OH$  completely burned?

- a) 2 mol of  $CO_2$                       b) 4 mol of  $CO_2$                       c) 6 mol of  $CO_2$

8. How many protons, neutrons and electrons are there in Ra-226?

- a) 92 – 146 – 92                      b) 88 – 138 – 88                      c) 86 – 136 – 86

## Quiz 7

1. Environmental Protection Agency has used the slogan “*Ozone: good up high, bad nearby*” in some of its publications. [2] What does it mean?

- a) Ground-level ozone is as beneficial as in the stratosphere.  
b) Both ground-level and stratospheric ozone are harmful air pollutant.  
c) Ground-level ozone is very harmful while stratospheric ozone has a beneficial effect.

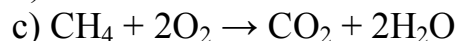
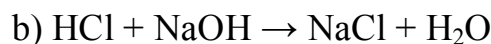
2. Which statement cannot be used in the description of oxygen allotropes,  $O_2$  and  $O_3$ ?



2. Which property is not associated with acids?
- They turn litmus paper blue.
  - They are corrosive to metals.
  - They release carbon dioxide from a carbonate.
3. Which solution contains more  $[H^+]$ ?
- a solution of pH = 6
  - a solution of pH = 7
  - a solution of pH = 8
4. Jet engines are associated with exhaust of several gases. Which gases do the jet engines emit directly?
- $O_3$ ,  $CO_2$ ,  $SO_2$
  - $CO$ ,  $CO_2$ ,  $NO$
  - $CO_2$ ,  $SO_2$ ,  $NO_2$
5. During nuclear reaction, high speed neutrons are generated and special moderators are required to slow down their speed. The first graphite-moderated nuclear power reactor was built in the Soviet Union in 1954. As this technology is obsolete now, pressurized water reactors, in which water is used as moderator, constitute a majority of all western nuclear power plants. Actually speaking, an ideal moderator must be of low molecular weight. [4]
- What is the molecular weight of graphite in comparison with water?
- The molecular weight of graphite is larger compared to water.
  - The molecular weight of graphite is smaller compared to water.
  - The molecular weight of graphite and water are the same.
6. Oxidation is a process in which an atom, ion or molecule ... one or more electrons.
- loses
  - gains
  - shares
7. Reduction is a process in which an atom, ion or molecule ... one or more electrons.
- loses
  - gains
  - shares
8. What substance cannot be classed as colloidal electrolyte?
- soaps
  - dyestuffs
  - acetone

## Quiz 9

1. As electrons must be transferred from the species losing electrons to the species gaining electrons, oxidation and reduction processes take place ...
- together.
  - separately.
  - one after the other
2. Which of the following examples is not an oxidation-reduction reaction?
- $Zn + 2 MnO_2 + H_2O \rightarrow Zn(OH)_2 + Mn_2O_3$



3. What bonds are broken when water is electrolyzed?

- a) intermolecular hydrogen bonds
- b) intramolecular hydrogen bonds
- c) supermolecular hydrogen bonds

4. These bottles are made of polyethylene. Is the structure of the material used the same or different?



- a) Neither of bottles is made of polyethylene.
- b) Both bottles are made of flexible, low-density branched polyethelene.
- c) Both bottles are made of rigid, high-density linear polyethylene.

5. Polyacrylonitrile is employed in making Acrilan fibers used widely in rugs and upholstery fabric. When acrylic fibers burn, one of the products is the poisonous gas ...

- a) hydrogen cyanide, HCN
- b) carbon monoxide, CO
- c) formaldehyde,  $\text{CH}_2\text{O}$

6. Which of the following compounds can contain only one carbon atom?

- a) a carboxylic acid and an ester
- b) an alcohol and an aldehyde
- c) a ketone and an ether

7. What fundamental types of materials does food provide to keep our bodies functioning?

- a) energy sources
- b) data source
- c) knowledge source

8. Which element contains two protons more than uranium?

- a) plutonium
- b) neptunium
- c) americium

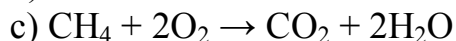
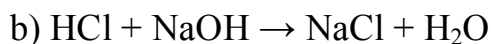
## Quiz 10

1. What is correct neither for fats nor for oils?

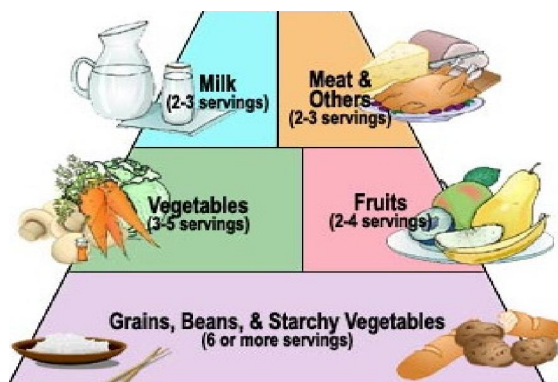
- a) They are both composed of nonpolar hydrocarbon chains.
- b) Edible fats and oils both contain some oxygen.
- c) They are both liquid at room temperature.

2. Which of the following reactions is the neutralization one, in which ions combine to form a soluble salt as well as covalently bonded water molecules?





3. Below there is the food pyramid without its top. What products can be found there as the least important?



- a) fats, oils and sweets      b) yogurt and cheese      c) cereal and pasta

4. The 'backbone' of the DNA strand is a polymer, a pattern of alternating deoxyribose sugar and inorganic phosphate groups. What does an acronym DNA mean?

- a) Digital Network Architecture  
b) deoxyribonucleic acid  
c) Distributed Internet Application

5. Adenine is one of the most important organic molecules for life. What functional groups are there in adenine?

- a)  $-\text{NH}_2$  groups      b)  $-\text{OH}$  groups      c) no groups

6. Do you believe that the DNA in an adult human would stretch from Earth to the Moon and back more than a million times?

Check it using the following data: distance from Earth to the Moon is  $3,8 \times 10^5$  km; number of DNA-nucleated cells in an adult human is  $1 \times 10^{13}$ ; length of stretched human DNA strand is 2 m [2].

7. Most fats and oils are triglycerides, which are esters of three fatty acid molecules and one glycerol molecule. If the triglycerides are solid at room temperature, the material is usually called ...

- a) a fat.      b) an oil.      c) either a fat or an oil.

8. How many isomers has the compound  $\text{C}_5\text{H}_{12}$ ? [2]

- a) 3      b) 6      c) 1

## UNIT 4. CHEMICAL LABORATORY AND EQUIPMENT

*A tidy laboratory means a lazy chemist.*  
Jöns Jacob Berzelius (1779-1848)

1. Give your comments on the words taken as an epigraph.  
***Why is Berzelius considered to be the father of Swedish chemistry?***  
***Do you agree with his opinion about a laboratory?***

2. An English philosopher and scientist Roger Bacon (1214 – 1294) placed considerable emphasis on the study of nature through empirical methods. He wrote: *The strongest arguments prove nothing so long as the conclusions are not verified by experience. Experimental science is the queen of sciences and the goal of all speculation.*

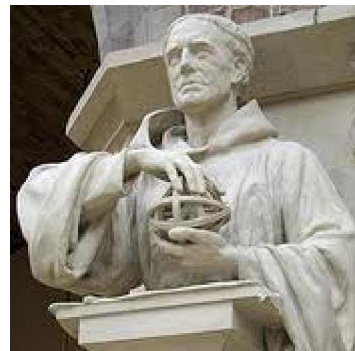
***Translate this passage.***

***Why do you think experimental science is called “the queen” of all sciences?***

***Is this statement true in relation to chemistry? How can you prove it?***

***Is chemistry an experimental science?***

***If chemistry is an experimental science, can it be named “the queen of sciences”? Argue your answer.***



3. Describe the laboratory you see in the photo.

***Is it a typical chemical laboratory?***

***What makes you think so?***

4. Describe the laboratory you are working in. Draw a scheme of it.

5. What safety rules are you to follow working in the laboratory?

6. ***What rooms can be found in the laboratory?***

Name the chemical premises making the right choice. Explain the function of every premise.

Dark room, dining room, distillery, game room, guest room, hood, changing room, laboratory desks, preparatory room, reading room, storage, utility room, weighing room

7. **Complete the descriptions with the appropriate names of the rooms and equipment.**

... (also called fume chamber/digestor) is a laboratory equipment where we can work with toxic, bad smelling and corrosive substances. The air in it is blown out by the ventilator.

... are stable and there are supplies of water, gas, air and electricity. Each ... is divided into several working places. Working ... is made of resistant materials, mostly of tiles. Under the ... there are a lot of ... for useful things like pipets, reagent bottles and chemical substances.

... (also called balance room) a small and perfectly dry place nearby the lab. It is used for weighing chemical substances using the analytical balances.

... is a place for distillation columns where the water and alcohol is distilled.

... room (also known as prep) a place where substances and solutions are made.

... (also storage) is a room that can be made completely dark, where it is possible to keep light-sensitizing agents.

The ... are available in capacities and readabilities ranging from  $62\text{g} \times 0.1\text{mg}$  to  $210\text{g} \times 0.1\text{mg}$ . Each features built in application modes including weighing, parts counting, percent weighing, check weighing.

... are designed for heating samples in specific gas environment. They are ideal for laboratory research and materials testing at high temperatures.

... have spiral or straight inner refrigerating tube for cool water, are used for gases or vapor condensing and hot liquids cooling (reflux and distillation procedures). It is also used for distillation.

... is used for examining or exploring very small substances and their structures.



8. Sydney Brenner (1927 – ) is a South African biologist and a 2002 Nobel prize in physiology. Brenner made significant contributions to work on the genetic code, and other areas of molecular biology. He has such a statement: *I also became interested in chemistry and gradually accumulated enough test tubes and other glassware to do chemical experiments, using small quantities of chemicals purchased from a pharmacy supply house.*



*I also became interested in chemistry and gradually accumulated enough test tubes and other glassware to do chemical experiments, using small quantities of chemicals purchased from a pharmacy supply house.*

**Translate this statement.**

**How can you characterise this scientist?**



9. There are a lot of substances we use in our everyday life. Below you can see a list of them.

Vinegar, aspirin, lime, charcoal, table salt, battery acid

*Can you change these common names into chemical terms?*

10. *What is a young researcher doing? Give a detailed description of the photo.*



11. *In the following text about important laboratory rules not all the words in every abstract are at their proper places. Find the mistakes and restore the correct sentences.*

Everybody working in the laboratory has to observe the following rules.

Every vessel used for the experiment must be absolutely glass. One has to be very careful in handling clean things.

One must pay special flame to the substances. Every precaution has to be taken to place the attention containing inflammable or explosive bottles as far as possible from any flame.

While making result it is necessary to register all the phenomena one observes. The yield of the obtained experiments and the substance of each experiment are to be registered too.

After finishing work, all order and benches used have to be washed, dried and put back in their places, the containers have to be cleaned too, so as to leave the working place in proper apparatus.

12. *The description of what acid is given below?*

In the Middle Ages, this acid was known to European alchemists as spirits of salt or acidum salis. It is still known as “Spirits of Salt” when sold for domestic cleaning purposes in the United Kingdom today. Gaseous acid was called marine acid air. The old (pre-systematic) name muriatic acid has the same origin (muriatic means “pertaining to brine or salt”), and this name is still sometimes used.

Notable production was recorded by Basilius Valentinus, the alchemist-canon of the Benedictine priory Sankt Peter in Erfurt, Germany in the XV<sup>th</sup> century. In the XVII<sup>th</sup> century, Johann Rudolf Glauber from Karlstadt-am-Main, Germany used sodium chloride salt and sulfuric acid for the preparation of sodium sulfate in the Mannheim process, releasing hydrogen chloride gas. [24]

13. Describe the picture.

*What do you see here? What laboratory items are used here?*



14. Most of the accidents in a chemistry laboratory happen due to the inappropriate clothing. People can spill acid on themselves, their group mates, their notes; they can set themselves on fire.

*What is laboratory dress code?*

*Comment on the following points. Explain what is preferable to wear in the laboratory. If some of these items are dangerous, explain why it is so.*

splash-proof goggles or safety glasses at all times

loose, long hair

shorts and mid-length skirts

natural fibers

peek-a-boo belly buttons

shoes and sandals

jewelry

*Work out a list of dress recommendations for a student to work in a chemical laboratory.*

15. Below you can see some rules of the lab from Jeff's Humor Collection [25]. *Give some comments upon them.*

*Is it necessary to introduce any suitable changes into the rules?*

A detailed record of data obtained is essential. The more details, the more evidence you were working.



Fast-acting, extremely toxic poisons should be kept in unmarked beakers.

Do not believe in miracles – rely on them.

Experience obtained is directly proportional to the equipment ruined. Moreover, the more it is ruined, the more evidence you were working.

Experiments must be reproducible, in other words, they should fail the same way each time.

First draw your curves and only then plot your data.

If that doesn't work, start at both ends and try to find a common middle.

If you can't get the answer in the usual manner, start at the answer and derive the question.

In case of doubtful findings, make them sound convincing.

Team work is essential. It allows you to blame someone else.

16. *Describe what you see in the photos.*



17. Nowadays sulphuric acid is prepared by contact process all over the world. The preparation of sulphuric acid by the mentioned above process is based upon the catalytic oxidation of  $\text{SO}_2$  to  $\text{SO}_3$ . The following steps of acid production are involved in the preparation of  $\text{H}_2\text{SO}_4$ :

Absorption of  $\text{SO}_3$

Dilution of oleum

Oxidation of  $\text{SO}_2$

Preparation of  $\text{SO}_2$

Purification of  $\text{SO}_2$

*Can you restore the correct sequence of the steps?*

18. The means of separating liquids through differences in their boiling points was invented around the year 800 by Islam's foremost scientist, Jabir ibn Hayyan, who transformed alchemy into chemistry, inventing many of the basic processes and apparatus still in use today. Ibn Hayyan emphasised systematic experimentation and was the founder of modern chemistry.

*Guess the names of these processes unscrambling the anagrammed below words.*

- cation + still + za + ry (*za* is an informal way of naming *pizza*; *ry* means *railway*)
- doz + ox + tan + 3I
- fact + on + pur + 3I
- quinta + oil + CEF
- trial + I + font
- vain + rate + poo

### ***Chemical laboratory rules quiz***

A. If you are to measure some quantity of liquid, you should pipette it off by your mouth.

- It is the quickest method of doing it.
- It is unhygienic so sterilize the pipette first.
- Never touch anything in the lab with your mouth.

B. What should you do when you don't need a Bunsen burner anymore?

- Ask for an empty Bunsen flask to put out a fire.
- Ask the teacher to turn it off.
- Turn off the gas.

C. What should be there on the bench during an experiment?

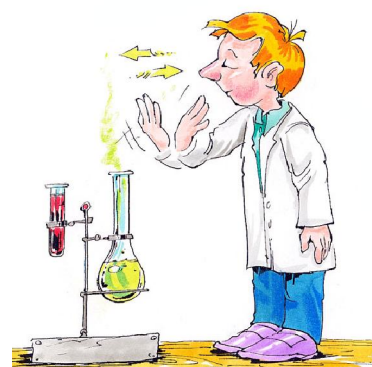
- If you are a girl, there should always be a mirror, a cosmetics bag and a mobile phone.
- There should be only necessary chemicals and required chemical glassware.
- There should be only chemicals and maybe a couple of sandwiches by a cup of coffee.

D. How should you heat solid or liquid substances?

- While heating it's necessary to let your group mate look into the test tube.
- You should make up a fire first.
- Look neither at the bottom of the test tube nor directly into it while heating.

E. What should you do if you need some chemicals?

- Take everything you like in the lab.
- Find the necessary chemicals according to the labels.
- Bring along everything you need.



F. The glassware item you need for the experiment should always be ...

- a) taken from the new package and thrown away after being used.
- b) clean enough for using and washed after the experiment.
- c) unwashed so that to know the results of the previous experiments.

G. What should you do with chemical excess at the end of your work?

- a) Offer it to your best friend.
- b) Return back to the teacher.
- c) Place it into a special glass jar.

H. How should you work with toxic or pungent substances?

- a) Just refuse to do it.
- b) Charge a junior with such important mission.
- c) Use the fume hood immediately.

I. How should you heat volatile highly inflammable substances?

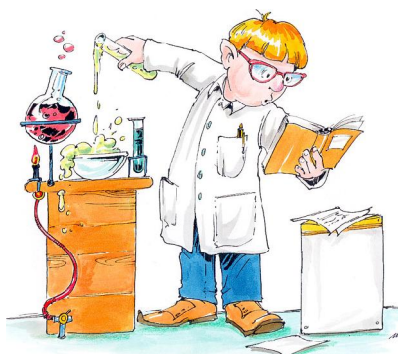
- a) You should do it directly with a flame.
- b) Does these properties matter anything?
- c) It is necessary to use a hot water bath.

J. How should you work with bromine?

- a) All experiments with bromine should be performed in a fume hood, in splash-proof safety goggles and gloves.
- b) All experiments with bromine require especially fragile glassware.
- c) You should remember that this substance is not toxic and never causes burns.

K. How should you improve the efficiency of your work in the laboratory?

- a) It is necessary to use your personal audio equipment while working.
- b) It is necessary to have synthetic finger nails as they keep your fingers safe.
- c) It is necessary to always perform the experiments precisely as you were instructed.



L. How should you dilute a concentrated acid?

- a) Always add the acid slowly to the water while stirring to avoid splattering and releasing the heat all at once.
- b) Never take a concentrated acid. If there is no a diluted one refuse to perform an experiment.
- c) Does it matter at all what the concentration of an acid is?

M. Where evaporating dishes and crucibles should be placed?

- a) They should be placed on wire gauze to cool.

- b) They should immediately be cooled with water.
- c) Everything you need should be on your lab bench.

N. What should you do after finishing the experiment in the laboratory?

- a) Cry ‘Hurrah!’, jump over the bench and rush to the canteen.
- b) Leave the laboratory after putting your working place in order.
- c) Inform every person in the laboratory about your success.

O. Your laboratory is supplied with the new apparatus. You don’t know how it works. What would you do?

- a) Ask the laboratory assistant to do the work for me.
- b) Try to find instructions and read them thoroughly.
- c) Start pushing every button I see until it works properly.

19. Below you can see a sixteenth-century alchemist’s laboratory. The man in the middle is making nitric acid, used for separating silver and gold.

*Name the processes these workers are monitoring.*



- 20. Glass chemistry lab beakers are used for routine measuring and mixing. *Are these lab beakers useful for accurate volume measuring?*
- 21. *What is a burette used for?*

22. Boiling flasks, or Florence flasks, are highly resistant to breakage due to heating or chemical attack. A flat bottom boiling flask can be used on a wire mesh, while a round bottom one needs a clamp.

***Why do you think boiling flasks should be resistant?***

23. Graduated cylinders are handy for accurate measurements of small volumes of liquid that can't be done with beakers and flasks.

***What does the term 'handy' mean?***

24. ***Complete the sentence:*** The pH of a solution indicates how acid or alkaline the solution is. A pH of less than 7 indicates that it is an ..., and a pH of more than 7 indicates that it is an ... .

***What is the origin of the figure expressing the acidity or alkalinity of a solution?***

25. ***What items of glassware are named after outstanding scientists?***

Do you know the names of the scientists?

Find information about these scientists and their discoveries.

***Name and describe each flask pictured below.***



26. **Translate the descriptions of the glassware and complete them with the proper names of each item.**

A ... flask is a vessel designed to provide very good thermal insulation. For instance, when filled with a hot liquid, the vessel will not allow the heat to easily escape, and the liquid will stay hot for far longer than in a typical container. The ... flask was named after its inventor, the Scottish physicist ... (1842–1923).

A more modern piece of glassware with roots in the brewing industry is the ... flask, round-bottomed and long-necked to trap splashes from material being boiled for analysis. It was devised by ... to solve a beer-related problem.

A very common use of the ... flask in laboratories is the storage of liquid nitrogen; in this case, the leakage of heat into the extremely cold interior of the bottle results in a slow boiling-off of the liquid (a pressure relief valve is provided to prevent pressure from building up). The excellent insulation of the ... flask results in a very slow boil and thus the nitrogen lasts a long time without the need for expensive refrigeration equipment.

An ..., also known as a conical flask, is a widely used type of laboratory flask. It is named after the German chemist ..., who created it in 1861.

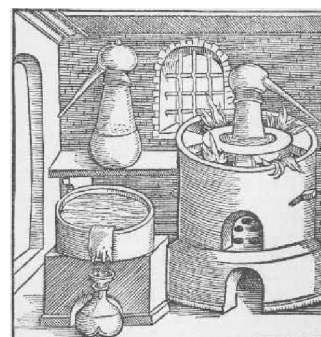
...’s solution was to design a flask with, in essence, two still heads stacked one above the other - the first to hold the capillary and the second for the thermometer. A ... flask is a glass laboratory item with a U-shaped neck, used for distillation.

... flasks are suitable for heating liquids, e. g. with a Bunsen burner. The flask is usually placed on a ring held to a ring stand by means of a ring clamp. A wire gauze mesh or pad is usually placed between the ring and the flask to prevent the flames from directly touching the glass in the same manner as for a beaker. When heating (or cooling) in a water bath the flask can be clamped by the neck to a stand or a hooped weight may be placed over the conical part of the flask to prevent it from floating in the bath.

27. Early Islamic chemists Jabir ibn Hayyan, Al-Kindi and Al-Razi contributed key chemical discoveries. A special apparatus called alembic still or retort was able to fully purify chemical substances.

**Can you name this apparatus?**

**What was it used for?**



28. Cork and rubber stoppers are used to seal glass test tubes and other types of glass to keep out airborne contaminants.

**What is the functional difference in using cork and rubber stoppers?**

29. A late sixteenth-century Dutch illustration of a chemical laboratory by Jan Van der Straet (1523-1605) is a mural in the palace of Cosimo de' Medici.



*What period of chemistry do you think this mural is connected with?*



30. Below you can see a list of the most common techniques.

Bioanalysis is a sub-discipline of the branch of chemistry covering the quantitative measurement of xenobiotics (drugs and their metabolites, and biological molecules in unnatural locations or concentrations) and biotics (macromolecules, proteins, DNA, large molecule drugs, metabolites) in biological systems.

Chromatography where an analyte is separated from the rest of the sample so that it may be measured without interference of other compounds.

Gravimetric analysis describes a set of methods for the quantitative determination of an analyte based on the mass of a solid.

In voltammetry information about an analyte is obtained by measuring the current as the potential is varied.

Microscopy is the technical field of using microscopes to view samples and objects that cannot be seen with the unaided eye.

Potentiometry is the field of the branch of chemistry in which potential is measured under the conditions of no current flow.

Spectroscopy is based on the interaction of an analyte with electromagnetic radiation.

Titrimetry is based on the quantity of reagent needed to react with the analyte.

*What branch of chemistry is this wide variety of techniques used in?*

31. Name these items of chemical glassware.



32. Describe the functions of each glassware item.

33. Write down the formula of industrial preparation of hydrogen chloride by the combustion.

34. Although there are thousands of chemical reactions, a significant number of them, especially those that are not organic ones, can be classified according to four general patterns: *combination*, *decomposition*, *displacement*, and *exchange*.

Below you see the descriptions of the reactions.

***Can you name each reaction according to the general classification?***

During this reaction, “partners” in compounds exchange their partners. One type of this reaction is called a neutralization reaction, the reaction between an acid and a base. The reaction of sodium hydroxide (lye) with hydrochloric acid is an example of such type.

***Write down the reaction.***

The second type of reactions can be considered to be the reverse of a combination reaction during which two or more products are formed from one substance (the reactant). This reaction is used industrially to produce large quantities of lime.

***What compounds are formed from calcium carbonate (limestone) at high temperatures during this type of reaction?***

The third type of reaction is one in which two or more substances (the reactants) form a single product.

***Write down the reaction to form table salt.***

The physical states of reactants and products are included where necessary. The symbols used are: (s) for solid, (l) for liquid, (g) for gas, and (aq) for aqueous (water) solutions.

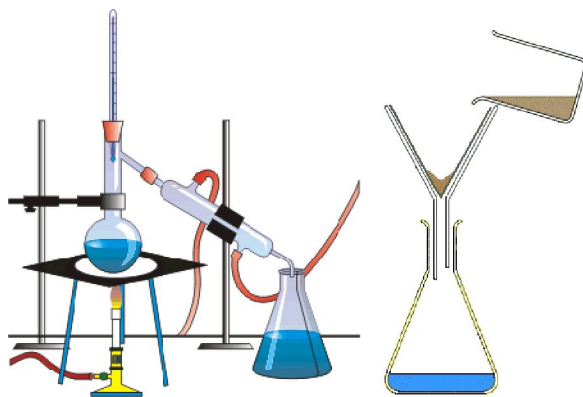
***Modify the above written equation according to the physical states mentioned.***

The fourth type of reaction (also called a single replacement reaction) occurs when an element reacts with a compound to form a new compound and release a different element.

An example is the reaction that releases silicon from sand via its reaction with carbon. When the reaction’s product is further purified, the silicon can be used in computer chips.

***Write down and modify the reaction.***

35. What processes can be performed with the help of such equipment?



36. *What chemical compound could be used for painting this horse in primeval ages?*



37. Analytical methods can be separated into classical and instrumental. Classical methods are also known as wet chemistry methods. Instrumental methods use an apparatus to measure physical quantities of the analyte.

*Distinguish the listed below methods as either a classic or instrumental one.*

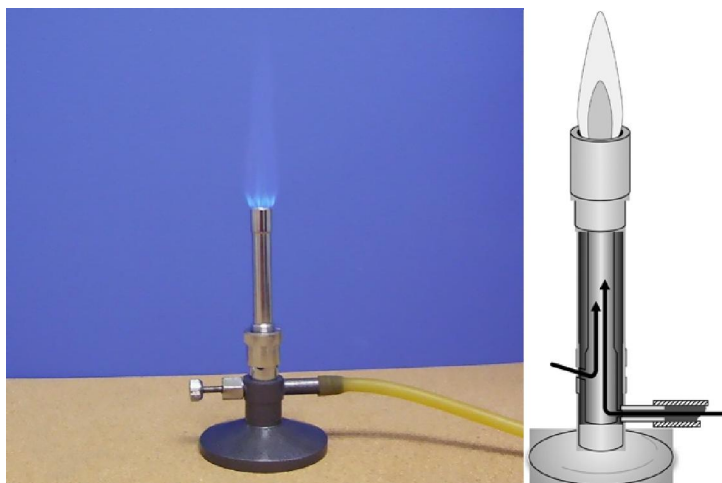
Chemical tests, electrochemical analysis, flame test, gravimetric analysis, hybrid techniques, mass spectrometry, microscopy, qualitative analysis, separation, spectroscopy, thermal analysis, volumetric analysis

38. What do you see in the photos?

*What is the name of the most commonly used apparatus in the chemistry laboratory?*

*What parts does this apparatus have?*

*Can you define every part of it?*



39. What precautions must be followed while using the Bunsen burners?
40. ***Complete the sentences describing the rules of keeping the apparatus in order.***

All apparatus should be kept at their proper places after experiments so that ...

All kinds of glass apparatus must be cleaned properly after use as ...

Cleaning with ordinary detergent is suggested. A solution of ... is made and with its help and with the help of a ...

In case of nasty or extremely dirty apparatus, ...

After cleaning with detergent solution or dilute chromic acid, the apparatus should ... [32]

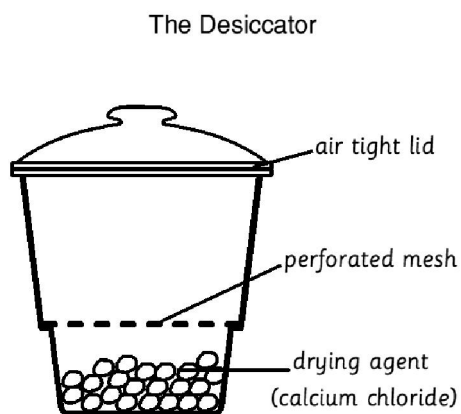
41. Which containers are used to measure volume?

42. What is a desiccator?

***What is it used for?***

***What types of desiccators do you know?***

***Describe the main parts of a desiccator.***



43. Nitric acid is a mineral mono-basic acid. It is a strong oxidizing agent and can easily oxidize metals and nonmetals. It is used in the manufacture of fertilizers, silk industry, explosive materials, etc.

There are three methods of industrial preparation of nitric acid.

- The first method which used  $\text{NaNO}_3$  is called Chile saltpeter's method.
- The Birkeland – Eyde process was developed by Norwegian industrialist and scientist Kristian Birkeland along with his business partner Sam Eyde in 1903, based on a method used by Henry Cavendish in 1784.
- The principal method of nitric acid manufacturing is the catalytic oxidation of ammonia. In the method developed by the German chemist

Wilhelm Ostwald in 1901, ammonia gas is successively oxidized to nitric oxide and nitrogen dioxide by air or oxygen in the presence of a platinum gauze catalyst. The nitrogen dioxide is absorbed in water to form nitric acid. [5]

***Can you restore the correct sequence of steps in nitric acid production?  
Translate the description of acid manufacturing.  
Write the reactions for each stage.***

NO<sub>2</sub> absorption (formation of HNO<sub>3</sub>): Nitrogen dioxide from secondary oxidation chamber is introduced into a special absorption tower. NO<sub>2</sub> gas passed through the tower and water is showered over it. By the absorption, nitric acid is obtained. Nitric acid so obtained is very dilute. It is recycled in absorption tower so that more and more NO<sub>2</sub> get absorbed. HNO<sub>3</sub> after recycle becomes about 68% concentrated.

Concentration: In order to increase the concentration of HNO<sub>3</sub>, vapour of HNO<sub>3</sub> are passed over concentrated H<sub>2</sub>SO<sub>4</sub>. Being a dehydrating agent, H<sub>2</sub>SO<sub>4</sub> absorbs water from HNO<sub>3</sub> and concentrated HNO<sub>3</sub> is obtained.

Primary oxidation (formation of nitric acid): Oxidation of ammonia is carried out in a catalyst chamber in which one part of ammonia and eight parts of oxygen by volume are introduced. The temperature of chamber is about 600°C. This chamber contains a platinum gauze which serves as catalyst. Oxidation of ammonia is reversible and exothermic process. Therefore according to Le Chatelier's principle a decrease in temperature favours reaction in forward direction. In primary oxidation of 95% ammonia is converted into nitric oxide (NO).

Secondary oxidation (formation of nitrogen dioxide): Nitric oxide gas obtained by the oxidation of ammonia is very hot. In order to reduce its temperature it is passed through a heat exchanger where the temperature of nitric oxide is reduced to 150°C. Nitric oxide after cooling is transferred to another oxidizing tower where it is oxidizing to NO<sub>2</sub> at about 50°C.



44. What is the name of the types of titration reactions expressed by the following equations?

- $\text{MnO}_4^- + 5\text{Fe}^{2+} + 8\text{H}^+ \rightarrow \text{Mn}^{2+} + 5\text{Fe}^{3+} + 4\text{H}_2\text{O}$
- $\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl} \downarrow$
- $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

45. ***What acid is available in two forms***: either as a solution of hydrogen chloride in water or as a colourless fuming gas?

46. You are to test the acid-base levels of vinegar, lime juice and soap.

***What do you need for making such a procedure?***

47. Hydrogen chloride may be prepared in the laboratory by heating concentrated sulphuric acid with sodium chloride.

***Write down the reaction.***

48. Below you can read the principles of analytical balance working.

***Can you arrange these principles in the correct order?***

- An analytical balance measures masses to within 0.0001 g. Use these balances when you need this high degree of precision.

- Before recording the mass, close the glass doors and wait until the stability detector lamp goes out. Record mass of solid.

- Carefully add the substance to be weighed up to the desired mass. Do not attempt to reach a particular mass exactly.

- Close the sliding glass doors.

- Place creased, small weighing paper on the balance pan.

- Press the control bar to cancel out the weight of the container or paper. The display will again read 0.0000.

- Turn the balance on by pressing the control bar. The display lights up for several seconds, then resets to 0.0000.

49. This is the scheme of a chemical laboratory.

***Can you describe it? What do you see?***

***Would you like to work in such a laboratory?***



## UNIT 5. FINAL TESTS

*To think is to practice brain chemistry.*

Deepak Chopra (1946 – )

### 1<sup>st</sup>-2<sup>nd</sup> YEAR

#### Test 1

1. Name each part of speech and single out the appropriate suffix. Translate the following words into Russian:

Hard — harder — hardly

Use — useful — usage — useless

One — only — the only

True — truly — truth

Danger — dangerous

Like — likely

2. Complete the sentences by using either pronoun “some” or “any”:

a) I've met (1) people, but I don't have (2) real friends yet.

b) I'd like to make (3) friends, but I haven't met (4) young people yet.

c) There are (5) biscuits left, but there isn't (6) cake.

d) I know you speak (7) French, but do you speak (8) German?

e) I thought I had met (9) of the people but I don't know (10) of them.

f) Have you (11) idea what time it is?

3. Rewrite the sentences using Passive Voice:

a) We received this letter after his departure.

b) Have dogs ever attacked you?

c) Who discovered the circulation of blood?

d) The doctor prescribed her new medicine.

e) Everybody laughed at this funny animal.

f) We shall insist on strict discipline.

g) They teach three foreign languages at this school.

4. Translate the following sentences into Russian:

a) Воздух можно разложить на составляющие его части.

b) Все газы сжижаются при температуре выше  $-273^{\circ}\text{C}$ .

c) Плавление, кипение веществ, изменение их формы, нагревание или охлаждение — все эти явления называются физическими.

d) Такие изменения веществ, в результате которых из одних получаются другие, называются химическими явлениями, или химическими реакциями.



- e) В результате физических изменений состав вещества не меняется.

## Test 2

1. Translate the following sentences into Russian:

- a) The sections of the house are planed according to a type design.
- b) Mendeleev designed his Table quite uniquely.
- c) Mendeleev tried hard to find more suitable places for those elements.
- d) All their efforts to place those elements according to their properties ended in failure.
- e) Ordinary iron behaves chemically like an active element.
- f) The behavior of platinum metal is peculiar.

2. Translate into Russian with the help of comparative degrees:

- a) The more you read, the more you know.
- b) The more you study, the better you know the subject.
- c) The more powerful our industry is, the stronger is our state.

3. Choose the correct form:

- a) The porter will (bring, be brought) your luggage to your room.
- b) Your luggage will (bring, be brought) up in the lift.
- c) You may (leave, be left) your hat and coat in the cloak-room downstairs.
- d) They can (leave, be left) the key with the clerk downstairs.
- e) From the station they will (take, be taken) straight to the hotel.
- f) Tomorrow he will (take, be taken) them to the Russian Museum.
- g) At the station they will (meet, be met) them in the hall upstairs.

4. Translate the following sentences into Russian:

- a) Окислы являются соединениями, образованными путем соединения какого-нибудь элемента с кислородом.
- b) Вода испаряется при нагревании.
- c) Так как водород — самый легкий из всех веществ, его плотность наименьшая.
- d) Существует много перекисных соединений. Перекись водорода является простейшим из них.
- e) Растворенное вещество часто осаждается в форме кристаллов.

## Test 3

1. Give the definitions of the following terms:

Matter, inorganic chemistry

2. Translate the abstract into Russian:

After the discovery of helium and argon the existence of neon, krypton, xenon and radon was clearly indicated by the periodic law, and the search for these elements in air led to the discovery of the first three of them; radon was then discovered during the investigation of the properties of radium and other radioactive substances. While studying the relations between atomic structure and the periodic law Niels Bohr pointed out that element 72 would be expected to be similar in its properties to zirconium. G. von Hevesy and D. Coster were led by this observation to examine ores of zirconium and to discover the missing element which they named hafnium.

#### Test 4

1. Give the definitions of the following terms:

Structure, chemistry

2. Translate the abstract into Russian:

The “zero” group was added to the periodic table after the discovery of the inert gases helium, neon, argon, etc., by Lord Rayleigh (1842-1919) and Sir William Ramsay (1852-1916) in 1894 and the following years. A similar form of the periodic table was devised in 1895 by the Danish chemist Julius Thomsen (1826-1909). After the discovery of the electron by the English physicist Sir J. J. Thomson (1856-1940) and the development of the theory of the nuclear atom by Ernest Rutherford (1871-1937), it was suggested in 1911 by the Dutch physicist A. van den Brock that the nuclear charge of an element, which we now call its atomic number, might be equal to the ordinal number of the element in the periodic table.

#### Test 5

1. Give the definitions of the following terms:

Substance, concept

2. Translate the abstract into Russian:

The development of our understanding of the behavior of gases provides an interesting example of the scientific method. Our knowledge of the physical world depends entirely on experiment. Some experiments are carried out, such as those made by Boyle on the compressibility of gases. A generalization is then induced from the results — a statement which has been carried out, but also predicts the results which can be expected of further experiments. The generalization obtained by this process of induction, if it is confirmed by the

results of further experiments selected at random from the great number of conceivable pertinent experiments, is called an experimental law.

### Test 6

1. Give the definitions of the following terms:

Composition, organic chemistry

2. Translate the abstract into Russian:

In 1862 the French chemist A. E. B. de Chancourtois arranged the elements in the order of atomic weight on a helical curve<sup>1</sup> in space, with corresponding points on the successive turns of the helix differing by 16 in atomic weight. He compared corresponding points and suggested that “the properties of elements are the properties of numbers”. The English chemist J. A. R. Newlands in 1863 proposed a system of classification of the elements in order of atomic weights, in which the elements were divided into seven groups of seven elements each.

### Test 7

1. Give the definitions of the following terms:

Scientific method, property

2. Match the beginnings of the sentences with the endings:

A. A man or a woman who selects chemistry as a profession...

B. Silicon oil consists of long, thin, flexible molecules...

a) ...which at low temperatures are nicely coiled up.

b) ...may at the same time work to discover something new.

### Test 8

1. Give the definitions of the following terms:

Empirical, principle

2. Match the beginnings of the sentences with the endings:

A. Our knowledge of the cells and molecules which make up the human body is not yet great enough to provide an understanding of...

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<sup>1</sup> Helical curve — спиральная кривая

- B. A chemist may become a teacher...
- C. The degenerative diseases are the most common causes of death...
- a) ...and they present an imposing challenge to the medical research worker.
- b) ...what these diseases really are.
- c) ...places no limitations on what he will do with his life.

## Test 9

1. Give the definitions of the following terms:  
Law, animate
2. Match the beginnings of the sentences with the endings:
- A. If a person selects a profession other than chemistry...
- B. In recent years we have seen the discovery of sulfa drugs and penicillin...
- C. Other oils become more fluid as the temperature is raised...
- a) ...which have largely overcome the danger of the infectious diseases.
- b) ...he may use his chemical knowledge to overcome unexpected problems.
- c) ...because at the higher temperatures the molecules undergo more violent thermal agitation.

## Test 10

1. Give the definitions of the following terms:  
Ratio, branch
2. Find the correct ending for the sentence:  
The final and most important step in the development of the periodic table was made by ...
- a) ...Meyer.                      b) Mendeleev.                      c) Ramsey.
3. Translate the abstract:  
A man or a woman who selects chemistry as a profession does not thereby place narrow limitation on what he will do with his life. He still has many roads open to him — he may become a teacher, and at the same time work to discover something new, to bring deeper understanding into the science; may be a research man, working either with inorganic substances or with organic ones, with metals or with drugs; he may help to control great industrial processes, to develop new ones; he may collaborate with medical workers in the control of disease. Even if he selects a profession other than chemistry, he may find

himself using this chemical knowledge not only in his everyday work but also on overcoming unexpected problems.

### Test 11

1. Give the definitions of the following terms:  
Inanimate, error
2. Find the correct ending for the sentence:  
A well-educated man or woman needs to have an understanding of the material world in which they live as well as of literature and history...
  - a) ...and they may find great pleasure in the appreciation of new knowledge as it results from scientific progress.
  - b) ...as it is now significant for international affairs and politics as well as for industry.
  - c) ...because a good understanding of chemistry is a necessity or a help in nearly every profession.

### Test 12

1. Give the definitions of the following terms:  
Composition, compound
2. Find the correct ending for the sentence:  
Memorizing facts will not determine your ability as a student of chemistry...
  - a) ...as the number of these facts is enormous.
  - b) ...as their number has been increasing rapidly year by year.
  - c) ...but inability to learn them might be interpreted as showing improper application on your part.

### Test 13

1. Give the definitions of the following terms:  
Universe, oxide
2. Find the correct ending for the sentence:  
Chemistry has not progressed so far as physics...

- a) ...because a discussion of the special properties of individual substances has not yet been incorporated into chemical theory.
- b) ...for some parts of physics have now become essentially theoretical sciences.
- c) ...as even the simpler phenomena of chemistry are not observed in our everyday life.

### 3<sup>rd</sup>-4<sup>th</sup> YEAR

#### Test 1

1. Переведите предложение, в котором местоимение that является заменителем существительного:

- a) The fact that gases can be converted into liquids which possess the property of cohesion proves that the molecules of a gas attract each other.
- b) The amount of heat liberated by very slow oxidation such as rusting of metals and the decay of wood is the same as that liberated by rapid combustion.
- c) That water is a compound was proved at the end of the 18<sup>th</sup> century.

2. Переведите предложение, в котором местоимение one является заменителем существительного:

- a) The difference between combustion on the one hand and corrosion and decay on the other is one of the rates of reaction and the temperature at which these reactions take place.
- b) In order to learn the properties of a substance one must have it in its pure form.
- c) Among the substances unaffected by oxygen one should mention the inert gases.

3. Переведите предложение с дополнением, выраженным личным местоимением it:

- a) Through this catalytic cracking it became possible to increase greatly the amount of gasoline obtained from the petroleum.
- b) Because of the partial decomposition of the carbide grey-cast is softer than white-cast iron, it has a higher melting point and it is much more suitable for castings.
- c) Those who study chemistry know that the law of conservation of mass makes it possible to write chemical equations.

4. Переведите предложение с инфинитивом в функции обстоятельства цели:

- a) It is possible to find a certain type of the catalyst which could prevent the reaction from slowing down.
- b) It would be difficult to fractionate such a mixture by distillation.
- c) To obtain good results in the experiment one must work hard.

5. Переведите предложение, не содержащее субъектный инфинитивный оборот:

- a) A mixture has been assumed to contain no less than two ingredients.
- b) Each student was instructed to report the per cent of aluminum in this sample.
- c) The samples were thought to be dry when no further loss of weights was observed.

6. Переведите предложение, не содержащее инфинитив в функции определения:

- a) The process to be treated subsequently in detail is known as ionization.
- b) These substances can be made to liquefy by methods to be described later.
- c) Let us assume the atomic weights to be integral.

7. Переведите предложение, содержащее придаточное времени:

- a) As the temperature is raised the total vapour pressure increases.
- b) As he was making his experiment he observed an interesting phenomenon.
- c) As chlorine is 2.5 times heavier than air it may be collected by displacing air.

8. Переведите предложение, содержащее придаточное условия:

- a) Since aluminium is light and strong, it is widely used in industry.
- b) You will finish your experiment in time provided you work hard.
- c) One must be very careful with mercury as it is poisonous.

9. Переведите предложение, не имеющее придаточного места:

- a) I found the book where I had left it.
- b) Wherever she lived, she always found friends.
- c) If a piece of tin is warmed, it melts.

10. Какой союз вводит придаточное предложение причины:

- a) if
- b) through
- c) because



## Test 2

1. Определите тип придаточного предложения:  
Any element when it combines with oxygen forms an oxide.
2. Определите значение местоимения that:  
The melting point of titanium is 2000° above that of aluminium.
3. Определите тип условного придаточного предложения:  
If a substance cannot be decomposed or produced by combination of other substances, it is called an element.
4. Переведите условное предложение второго типа:
  - a) If water had been poured into concentrated sulphuric acid, an explosion would have occurred.
  - b) If an aqueous solution of chlorine yellow in colour is exposed to light, the yellow colour will gradually disappear.
  - c) The volume the gas would occupy provided it was dry is less than that which it occupies when water vapour is present.
5. Измените предложение, используя субъектный инфинитивный оборот:  
We know that red phosphorus is a more stable form than white phosphorus.
6. Подчеркните объектный инфинитивный оборот:  
We believe an atom to contain three kinds of particles.
7. Укажите правильный перевод предложения:  
The reaction found to occur in steps will be thoroughly studied.
  - a) Реакция была изучена, и было показано, что она протекает ступенчато.
  - b) Реакция, которая, как найдено, протекает ступенчато, будет тщательно исследована.
  - c) Полученная реакция будет протекать ступенчато.
8. Назовите функцию инфинитива:  
To determine the volume of a gas at a definite temperature is rather easy.
9. Выберите правильное окончание предложения:  
Chemistry has not progressed so far as physics...
  - a) ...because a discussion of the special properties of individual substance has not yet been incorporated into chemical theory.



- b) ...for some parts of physics have now become essentially theoretical sciences.
- c) ...as even the simpler phenomena of chemistry are not observed in our everyday life.

10. Напишите формулу химического соединения:  
Rubidium silver iodide

### Test 3

1. Выберите правильное название химического соединения: AgI

- a) Silver iodide      b) Potassium silver iodide      c) Aurum iodide

2. Выберите правильное описание газа:

Hydrogen is

- a) ...a colourless gas that burns easily and it the lightest element in the universe.
- b) ... a colourless odourless gas that forms four-fifths of the air and is an essential part of all animal and plant life.
- c) ...a poisonous strong-smelling pale yellow gas that is the most reactive of all the elements.

3. Выберите правильное описание:

A poisonous strong-smelling greenish-yellow gaseous element, used in water purification and as a disinfectant, and, combined with sodium, to make common salt is ...

- a) chlorine.                      b) chloride.                      c) chlorate.

4. Выберите правильное описание элемента:

A light malleable silvery-white metallic element that does not rust and is covered with an oxide film is ...

- a) silver.                      b) aluminium.                      c) steel.

5. Выберите правильное окончание предложения:

The simplest unit of a chemical compound that can exist, consisting of two or more atoms held together by chemical bonds is ...

- a) molecule.                      b) mole.                      c) atom.

6. Выберите правильное окончание предложения:

The Dutch physicist van den Brock dealing with the periodic system suggested that ...

- a) ...the determination of the correct values of the atomic numbers may be done by the study of the X-ray spectra of the elements.
- b) ...the nuclear charge of an element might be equal to the ordinal number of the element in the periodic system.
- c) ...the periodic table may be interpreted in terms of electronic structure of atoms.

7. Выберите правильный перевод подчеркнутого слова:

In the Earth's crust helium appears to be essentially non-existent.

- a) появляется
- b) оказывается
- c) обнаруживается

8. Выберите правильный перевод подчеркнутой группы слов:

All we have to add are halogens.

- a) Все, что мы должны...
- b) Все, что мы имеем...
- c) Все мы имеем...

9. Выберите нужную грамматическую форму:

All you have ... is to mix the finely powdered substance in definite proportions.

- a) ...done...
- b) ...do...
- c) ...to do...

10. Укажите правильный перевод слова for:

There is no reason for this electron shell to accept electrons.

- a) Для...
- b) Так как...
- c) Для того чтобы...

#### Test 4

1. Переведите предложение, где местоимение it является заменителем существительного:

- a) It is common knowledge that chemical science is part and parcel of man's everyday existence.
- b) If you take biochemistry, it is the branch that will tell us what life is.
- c) It is these hybrid branches that almost daily bear the most remarkable fruit.

2. Выберите правильный перевод предложения:

It was found that atomic weights were an unreliable footing for the Periodic Law.

- a) Нашли, что атомный вес является ненадежной опорой для периодического закона.
- b) Атомный вес, который был обнаружен, оказался ненадежной опорой для периодического закона.

c) Атомный вес оказался ненадежным для открытия периодического закона.

3. Переведите предложение, в котором слово for выполняет функцию союза причины:

- a) Chemists now often use platinum laboratory ware for their experiments.
- b) They say that miracles don't happen, but for reasons unknown the four gaps of the Periodic table remained vacant.
- c) It could be a great surprise to chemists for it was not impossible that its properties would be weakly metallic.

4. Переведите предложение, в котором глагол to have выражает долженствование:

- a) There remained several "blank" spaces in the Periodic table which had to be filled.
- b) Physics and chemistry had made tremendous progress by the twenties of last century.
- c) The Periodic System has curious groups of elements whose atoms have quite a peculiar constitution.

5. Выберите правильный перевод первого слова в предложении:

Since all the lanthanides have three electrons in their outer shells, they are trivalent, as a rule.

- a) Пока...
- b) С тех пор как...
- c) Так как...

6. Переведите предложение, в котором местоимение that является заменителем существительного:

- a) That is why chemists found it possible to place all the lanthanides in one single box together with lanthanum.
- b) He accomplished the first chemical reaction, that of combustion.
- c) They say that miracles don't happen.

7. Переведите предложение, в котором инфинитив выполняет функцию обстоятельства цели:

- a) To put it more exactly, the valence bonds between the hydrogen and the oxygen atoms must be weakened.
- b) These compounds had no inclination to enter into chemical reactions.
- c) To combine into a water molecule hydrogen and oxygen must collide.

8. Выберите нужную грамматическую форму:

The salt combines with water ... crystals.

- a) Formed
- a) to form
- c) forms

9. Переведите предложение с инфинитивом в функции определения:  
a) It would be interesting to note that five elements: carbon, nitrogen, oxygen, phosphorus and sulphur make the molecular building blocks of living matter.  
b) Gold was the first of the metals to become known to man.  
c) Some elements were named to immortalize the names of great scientists: curium, mendelevium, einsteinium, etc.

10. Выберите правильный перевод подчеркнутой группы слов:  
What was to be done about it?  
a) было сделано                      b) делалось                      c) следовало сделать

## Test 5

1. Выберите нужную грамматическую форму:  
He would have paid clearly to make helium ... like the other.  
a) ...to behave...                      b) ...behave...                      c) ...behaved...
2. Переведите предложение, содержащее инфинитив в функции обстоятельства цели:  
a) Rhenium is known to form negative univalent ions.  
b) To balance one cube of osmium is not an easy task.  
c) To balance one cube of osmium we would have to put on the other tray three cubes of copper and two cubes of lead.
3. Переведите предложение, в котором that выполняет функцию заменителя существительного:  
a) What is the difference between metals and non-metals? That is a good question to start with.  
b) The density of lithium is almost half that of water.  
c) That is why the alkali metals are chemically the most active of all known metals.
4. Укажите, какое существительное заменено словом ones:  
The observant eye can discern metals dark-grey like sea water and shiny silvery ones which reflect solar rays like a mirror.  
a) eye                                      b) rays                                      c) metals
5. Выберите правильный перевод подчеркнутой группы слов:  
The atoms of one of the elements give away electrons, and those of the other accept them.  
a) атомы других                      b) те другие                      c) другие электроны

6. Выберите правильный перевод подчеркнутой группы слов:  
It doesn't take much more to complete the list of the chemical "alphabet".  
 a) Он не берет...      b) Это не требуется...      c) Не требуется...
7. Выберите правильный перевод инфинитива в функции определения:  
 He was the first to draw attention to the unlimited supply of nitrogen in the atmosphere.  
 a) ... был первый и обратил внимание...  
 b) ... первым обратил внимание...  
 c) ... был первым, кто обратил внимание...
8. Укажите правильный перевод субъектного инфинитивного оборота:  
 It was found to be an excellent fertilizer.  
 a) Было найдено отличное удобрение.  
 b) Он был найден, чтобы быть отличным удобрением.  
 c) Обнаружено, что это отличное удобрение.
9. Определите, какое существительное заменено местоимением that:  
 Another very interesting role of uranium and its compounds is that of catalysts for many chemical reactions.  
 a) Role      b) Uranium      c) its compounds
10. Выберите правильный перевод подчеркнутой группы слов, укажите функцию слова for:  
For it was uranium that started the first nuclear reactor.  
 a) Для этого был уран, который...  
 b) Так как это был уран, который...  
 c) Так как именно уран...

## Test 6

1. Переведите предложение, в котором сказуемое не имеет модальное значение долженствования:  
 a) White phosphorus should be handled with extreme caution.  
 b) For this reason it is to be under water.  
 c) Scientists had to create synthetic substances possessing better properties.
2. Переведите предложение, в котором инфинитив выполняет функцию обстоятельства цели:  
 a) Every chemical change is certain to involve physical changes as well.

- b) Oxygen is used to enrich the air blast during the production of iron from ore in the blast-furnace.
- c) A catalyst is necessary if a reaction is to occur in a short length of time.

3. Переведите предложение, в котором местоимение that выполняет функцию союза:

- a) It is ozone that makes the air seem cleaner.
- b) Drinking water treated with ozone has a more pleasant taste than that of chlorinated one.
- c) The tendency of matter to sacrifice energy in its drive toward stability is a property that all of us have observed many times.

4. Переведите предложение, в котором глагол to have имеет значение долженствования:

- a) We would have to wait millions of years “to burn” even a fraction of hydrogen.
- b) This concept has nothing to do with the problem in question.
- c) These scientists have to the general astonishment of the assembly discovered a new element as well.

5. Переведите предложение, в котором слово as выполняет функцию союза:

- a) It is known that various organisms contain such elements as cobalt, iodine, zinc and even radium.
- b) The Sun as well as billions of stars is now believed to consist mostly of hydrogen.
- c) As analysis methods progressed scientists began to find more and more elements in living matter.

6. Выберите правильный перевод слова for:

For plants to stay alive they had to assimilate these ten elements.

- a) Для...
- b) Так как...
- c) Чтобы...

7. Выберите правильное окончание предложения:

A colourless odourless gaseous element essential to life processes and to combustion is ...

- a) hydrogen.
- b) nitrogen.
- c) oxygen.

8. Переведите предложение, в котором инфинитив выполняет функцию определения:

- a) To put it more exactly, the valence bonds between the hydrogen and the oxygen atoms must be weakened.
- b) These compounds had no inclination to enter into chemical reactions.

c) To combine into a water molecule hydrogen and oxygen must collide.

9. Переведите предложение, в котором слово one является числительным:

a) Only one single atom, an unknown atom, announced its birth.

b) The individual lanthanides come out of the mixture in a strict sequence, the heavier ones first, and then the lighter ones.

c) It had been comparatively easy to calculate the conditions under which one could hope to synthesize element No. 101.

10. Переведите предложение, в котором слово that является союзом:

a) It was just that quality that enabled Cavendish to discover hydrogen.

b) The solubility of hydrogen in water is very slight, compared to that of oxygen.

c) It was thought that there was only one hydrogen on Earth, that with the atomic weight of one.

## Test 7

1. Переведите предложение, в котором глагол to be выражает долженствование:

a) These elements were sought in manganese ores.

b) These elements were to be sought in the rarest and most exotic minerals.

c) There are some cases which do not fit very well into the Periodic Table.

2. Переведите предложение, в котором слово for является союзом придаточного предложения причины:

a) You could see for yourself how it all happened.

b) The legend of Prometheus, for instance, who gave people fire, is the legend of the first chemical reaction.

c) The evolution of life on the globe is due to chemistry, for the great variety of chemical compounds owes its existence to the chemical processes.

3. Переведите предложение с субъектным инфинитивным оборотом:

a) The solar system like the universe seems to be 99 per cent hydrogen and helium.

b) It was important to think up a name which would be at least partly indicative of the element's properties.

c) People try to estimate the amounts of the separate elements our planet had stored away in its crust.

4. Переведите предложение, в котором слово that является заменителем существительного:

- a) It was just that quality that enabled Cavendish to discover hydrogen.
- b) The solubility of hydrogen in water is very slight, compared to that of oxygen.
- c) It was thought that there was only one hydrogen on Earth, that with the atomic weight of one.

5. Выберите правильный перевод подчеркнутой группы слов:

The six elements appeared to fall out of the sphere of activity of chemical science.

- a) Появилось шесть элементов...
- b) Шесть элементов оказались...
- c) Шесть элементов, как оказалось,...

6. Выберите нужную грамматическую форму:

The noble gases appeared ... some ability to do practical work.

- a) ...exhibit...
- b) ...exhibited...
- c) ...to exhibit

7. Укажите, какое существительное заменено местоимением ones:

Metallurgists consider the ferrous metals to include iron and its alloys while the rest are non-ferrous metals, except for the noble ones.

- a) Metals
- b) Metallurgists
- c) alloys

8. Выберите правильный перевод подчеркнутой группы слов:

Non-metals find it more profitable to accept electrons.

- a) ...находят это...
- b) ...находят, что это...
- c) Находят, что...

9. Переведите предложение, в котором инфинитив выполняет функцию обстоятельства цели:

- a) It had been easy to calculate the conditions under which one could hope to synthesize elements.
- b) Is it possible to study chemical properties of a single atom?
- c) Scientists used ion-exchange chromatography to establish the chemical nature of the new man-made atom.

10. Переведите предложение, в котором местоимение one является формальным подлежащим:

- a) One microgram is one-thousandth of a milligram or one-millionth of a gram.
- b) What could one do with such an amount of a substance is difficult to discern.



c) The properties of the elements of the Periodic System graduate quite regularly from the light elements to the heavy ones.

## Test 8

1. Переведите предложение, в котором сказуемое не имеет модальное значение долженствования:

- a) When working with the transuranium elements chemists had to forget entirely such weight units as grams, milligrams, or even micrograms.
- b) It had been easy to calculate the conditions.
- c) During all kinds of chemical reactions chemists have had to resort repeatedly to weighing.

2. Определите функцию инфинитива в предложении:

Avogadro's number being so large, it is obvious that all attempts to obtain an absolutely pure substance containing no impurities at all would be futile.

- a) Обстоятельство цели
- b) Определение
- c) Часть составного сказуемого

3. Переведите предложение, содержащее субъектный инфинитивный оборот:

- a) Chain reactions are known to physicists too.
- b) Enzymes appear to be very specific in their chemical combination.
- c) Chemists would be lucky to get as far as the hundred and tenth element.

4. Переведите предложение, в котором глагол to make имеет значение «заставлять»:

- a) The presence of a catalyst makes things entirely different.
- b) Substances capable of "making reactions go lightning" are called catalysts.
- c) Let us talk of how scientists made their great discoveries.

5. Выберите правильный перевод сказуемого в предложении:

Inhibitors are to show down rapid chemical reactions.

- a) ...являются...
- b) ...должны...
- c) ...состоят в том, чтобы...

6. Укажите дополнение в следующем предложении:

Modern chemical processes require the use of very sophisticated apparatus and machines, high-degree mechanization of production processes.

- a) ...the use...
- b) ...apparatus and machines...

c) ...high-degree mechanization...

7. Переведите предложение, в котором глагол to be имеет модальное значение долженствования:

- a) Its task is to produce enzyme preparations.
- b) Principally new methods of producing chemical goods by means of nuclear radiation energy are being introduced.
- c) The output of plastics and synthetic resins is to be increased by 100 per cent.

8. Переведите предложение с субъектным инфинитивным оборотом:

- a) Seeing the gases accumulate in the space above water, we had to stop the reaction.
- b) The ethyl derivative known to yield alcohol was used in the previous test.
- c) To synthesize water we had to combine oxygen and hydrogen.

9. Переведите предложение, содержащее инфинитив в функции определения:

- a) The stability of the compound to be formed is to be considered.
- b) He studied the properties of water always believed to expand on heating.
- c) The work is not sufficiently advanced for any definite opinion to be formed.

10. Выберите правильное окончание предложения:

- The key to understanding of this high ionic conductivity has been proved by ...
- a) ...neutron diffraction.
  - b) ...NMR spectroscopy.
  - c) ...X-ray crystallography.

## Test 9

1. Выберите правильное окончание предложения:

- Chemistry of elements is not dealing with ...
- a) ...compositions of substances.
  - b) ...properties of substances.
  - c) ...values of substances.
2. Выберите правильный перевод подчеркнутой группы слов:
- Chemists have not found argon to be able to combine with other elements.
- a) ...не нашли аргон...

- b) ...не нашли, что аргон...
- c) ...нашли, что аргон не...

3. Определите, какое существительное заменено местоимением ones:  
Chemistry was confronted with the tasks of teaching people the right way to use known fertilizers and of inventing new ones.

- a) Tasks
- b) People
- c) fertilizers

4. Определите тип придаточного предложения, переведите все предложение:

As chlorine is 2.5 times heavier than air it may be collected by displacing air.

5. Какой союз вводит уступительное придаточное предложение?

- a) If
- b) Though
- c) Because

6. Определите функцию инфинитива, переведите предложение:

In order to learn the properties of a substance one must have it in its pure form.

7. Переведите предложение, в котором that выполняет функцию заменителя существительного:

- a) What is the difference between metals and non-metals? That is a good question to start with.
- b) The density of lithium is almost half that of water.
- c) That is why the alkali metals are chemically the most active of all known metals.

8. Переведите предложение, содержащее субъектный инфинитивный оборот:

- a) A mixture has been assumed to contain no less than two ingredients.
- b) Each student was instructed to report the per cent of aluminum in this sample.
- c) It had been easy to calculate the conditions under which one could hope to synthesize elements.

9. Выберите правильный перевод предложения:

They are known to form negative ions.

- a) Они, как известно, образуют отрицательные ионы.
- b) Это — известные отрицательные ионы.
- c) Они знают, как образовать отрицательные ионы.

10. Преобразуйте предложение с помощью объектного инфинитивного оборота:

We may suppose that these particles are in motion.

### FINAL TEST ON NAMING THE ELEMENTS AND COMPOUNDS

1. Classify each of these substances as an element, compound, or mixture.

- A sample of “laughing gas” (dinitrogen monoxide, also called nitrous oxide).
- Steam coming from a pan of boiling water.
- A bar of deodorant soap.
- A sample of copper.
- A cup of mayonnaise.
- The helium filling a balloon.

2. Name the compounds formed when these elements combine.

- Potassium and oxygen
- Aluminum and chlorine
- Sodium and iodine
- Magnesium and bromine

3. Write the chemical formula for each of these.

- “Laughing gas”, dinitrogen monoxide (also called nitrous oxide).
- Ozone, an air pollutant, also used to purify water.
- Sodium fluoride, an ingredient in some toothpastes.
- Carbon tetrachloride, formerly used as a dry-cleaning agent.
- Calcium bicarbonate
- Calcium carbonate
- Magnesium chloride
- Magnesium sulfate

4. These compounds are trace components of the atmosphere.

What information does each chemical formula convey in terms of the number and types of atoms present?

- $\text{CH}_2\text{O}$ , formaldehyde.
- $\text{H}_2\text{O}_2$ , hydrogen peroxide.
- $\text{CH}_3\text{Br}$ , methyl bromide.

5. Write balanced chemical equations to represent these reactions.

- Nitrogen reacts with oxygen to form nitric oxide.
- Ozone decomposes into oxygen and atomic oxygen.
- Sulfur reacts with oxygen to form sulfur trioxide.

6. Write the formulas of the ionic compounds that will form from each pair of elements. Name each compound.

- a) Ca and Br                      b) K and F                      c) Li and O                      d) Sr and Br

7. Write the formula and give the name of the ionic compound formed by the reaction of each pair of elements.

- a) Na and S      b) Al and O      c) Ga and F      d) Rb and I      e) Ba and Se

8. Give the name of each compound.

- a)  $\text{CH}_3\text{COOK}$       b)  $\text{Ca}(\text{OCl})_2$       c)  $\text{LiOH}$       d)  $\text{Na}_2\text{SO}_4$

## FIND GOOD RUSSIAN EQUIVALENTS OF THE FOLLOWING SENTENCES

### Test 1

1. A compound model is introduced in which each physical defect is assumed to produce a random number of logical faults.
2. A long series of experiments having being carried out, they determined what equipment modifications would be necessary.
3. Although almost any metric would do, we chose the quadratic metric.
4. And this adds hundreds of thousands of new compounds to the reserves of organic chemistry.
5. At the times the great writer of science fiction was putting the finishing touches to his book, chemists were absolutely certain that argon could not combine with anything under any conditions.
6. Chains are capable of branching and closing up into cycles. These are polygons consisting of 3,4,5,6 and more carbon atoms.
7. Does the use of automatic computers in business make people any easier or any more difficult for management to manage? No, it does not. People are still people. People are still management's number one problem and resource.
8. Every factor preventing the process from proceeding smoothly should be paid much attention to.
9. Experiments have proved the pressure of a gas at fixed temperature to depend on its concentration.
10. For the desired properties of the substance to be prepared, some preliminary indication should be given.
11. For the remarkable properties of rubber to be carefully examined, one has to carry out a long series of experiments.
12. Fortunately, there are several things we can do to permit analysis.
13. Given this framework, the process of reaching the best decision is known as optimization.



14. Had nitrogen not been discovered in 1766, but say, half a century later (such a thing could have happened), the progress of chemistry would have been retarded for a long time.
15. Having finished the work, they left the lab.
16. Having separated nitrogen from other gases, they obtained it in nearly pure condition.

## Test 2

1. Having separated nitrogen from other gases, they obtained it in nearly pure condition.
2. He proved that it was possible for the angle to be altered.
3. He treated the problem beautificationistically.
4. However, to engineer them into power stations so that these benefits can be obtained has required considerable research, ranging from the development of programming languages easily used by engineers and of better control-and-display philosophies, through to considerations of reliability and how the computers should be interfaces with a plant.
5. Hydrogen reacts with the oxides of number of metals forming water and free metal.
6. I have six honest serving men. They taught me all I knew. Their names are What, and Why, and When, and How, and Where, and Who.
7. If all the nitrogen in the atmosphere were transformed into fertilizers, there would be enough to nourish all the plants in the world for more than a million years.
8. If done frequently, this process is unacceptably slow.
9. If objects in the picture are supposed to move, the program must be fast enough to make the motion look natural.
11. If some relaxation actually did occur in the incident shock, the real temperature would have been lower than the calculated one.
12. If the theory was to become more than an unattainable ideal, we would have had to have been willing to accept a less ambitious goal than proving program correctness by testing.
13. If, in time, the industry we know reaches a plateau, the potential revolution in power conversion may well give rise to another period of extraordinary growth.
14. In burning the fuel unites with oxygen — one of the constituents of air.
15. In case no organic matter is present, neither gaseous evolution occurs nor abnormally soluble salts formed.
16. In order to understand the procedure the chemists considered the following analogy.

### Test 3

1. In the organic laboratory carrying out a reaction is only a small part of the chemist's work.
2. In this way he revealed an interest in novelty and an opportunity to learn something new.
3. Indeed, we should be worried were this not the case.
4. It is believed that there are more than a hundred different atoms.
5. It is desirable to perform a quantitative analysis and a molecular weight determination for an unknown organic compound to be identified.
6. It is difficult to undo the effects of wrong decisions.
7. It is hard to memorize all scientific facts, their number increasing with each passing year.
8. Knowing the ethyl derivative to yield alcohol, we modified the reaction conditions.
9. Let us take two blocks of metal. One block of the metal is twice as large as the other, the first one weighing as much as 10 pounds.
10. Microprobe analyses failed to show any systematic differences between the two samples, save possibly for the greater uniformity in the latter case.
11. Molecules of hydrogen chloride being decomposed, single atoms of hydrogen and chlorine are liberated.
12. Molecules of hydrogen chloride being decomposed, single atoms of hydrogen and chlorine are liberated.
13. Note that the contour does not need to be closed.
14. On the other hand, papers of a certain type, however long may be, require a short abstract.
15. One may safely expect this prediction to be quite reliable.
16. One would lose all of the user response time that had been gained by having to wait for the extra data transmission to complete.

### Test 4

1. OR's (operation research) role in solving some of the more important and critical problems facing humanity has to be properly reasoned and redefined.
2. Oxygen and hydrogen can be obtained when decomposing water by electrolysis.
3. Phosphorus dissolves in alcohol, ether, benzene and carbon disulfide, the best solvent being the latter.
4. Plastics are known to be a class of materials not to be found in nature.
5. Polonium was one of the first radioactive elements to be isolated by chemists.

6. Probably the first man to draw attention to the unlimited supply of nitrogen was Timiryazev.
7. Processing is performed sequentially and monotonically on cycles from lowest to highest resolution.
8. Producing new kinds of materials, engineers were especially interested in their quality.
9. Radium is interesting particularly because the rays it emits are believed to be similar to those discovered in case of uranium
10. Remarkable as our technical achievements may be, some people still wonder how we got to be number two so rapidly in such a fiercely competitive business.
11. Seeing the gases accumulate in the space above water, we had to stop the reaction.
12. Simple substances consist of atoms, each substance having its own special atom.
13. Solids are able to dissolve in solids as well as liquids dissolve in liquids. As an example of the former some alloys are mixtures of metals, an example of the later being alcohol dissolved in water.
14. Take while the taking is good, and hold fast to what you have managed to get.
15. The acids investigated by them were made by the combustion of some substance in oxygen.
16. The acids investigated by them were made by the combustion of some substance in oxygen.

## Test 5

1. The amount of polonium to be obtained from uranium mineral can be simply calculated.
2. The artificiality of this theory and the inadequacy of the evidence it was based on have been pointed out by various scholars.
3. The atoms of the inert gases are capable neither of donating nor of accepting electrons.
4. The author was the first to note the presence of oxygen ion in the substance under investigation.
5. The crystal units had rearranged to produce a pseudomorphic form.
6. The different natural forms an element can exhibit are called allotropic forms of this element.
7. The double bond in ethylene giving this compound the property of being unusually reactive is beyond question now.
8. The electric conductivity of aluminum is less than that of copper.
9. The experiment is to show the dependence of temperature on solubility.



10. The experiments showed that the solution of phenol in water became quite clear.
11. The expert will have the ability to introduce new assignment functions whenever necessary.
12. The extreme importance of uranium as a source of atomic energy has led to a very large amount of work being done during the last ten years.
13. The fact of its having isotopes does not distinguish hydrogen among the chemical elements.
14. The factory has been producing these materials for ten years.
15. The general question is would you rather have the lottery resolved in two stages rather than all at once?
16. The high accuracy that is obtainable makes the proposed method comparable to the established methods, so far as accuracy is concerned.

## Test 6

1. The hydrogen atom enabled the Danish physicist Niels Bohr to work out a theory of the arrangement of electrons around the atomic nucleus, without which the physical sense of the Periodic Law could not have been understood.
2. The kinetic theory of gases assumes a gas to be made up of particles moving about with random motion.
3. The life of society is damaged by whatever damages its units.
4. The main purpose of the book is to give experimental evidence which lies in the sphere of electronics and nuclear physics.
5. The main task confronting our chemical industry is to ensure the efficient use of raw materials.
6. The melting point having been discovered, it was possible to continue our research work.
7. The new method was investigated in our research Institute.
8. The news of our group having been awarded the prize was met with approval.
9. The plant producing the machines was built last year.
10. The position we shall take here is that all stages may and usually do go simultaneously.
11. The possibility of chemical energy being transformed into electric energy is evident.
12. The results being obtained in this experiment were good.
13. The results seem to agree with theoretical prediction.
14. The second case gives possibilities to transfer data into an element from all the elements it is connected with only for one step.
15. The solution having been evaporated, they began to examine the residue left.

16. The substance being investigated can be used in the experiment.

### Test 7

1. The surface tension of water is strong enough to let a float on water.
2. The truth doesn't come at once.
3. The underlying presumption is that the decision maker would be risk neutral if it were not for the effects of disappointment and elation.
4. The uranium content of rivers is thought to be of the same magnitude as that of sea water.
5. The use of the model does not necessarily lead to the adoption of an optimal strategy for each situation.
6. There are 8 columns, or groups, and 10 rows (7 periods) in the periodic table, the hydrogen being separately classified as the only element in the first period.
7. There is a certain point at which a large number of small changes add up to an important difference without any break or jump.
8. There is a possibility that this search will prove fruitless.
9. There is one exception — likely to be followed by a second.
10. There were other than military considerations to be taken into account.
11. "There would be many more jobs for young people if employers could take them on at much lower wages than they have to pay at present", said the Prime Minister.
12. They found the ill-starred substance to be a compound of the inert gas argon with some elements not yet known on Earth.
13. This consistency does not appear to be the case, since discrepancies are generally erratic.
14. This had enabled changes in circuit design to be rapidly evaluated.
15. This means that questions are asked in such a way that they cannot be answered by a simple "yes" or "no".
16. This venture, it is now believed, was by no means such a complete failure as it was made to appear by some of the sources.

### Test 8

1. This work may not appear to have anything to do with arithmetic.
2. This would have to be a basic postulate for any general theory of computer applications.
3. Three criteria should be regarded in distinguishing between chemical and physical changes.

4. To control the accuracy of the method the students have prepared the solution of known composition of these acids.
5. To do this coolly, skillfully, and with a true aim required great practice as well as much courage and presence of mind.
6. To explain this simple fact in terms of the experimental data is not so very easy.
7. To find a mass of electron was then of prime importance.
8. To rely on one's intuition about the meaning of names can be dangerous even when dealing with familiar types.
9. To see the meaning of these figures, we turn again to the charge clouds.
10. To sort out these scattered fragments and to piece them together into a comprehensive picture requires the hand of an expert and imagination of an artist.
11. Various economic tendencies are liable to react on the progress of automation, as well as being affected by it.
12. We are able to estimate how stable a given viewpoint is.
13. We are to take advantage of the high penetrating power of these rays.
14. We may suppose the alpha particles within the nucleus to be in motion.
15. We shall develop a new method, putting emphasis wherever it is possible on mathematical prototype.
16. When an organization grows, both it and its procedures change, as responsibilities move from individual to individual, as operations are distributed geographically, and as problems arise and are identified and solved.

## Test 9

1. When writing a popular scientific article you want to interest or even excite your readers, but not to give them complete information.
2. Willing and thinking are asserted to be identical.
3. To find a mass of electron was then of prime importance.
4. Polonium was one of the first radioactive elements to be isolated by chemists.
5. Oxygen and hydrogen can be obtained when decomposing water by electrolysis.
6. The melting point having been discovered, it was possible to continue our research work.
7. The main task confronting our chemical industry is to ensure the efficient use of raw materials.
8. The experiment is to show the dependence of temperature on solubility.
9. The experiments showed that the solution of phenol in water became quite clear.

10. Molecules of hydrogen chloride being decomposed, single atoms of hydrogen and chlorine are liberated.
11. Plastics are known to be a class of materials not to be found in nature.
12. To control the accuracy of the method the students have prepared the solution of known composition of these acids.
13. Simple substances consist of atoms, each substance having its own special atom.
14. The solution having been evaporated, they began to examine the residue left.
15. In order to understand the procedure the chemists considered the following analogy.
16. The surface tension of water is strong enough to let a float on water.

### **Test 10**

1. Having finished the work, they left the lab.
2. Having separated nitrogen from other gases, they obtained it in nearly pure condition.
3. Experiments have proved the pressure of a gas at fixed temperature to depend on its concentration.
4. The results seem to agree with theoretical prediction
5. Hydrogen reacts with the oxides of number of metals forming water and free metal.
6. The results being obtained in this experiment were good.
7. To explain this simple fact in terms of the experimental data is not so very easy.
8. We are to take advantage of the high penetrating power of these rays.
9. The substance being investigated can be used in the experiment.
10. The new method was investigated in our research Institute.
11. The main purpose of the book is to give experimental evidence which lies in the sphere of electronics and nuclear physics.
12. The author was the first to note the presence of oxygen ion in the substance under investigation.
13. The acids investigated by them were made by the combustion of some substance in oxygen.
14. The factory has been producing these materials for ten years.
15. The amount of polonium to be obtained from uranium mineral can be simply calculated.
16. To see the meaning of these figures, we turn again to the charge clouds.
17. The plant producing the machines was built last year.
18. Producing new kinds of materials, engineers were especially interested in their quality.

## Test 11

1. Translate the following sentences paying attention to the participle construction:

Three catalyst systems have been described for the polymerization of isoprene to a high *cis*-1,4 content, two being lithium alkyls and lithium dispersions.

Rubber, either in the form of latex or solid sheet, when stored for considerable period, develops an increased hardness, the change in solid sheet being generally greater the fewer the initial hardness.

2. Translate the following sentences paying attention to the functions of the Infinitive:

Natural rubber can be isomerized to give material of somewhat reduced *cis*-content.

To increase the capacity of surface condensers, the usual change is to increase the velocity of the water flowing through the tubes.

Storage hardening of rubber was assumed to have resulted from the presence of carbonyl in small proportions.

3. Translate into English:

70 лет тому назад установили, что изопрен можно превратить в каучуко-подобное вещество.

Нужно помнить, что физические и технологические свойства *цис*-1,4 полиизопренов близки к свойствам натурального каучука.

Считают, что некоторые виды применяемых в промышленности синтетических материалов, в отличие от натурального каучука, при растяжении кристаллизуются в меньшей степени.

## Test 12

1. Translate the following sentences paying attention to the participle construction:

Some catalyst systems are formed by the interaction of an organo-metallic compound with a metal halide, the relative proportion being critical.

Rubber hydrocarbon interacts with oxygen forming hydro peroxide, the decomposition of them resulting either in degradation or cross linking of the rubber molecules.

2. Translate the following sentences paying attention to the functions of the Infinitive:

The question of the number of effects to use is dependent on the amount of material to be handled and the cost of equipment, repairs, labour etc.

If a compound is to be used as a commercial plasticizer, it is desirable for it to be compatible with as many different high polymers as possible.

Synthetic polyisoprenes are very susceptible to oxidative degradation and require to be protected by the addition of an antioxidant after polymerization.

3. Translate into English:

Методом сравнения дифракций X-лучей, инфракрасного спектра, озонлиза и т. д. было установлено, что структура синтетических полиизопренов аналогична структуре натурального каучука.

Инициирование полимеризации винильного мономера в латексе можно провести различными методами.

После того как полимеризация в латексе заканчивается, малые частицы содержат большее количество полимера, чем крупные частицы.

### Test 13

1. Translate the following sentences paying attention to the functions of the Infinitive:

70 years ago isoprene was first found to be convertible into a rubber-like substance.

The structure of the synthetic polyisoprenes has been shown to be similar to that of natural rubber by comparison of X-ray diffraction.

Butlerov and Gorianov appear to have been the first to observe the polymerizing action of fluoride.

2. Group the following words into pairs of antonyms:

Original, rapidly, start, insoluble, as high as, final, slowly, complete, conventional, in particular, above, as low as, soluble, unusual, below, in general

3. Translate into English:

В настоящее время синтетические каучуки широко используются как для замены натурального каучука, так и для изготовления изделий со специальными свойствами.

Известно, что латекс, полученный из Гевеи, представляет собой дисперсию частиц каучука в воде.

Агрегация, как известно, является коагуляцией, которая может быть обратима, а именно: при соответствующих условиях агрегаты глобул могут распадаться.

## Test 14

1. Group the following words into pairs of synonyms:

Employed, diluted, presumably, investigation, if, initial, utilized, entirely, probably, provided, watered, totally, original, precisely, procedure, exactly, search, process

2. Translate the following sentences paying attention to the Complex Object:

Investigators find the infra-red spectrum to be closely similar to that of natural rubber.

One might expect the increase in hardness to be a result of infra-particle cross linking.

Researchers dealing with latex know biologically induced oxidation to proceed in the vicinity of the taping cut.

3. Translate into English:

Установлено, что коагуляция по своему существу является не химическим, а физическим процессом.

Нагрев, замораживание, интенсивное перемешивание и т. д. относятся к внешним воздействиям, обуславливающим коагуляцию.

Для проведения полимеризации широко используется метод с применением гидроперекиси, активируемой полиамином.

## Test 15

1. Translate the following sentences paying attention to the Gerund:

Reheating rubber is always attended by increasing its volume.

Many surface coatings shrink slowly on having been aged.

Natural rubber vulcanized with zinc oxide in the absence of free sulphur is known for being resistant to ageing.

The highly coiled rubber chains permit their being extended up to seven times their original length.

2. Form nouns from the following adjectives:

Capable, flexible, labile, mobile, versatile

3. Translate into English:

Известно, что в последнее время жесткие и твердые термопластичные материалы вытеснили металлы в ряде областей техники.

С одной стороны, при низких или умеренных температурах эластопласты сохраняют свойства резин, с другой стороны, при высоких температурах они способны к вязкому течению.

Эластопласты, как известно, являются блок-сополимерами стирола и бутадиена.

Ученые считают, что эластопласты не содержат никаких химических или поперечных связей.

## TRANSLATE THE SENTENCES INTO ENGLISH

1. Алмаз является самым твердым веществом, при помощи которого режутся различные материалы.
2. Был сделан анализ соединения кремния и углерода, чтобы определить различия между ними.
3. Было показано, что красный фосфор воспламеняется на воздухе при нагревании до  $240^{\circ}\text{C}$ .
4. В течение этой реакции должно выделяться тепло.
5. Ваша работа заключается в том, чтобы наблюдать за повышением температуры.
6. Вещество было настолько летучим, что его можно было собрать с большим трудом.
7. Вещество, которое будет применяться, тщательно исследовали.
8. Воду, которая должна быть использована для питья, следует тщательно очищать.
9. Выделенное тепло должно было ускорить реакцию.
10. Давление в котле было слишком низким, чтобы двигатель мог развить такие обороты.
11. Действие, которое последует за соединением равных объемов водорода и хлора на солнечном свете, известно как взрыв.
12. Для воспламенения некоторых элементов их нужно нагреть.
13. Для получения серной кислоты в больших количествах используют разложение определенных сульфатов.
14. Доказать этот закон экспериментально очень трудно.
15. Известно, что все тела поглощают волны, излучаемые другими телами.
16. Известно, что до эксперимента это вещество взвесили.
17. Из-за того, что конструкторы допустили небрежность, произошла авария.
18. Исследование свойств кремния доказало, что он играет важную роль в неорганическом мире.
19. Кислород обладает большой способностью образовывать двойные связи.
20. Краска на ткани проявилась после ее обработки паром.





21. Менделеев был первым ученым, который расположил элементы в соответствии с их атомными весами.
22. Мы можем предположить, что эти частицы находятся в движении.
23. Оказывается, что сероуглерод является лучшим растворителем фосфора.
24. Окисление привело к тому, что реакция пошла по другому пути.
25. Он высушил осадок на бумаге, не удаляя ее из воронки.
26. Он объяснил схему еще раз, чтобы студенты лучше поняли ее.
27. Перекись натрия, смешанная с окисью меди, которая должна служить в качестве катализатора, реагирует с водой, выделяя кислород.
28. Плотность – одно из обсуждаемых свойств воздуха.
29. Плотность воздуха является одним из его свойств, которое нужно обсудить.
30. Повышение температуры благоприятствует осаждению.
31. Помимо того, что эта методика очень сложная, она требует очень больших затрат.
32. Преимущество этих веществ в том, что они дешевле.
33. При переходе из твердого состояния в жидкое вода уменьшается в объеме.
34. Приготовленный раствор был достаточно насыщен, чтобы его использовать в этом случае.
35. Профессор попросил студента более точно определить единицу сопротивления.
36. Расчеты, которые им следует произвести сейчас, достаточно сложные.
37. Реакция, которая, как мы полагаем, обуславливается образованием бесцветного продукта окисления, имеет большое промышленное значение.
38. С целью вовремя закончить эксперименты они упорно работали.
39. Своевременное окончание студентами этой работы зависит от многих обстоятельств.
40. Свойство воздуха, которое будет теперь обсуждаться, – его плотность.
41. Фосфор следует нагреть значительно выше его температуры кипения, чтобы молекулы начали диссоциировать.
42. Чтобы обеспечить необходимый выпуск продукции, заводу нужно было перейти на новую технологию.
43. Чтобы получать искусственные алмазы из углерода, требуется высокое давление и высокая температура.
44. Чтобы соль растворилась быстрее, ее нужно помешать.
45. Элементарные ячейки кристалла перегруппировались, приобретя псевдоморфную форму.
46. Я помню, что мне тогда помогли.
47. Я помню, что мои коллеги помогли ему.

## UNIT 6. RENDERING INTO ENGLISH



*I do not know whether you are fond of chemical reading.  
There are some things in this science worth reading.*  
Thomas Jefferson (1743 – 1826)

## **Тексты для самостоятельного перевода**

### **Азот**

Азот — бесцветный газ, без вкуса и запаха. Один из самых распространенных элементов, главная составляющая часть атмосферы Земли. Слово «азот», предложенное французским химиком А. Лавуазье, греческого происхождения. «Азот» означает «безжизненный» (приставка «а» — отрицание, «зоэ» — жизнь»). Именно так считал Лавуазье. Именно так считали его современники, в том числе шотландский химик и врач Д. Резерфорд, выделивший азот из воздуха чуть раньше своих известных коллег — шведа К. Шееле, англичан Д. Пристли и Г. Кавендиша. Резерфорд в 1772 г. Опубликовал диссертацию о так называемом мефитическом, т. е. неполноценном, воздухе, не поддерживающем горения и дыхания.

### **Алхимия**

Начиная с XIII в. большое распространение алхимические занятия получили в Западной Европе. Первые европейские алхимики были учениками арабов. Еще в середине XII в. появились переводы арабских алхимических сочинений на латинский язык. Вскоре в городах и монастырях возникли многочисленные алхимические лаборатории, в которых адепты (приверженцы) алхимии упорно работали, отыскивая пути приготовления искусственного золота. Основной их целью было получение «эликсира». Позднее его назвали «философским камнем». По убеждению адептов, ничтожные количества «эликсира» могли превращать неблагородные металлы в чистое золото.

### **Аналитическая химия**

Аналитическая химия — наука о методах изучения состава вещества. Она включает два основных раздела: качественный анализ и количественный анализ. С помощью приемов качественного анализа можно установить, из каких химических компонентов состоит интересующее нас вещество. Цель количественного анализа — установление количественного соотношения компонентов — химических элементов и отдельных соединений, входящих в состав анализируемого вещества. Очень важно также определить концентрацию, т. е. массу

элемента или другой составной части, отнесенную к единице объема или массы анализируемого образца.

### **Биоорганическая химия**

Эта область науки сформировалась в конце 1920-х гг. благодаря достижениям биохимии и органической химии (в особенности химии природных соединений). Биоорганическая химия изучает зависимость между строением различных органических веществ и их биологическими функциями. К таким веществам относятся белки, жиры, углеводы, витамины, гормоны, антибиотики и другие природные, а также синтетические соединения. В исследованиях применяется обширный арсенал методов органической и физической химии и физики.

### **Вода**

Вода — вещество привычное и необычное. Отечественный ученый академик И. В. Петрянов свою научно-популярную книгу о воде назвал «Самое необыкновенное вещество в мире». А «Занимательная физиология», написанная доктором биологических наук Б. Ф. Сергеевым, начинается с главы о воде — «Вещество, которое создало нашу планету». Ученые абсолютно правы: нет на Земле вещества более важного для нас, чем обыкновенная вода, и в то же время не существует другого такого вещества, в свойствах которого было бы столько аномалий.

### **Галогены**

Галогены — общее название для пяти элементов, составляющих VIa подгруппу периодической системы — фтора, хлора, брома, иода и астата. Термин «галоген» предложил в 1811 г. немецкий химик И. Швейгер для наименования элемента хлора, который, соединяясь со щелочными металлами, образует соли. «Галоген» происходит от двух греческих слов, означающих «соль» и «рождаю». Но предложение Швейгера не было принято, и позднее слово «галогены» стало групповым названием для хлора и его аналогов. В научной литературе употреблялся, а иногда и употребляется термин «галоиды» («солеподобные»), но он, очевидно, не является удачным.

### **Периодическая система химических элементов**

Периодическая система — упорядоченное множество химических элементов, их естественная классификация, которая является графическим (табличным) выражением периодического закона химических элементов.

Структура ее, во многом сходная с современной, разработана Д. И. Менделеевым на основе периодического закона в 1869-1871 гг. Пробразом периодической системы был «Опыт системы элементов, основанной на их атомном весе и химическом сходстве, составленный Менделеевым 1 марта 1869 г. На протяжении двух с половиной лет ученый непрерывно совершенствовал «Опыт системы», он ввел представление о группах, рядах и периодах элементов.

### **Химия**

Душу химии оставляют химические реакции. Они протекают в различных условиях. Одни — на холоде, другие — при комнатной температуре, третьи — при небольшом нагревании, четвертые — при высоких температурах. Одни реакции происходят мгновенно, иногда со взрывом. Другие в обычных условиях или вообще не идут, или протекают чрезвычайно медленно, но их можно ускорить с помощью катализаторов. Частью новейшей химии является химия плазмы: здесь предмет химического исследования — четвертое состояние вещества. Благодаря химии высоких давлений получают искусственные алмазы и водород в металлическом состоянии.

### **Электролиты**

Электролиты — жидкие и твердые вещества, которые в растворенном или расплавленном состоянии проводят электрический ток. Вещества, водные растворы или расплавы которых не проводят электрический ток, называют неэлектролитами. Электролиты — проводники второго рода. Передача электричества в них осуществляется движением положительных и отрицательных ионов, тогда как в проводниках первого рода — движением электронного газа. Примером типичного электролита может служить хлорид натрия. К электролитам относятся кислоты, основания и соли. При растворении в воде они диссоциируют на ионы.

### **Электроотрицательность**

Электроотрицательность — способность атома в молекуле притягивать к себе электроны, участвующие в образовании химической связи. Эта способность оценивается эмпирическими величинами относительной электроотрицательности. У лития она принята равной 0,97, тогда у остальных элементов получаются простые и удобные для сравнения величины. Очевидно, у инертных газов относительная электроотрицательность равна нулю, так как внешняя электронная

оболочка в их атомах устойчива. Величина относительной электроотрицательности элементов определяет многие свойства образованных ими веществ, например, знак степени окисления, реакционная способность.

### **Оксиды**

Оксиды — соединения элементов с кислородом. Чаще всего образуются при непосредственном окислении простых и сложных веществ. В последнем случае обычно получается смесь оксидов тех элементов, которые входили в состав сложного вещества. Понятие «оксиды» включает бесконечное разнообразие веществ. Оксид водорода — это вода, оксид кремния — песок. Аметист — кристаллический оксид кремния, окрашенный в фиолетовый цвет оксидами марганца и кобальта. Оксиды могут быть газами, как, например, образующиеся в процессе горения оксиды углерода. Так, оксид фосфора (V) применяют для сушки химических реактивов, оксид хрома (III) — для полирования линз.

### **Химические элементы**

Все многообразие окружающей нас природы состоит из сочетаний сравнительно небольшого числа химических элементов. В организме человека их содержится около 70. Нет точных сведений, откуда произошло слово «элемент». В различные исторические эпохи в это понятие вкладывался разный смысл. Древнегреческие философы в качестве «элементов» рассматривали четыре «стихии» — тепло, холод, сухость и влажность. Сочетаясь попарно, они образовывали четыре «начала» всех вещей — огонь, воздух, воду и землю. В Средние века к этим началам добавились соль, сера и ртуть. В XVII в. Р. Бойль высказал мысль, что все элементы носят материальный характер.

### **Нобелевская премия по химии**

Нобелевскую премию по химии в 2009 г. получили ученые, определившие структуру и функции рибосом — молекулярных машин, обеспечивающих синтез белка в клетке. Лауреатами стали: ученый из Великобритании Венкатраман Рамакришнан (*Venkatraman Ramakrishnan*), американец Томас Стейц (*Thomas A. Steitz*) и израильтянка Ада Йонат (*Ada E. Yonath*).

Сумма премии составляет 10 миллионов шведских крон (975 тысяч евро). Церемония объявления лауреатов проходит в Каролинском университете в Стокгольме.

Рибосомы являются одними из важнейших органелл живой клетки. Они представляют собой нуклеопротеиды, то есть структуры, состоящие из белка и РНК. Рибосомы образуются в ядрышке – особой структуре внутри клеточного ядра – и затем мигрируют в цитоплазму, где обеспечивают синтез молекул всех белков, производимых в клетке, из элементарных "кирпичиков" – аминокислот.

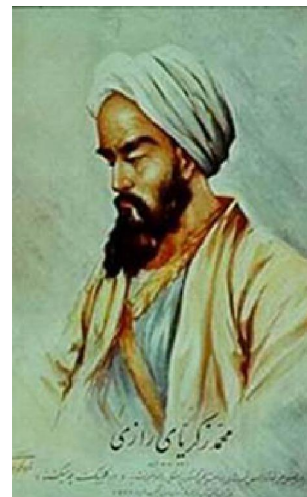
В 2008 году самую престижную научную премию в номинации «химия» получили исследователи Осаму Симомура (*Osamu Shimomura*), Мартин Чалфи (*Martin Chalfie*) и Роджер Тсиен (*Roger Tsien*), выделившие в чистом виде зеленый флуоресцентный белок и создавшие его новые формы.

## ТЕКСТЫ ДЛЯ ИТОГОВОГО САМОСТОЯТЕЛЬНОГО ПЕРЕВОДА

### 1 year

#### Труды арабского алхимика Абу Ар-Рази

Абу Бакр Мухаммед ибн Закария Ар-Рази (Abu Bakr Muhammad ibn Zakariya Razi) родился в персидском городе Рее (Rey), близ Тегерана. В Персии, а также в городах, расположенных на территории современных Узбекистана и Таджикистана, он получил разностороннее образование и, в частности, изучал философию, метафизику, поэзию и алхимию. Еще в молодости он начал заниматься опытами облагораживания металлов и поисками «эликсира». В 30-летнем возрасте Ар-Рази отправился в Багдад, где изучал медицину. Вскоре он прославился как весьма искусный врач; руководил клиникой в Рее, затем в Багдаде. Ар-Рази был хорошо знаком с античной наукой, медициной и философией; он оставил труды по философии, этике, теологии, логике, медицине, астрономии, физике и алхимии – всего 184 сочинения, из которых до нас дошло 61. Многие труды Ар-Рази в X — XIII вв. в Европе были переведены на латинский язык.



Наиболее известные алхимические сочинения Ар-Рази – это «Книга тайн» и «Книга тайны тайн». Ар-Рази был знаком с трудами греческих философов и произведениями александрийских алхимиков, а также внимательно изучил оригинальные сочинения арабских авторов VIII и IX вв.

Ар-Рази полагал, что целью алхимии является трансмутация металлов при помощи особого эликсира и получение драгоценных камней из «обычных» кварца и стекла. Основными элементами, или принципами, составляющими металлы, Ар-Рази, так же, как и Джабиру, считал ртуть и серу, однако он добавил к ним еще третий принцип – соль. Именно это представление о составе металлов получило в дальнейшем широкое распространение в европейской алхимической литературе.

В своих сочинениях Ар-Рази описал не только различные химические аппараты и приборы, но и химические операции. В *«Книге тайн»* весь материал алхимии разбит на три основных раздела: 1) *«Познание вещества»*, 2) *«Познание приборов»* и 3) *«Познание операций»*.

Именно Ар-Рази впервые в истории химии предпринял попытку классифицировать все известные ему вещества. Он разделил их на три больших класса:

- землистые, или минеральные вещества,
- растительные вещества,
- животные вещества.

Минеральные вещества, в свою очередь, были распределены по шести группам:

- «духи» (спирты, летучие вещества), куда относятся ртуть, нашатырь, аурипигмент (или реальгар), и сера;
- «тела» (то есть металлы), которых насчитывалось в то время всего семь: золото, серебро, медь, железо, олово, свинец и так называемый «харасин» (что, по всей вероятности, означало «цинк»);
- «камни», которых насчитывалось тринадцать видов (марказит, марганцовая руда, бурый железняк, галмей, ляпис-лазурь, малахит, бирюза, красный железняк, белый мышьяк, сернистый свинец и сернистая сурьма, слюда, гипс и стекло);
- купоросы: черный купорос, квасцы, белый купорос (вероятно, цинковый), зеленый купорос, желтый, красный (сульфат железа);
- «боракы»: хлебная бура (вероятно, поташ), натрон (сода), бура ювелиров, «тинкал» (род мыла, применявшегося при пайке металлов), зараванская бура, арабская бура;
- «соли»: хорошая соль (поваренная), горькая (возможно, мирабилит или английская), каменная, белая, нефтяная, индийская, китайская соль, поташ, соль мочи, известь и соль золы.

Растительные вещества Ар-Рази не перечислял, упоминая лишь о том, что они редко употребляются. Из животных веществ он выделял десять наиболее важных и распространенных видов, такие как волосы, кости черепа, мозг, желчь, кровь, молоко, моча, яйца, раковины и рог.

Среди аппаратов и приборов, описанных в сочинениях Ар-Рази, фигурируют, в частности, кубки, колбы, тазы, стеклянные блюда для

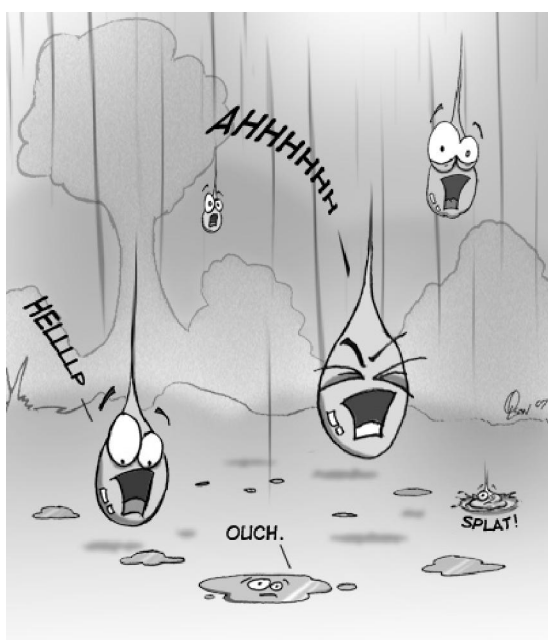


кристаллизации, кувшины, кастрюли, горелки, нефтяные лампы, жаровни и печи (атанор), печи для плавки, напильники, шпатели, ковши, ножницы, молотки, щипцы, песчаные и водяные бани, фильтры из тканей и шерсти, аламбики, воронки, ступки с пестиками, сита металлические, волосяные и шелковые, другие приборы и принадлежности.

Ар-Рази описал и различные химические операции, в частности плавление тел, декантацию, фильтрование, дигерирование (настаивание при повышенной температуре), дистилляцию, сублимацию, амальгамирование, растворение, коагуляцию (сгущение).

2 year

### *Сколько кислоты в капле дождя? [17]*



Впервые о кислотных дождях заговорили в 1852 году. Человек с оригинальной английской фамилией Смит, проживавший в Манчестере, собрал в фотографическую кювету дождевую воду и почему-то добавил туда раствор соли бария. Вода стала мутной. Поскольку это известная качественная реакция на сульфат-ион, то стало понятно, что в дождевой капле есть серная кислота. Правда, задолго до Смита, в 1696 году, Р. Бойль тоже обнаружил кислую реакцию дождевой воды, но так и не определил, почему это происходит.

Поэтому долгое время полагали, что в капельках дождя просто растворяется  $\text{CO}_2$  и образуется слабая угольная кислота (при том содержании углекислого газа, которое характерно для атмосферы, pH должен быть около 5,6). Когда Смит обнаружил серную кислоту, ему не сразу поверили, и многие бросились перепроверять его результат. Оказалось, что, помимо серной, в дождевой капле есть еще и азотная кислота, потом нашли муравьиную, а впоследствии щавелевую и уксусную.

Почему же именно в середине XIX века удалось обнаружить целый набор кислот в дождевых каплях, причем самыми простыми способами? Дело в том, что это было начало технологической и индустриальной революции: в Англии появились первые мастерские и предприятия, заработали топки, где в большом количестве сжигали уголь. А сжигание любого ископаемого топлива, твердого или жидкого, дает не только

углекислый ( $\text{CO}_2$ ), но и сернистый газ ( $\text{SO}_2$ ). Сначала думали, что механизм образования серной кислоты предельно прост – это обычное растворение сернистого газа в дождевой капле, но, как мы увидим дальше, этот механизм оказался значительно сложнее. Поначалу ученые даже обрадовались кислотным дождям, ведь каждое облако приносило на поля не только влагу для почвы, но и удобрение – серу и азот. Но радость была недолгой. Вскоре стало ясно, что вреда от кислотных дождей больше, чем пользы. Если расположить неприятности, связанные с кислотными дождями, по мере убывания их вредности, то получится такой ряд:

1. Снижение урожайности основных сельскохозяйственных культур (пшеницы, ржи, кукурузы и т.д.).

2. Гибель лесов. Из-за кислотных дождей деревья теряют иммунитет, заболевают разными болезнями, у них снижается фотосинтез, и они погибают. Сегодня поражена значительная часть лесов Европы, а в США и Канаде масштабы бедствия еще больше. Такие леса выглядят как после пожара: голые стволы и ни одного листочка.

3. Гибель закрытых водоемов (озер). Происходит это постепенно, и механизм здесь таков: под действием кислоты растворяются алюмосиликатные породы (там, где они есть), а алюминий токсичен. Погибли уже тысячи озер в США, Канаде и Швеции (правда, есть надежда, что на этом процесс закончится).

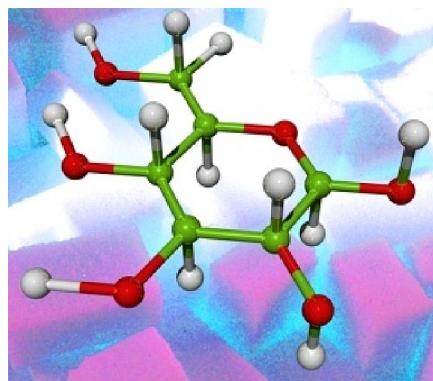
4. Коррозия и разрушение известковых, каменных зданий, металлических крыш и разных сооружений. В XIX веке в Европе именно по этой причине стали покрывать крыши черепицей: она служила гораздо дольше.

Итак, дождевая капля содержит целый набор кислот, а также ионы аммония, железа, натрия, кальция, марганца, магния. Чтобы понять, как собирается такой химический букет, надо вспомнить, как образуется облако. Небо Земли постоянно более чем наполовину закрыто облаками. Все они живут примерно час, потом 85% облаков рассасывается, а остальные выпадают в виде осадков. Если облако попадает в зону с меньшей влажностью или более высокой температурой, то никакого дождя не будет: капли испарятся, и облако, теперь уже газовое, будет двигаться дальше. Так, испаряясь и конденсируясь снова, облако может перемещаться на очень большие расстояния, до 2000 км. Поэтому облако, родившееся в одной стране, может выпасть кислотным дождем в другой, которая достаточно далека от места загрязнения. Это и называется трансграничным переносом: облако образуется где-нибудь в Германии, а выпадает на Швецию или Данию, образуется в США, а озера гибнут в Канаде.

### *Необычные свойства полимеров [9]*

Почему ориентированные полимеры прочнее обыкновенных? Для начала нужно ответить на вопрос: а почему обыкновенный полиэтилен такой непрочный? Этот вопрос не так наивен, как кажется. Алмаз, состоящий из тех же атомов углерода, связанных между собой теми же ковалентными связями, что и атомы углерода в молекулярной цепочке полиэтилена, — один из самых твердых и прочных материалов в природе. Разницу между ними можно объяснить, вспомнив древнюю легенду о мудром старце. Перед смертью он попросил своих сыновей сломать прутики хвороста, сложенные в пучок, что они так и не смогли сделать, несмотря на свою молодость и крепость мышц. Физико-химический смысл этой сказки очевиден. Чтобы разделить рыхлую кучу хвороста на части, больших усилий не нужно. Стоит чуть-чуть потянуть, и хворостинки разделятся на две кучки, не ломаясь. Если и придется сломать одну-две, то это будет довольно просто. А вот сломать пучок плотно уложенных хворостинок намного труднее, ведь ломать придется все одновременно. И чем больше в пучке палочек, тем труднее будет это сделать.

В полиэтилене такие «хворостинки» — полимерные цепочки. Между собой они связаны физическими межмолекулярными связями, которые в сотни раз слабее химических углерод-углеродных (тех, которыми соединены молекулы углерода в полимере). Поэтому реальная прочность обычного полиэтилена намного меньше прочности алмаза, в котором все углероды связаны между собой химическими связями.



У полимерных молекул есть одно существенное отличие от жестких прутьев, которое сильно осложняет достижение нужного результата. Молекула полиэтилена — не жесткий стержень. Она очень гибкая, поскольку связь между атомами углерода в полимерной цепочке подвижная, и атомы углерода вращаются относительно друг друга. Так как они связаны между собой под углом около 110 градусов, то их движение заставляет зигзагообразные полимерные молекулы извиваться с огромной скоростью, подобно наноразмерным змеям. В результате эти «змеи» при синтезе сворачиваются в клубки — как цепочка, которую положили на хаотично вибрирующую поверхность. Именно поэтому легко разорвать обычную полиэтиленовую пленку: в ней не нужно рвать все цепочки полиэтилена.

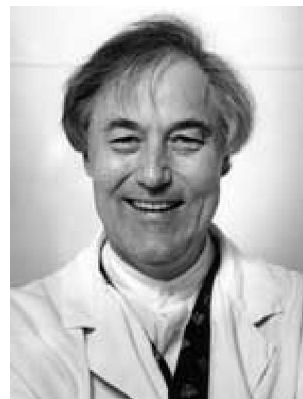
Если полимер со свернутыми молекулами нагреть и растянуть, то они вытянутся в направлении растягивающей силы. Но как только

внешняя сила перестанет действовать, хаотичное тепловое движение заставит макромолекулы вновь свернуться в клубки. Это свойство называется упругостью, а точнее термоупругостью, так как она — следствие теплового движения. Термоупругость отличается от обычной упругости стальной пружины, поскольку она связана не с изменением расстояния между атомами в молекуле, а с размерами молекулярного клубка — меняются расстояния между концами длинной молекулы. (Когда в следующий раз вы растянете кусок резины, то имейте в виду, что вы растягиваете молекулярные клубки и ощущаете их суммарную термоупругость. А когда вы отпустите один из концов, то представьте, как эти молекулы, извиваясь в тепловом движении, снова сворачиваются.) Термоупругость мешает ориентации молекул, которая делает полимер прочным. Если же растянутый образец охладить до низкой температуры, то можно «заморозить» молекулы, и образец сохранит свою новую форму и структуру. Так делают ориентированные пленки.

#### 4 year

##### *Молекулярная гастрономия [21]*

Чуть больше десяти лет назад французский ученый Эрве Тис (*Herve This*) придумал молекулярную еду – продукт, созданный на стыке кулинарии и химии. Уже само название имеет вкус будущего: молекулярная гастрономия. Иначе говоря: анализ физико-химических законов во время приготовления еды и использование новых открытий для создания необычных рецептов. Это зарождающееся направление, прежде всего в Европе, в котором участвуют шефы ресторанов, специалисты по физике материи и эксперты-химики. Отправным моментом было то, что между различными продуктами (шоколад и икра, спаржа и лакрица, например) существуют неожиданные молекулярные связи, и их обнаружение может создать базу для изобретения неожиданных миксов.



Молекулярная кухня – одна из модных тенденций в среде европейских гурманов. Например, в бокал для шампанского наливается сначала горячий мятный суп-пюре, а сверху – осторожно, чтобы не перемешать слои, – холодный гороховый суп. Возникает сразу тройной контрастный эффект: вкусовой, температурный и консистентный. Говоря проще, в молекулярной кухне используют новейшие технологии для получения необычных консистенций и вкусовых сочетаний. Кофе в виде печенья, чай в виде желе, мороженое со вкусом ветчины – все это звучит

необычно и нравится пока не всем. Но есть и те, кто в полном восторге от такой еды.

В народ молекулярная кухня пошла, начиная с 2001 года. Последователи и ученики Эрве Тиса: Ферран Адриа (*Ferran Adrià*, Испания), Хестон Блюменталь (*Heston Blumenthal*, Великобритания), Мишель Брас (*Michel Bras*, Франция), Пьер Ганьер (*Pierre Gagnaire*, Франция), Анатолий Комм (*Anatoly Komm*, Россия). В Италии одним из самых известных представителей нового течения является Давид Кассиа (*Davide Cassia*), специалист в области физики материи Пармского университета.



Отпечаток новых технологий отложился и на другом пищевом сценарии, который в будущем будет играть главенствующую роль: речь идет о запахах и вкусах, синтезированных в лаборатории. В частности, в лаборатории разработки ароматов швейцарского парфюмерного гиганта Givaudan. Оказав содействие в создании свыше 20 тысяч искусственных ароматов (300 только для одной клубники), биологи многонациональной компании организовали экспедиции в леса Мадагаскара в поисках молекулы, из которой можно извлечь новые запахи. Эти ароматы на молекулярном уровне будут идентичны натуральным, как утверждают ученые, только будут получены благодаря химическим процессам.

На прошедшем недавно международном фестивале науки в Эдинбурге Эрве Тис поделился секретами, как с помощью химии придумывать новые, порой весьма необычные комбинации пищи. Как утверждает Э.Тис, чтобы сделать вкус дешевого виски таким же, как у

дорогого, достаточно добавить в напиток ванилин, который преобразует виски и дает ему великолепную законченность и теплоту. Эксперимент основан на открытии, что химические элементы, образующиеся во время выдержки виски в деревянных бочках, похожи на элементы в ванилине. Французский ученый Эрве Тис, изучающий тайны вкуса, уверен, что лучшие повара – это не те, кто использует свою интуицию и фантазию, готовя изысканные блюда, а те, кто знает секреты химии и физики и готовит с точностью техника лаборатории.

Лучшие повара мира уже экспериментируют с научными достижениями. В частности, в одном английском ресторане ученик Тиса управляет молекулярными структурами, чтобы создать бекон и яичное мороженое, а также другие блюда, такие как белый шоколад и икра. Он также впрыскивает лаймовый мусс и мусс из зеленого чая в шарики азота: когда такой шарик попадает на язык, он испаряется, словно облако пара, не оставляя ничего, кроме вкуса.

Тис полагает, что молекулярная гастрономия поможет также и поварам-любителям, включая обычных домохозяек. Они смогут разнообразить свое домашнее меню, причем многие блюда можно будет приготовить даже за отсутствием необходимых ингредиентов. Например, если нет возможности купить настоящие грибы для блюда на ужин, нужно всего лишь помнить, что октенол, или бензил транс-2-метилбутеноат, продающиеся в любом магазине химии, придают блюду замечательный грибной вкус.

Для создания молекулярной пищи используется жидкий азот, вакуум, высокие температуры, кислород и инертные газы, агар-агар, различные химические реакции (дегидрации, например), центрифугирование, эмульгирование, размельчение продуктов практически до молекул и др.



## UNIT 7. FOR YOU, BRAINIACS!



**Do you know the answers to the following questions?**

1. A well-known Russian writer Alexander Kouprin called a horse in honour of transparent sort of beryl. It is a bright green precious stone consisting of a chromium-rich variety of beryl.

***What was the name of the horse?***

2. Alchemists called this saltpetre ‘infernial stone’.

***What is the modern name of this substance?***

3. An English chemist Humphrey Davy obtained little balls accompanied with explosions during caustic potash electrolysis.

***What were they?***

4. An English physicist and chemist Michael Faraday suggested the name for this charged particle in 1834.

***What name did he give to it?***

5. Aquamarine and heliodor are sorts of one mineral.

***What is the name of the mineral?***

6. Carbon has the unique ability to form long chains with other carbon atoms.

***What name is given to a long chain consisting of many identical smaller molecules (called monomers)?***

7. Catherine II, empress of Russia, known as Catherine the Great, invented a fairy tale for her grandson.

***What was the hero’s name?***

8. Electric arc was designed with the help of zinc and copper discs by this famous Italian physicist and inventor.

***Name this person.***

9. How many protons are there in an atom of gold?

10. Humans breathe out carbon dioxide (CO<sub>2</sub>).

***What do you call a process during which plants convert carbon dioxide into food using energy from sunlight?***



11. If someone wants to bake a cake he goes to the cupboard to get some sucrose there.

***What ingredient is he looking for?***



12. If to peel this fruit the beautiful aroma of limonene wafts up to a nose.

***What fruit is it?***

13. In the ex-USSR such name was given to fibers form polyethylene terephthalate according the place of their obtaining.

***Do you know the name?***

14. Individuals were not allowed to buy this substance in 1733.

***What was the name of the substance?***

15. It was only a French scientist Lavoisier who proved that it was not a substance but a consequence of the combustion process.

***Can you name it?***

16. Osmium and iridium were discovered while melting this metal in *aqua regis*.

***What is the name of the metal?***

17. The discovery of what chemical elements did experimentally confirm both the periodic law and periodic system of elements?

18. The piece of any of these metals is melting on the palm.

***What are they?***

19. The tricky part of hydrocarbon nomenclature is when you come across molecules with the same molecular formula, yet different structure.

***What are these compounds called?***

20. There is a very common chemical that can be very dangerous. If this chemical is inhaled, it can be fatal, but beneficial when swallowed. Under certain conditions, contact with the skin may cause a burn. However, once a person's body becomes dependent upon this chemical, prolonged separation will almost certainly cause death. Although scientists are well aware of this chemical and it is found in nearly every drinking source, nothing is being done by the government to try to eliminate it.

***What is this chemical?***

21. **Using all the letters, compose new words:**

mystic + her

busset + can

cationer

noxa + idiot

soul + O + tin

grain + coin

cole + mule

moist + bun + OC

concert + nation

neat + bus + Cs

22. This crystal transforms into violet vapour while heating avoiding liquid phase.

***What is it?***

23. This particular vegetable is easily making one's eyes all teary due to the propanthial S-oxide it contains.

***Which vegetable is it?***

24. This popular comfort food has an active ingredient called phenyl ethylamine.

***What is it?***

25. This vegetable is stunningly-colored due to the beta-carotene it contains.

***Which vegetable is it?***

26. What are four greatest Chinese inventions?

27. What do properties of chemical elements and their compounds periodically depend on?

28. What feature of atomic structure is shared by fluorine, chlorine, bromine, and iodine? To which group do they belong?

29. What gas did the Dutch inventor of the first navigable submarine use for breathing?

30. What gas predicted by Mendeleev was discovered by a Scottish chemist Ramsay, the report about that undiscovered gas being given in Toronto in 1897?

31. What is the rarest halogen existed in nature?

32. What metals can you find in the following organs of a human organism?

• brains?

• lungs?

• heart?

• pancreas?

• thyroid gland?

• liver and kidneys?

• spleen?

33. *What substance was used by Arthur Conan Doyle in his most well known detective story about a fierce and horrible animal?* By the way, the same substance appeared to be necessary for the description of people of future 2030s given by Mayakovski in his play “*Bathhouse*”.

34. Which noble gas is rather rare in atmosphere?

35. Which tissue in the human organism is most rich with water? Which is the least rich?

36. Who was the mother of the “constant tin soldier”?

37. With the help of Mohs scale it is possible to calculate the relative mineral hardness. 10 standard minerals are taken, the softest and the hardest ones.

*What are they?*

38. Below you see chains of words connected together.

*Single out separate hidden words and compose sentences with them. Bear in mind that the last letter of every word at the same time is the first of the next one.*

Acidioxanelectroniobiumendeleyevacuummolecule  
 Chemistryieldefinitionnitrogenitratelementtemperature  
 Cobaltreatchneciumildioxidexacttechnique  
 Liquidensityttriumeltreatment  
 Solideuteriumixtureinsteiniometallichtube  
 Watereagentreatalliumeasurenteraw

39. *Do you know the translations of the following words?*

Few, hazardous, integration, natural, noted, old, rigorous, significance, single, state, steam, stream, strict, synthetic, water

Name what part of speech is every translated word. Enumerate suffixes of each part of speech. Can you give any synonyms and antonyms? Compose your own sentences with the words.

If you move only in vertical and horizontal directions you will find all of the given above words inside the square you see below. Good luck to you!

m	a	t	e	s	i	g	f	i	c
a	w	s	r	e	t	n	i	s	a
e	r	t	s	t	a	e	n	i	n
s	t	e	a	i	n	l	g	e	c
o	i	t	m	e	t	h	a	z	a
n	r	a	r	g	t	i	c	d	r
g	i	s	y	h	e	s	u	o	n
o	u	s	n	t	r	i	c	t	a
r	o	e	d	o	t	s	l	a	t
n	o	t	d	l	f	e	w	r	u

40. **Some special tasks for you**

A. During the combustion of 9.2 g of an unknown organic material in oxygen 17.6 g of carbon dioxide and 10.8 g of water are formed.

**Determine the formula of the substance** if the density of its vapour in nitrogen oxide IV is equal to 1.

B. A 0.2000 g sample of an organic compound, W, was analyzed by combustion. 0.4800 g of carbon dioxide and 0.1636 g of water were obtained. A second 0.2000 g sample of W produced 0.0618 g of ammonia in a Kjeldahl analysis.

**Use these data to show that W contains only carbon, hydrogen and nitrogen and calculate the empirical formula of W.** [31, p 274]

C. 40 g of an alloy containing zinc, aluminum and nickel are treated with an excess of sodium hydroxide solution. 15.68 L of gas is formed, the mass of the solid residue being 8.6 g.

**What is the alloy composition?**

D. A student prepared a sample of 1-bromobutane,  $C_4H_9Br$ , from 10.0 g of butan-1-ol,  $C_4H_9OH$ . After purification she found she had made 12.0 g of 1-bromobutane.

**What was the percentage yield?** [31, p 275]

E. 27.8 crystalline hydrate ( $FeSO_4 \cdot nH_2O$ ) was dissolved in 50 ml of water so that  $W(FeSO_4)$  was 19.54% in the resulted solution.

**Determine the formula of crystalline hydrate.**

F. Unknown elements X and Y form compounds  $X_2YO_5$  and  $X_2Y_2O_3$ , the mass fraction of oxygen in both compounds being equal to 70.16% and 42.096%, respectively.

**Identify both unknown elements.**

G. If you dissolve pure sugar in pure water is it a pure substance?

H. You are given a mixture of sand, salt and water.

**How would you separate the three compounds?**

I. Which is heavier: 1 g of rock or 1 g of cotton?

Which is heavier: 1 mL of rock or 1 mL of cotton?

41. ***Guess the names of the elements described in the poems.*** [26]

An active sailor, yet seldom free,  
An old salt, Peter, afire in the sea,  
Near noble, yet base and prone to lie,  
Purple with rage when excited am I.

Shunned by most and craved by all,  
Food for rabbits, yet made from straw,  
Millions found greed and abandoned sense,  
Though not a fool, I am quite dense.

42. ***Rearrange the elemental symbols to solve the riddle.*** [26]

Uranium, sulfur, radon and boron are the names of chemical elements.

***Can you guess in what way they are connected with an injury caused by heat or fire?***

43. All these riddles describe one and the same substance.  
***Do you know the name of it?***

- What is more precious than gold, clearer than diamonds; is the source of life, and is said to be the purveyor of legends?
- What kind of bank needs no money?
- What lives in winter, dies in summer, and grows with its root upward?
- What runs and has no feet, roars but has no mouth?
- What runs but never gets tired?
- What three letters mean “stiff water”?



44. A new set of words for you to find. You can also move either horizontally or vertically. The words can be broken in the same way.

Achieve, branch, complexity, create, difficult, error, knowledge, nutritionist, range, simplicity, arrange, change, composition, definition, element, goal, master, occupy, ratio, valid, behavior, chemistry, concept, development, entirely, govern, matter, physician, science, vast

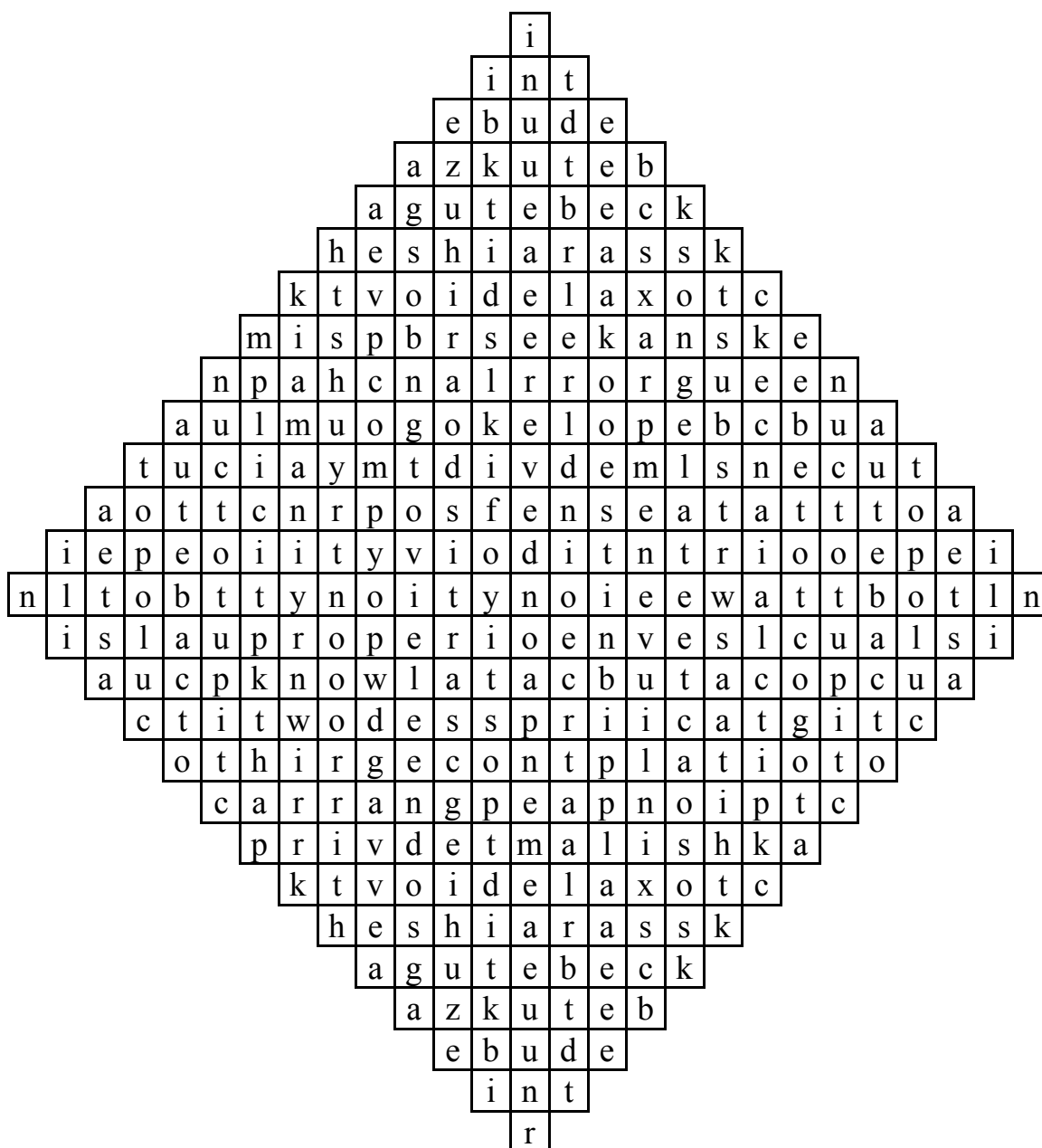
***When you find all the given words, compose the sentences with them.***

C H E M I S T R Y I K J B S T T Y Z U Y T E L E M E N U G O K T R A I L  
Z O T F R F U C K I D H N X Z A B M J L T V E V K A T S Y L J Y Y I K J  
S U T F G M A S T E R F R S Q Y C Y R E C P Y K J H K M E O T P S X F G  
K T N S R Y H N B F S Q E C H E A M I R I O N C L U D E C J R U B K Y E  
H L D U N I V E R S E J V J T G S T T E N A I U I D J G U H G C O J E A  
B U S S N T F Q W B T E O S E N G J N Q R W O P A K V C D T D C S H C F  
C C A F E E Y A R Y R S G G T A F B E K A H D E V I C E O R Z O Y F A D  
Q I A J V K O E J L V B Q I E R F C C J P E W C Y K J S R Y O L E J P J  
W F W U E Y J T B S U M M E R R G S T H U N I Q U E B N P U Y U Y X S H  
T F B Y I E K A C I V A S T A F L I G K Z X C V I S B I A L R T A S C  
O I N E H X A E F M A T H E R F N A P F A N Y T R F J E Y C V U I O O L  
P D K G C J Y R P A V A L I D H F I J D I T I O N I S T A J E D C I L P  
I E X V A C G C O F Y H N J U Y T R G S R X F G Y U I K J F G K F H R M  
A T S U Y B C A I T I O N A L T T X A T V I M A T T E R G D C K G A I  
O T H R S E G A W S Q A Z X C V I N J U U Y Y K G A I W M F E I Y K M S  
I W C O A G V T U O I Y L I C I A N T Y N R A T O S E R B W L N T H R Y  
T G N K E N F Y H P I T E S P Y U R E W S F G J I D G J F Y W R R N E L  
A L A J H Y I C O M O I F Y W Q H O P M E N T B T V N B K N O A E W Y A  
C M R B C T P J B E R X Y H V O F L U J M K I O A E A A Q F J P P T T R  
I K B R X X C O M P L E V P E R A E P L K H F S R T R J D U I A O O I U  
L J I E J Z L E R E W C Y K J H H V H O W N F Y A S F B M M L N R P N D  
P H E H A V I O R O Q N C E P T A E H D E F I N I T I O N R A L P I A M  
A P G B Q H I K E N L C O Y I K J E D E F L U U G O P A K W E O U Y T T U  
F E S C I E N C E Q A S X F G Y U I K J F U E R R O R Y H G R H G E H

45. This very unusual lexical square contains a list of words without which it is impossible to speak of chemistry.

Application, branch, composition, contribute, deal, definition, developments, error, goal, growth, humanity, invent, knowledge, property, range, ratio, scope, seek, simplicity, space, substance, sweet, trial, try

*Do you know the translation of the given words?  
Find all of the given words in this puzzle.*





46. ***What are they?***

They are so small.  
They're round like a ball.  
They make up the air.  
They're everywhere.

Can't see them at all:  
They're tiny and they're teeny.  
Much smaller than a weenie.  
They never can be seenie.

47. Here are some English words which you are to analyze from periodic point of view.

Dynamics, because, acoustic, attain, money, capture, cabbage, general, benefaction, amputation, Britain, arrange, America, plan, wife, book, clock

***Symbols of which chemical elements from the periodic table do you see? Compose English words using the symbols of chemical elements. Have a look at the periodic table.***

48. ***Guess the name of the element*** [18]

It is one great element,  
An element that is tetravalent.  
It is so very common and nonmetallic,  
Plus it has many forms that are allotropic.

Its atomic number is six,

With almost every other element can mix.

The number of its compounds is about ten million.

It has been found on comets and on the sun.

It has the highest melting point on the table

And by itself, it's not very stable.

At room temperature it is always a solid,

But at 3500 degrees Celsius it becomes a liquid.

49. ***What is the symbol of this chemical element?***

Its atomic number is 7. Its mass is 14.00674. Its nucleus contains 7 protons. Daniel Rutherford discovered it. It is a nonmetal and colorless. It is used to fertilize things. It is in our food. It is also used in rocket fuel. It is the fifth most abundant element in the universe.

50. Here are some interesting facts about one famous person.

***Can you guess his name?***



- He is a Dutch physical and organic chemist but he was born in Holland in Rotterdam.

- He lived in the eighteen and nineteen centuries.
- He was a doctor of maths and of nature philosophy.
- He worked as a veterinary surgeon.
- This man helped to found your favourite subject - physical chemistry.
- He was the winner of the Nobel Prize in chemistry.



51. *Find the answers to the riddles* [26]

- What substance is combined with chlorine to make food taste better?
- What substance is often found in jewelry but is not as expensive as other metals also used in this industry?
- What substance is often used to make containers for cookies and sweets (especially at Christmas!)?
- What is used to write on papers?

52. *The Washington Post* has recently announced a contest and asked readers to dream up new elements for the Periodic Table [7]. Read through the best of the batch.

Billclintium, Bc – *with a slick appearance and slimy texture, this element undergoes a series of interesting changes when in hot water.*

Canadium, Eh – *similar to Americium, but a little denser. Much more rigid. Often called Boron.*

Newtium – *extreme irritant. Carries a strong negative charge. Does not possess magnetic properties. Can be purchased cheaply.*

Politicism, Po – *contains a great deal of gas. Similar to Radon as it can reach lethal concentrations in the house.*

Congress, Cg – *atomic number 525. Can never be found in a solution.*

***Comment upon the descriptions of imaginary elements. Do you like them?***

***Why do you think such names were proposed?***

***What elements would you offer for this list?***

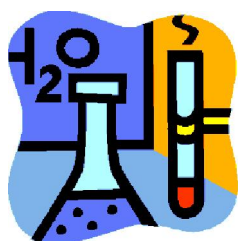
53. And now let us look through a list of winners among chemical elements.[ibid]

***Do you know them?***

- What do you think is the lightest element?
- What is the noblest element?

- Which element has the lowest thermal conductivity?
- Which element is ‘dumb blonde’?
- Which element is the most autistic element, being the most resistant to forming chemical bonds?
- Which element is the most diamagnetic?
- Which element is the most electronegative?
- Which element is the most versatile?
- Which is the noblest element in the subcategory of metals?

*Do you agree with this list?*



54. *Complete the following funny lines with the name of a proper substance.*

Little Willie was a chemist.  
Little Willie is no more.  
For what he thought was H<sub>2</sub>O,  
Was ...

*Try to pronounce it as tongue-twister.*

*Are you good at tongue twisters? Do you like them?  
Then try to pronounce the following one.*

A chemist has poisoned my brain!  
The cause of his sorrow  
was para-dichloro-  
diphenyltrichloroethane!



55. *Find English translations of these words in the following square:*

Анализ, вещество, вселенная, гипотеза, деятельность, достигать, закон, знания, изменение, исходный факт, критерий (ед.ч. и мн.ч.), максимум (ед.ч. и мн.ч.), масштаб, материя, напластование (формация), наука, определение, основа, отрасль, ошибка, поведение, применение, пространство, пустота, равновесие (мн.ч.), развитие, рост, свойство, симпозиум, синтез, создавать, соотношение, состав, спектр, способ (физическая среда), структура, улучшать, учебный план, фаза, фокус (мн.ч.), химия, цель, явление, ядро (мн.ч.)

b	e	h	a	v	t	c	s	t	s	t	y	h	r	r	t	s	r	q	p	o	w	a	l	a
b	r	a	n	i	d	i	e	u	i	r	p	j	u	u	h	p	a	w	u	z	e	i	h	c
m	a	t	c	o	s	c	n	r	s	z	o	k	j	c	e	z	t	o	c	z	v	c	h	g
r	e	t	h	u	v	c	c	f	e	h	t	y	i	t	n	o	i	z	e	q	e	o	u	m
y	e	a	t	r	b	g	e	t	s	g	x	v	w	u	o	m	g	k	w	k	e	m	o	e
c	r	e	e	e	n	q	a	g	e	p	s	d	q	r	e	e	e	f	d	s	o	p	i	d
d	a	w	m	b	i	b	y	a	c	t	i	u	g	a	p	n	q	h	w	i	c	m	u	t
m	i	x	a	i	e	d	u	r	t	r	c	y	x	t	y	o	u	k	d	t	u	e	r	r
a	p	r	l	e	g	o	a	l	s	u	m	d	a	e	i	n	i	i	a	i	r	q	t	o
w	s	o	c	s	o	y	w	s	g	f	e	g	i	r	b	i	l	u	b	o	r	i	c	u
a	t	p	u	y	d	s	f	i	s	t	r	e	d	s	a	r	y	c	d	n	c	a	r	l
a	r	e	n	n	t	h	e	s	p	y	l	g	d	e	l	w	o	n	t	d	t	e	a	u
t	g	r	t	y	y	u	o	c	h	e	m	i	s	t	r	y	t	k	n	e	i	r	n	m
a	s	i	b	a	e	w	m	g	p	s	u	o	p	o	i	t	i	n	i	f	v	w	g	e
d	q	s	a	h	r	e	u	n	u	c	z	b	u	n	i	p	d	w	r	y	i	a	d	a
p	h	a	s	c	y	v	t	a	d	r	x	d	x	y	z	x	p	o	i	y	t	f	n	u
i	z	b	i	z	i	o	r	p	t	f	i	c	o	f		m	e	n	t	a	y	n	i	s
n	a	m	s	x	a	m	d	m	o	n	x	e	h	g	z	p	o	l	e	v	e	d	v	p
a	z	u	m	i	o	s	i	i	i	o	u	a	v	n	x	m	b	r	e	s	s	r	e	a
l	y	e	r	y	l	i	c	a	t	c	n	i	y	p	o	r	e	t	i	t	e	a	e	c
j	s	w	a	p	p	t	n	o	r	r	e	j	t	a	r	i	q	j	r	u	f	b	s	f
s	i	o	i	p	i	f	a	i	j	i	f	e	u	f	t	a	m	a	c	j	f	c	m	g
j	b	e	n	a	r	a	s	r	e	t	u	g	m	d	s	h	u	y	v	a	c	u	p	u
x	g	e	c	t	s	b	u	h	v	h	a	n	u	y	o	g	i	r	m	y	s	u	i	o
o	r	o	u	t	h	r	o	u	b	c	n	v	m	a	f	d	s	o	p	r	y	m	y	l

56. Another original list of elements which are ‘favorites’ of some people because of their jobs was composed by Americans [7].

***Can you guess the names of these chemical elements?***

What does a doctor do? He cures and heals his patients. What elements should the doctor be fond of?

A mortician is a person whose job is to deal with the bodies of people who have died and to arrange funerals. What chemical element ‘helps’ the mortician to perform his duties?

It is always rather difficult to choose what country should be visited first especially if a person has never been anywhere. It is possible to use the Periodic Table as a guide for tourists? What chemicals elements are the tourists’ ‘best friends’?

Having a holiday every person wants to make up as bright as possible to keep it in mind for a long time. What chemical element is very 'suitable' in this function?

A baker is a person whose job is to bake and sell bread, pastries, and cakes. Without what element his cakes will never be puffy?

A person who commits robbery never wants to meet with a policeman. What chemical element always 'reminds' a robber about the police?

If person is on the stage, what chemical element is his 'favourite'?

Conan Doyle portrays Watson as a capable and brave individual. Doctor Watson is described as an excellent doctor and surgeon. Try and remember whose assistant and flat mate Watson was. Then you will name the 'favourite' Watson's element.

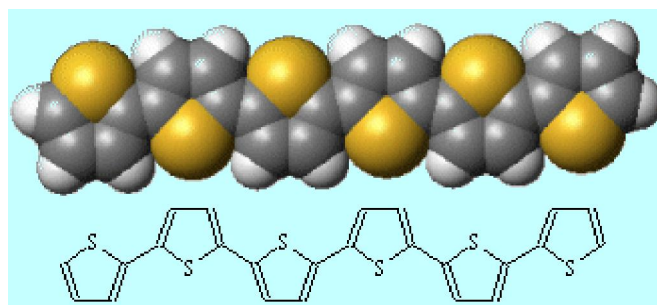


57. *Write chemical formulae which are spelt like English words. What words are these?* [ibid]

Hydrogen iodide, hydrogen astatide, gallium phosphide, radium telluride, radium titanate, barium selenide, carbon tetra-astatide

58. Have a look at this molecule! It has 6 sub-units, which are thiophene rings in this case. Isn't this molecule 'sexy'? It is as its name is sexithiophene!

*Does its conjugated system of double bonds contribute to the property of this organic molecule to conduct electricity quite well?*



59. In the following square nine chemical terms are hidden. Some of them are in the singular form; the others are given in the plural form.

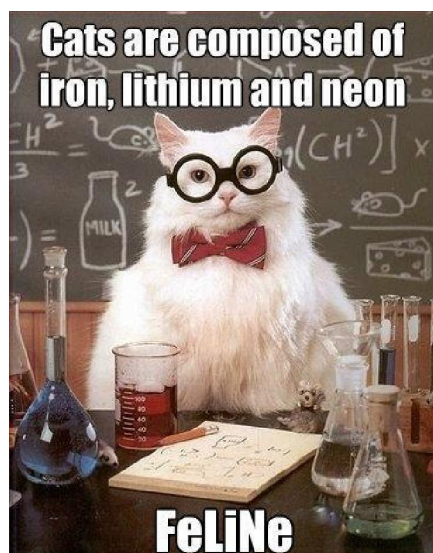
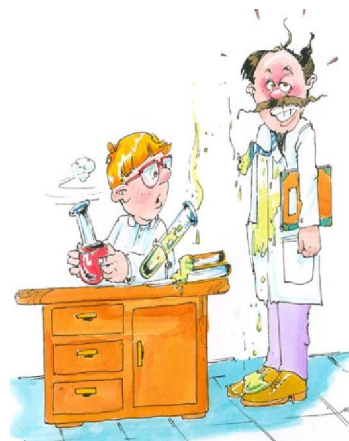
*Find these nine terms moving across, down or along the diagonal.*

M	S	A	T	O	M	S	R	S
M	O	H	C	O	M	P	O	T
R	E	L	Y	I	T	I	S	N
E	P	I	E	O	N	E	L	E
A	R	O	P	C	C	U	C	M
C	T	I	E	S	U	S	U	E
T	S	O	R	C	I	L	N	L
B	U	N	T	Y	E	N	E	E
S	T	A	N	C	E	C	E	S

*If you find all these words, it will be possible to compose one more word from the left unused letters.*

60. *In order to complete this funny poem you are to write the reactions first.*

Johnny, finding life a bore,  
 Drank some  $\text{H}_2\text{SO}_4$ .  
 Johnny's father, an MD,  
 Gave him  $\text{CaCO}_3$ .  
 Now he's neutralized, it's true,  
 But he's full of ....

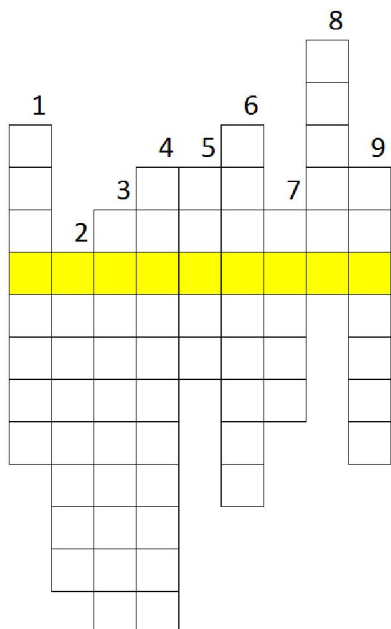


61. Can you prove that such chemical elements as iron, lithium and neon are found in cat's organism?

## PUZZLES

### Puzzle 1

*Solve this crossword answering the following questions*

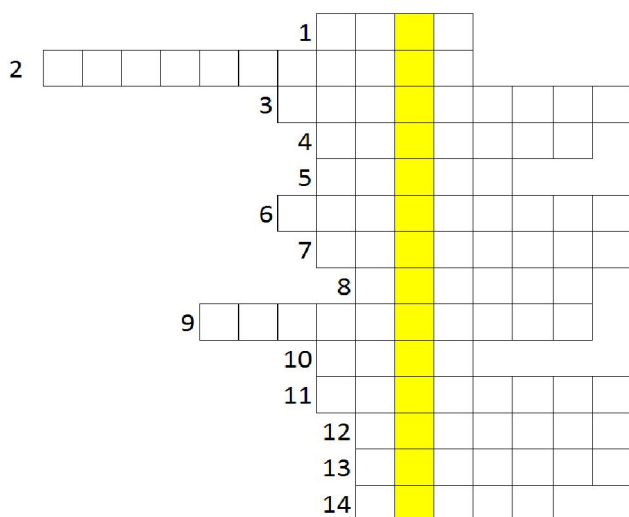


1. The transformation of one substance into another
2. The first element in the Periodic Table
3. Scientist who discovered the periodic law
4. The arrangement of various parts of which something is made up
5. An act of testing something
6. A material, type of matter
7. Chemically indivisible particles
8. The material that makes up the world and everything in space and can be seen or touched
9. Science which is closely related to chemistry

*If the puzzle is solved correctly, one more word will appear in the middle of the puzzle.*

### Puzzle 2

*Do you know all of the following definitions? Then complete this crossword.*



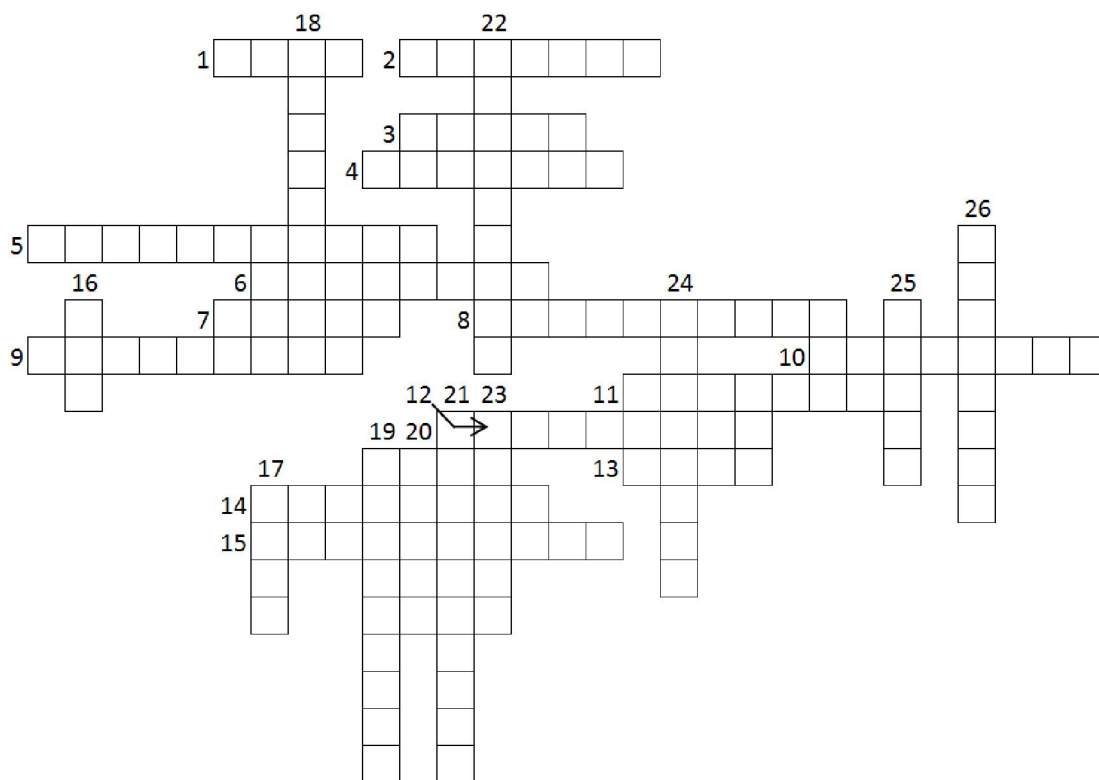
1. A series of very closely spaced, nearly continuous molecular orbitals that belong to the crystal as a whole
2. A device used to measure the heat transfer between a system and its surroundings
3. Poor electric and heat conductor
4. Electrode at which reduction occurs in a cathode ray tube, the negative electrode
5. A piece of volumetric glassware, usually graduated in 0.1-ml

intervals that is used to deliver solutions to be used in titrations in quantitative (drop wise) manner

6. A commercial term used to describe ethanol that is not useful for human consumption because of the addition of harmful ingredients
7. A group of atoms bonded together, representing the smallest fundamental unit of a chemical compound that can take part in a chemical reaction
8. A Lewis base in a coordination compound
9. The process of burning
10. A class of silicate and aluminosilicate minerals with sheet-like structures that have enormous surface areas that can absorb large amounts of water
11. A substance that alters (usually increases) the rate at which a chemical reaction occurs
12. A molecule in which a concentration of positive electric charge is separated from a concentration of negative charge
13. A heterogeneous mixture in which solute-like particles do not settle out
14. A negatively charged ion

***If the puzzle is solved correctly you will find the name of the reaction of an acid with a base to form a salt and water.***

### **Puzzle 3**



**Across:**

1. The class of chemical compounds which contain atoms of hydrogen in the structure
2. The 'science' of ancient time
3. The one of characteristic properties of substance
4. The set of systems with an identical serial number
5. Qualitative or quantitative characteristic of system components
6. The amount or number of a material
7. Pier and Mary who were the first researchers of radioactivity
8. The scientist who carried out the first nuclear reaction
9. The scientist who laid the bases of organic chemistry
10. Qualitative or quantitative characteristic of a subject or a phenomenon
11. Complex or simple substances used in human household
12. What were the early developments?
13. The smallest neutral particle of a chemical element
14. Correct in all details; exact
15. An exothermal reaction

**Down:**

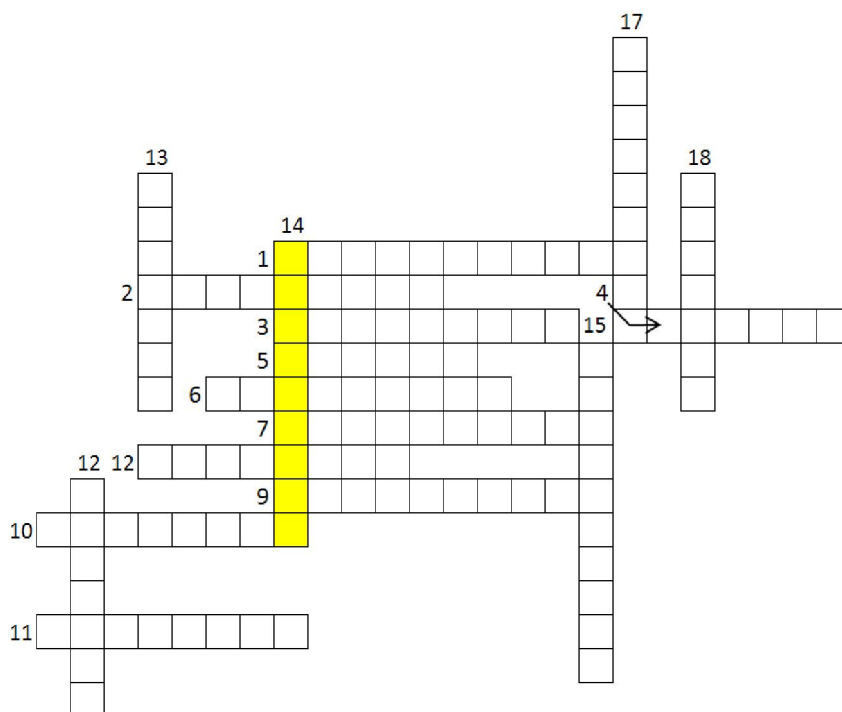
16. The phase of matter at which its particles chaotically move filling the volume
17. A substance with particular chemical properties including turning litmus red, neutralizing alkalis, and dissolving some metals
18. The way matter is arranged
19. The synonym of matter
20. Medical remedies
21. The ability to return to its original shape, size, and condition after it has been stretched
22. The science that deals with the composition and properties of substances as well as with reactions by which substances are produced from or converted into other substances
23. Physical substance in general
24. The process of interaction
25. The form of spatial existence of substance in microcosm
26. The smallest fundamental unit of a chemical compound

**Puzzle 4****Across:**

1. What shows the ratio of the structure parts?
2. The formation of a compound from simpler substances
3. What is the method based on trial and errors?



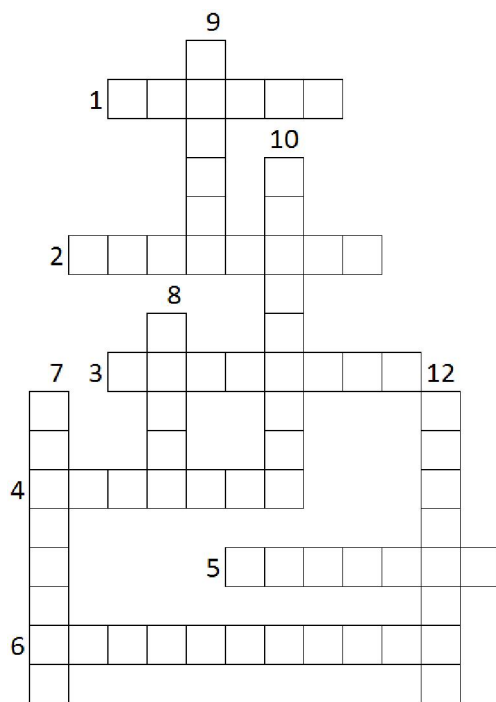
4. What is the building block of matter?
5. What has mass and occupies space?
6. A fundamental truth or proposition
7. What method is based on the theory of matter?
8. What process changes the composition and the structure of atomic systems?
9. What is the arrangement of molecules and atoms?
10. What is the characteristic of matter?
11. What is the process breaking down a compound into simpler substances?



**Down:**

12. What is the branch of chemistry concerned with carbon compounds?
13. What science is closely related with chemistry?
14. This word will appear if you solve everything correctly.
15. Something done wrongly
16. Who wanted to change base metals into gold and thus to prolong life?
17. Synonym of the term “material”
18. What is some general idea?

## Puzzle 5



1. A part of science
2. Much more than big
3. Characteristic
4. To do something better
5. To do something longer
6. Very important
7. All space and the matter around us
8. Mistake
9. Something that occupies space and has mass
10. All what we know
11. If something has its own place, it ... this place.
12. All people on the Earth

## Puzzle 6

a	c	h	e	n	o	c	c	u	p	y	p	o	r
b	e	i	e	j	e	g	d	p	a	u	e	e	p
d	h	a	v	o	w	l	e	i	r	n	r	t	e
e	a	v	e	y	o	n	n	d	r	i	q	y	d
v	e	i	o	u	r	k	o	a	p	p	u	e	u
d	l	o	p	c	c	o	i	t	a	l	n	c	l
i	f	f	m	e	n	n	t	a	c	i	i	t	y
r	o	i	c	n	o	d	r	i	b	u	t	e	l
p	v	e	u	t	i	e	f	e	n	t	i	a	l
m	i	t	l	p	t	i	i	s	g	o	a	l	e
n	c	i	e	n	t	s	n	s	e	p	e	r	r
a	i	c	o	m	p	o	i	t	i	o	n	r	o

*To solve this puzzle you are to do the following steps.*

*Translate the following words into English:*

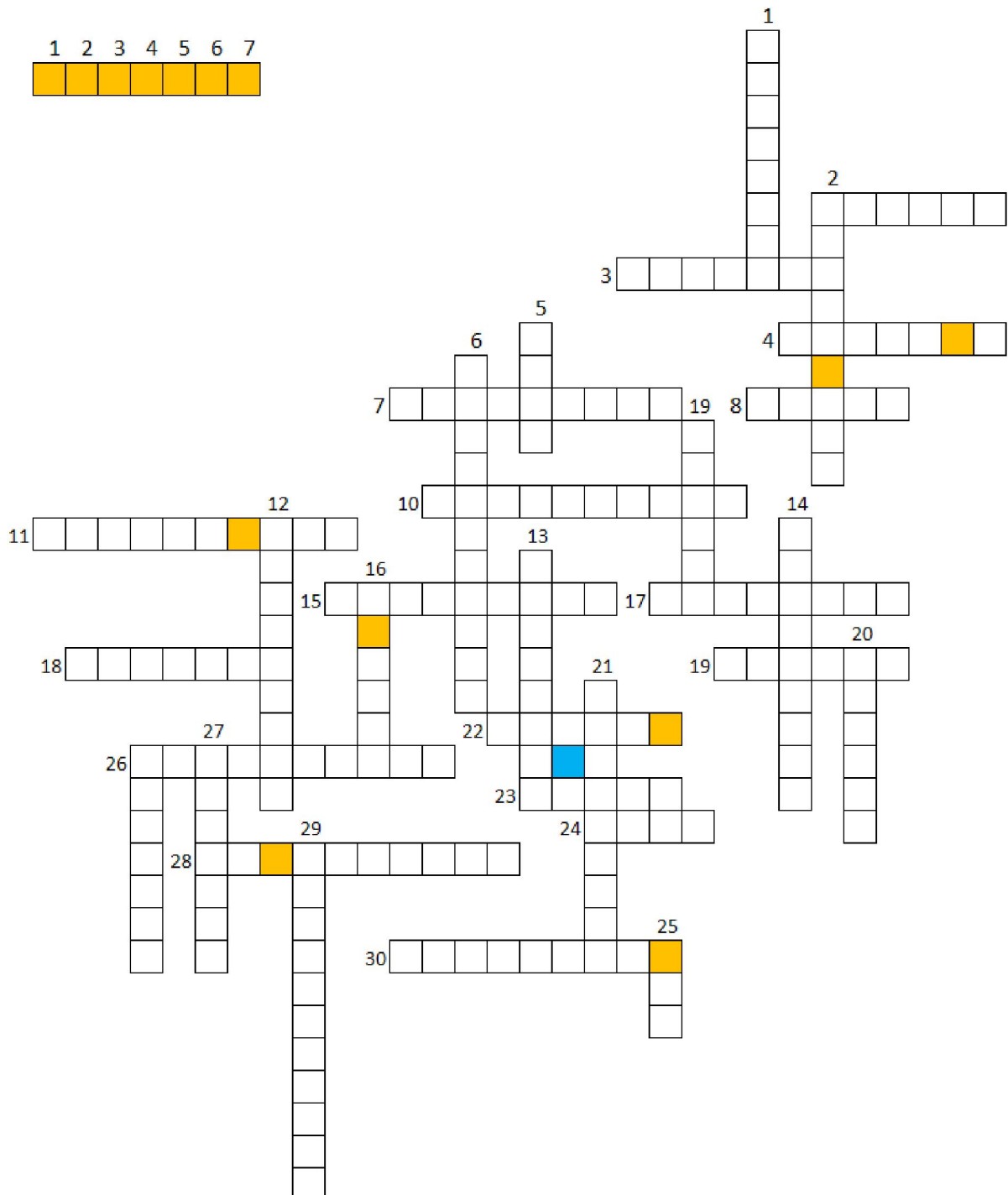
Быстрый, включать, вносить вклад, достигать, древний, занимать, знания, наслаждаться, определение, ошибка, поведение, применение,

развитие, свойство, состав, существенно, трудный, улучшать, уникальный, цель

*Then you are to find these words in the following square. Remember that the words can be broken only in horizontal or vertical directions.*

*If all the words are found correctly, 10 unused letters will appear. Use all the found letters to compose one word.*

### Puzzle 7



**Across:**

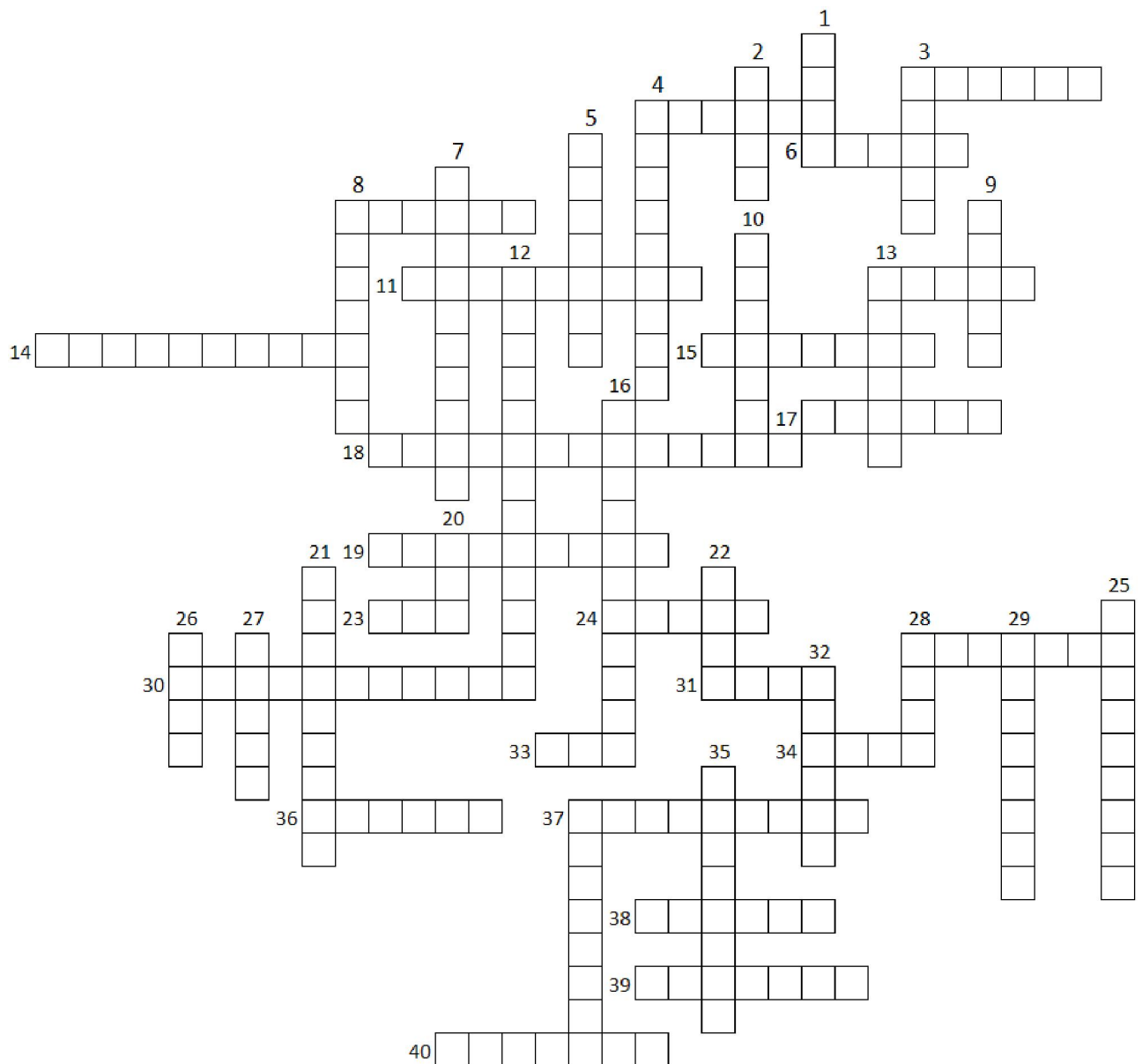
1. Element being a basic of organic chemistry
2. The special kind of human activity directed on finding and proving knowledge of the world around
3. Branch of science studying all alive
7. The data, the information
8. Links between the parts of structure
10. Ancient civilizations ... to the development of chemistry.
11. The unproved statement, the assumption or a guess
15. The form of matter which has weight
17. Attribute on which substances differ from each other or are similar
18. The section of chemistry
19. Process of increasing of any quality in due course
22. The detached part of science
24. Desirable result of activity
26. Scientifically performed experience, observation of investigated phenomena
28. Method of new knowledge obtaining on the base of physical proofs
30. Method of new knowledge obtaining achieved by trial and error

**Down:**

1. Transformation of some substances into others
2. Science about substances, their properties and transformations which studies phenomena accompanying these transformations
5. Metal which alchemists wanted to receive
6. Description of quality, amount and other characteristics of the given substance
9. The form of existence of substance or energy
12. The internal device of a substance
13. All forms of matter in space and time
14. All events occurring in nature (Pl)
16. Very special, exclusive
20. Briefly formulated assumption
21. The branch of chemistry studying chemical elements and their compounds
23. Mistake
25. Rules according to which phenomena in nature occur
27. Science about nature
29. Position at which chemical reaction proceeds in the same degree as well as return reaction. The result of it is no change in the quality of each component.

***From the 7 letters in the coloured squares you are to compose a word.  
What word is it?***

## Puzzle 8



### **Across:**

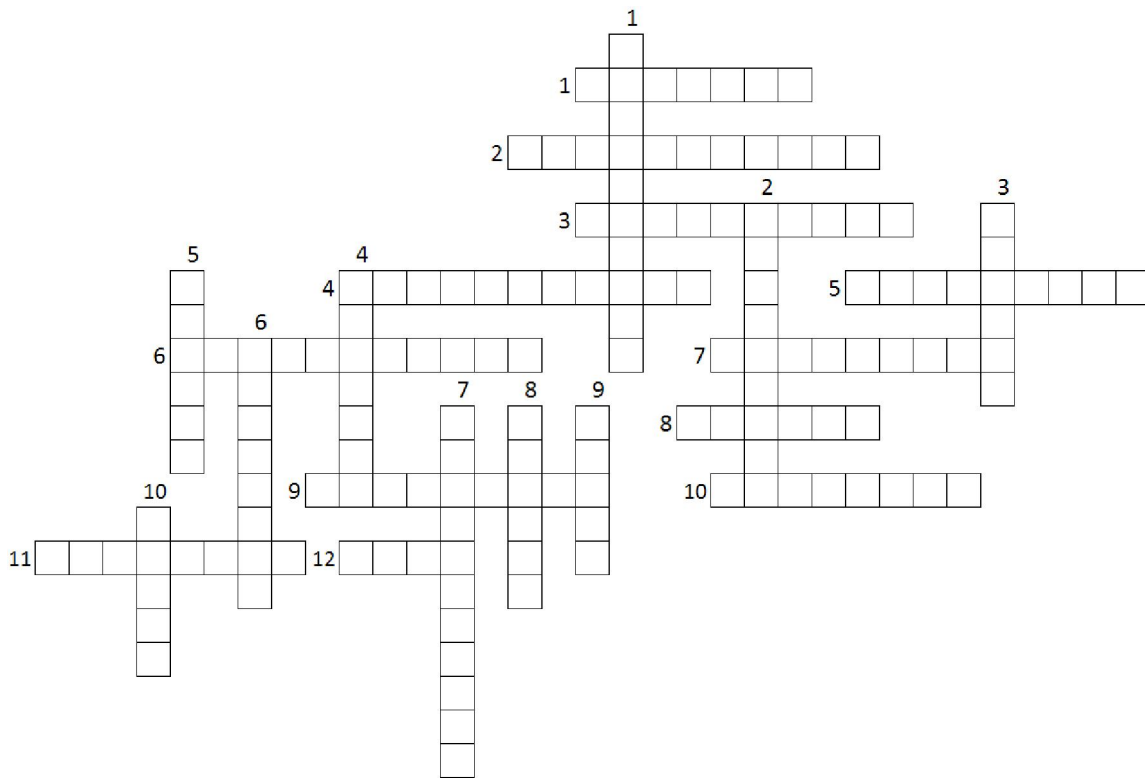
1. Composed of one part
2. Particles of moisture or other substance suspended in air and visible as clouds, smoke, etc.
6. Of special note or significance
8. Belonging to or shared by members of one or more nations or communities; public
11. A particular state of being or existence
13. The structure or form of something
14. Incapable of occurring or happening
15. 'Face' of an object
17. Obvious, evident or noticeable

18. For one thing only
19. Not easy to do; requiring effort
23. Recently made or brought into being
24. To place or spread something over so as to protect or conceal
28. In an exact manner; accurately or precisely
30. The act of combining or adding parts to make a unified whole
31. Therefore
33. Having lived or existed for a relatively long time
34. Multitude
36. Not typical
37. In a precise manner
38. Any steady flow of water or other liquid
39. In the ordinary course of events
40. Showing or characterized by mercy or tolerance

**Down:**

1. To destroy or be destroyed by fire
2. To make or become cooler
3. The gas or vapour into which water is changed when boiled
4. A place from which something can be viewed
5. One of four equal or nearly equal parts of an object, quantity
7. The state of being important; significance
8. Present
9. Any body or area of this liquid, such as a sea, lake, river, etc.
10. Being so through innate qualities
12. The state brought about by this process
13. Free from danger, damage, etc.
16. Made up of intricate parts or aspects that are difficult to understand or analyse
20. A small number of; hardly any
21. Causing danger; perilous
22. The energy transferred as a result of a difference in temperature
25. Proposition having the truth value that is not determined
26. Expresses similarity
27. Demanding that rules concerning behaviour are obeyed and observed
28. Not requiring much labour or effort
29. In a coarse or vulgar way
32. Substance or material consisting of only one chemical compound rather than a mixture of compounds
35. Accurate, scrupulous
37. Having potential or capabilities for favourable use or development

## Puzzle 9



### **Across:**

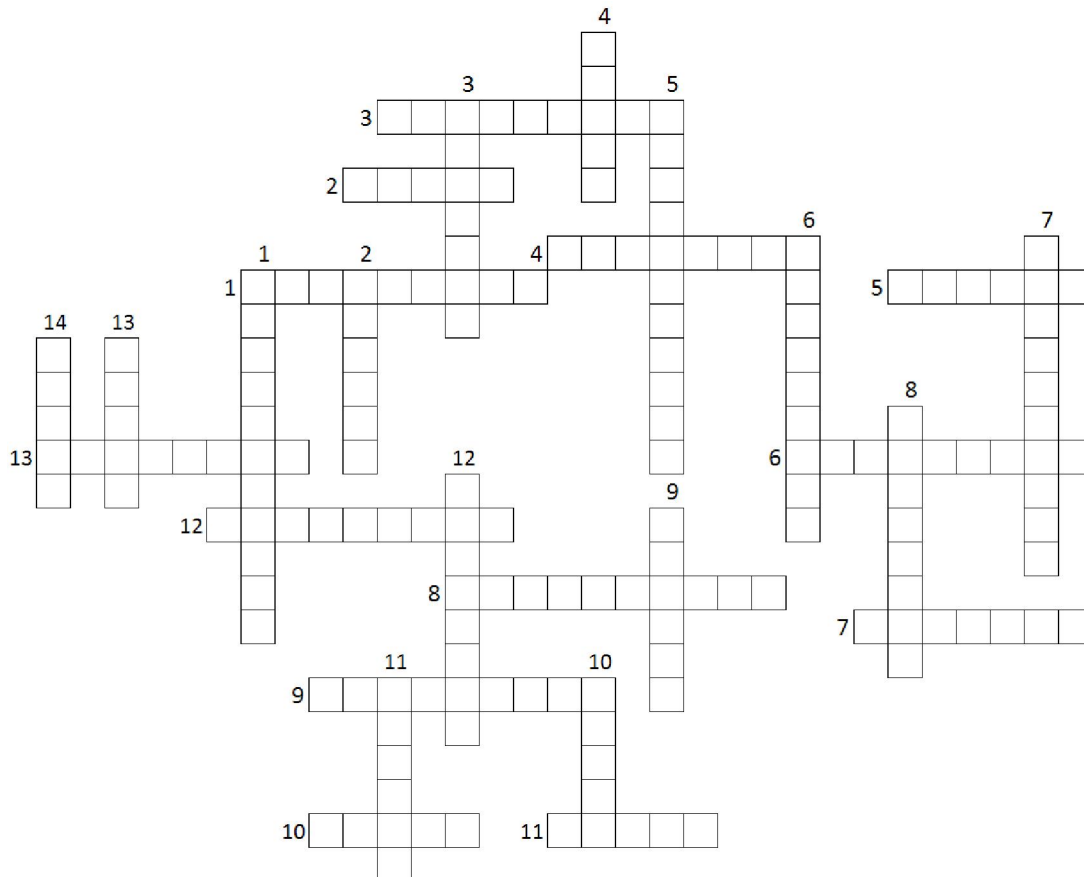
1. Elementary fundamental definition of something
2. It shows what something consists of
3. ... of the word should be here
4. Practical use of something
5. Content of anything which has mass
6. Somebody's success as a result of long and hard work
7. Information about something
8. Substance dangerous for somebody's health or life
9. The way of somebody's action
10. System which consists of all the existing objects and fields as well as space which they are situated in
11. Unique feature associated with exact object
12. Aim

### **Down:**

1. Complicated things have got it
2. Principally new artificial thing that has not existed before
3. Anything which can influence substance
4. Moving forward
5. Large and complicated part of something (a tree has a lot of them!)
6. Mankind

7. Progressive change of something which makes something more complicated
8. Increasing in size
9. Mistake
10. Place which is not limited by something valuable

### **Puzzle 10**



#### **Across:**

1. The science studying substances which make up the Earth, the universe and living things
2. A figure showing the number of times one quantity contains another
3. Nonliving objects
4. It generally means the reaction of taking something apart in order to study it.
5. It is a volume of space that is empty of matter, including air, so that gaseous pressure is much less than standard atmospheric pressure.
6. Any academic conference to discuss a particular subject
7. The central and most important part of an atom



8. A fact or situation that is observed to exist or happen, especially one whose cause or explanation is in question
9. A particular kind of matter with uniform properties
10. A special point use in describing conic sections
11. An act of testing something
12. Arrangement of atoms within a molecule (usually linked by covalent bonds)
13. All space and the matter around us

**Down:**

1. The proportion and combination of certain elements forming substance
2. The material that makes up the world and everything in space and can be seen or touched
3. Living animals and plants
4. Something that surrounds all objects and continues in all directions
5. State in which a chemical reaction proceeds at the same rate as its reverse reaction
6. The process of forming a particular molecule from chemical precursors
7. The subjects comprising a course of study in a school or college
8. The range of different colours
9. A dissertation
10. A mistake
11. A division of science
12. Material's behavior under ambient conditions
13. Underlying support or foundation for an idea, argument, or process
14. A piece of information

**Puzzle 11**

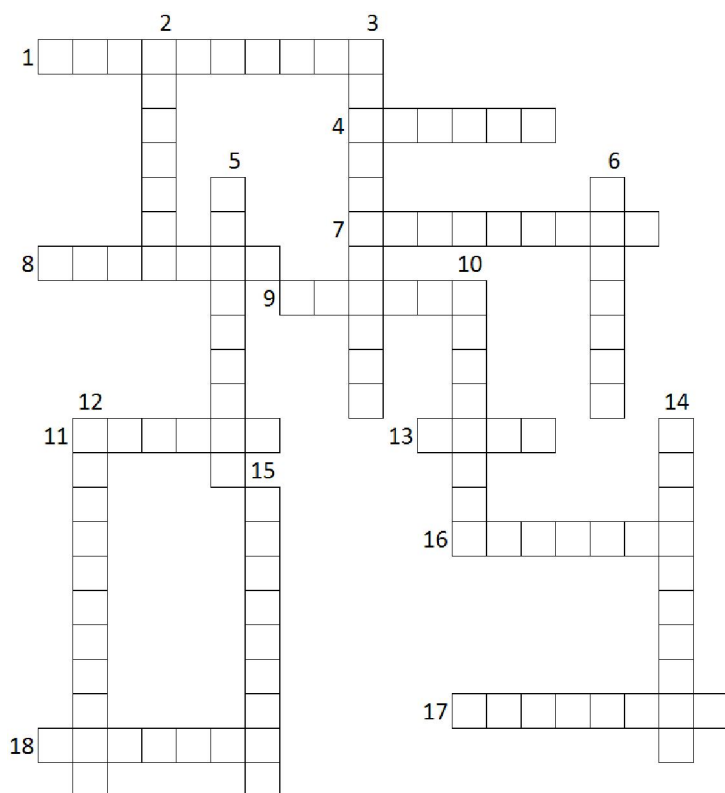
1. and 4. What do you call systematic experimentation?
2. A set of atoms with an identical charge of a nucleus
3. The nature of something's constituents; the way in which a whole or mixture is made up
5. The element named after one of the West-European countries
6. The element named after the planet in the solar system
7. The way the matter is arranged
8. Two or more substances combined together
9. What is defined as anything that has mass and occupies space?

10. A chemical process in which substances act mutually on each other and are changed into different substances, or one substance changes into other substances

11. The lightest gas

12. This metal is a liquid under normal conditions

13. The least part of a chemical element being the carrier of its properties



14. The element of the third period with five outer electrons

15. This is the science of substances and their transformations

16. The part of an atom where its main mass focuses

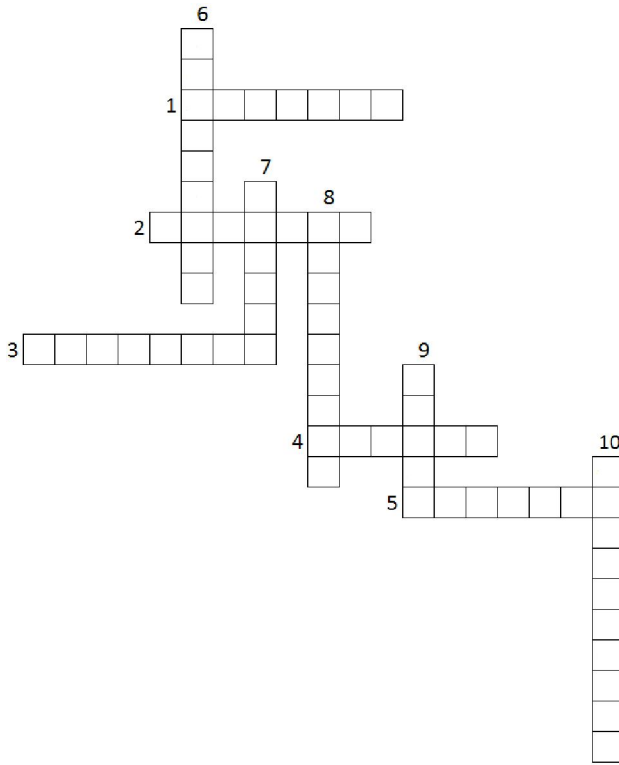
17. The element named after the Earth's natural satellite

18. The element whose atomic nucleus contains 16 protons

## **Puzzle 12**

### **Across:**

1. The total weight of this element in our body is above 20 kilograms.
2. The branch of chemistry dealing with compounds that include carbon
3. If we want to get ethane from ethene we must use this reagent.
4. The process of burning can't be realized without the molecules of this element.
5. One of the most reactive particles



**Down:**

- 6. The scientist who first discovered the phenomenon of radioactivity
- 7. The scientist who created atomic theory
- 8. Substance slowing down a chemical reaction
- 9. The improver of taste mainly containing sucrose
- 10. What helps metals to produce current?

**REBUSES**

*Now some rather original brain-teasers designed especially for you by one of the students of the fourth course from our university.*

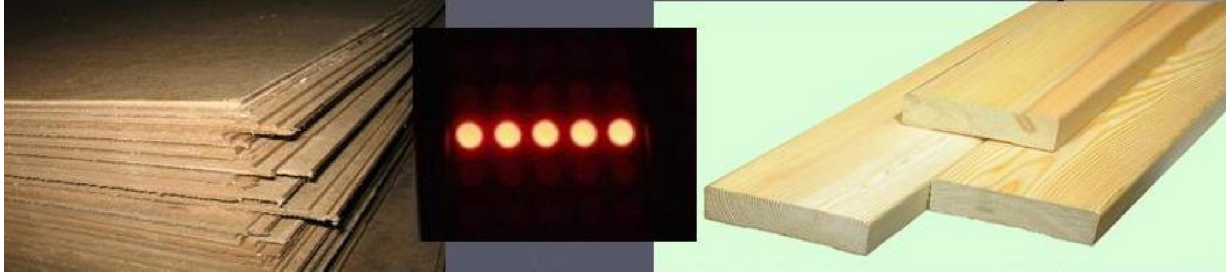
*Guess which words are hidden in these rebuses.*

To solve rebuses is not so easy. That is why there are some tips for you to simplify the problem. Every rebus is supplied with the quotation of an outstanding person that contains either the word itself or its synonym. Take your chance!

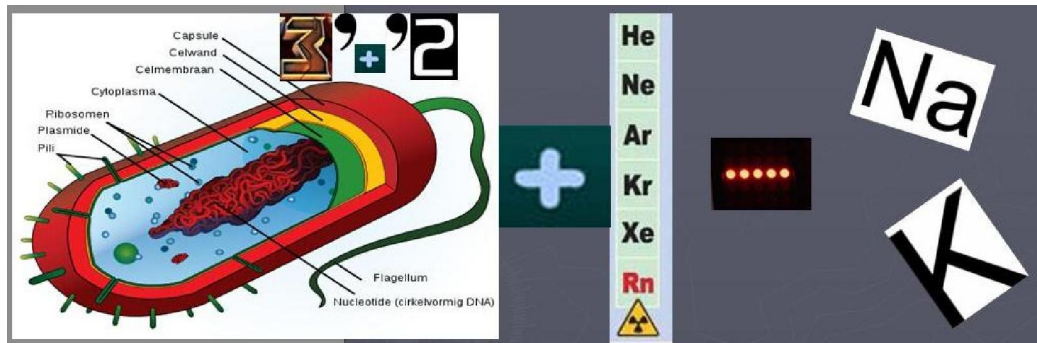
**Tip 1.** A French philosopher and writer Rene Descartes (1596 – 1650) once said: *I think, therefore I exist*. A well known Latin saying is: *Cogito, ergo sum*.



**Tip 2.** The 34<sup>th</sup> President of the United States Dwight Eisenhower (1890 – 1969) once mentioned: *The spirit of man is more important than mere physical strength and the spiritual fiber of a nation more than its wealth.*



**Tip 3.** An American figure skater Sasha Cohen (born in 1984) explained in an interview: *I eat a variety of foods like vegetables, fruit and beef for protein and iron.*



**Tip 4.** *Each problem that I solved became a rule, which served afterwards to solve other problems.* (Descartes)



**Tip 5.** An English physicist Henry Moseley (1887 – 1915) wrote in one of his letters: *There is here a whole new branch of spectroscopy, which is sure to tell one much about the nature of an atom.*

Dif + 1/96 of zolotnik ~ 44,435 mg

**Tip 6.** An American actor and writer Stephen Wright (born in 1955) noted: *If you're not part of the solution, then you're part of the precipitate.*



**Tip 7.** An English novelist and essayist E. M. Forster (1879-1970) has such a thought: *Faith, to my mind, is a stiffening process, a sort of mental starch.*



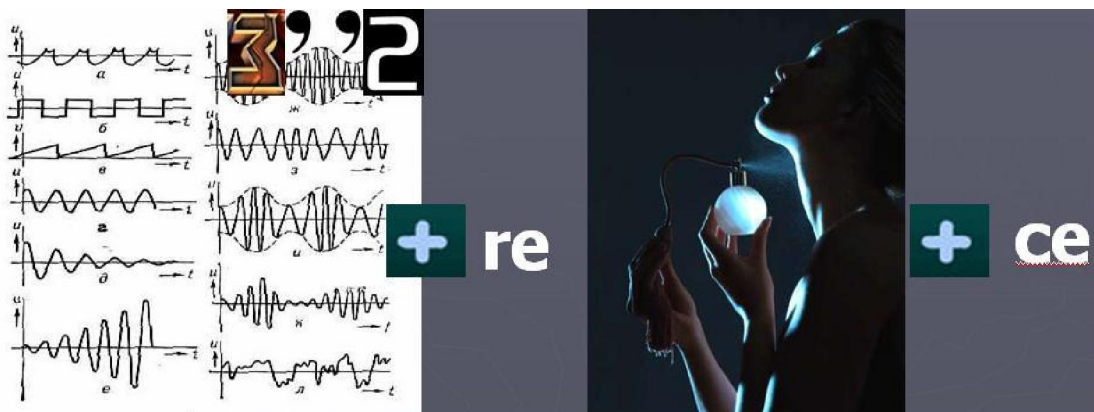
**Tip 8.** An English military and political leader Oliver Cromwell (1599 – 1658) said: *Put your trust in God; but be sure to keep your powder dry.*



**Tip 9.** Here are the words of a former Major League Baseball third baseman Wade Boggs (born in 1958): *A positive attitude causes a chain reaction of positive thoughts, events and outcomes. It is a catalyst and it sparks extraordinary results.*



**Tip 10.** Some thoughts from the private correspondence of an American inventor, scientist, and businessman Thomas Alva Edison (1847 – 1931). He wrote: *I have a peculiar theory about radium, and I believe it is the correct one. I believe that there is some mysterious ray pervading the universe that is fluorescing to it. In other words, that all its energy is not self-constructed but that there is a mysterious something in the atmosphere that scientists have not found that is drawing out those infinitesimal atoms and distributing them forcefully and indestructibly.*



If you still experience difficulty in solving the rebuses read through the definitions of the hidden words first.

**Tip 11.** It is a heterocyclic compound having a metal ion attached by coordinate bonds to at least two nonmetal ions.



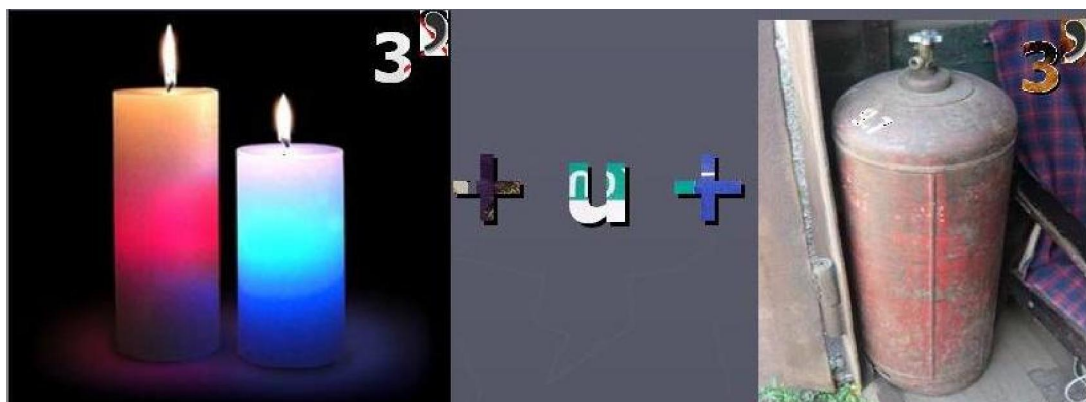
**Tip 12.** And now some ideas from William Arthur Ward (1921–1994), who is one of America’s most quoted writers of inspirational maxims: *Wise are they who have learned these truths: Trouble is temporary. Time is tonic. Tribulation is a test tube.*



**Tip 13.** A German chemist Justus Liebig (1803 – 1873) wrote in *Familiar Letters on Chemistry*: *By its means, and with the aid of India rubber, we connect our vessels and tubes of glass, and construct the most complicated apparatus.*



**Tip 14.** It is a colorless liquid hydrocarbon present in coal tar and petroleum and used as a solvent and in organic synthesis. It is also known as *methylbenzene*, its chemical formula being  $C_6H_5CH_3$ .

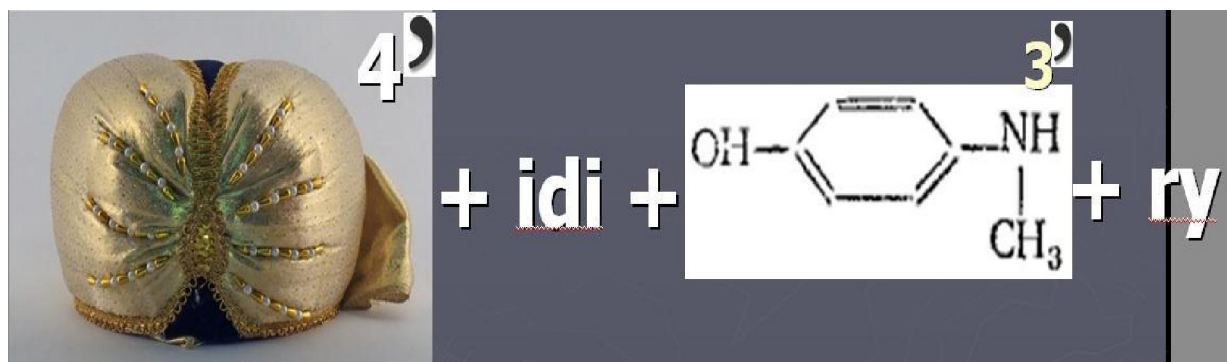


**Tip 15.** It is a salt in which the anion contains both silicon and oxygen, especially one of the anion  $SiO_4^{2-}$ . Moreover, it is any of the many minerals consisting of silica combined with metal oxides, forming a major component of the rocks of the earth's crust.





**Tip 16.** Chemical analysis based on the phenomenon whereby light, passing through a medium with dispersed particles of a different refractive index from that of the medium, is attenuated in intensity by scattering. With the help of this method the intensity of light transmitted through the medium, the unscattered light, is measured. While in nephelometry, the intensity of the scattered light is measured, usually, but not necessarily, at right angles to the incident light beam.



Have a look at the *Diamond poems* composed by some mastership students of our university who tried to connect the two important disciplines such as chemistry and English.

***Can you guess why these are diamond poems?  
Do you realize what principles are used in these poetizing?  
Do you agree with their view?***

Chemistry  
Enigmatic. Mysterious.  
Amazing. Surprising. Interesting.  
Subject. Matter. Knowledge. Language. Culture.  
Exciting. Discovering. Improving.  
Incredible. Fabulous.  
English.

Chemistry.  
Essential. Interesting.  
Learning. Planning. Living.  
Science. Future. Hobby. People. Dialogue.  
Reading. Comparing. Remembering.  
Absorbing. Useful.  
English.

Chemistry.  
 Enormous and rapid.  
 Observing, inventing, improving.  
 Phenomena, goal, variety, poem and rabbit.  
 Creating, and whistling, and moving.  
 Oh, wonderful, wonderful  
 English!

***Analyse and interpret these poetic forms.***

***If possible, create your own diamond poem using the following structure:***

The first line (line 1) is the name of the first noun (Subject 1).

The second line (line 2) contains two adjectives describing the first subject.

The third line (line 3) contains three participles ending in –ing-suffix giving additional descriptions of the first subject.

The fourth line (line 4) contains five nouns. The first two words relate to Subject 1, the last two words relate to Subject 2. The noun in the middle describes both subjects.

The fifth line (line 5) contains three participles ending in –ing-suffix giving additional descriptions of the second subject.

The sixth line (line 6) contains two adjectives describing the second subject.

The seventh line (line 7) contains the name of the second subject (Subject 2).



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## Keys to the tests

### UNIT 1

#### **Quiz 1**

1a) 2c) 3a) 4b) 5b) 6c)

#### **Quiz 2**

1a) 2b) 3a) 4a) 5c) 6b)

#### **Quiz 3**

1b) 2a) 3c) 4b) 5c) 6c)

#### **Quiz 4**

1b) 2c) 3b) 4b) 5a) 6b)

#### **Quiz 5**

1b) 2c) 3b) 4b) 5a) 6c) 7c)

#### **Quiz 6**

1b) 2a) 3c) 4b) 5a) 6c) 7a)

#### **Quiz 7**

1b) 2a) 3b) 4c) 5c) 6c) 7c)

### UNIT 2

#### **Quiz 1**

1a) 2a) 3b) 4a) 5a) 6a) 7b) 8a)

#### **Quiz 2**

1a) 2b) 3a) 4c) 5a) 6b) 7c) 8b)

#### **Quiz 3**

1a) 2b) 3b) 4c) 5a) 6a) 7b)

#### **Quiz 4**

1c) 2a) 3b) 4a) 5b) 6c) 7b)

#### **Quiz 5**

1c) 2b) 3a) 4b) 5a) 6b) 7c) 8a)

**Quiz 6**

1c) 2a) 3c) 4a) 5a) 6b) 7a) 8a)

**Quiz 7**

1b) 2a) 3c) 4b) 5a) 6b) 7a) 8b)

**Quiz 8**

1b) 2a) 3b) 4a) 5a) 6c) 7a)

**Quiz 9**

1a) 2b) 3a) 4b) 5c) 6c) 7b)

**Quiz 10**

1b) 2b) 3c) 4a) 5c) 6b) 7c) 8b)

**UNIT 3****Quiz 1**

1c) 2a) 3b) 4c) 5a) 6b) 7b) 8c) 9c)

**Quiz 2**

1c) 2c) 3c) 4c) 5a) 6a) 7b) 8b)

**Quiz 3**

1b) 2c) 3b) 4b) 5a) 6b) 7c) 8a)

**Quiz 4**

1a) 2a) 3c) 4b) 5b) 6b) 7a) 8a)

**Quiz 5**

1c) 2a) 3a) 4a) 5a) 6c) 7b) 8a)

**Quiz 6**

1a) 2c) 3b) 4a) 5b) 6b) 7a) 8b)

**Quiz 7**

1c) 2b) 3a) 4a) 5a) 6b) 7c) 8a)

**Quiz 8**

1a) 2a) 3a) 4b) 5a) 6a) 7b) 8c)

**Quiz 9**

1a) 2b) 3b) 4b) 5a) 6b) 7a) 8a)

**Quiz 10**

1c) 2b) 3a) 4b) 5a) 7a) 8a)

**UNIT 5 (3<sup>rd</sup>-4<sup>th</sup> YEARS)****Test 1**

1b) 2a) 3c) 4c) 5b) 6c) 7b) 8b) 9c) 10c)

**Test 2**

4a) 7b) 9b)

**Test 3**

1a) 2a) 3a) 4b) 5a) 6b) 7b) 8a) 9c) 10c)

**Test 4**

1b) 2a) 3c) 4a) 5c) 6b) 7c) 8b) 9b) 10c)

**Test 5**

1b) 2c) 3b) 4c) 5a) 6c) 7b) 8c) 9a) 10c)

**Test 6**

1a) 2b) 3c) 4a) 5c) 6c) 7c) 8b) 9a) 10c)

**Test 7**

1b) 2c) 3a) 4b) 5c) 6c) 7a) 8c) 9c) 10b)

**Test 8**

1b) 2b) 3b) 4b) 5b) 6a) 7c) 8b) 9a) 10b)

**Test 9**

1c) 2c) 3c) 5b) 7b) 8a) 9b)

**FINAL TEST ON NAMING THE ELEMENTS AND COMPOUNDS**

2. Name the compounds formed when these elements combine.

*potassium oxide*

*aluminum chloride*

*sodium iodide*

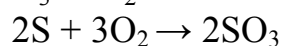
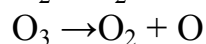
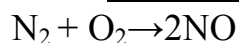
*magnesium bromide*

3. Write the chemical formula for each of these.

$N_2O$



5. Write balanced chemical equations to represent these reactions.



6. Write the formulas of the ionic compounds that will form from each pair of elements. Name each compound.

a)  $CaBr_2$ , calcium bromide

b)  $KF$  — potassium fluoride

c)  $Li_2O$ , lithium oxide

d)  $SrBr_2$ , strontium bromide

7. Write the formula and give the name of the ionic compound formed by the reaction of each pair of elements.

a)  $Na_2S$

sodium sulfide

b)  $Al_2O_3$

aluminum

oxide

c)  $GaF_3$

gallium

fluoride

d)  $RbI$

rubidium

iodide

e)  $Ba_3Se_2$

barium

selenide

8. Give the name of each compound.

a) potassium

acetate

b) calcium

hypochlorite

c) lithium

hydroxide

d) sodium

sulfate



Учебное издание

Милеева Марина Николаевна

## CHEMISTRY IN QUESTIONS AND TESTS

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